
Empirical Analysis of 2011 Alberta and Mid-West Crude Oil Price Differential

MA Major Paper Final

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Abstract

In late 2011, spot prices for the Alberta bench mark heavy crude oil, Western Canadian Select, other exported Alberta crudes as well as Mid-Western United States crudes such as West Texas Intermediate, began to trade at large discounts relative to the global market for crude, the so-called 'Bitumen Bubble'. It has been widely argued that since 2008, new shale-oil extraction techniques have sparked a massive increase in supply in these crudes, while infrastructural capacities of pipeline and refining have failed to keep pace. This paper aims to provide evidence for the hypothesis that the discount is being driven by infrastructural constraints. Following previous empirical studies, a series of cointegration tests is performed under the assumption that crude-prices are globally integrated and have stationary differentials. The constrained oils should therefore exhibit a break from the stationary differentials and unit roots with respect to unconstrained sea-traded crudes. The study finds that price discounts may indeed be driven by infrastructural constraints, caused by a supply glut for the transportation of Canadian and Mid-Western (land sourced) crudes. Relative to sea-sourced crudes, the crudes that converge at Cushing experience a deep discount beginning in late 2011.

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1. Introduction

In late 2011, the spot prices for Alberta based US-exported crude oil, as well as for Mid-Western United States sourced oil such as West Texas Intermediate, started to face large discounts relative to the global market for crude, the so-called ‘Bitumen Bubble’. The discount sparked a large media debate over the root causes of the discrepancy as well as the overall economic impact of the loss of revenues. It has been widely argued that since 2008, new shale-oil extraction techniques have sparked a massive increase in supply, while infrastructural capacities of pipeline and refining have failed to keep pace. The result of the discount on crude prices has been a drop in the overall economy for Alberta and Saskatchewan. While this result lends itself to the argument for increased pipeline infrastructure, most notably the Keystone XL expansion, it is important to understand whether this drop in prices has been a result of infrastructural constraints rather than some other exogenous factor relating to the Canadian market for crude.

This paper examines the assumption that the spread on Canadian and Mid-Western oil prices is in fact due to infrastructural constraints creating excess supply and driving down prices. Previous literature points to a market for crude oil that is global, with much price arbitrage leading to highly integrated prices among different crudes. The regional discount on Alberta and Mid-Western crudes thus does not follow this theory. This paper tests the globalized oil hypothesis on various crudes subject to the price discount. Section 2 introduces the literature about the root causes of oil-price differentials and discusses the natural benchmark prices at which the various crudes have historically traded. Section 3 presents various theoretical models that could account for drop in oil prices as a result of infrastructural constraints. Section 4 analyzes crude oil spot price data through various tests for cointegration to determine whether Canadian crude has been subjected to infrastructural constraints. Finally section 5 discusses the economic implications of the price discount.

The study finds that price discounts may indeed be driven by infrastructural constraints, caused by a supply glut for the transportation of Canadian and Mid-Western (land-sourced) crudes. Relative to sea-sourced crudes, the crudes that converge at Cushing experience a deep discount beginning in late 2011.

2. Crude Price Differentials

2.1 Primer on Crude Oil Price Differentials

The market for crude oil is the most liquid commodity market globally, and as such the market for crude is highly open to arbitrage (CME group, 2013). Due to arbitrage conditions, empirical studies have noted that crude prices of similar qualities tend to move closely together in short time horizons (Gülen, 1997; 1999; Kleit, 2001) leading to the conclusion that the world market for oil is ‘unified.’

Specific characteristics of various crudes do however create persistent price differentials. Bacon and Tordo (2005) point to quality and transportation costs as the main causes for price differentials. High quality crudes are cheaper to refine while low quality crudes (require specialized refineries) cost significantly more. Pipeline and tanker transport of low quality crude also cost more and given refineries and transport companies are the main purchasers of crude oil, low quality crude is traded at a discount.

Oil quality is categorized by The American Petroleum Institute (API) gravity index, sulfur content (sweetness) and total acidic number (TAN) (see figure 2.1)

Figure 2.1 Crude characteristics

API Gravity	A measure of how heavy or light a crude is relative to water. The lighter the oil the higher its quality as it is cheaper to refine and transport. If the API number is higher than 10 it floats on water given it is lighter, if it is greater it sinks and is heavier, thus there is an inverse relation between API number and quality
Sulfur Content	Lower sulfur content (sweet) is higher quality than high sulfur content (sour) as it is cheaper to refine. The New York Mercantile Exchange NYMEX defines sweet oil as having a sulfur content of 0.42%, anything greater than that is considered sour.
TAN	Total Acidic Number measures the acidity of oil. The TAN value points to the potential corrosive nature of the crude on pipeline and refinery infrastructure. The measurement refers to the total amount of potassium hydroxide necessary to neutralize the crude. A higher TAN number is associated with lower quality crude.

The benchmark US oil, West Texas Intermediate is considered a light sweet crude, while the Alberta Oil Sands Benchmark is a heavy sour crude. Figure 2.2 outlines the qualities of the various crudes discussed in this paper.

Figure 2.2 Crude quality

Crude Oil	API	Sulfur content•
Brent International*	38.0°	0.37%
West Texas Intermediate*	39.6°	0.24%
Western Canada Select*	20.3°	3.43%
Maya**	21.8°	3.33%
Edmonton Par*	40°	0.5%

*Center for Energy: Alberta

**Vurup.sk

•TAN omitted given that API and Sulfur content drive the majority of the quality differentials.¹

As can be seen in the figure, there is considerable variability in the quality of crudes that are examined in the paper. There is as described by Bacon and Tordo a natural price discount for low quality crudes vs high quality crudes, thus while our primary concern will be to study the price changes of Mid-West sourced crudes as compared to Brent, we will also look at Maya oil, which is of similar quality to Western Canada Select, and sourced at the sea, to confirm that there is no additional quality discount driving the drop in prices during the glut.

2.2 InLand vs. Sea Sourced Crude

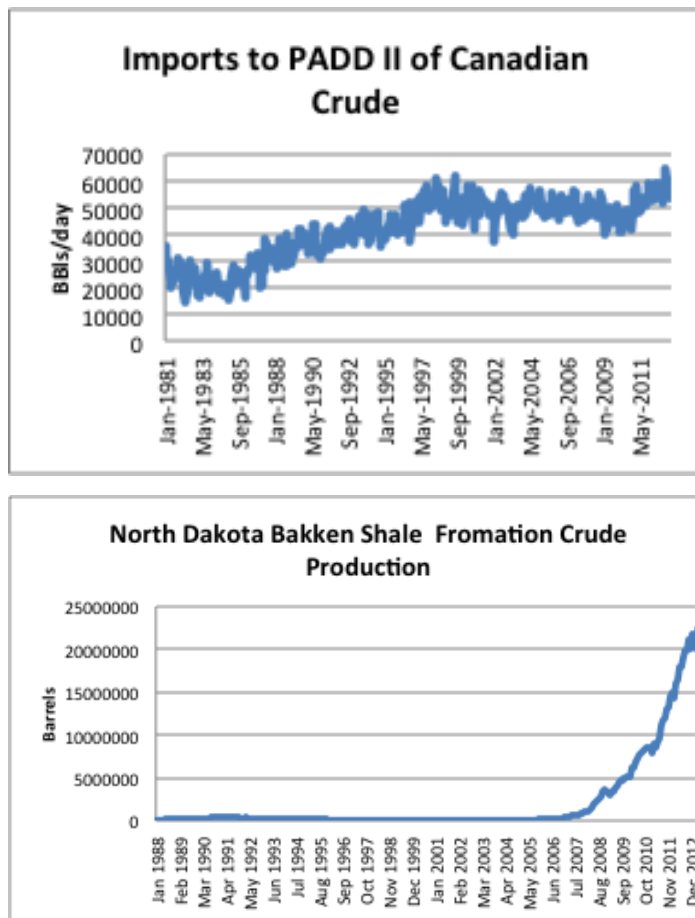
Before dissecting the root causes of the price differential between Western Canada Select (WCS) and West Texas Intermediate (WTI), it is important to understand the natural premiums at which various oils trade. The relatively high efficiency of sea transportation of crude oil has led most to assume the price of oil is determined by the global market; it follows thus that the price of crudes of similar quality are closely related due to the arbitrage condition (Borenstein & Kellogg, 2012). However, several important distinctions must be made between WCS and WTI relative to Brent Crude (Brent Crude - sourced at the North Sea and often used as the international standard) and other North American blends such as Light Louisiana Sweet (LLS) and the light crude Edmonton Par (EP). WCS, WTI, EP as well as other blends from Saskatchewan (we shall refer to these collectively as Western crudes) are priced at Cushing, Oklahoma. Many pipelines from Canada and the Northern States of the USA converge to Cushing (EIA, 2012) and until recently the price determined at Cushing has been

¹ As shown in the report by the U.S Energy Information Administration report (2012) ‘Crude oils have different quality characteristics.’

very much tied to the prices determined at sea ports, such as the price sourced at the Gulf coast. Historically, the price determined at Cushing was used as the primary crude pricing point for futures contracts at the New York Mercantile Exchange (NYMEX) given that pipeline transportation was considered as more efficient and less risky than other forms of transportation (Borenstein & Kellogg, 2012).

Recent extraction innovations, most notably shale-oil fracking procedures, have greatly increased crude production in both the oil sands in Alberta and the Bakken oil-shale formation in North Dakota. Between 2008 and 2012, North Dakota increased aggregate crude oil production from 172 to 663 thousand barrels a day, while Western Canadian oil imports into the Mid West USA (this oil is imported into a region known as Petroleum Administration for Defense Districts – PADD II) rose from 380 thousand barrels a day in 2008 to 539 thousand barrels a day in 2013² (Figure 2.3).

Figure 2.3 Influx of crude Oil to PADD II



Sources: Energy Information Administration (EIA) and Department of Mineral Resources State of North Dakota

² Oil production by province: National Energy Board (NEB) Canada
Crude oil production by PADD: EIA

The Bakken oil-shale formation which has been responsible for 88% of the increased Midwestern production in crude in the last 2 years (See figure 2.3, 2.4)

Figure 2.4. Crude Oil Production by Year Bakken, ND and Alberta.

Crude Oil Production by Area: in 1000/Bbls		
Year	Bakken ³	Alberta ⁴
2007	7,382	677,805
2008	27,233	669,075
2009	49,294	709,204
2010	85,075	748,530
2011	126,178	812,836

From the data in figure 2.4 it is clear that crude production has expanded massively in the last 5 years in North Dakota increasing 1700%, while production has followed a fairly modest linear increase of between 5-8% per year in Alberta. While the Alberta oil production increase is modest, given the vast increase in aggregate oil production from the Midwest coupled with the limited pipeline capacity from Chicago to Cushing (Borenstein & Kellogg, 2012), it is clear that Alberta producers would face increased competition to supply oil and be forced to lower their prices (see section 3).

This increased supply of oil has outpaced the current infrastructure of technically restricted oil pipelines - oil can only flow in one direction in pipelines and refined products and crude must travel in different pipelines. This excess production in the face of constrained transportation has caused a supply glut at Cushing given its limited pipeline capacity to the Gulf Coast (CAPP, 2012). The resulting effect has been a price fall at Cushing of Western sourced Crudes relative to international Brent prices (see Figure 2.5) in the years since the increased production, with WTI trading on average at a \$19/barrel discount to Brent Int. in 2012. The price decrease is explained in Section 3 Model 1. In order to confirm that this decrease in price has been caused by a supply glut at Cushing, rather than some other factor specific to North American crude market, we must look at crude prices of sea-sourced North American crude.

³ Department of Mineral Resources State of North Dakota

⁴ Alberta Office of Statistics and Information: aggregated crude production

During World War II, the US government divided the country into five Petroleum Administration for Defense Districts (PADDs) in order to best plan oil production, transportation and refining (EIA, 2012). Western oils converge on Cushing via Mid-Western PADDs IV and II, while pipelines from PADDs I and III transport directly to the Gulf Coast. Oil produced in PADD III such as LLS, does not accumulate at Cushing and thus does not face the same supply glut as the Western crudes and as such does not face the same discounted price. This is exhibited in its price relative to international Brent (Figure 2.5) varying only on average as much as \$5/barrel in 2012 relative to the international standard.

Between 2007-08 the world saw a boom in oil prices (Baffes, 2010). This boom saw a spike in the price of crude for all major crudes (Fig. 2.5). The average price of WTI (\$99.7/barrel) actually surpassed that of Brent Int (\$98.94/barrel) in 2008 by one dollar; (the historical difference between Brent and WTI are negligible (CAPP, 2013)). This fact points either to the fact that these crudes are of similar quality, or that there is differential demand for the two crudes of different quality – however as shown by Alizadeh (2007) the lack of historical differential can be explained by their similar qualities. The boom was swiftly followed by a fall in oil prices in 2009 before once again increasing to record levels. During the expansion of production in the Mid-West, WTI traded at a \$17 average discount over Brent in 2011. This discount increased to 19\$ in 2012. This differential was not seen between another American crude, Light Louisiana Sweet, which doesn't pass through the Cushing to Houston pipeline. Light Louisiana sweet continued to trade within \$3 of its historical average price discount of about \$1/barrel of Brent. This discrepancy points to the supply glut at Cushing as a major determinant of the creation of the price differential between WTI and Brent.

Figure 2.5: Yearly Crude Price Averages and Discounts (Various)

Years	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average 2000-12
Oil Companies														
WTI Cushing [1]	30.38	25.98	26.18	31.08	41.51	56.6	66.05	72.34	99.67	61.95	79.48	94.88	94.05	78.13
Brent Europe [2]	28.66	24.46	24.99	28.85	38.26	54.6	65.16	72.44	96.94	61.74	79.61	111.26	111.63	81.67
Louisiana Light Sweet [3]					40.24	52	64.04	72.93	104.51	61.26	79.28	108.48	107.53	81.25
Brent International [4]						55	66	73	98	62	80	112	113	82.38
WTI NA [4]						57	66	72	100	62	80	95	94	78.25
WCS Heavy - Western Canada [4,5]						36.2	45.04	49.62	80	52	65	78	72	59.74
Syncrude Sweet Synthetic crude Western Canada [4]							66	75	102	62	78	104	93	82.86
Edmonton par light Western Canada [4]						57	65	72	96	58	75	96	86	75.63
Brent International - WTI NA Diff						-2	0	1	-2	0	0	17	19	4.13
WTI NA - WCS Heavy Diff						20.8	20.96	22.38	20	10	15	17	22	18.51
WTI NA - Edmonton par light Diff						0	1	0	4	4	5	-1	8	2.63
Brent International - Louisiana Light Sweet Diff						3.05	1.96	0.07	-6.51	0.74	0.72	3.52	5.47	1.13
[1] US energy information Administration –Cushing OK WTI Spot price FOB US\$ per barrel														
[2] US energy information Administration – Europe Brent spot price FOB US\$ per barrel														
[3] US energy information Administration –Louisiana light sweet First purchase price US\$ per barrel														
[4] Bloomberg and TD economics www.td.com/document/PDF/economics/special/Drilling March 14 2013 US\$ per barrel														
[5] WCS Heavy data sources:www.baytex.ab.ca (2005-2007) & Bloomberg and TD economics (2008-2012)														

2.3 WTI vs. WCS

Western Canadian crudes have since 2011 faced a larger price discount to international Brent than WTI (see Section 4 data). Such a discount is being fueled by the compounding effect of the supply glut at Cushing as well as a further over supply build up in PADD III as Alberta oil travels down through Chicago (TD Economics, 2013). The rising production in the oil sands in recent years has added to the already over-supplied American Market for oil and thus is competing with US oil producers for the limited takeaway thus driving down the price (TD Economics, 2013).

This explanation however, while prevalent as a rationale for expanding pipeline access fails to address some other potential sources for the price differential. Fattouh (2008) argues that a sharp increase in the level of crude prices drive up the price differentials between oils of low quality and high quality. This occurs as refiners and pipeline producers operate at very high capacity levels and fulfill demand with high quality oil (Fattouh, 2008). Given that global oil prices have increased sharply since 2007-08 (from already a 500% increase over the last 20 years) (Baffes, 2010), this could potentially create a further differential between the price of Brent and WCS given the quality differences (see Figure 2.2).

WCS is comprised mainly of a heavy crude. Heavy crude travels more slowly in pipelines and is more costly to refine and thus receives a price discount relative to lighter crudes (Baffes, 2010). This distinction however cannot account fully for the discount paid for Canadian produced oil. This is exhibited in the distinction between WCS and Edmonton Par (EP). WCS is of a heavy blend while EP is light and sweet of similar quality to WTI and Brent. Looking at historical data (figure 2.5), we can see that EP has traded with almost no price differential relative to WTI, while WCS has maintained approximately a \$16/barrel discount (NRCAN, 2013). However beginning in late 2011, the price differentials for both the heavy and light varieties of Canadian crudes began to face a steep decline in prices with WCS trading at \$63.17/barrel, EP at \$74.22/barrel while WTI trading at \$88.45/barrel and Brent crude was at \$110/barrel (NRCAN, 2013)⁵ The spot price differentials of over \$50/barrel for WCS and over \$40/barrel for EP exhibited a large deviation from historical averages as outlined above.

Since mid 2012, price differentials, while still prevalent, have contracted for both WTI and WCS relative to Brent Int. due in part to the recent reversal of the Seaway pipeline that now brings oil from Cushing to the Gulf coast and that will add 1.4 million barrels/day of pipeline capacity (RBC Capital Markets, 2013). While most Alberta oil flows first to Chicago and not to Cushing, the increased demand for oil by the proposed expansions should further reduce the differential. Proposed pipelines such as the Keystone XL pipeline delivering Alberta oil directly to Gulf of Mexico; and the Northern Gateway pipeline to open up new exports to Pacific countries, could further reduce the differential.

3. Supply and Demand models

This section will show graphically, how the supply glut has caused prices to fall (discussed in Section 2). For simplicity we will limit the graphical analysis to a discussion of Cushing sourced crudes (which we will refer to as WTI) versus sea sourced crudes (Brent) rather than distinguishing among the various types of crude.

⁵ Conversion of Canadian oil prices from m3 to barrels used at 6.29m3/barrel at spot exchange rate of 0.9903

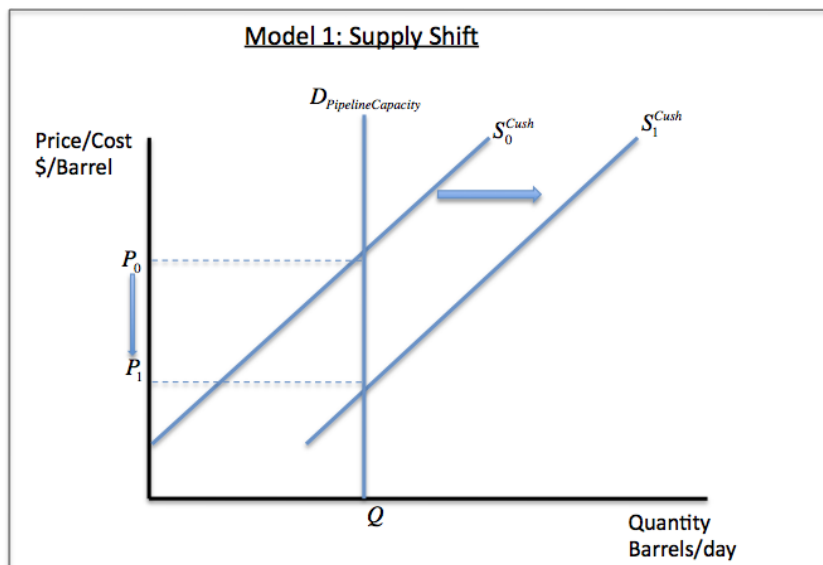
The models are used to give an intuitive understanding for the basis of the data analysis in Section 4.

We will look at three such models that present the issue of pipeline infrastructure constraints. The first will look at the effect of the recent increased production of crude in Oklahoma and Alberta given pipeline constraints. The second will look at a counterfactual distinction for what would happen without any supply constraint. The third model will examine the supply constraint in a 2-region model looking at the various marginal costs associated with transportation (pipeline vs. sea) in order to understand the price differentials.

3.1 Model 1: Increased Supply

Our first model (Fig. 3.1) demonstrates the drop in price for crude resulting from an increase in supply of oil with the constrained pipeline capacity. To understand the pipeline constraint, we assume the demand for oil (demand by the pipeline) to be perfectly inelastic at the quantity of oil it is limited by. We assume that we begin at equilibrium of price P_0 , and quantity Q . The supply curve of crude shifts to the right by the value of the increased production in North America. With the demand for oil constrained by the amount of current pipeline capacity available, this shift results in a fall in price as producers compete for the ability to sell their oil – price falls from P_0 to P_1 , while we stay at level Q . The area between P_0 and P_1 and bounded by Q is the loss in producer surplus created by the supply glut. This value is equal to the economic loss to producers and governments via profits and government royalties lost while it represents a gain to pipeline providers.

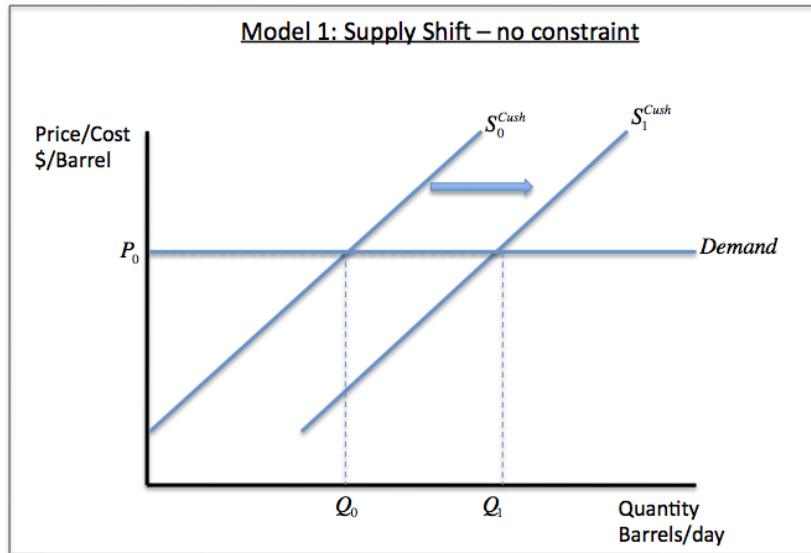
Fig. 3.1 Model 1: Supply Shift



We can compare this shift to what would happen without the constraint of a pipeline. Analysis by Borenstein and Kellogg (2012) shows that the bottleneck created between PADD II at Cushing and the Gulf Coast is equal to 500,000 barrels/day – equal to the increase in daily crude oil production in North Dakota and Canada between January and December 2011. This is in the face of a global market of about 90 million barrels per day and thus this small impact is not likely to affect world prices. Given this large market for crude we can assume a very large demand for oil⁶. We can thus assume for simplicity that the demand curve for crude will be perfectly elastic at the world price. Our shift therefore in supply from increased production, without pipeline constraints would thus not distort prices, but rather just increase the quantity sold from Q_0 to Q_1 . (Fig. 3.2)

⁶ Given the recent economic slowdown, oil consumption and investment could slow in near term, however according to the International Energy Agency (IEA) global energy use is projected to rise 40% by 2035 thus the long term effects can be negligible (IEA, 2011)

Fig. 3.2 Model 1: Supply shift without constraint



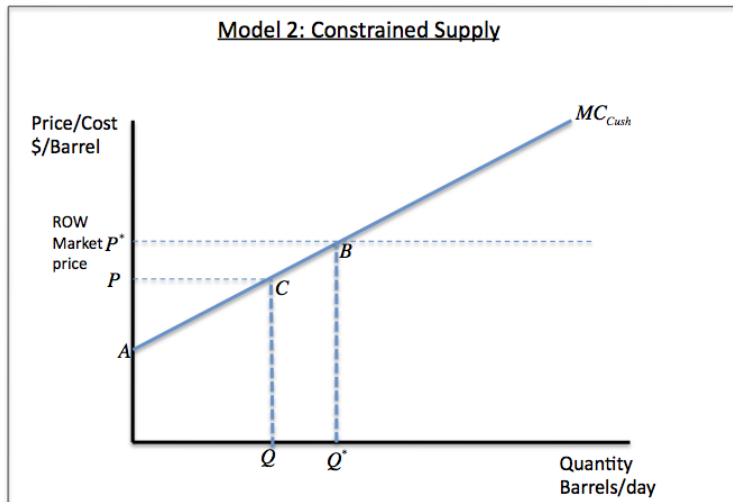
3.2 Model 2: Constrained Supply

We can also understand how the supply glut can drive down the price of oil at Cushing by considering a simple model depicting the supply constraint created by the glut at Cushing (Fig. 3.3). This model is slightly different to Model 1, in that it depicts a situation in which crude sourced at Cushing, will face a price drop relative to the crudes sourced at sea. We assume that the world price is exogenously determined by the global market referred to as Rest of World (ROW). We assume no excess supply, that is to say we assume that all supply of crude is fully taken up by demand. We further assume no difference in the qualities of various crudes – that is to say Cushing crudes refer to WTI, WCS and other blends from Canada and the USA. For simplicity, the supply of Cushing oil follows an upwards sloping marginal (MC) cost curve (in Model 3 we will consider a more realistic MC curve, however for the purpose of this analysis it does not change the outcome).

Given no pipeline constraints, oil sourced at Cushing would be supplied at Q^* and receive the world price P^* - this is in line with historical values (see Section 2 data). Crude producers would therefore receive a profit of ABP^* . In the face of pipeline constraints however, supply is capped at level Q . Given this constraint, the price level falls from P^* to P and profits shrink by P^*PCB . This area corresponds to the fall in

producer surplus caused by the infrastructure barriers. It also causes the loss in government royalties accrued from the crude production.

Fig. 3.3 Model 2: Constrained Supply



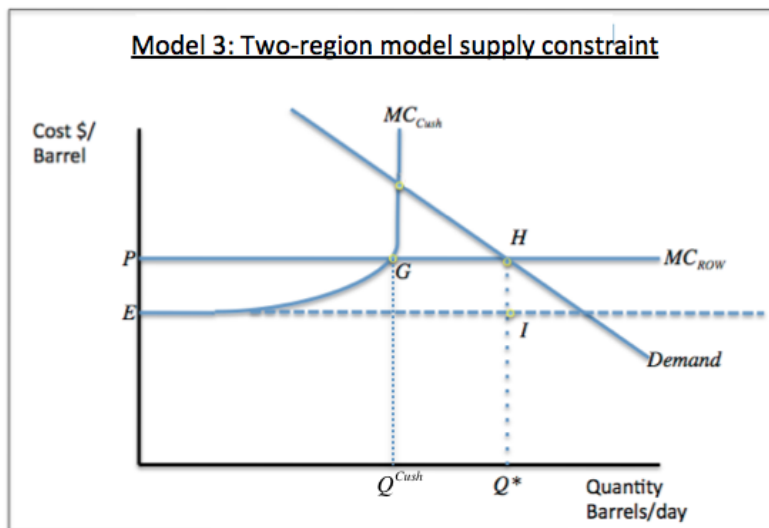
3.3 Model 3: Two-Region Model

An alternative model to understand the fall in rents due to the supply constraints on WTI, can be visualized through a simple 2-region model (Fig. 3.4). While the model itself does not depict a price spread, this price spread is implied in the transaction for the crude. Given that the pipeline producers face greater cost of carry of oil, they will demand lower prices of the crude from crude suppliers, thus generating the price spread between sea-sourced and landlocked, supply-constrained sourced oil. The model compares the supply of crude either via Cushing or via the ROW referring to water transported crude. We assume the ROW supply (MC_{row}) is perfectly elastic due to the arbitrage condition and the large number of global oil exporters. The MC for Cushing oil (MC_{cush}) will be perfectly elastic up until the point of constrained pipeline capacity at which the MC will rise steeply close to capacity and be perfectly inelastic at capacity. We will also consider the MC of ROW supply to be higher than the initial MC of Cushing oil given that additional tankers are required increasing transportation costs via sea while the additional cost for oil within pipelines can be considered to be relatively elastic until near capacity.

Without supply constraints, Cushing Oil producers fulfill the full demand at Q^* and charge the world price, while earning rents due to the lower cost of transportation.

This rent can be seen as the region *PHIE*. However given the pipeline constraint, the rising marginal cost causes it to become relatively more expensive as compared to the rest of world. They thus can only fulfill demand up until point *G*, losing out on rents equal to *GIH* as the ROW picks up the extra demand from $Q^* - Q_{cush}$.

Fig. 3.4. Model 3: Two Region Model – Cost Differential



4. Data Analysis

4.1 Data

Monthly average crude spot price data from January 2005-June 2013 were collected from the Energy Information Administration (EIA) and Department of Energy of Alberta for the following crude oils: Brent International, West Texas Intermediate (WTI), Western Canada Select (WCS) Edmonton Par (EDPar) Edmonton Syncrude Sweet (EDSyn) and Maya⁷. The monthly average exchange rate between USD\$ and CAD\$ was collected from the EIA in order to convert all prices into USD\$ using the same information set used by the EIA for Maya and Brent price conversions.

⁷ Edmonton Syncrude Sweet data was collected from August 2008

4.2 Empirical Background

Multiple studies on oil price differentials utilize cointegration tests to test the null hypothesis that the differential between two oil prices contain a unit root or that the differential is stationary (Gulen, 1997; 1999; Kleit, 2001; Milonas & Henker, 2001; Fattouh, 2008). By testing to see whether the time-series differential follows a stationary process, one can understand if different crude prices are fully integrated. This approach is used to test the globalized oil price hypothesis stated in the introduction. Should differentials follow a stationary process, it would seem that due to arbitrage, crude price differentials would be fully based on quality differentials rather than regional differences.

Using tests of cointegration (Augmented Dickey-Fuller, TAR), empirical studies have shown the global market for crude is integrated due to the vast global trade of crude futures (Fattouh, 2008; Gulen 1997; 1999). Previous studies simply examined oil markets with simple correlation analysis (Weiner, 1999) which found high support for 'regionalization' of oil markets, however as noted by Fattouh (2008) these studies were flawed in that they lacked the proper specification. The advantage of using cointegration tests is that due to the global market for refined oil products that responds to shocks, taking the difference between 2 crudes eliminates the need to control for demand shocks that apply to all crude markets. Price differentials can thus be modeled in terms of a stationary quality discount between the oils subject to supply shocks to the cost of transportation as shown by Alizadeh and Nomikos (2004) and Fattouh (2008). Using Brent and WTI the model is thus:

where B_t and W_t are the prices of Brent and WTI crude respectively at time t , C is the cost of carrying (transportation) of Brent relative to that of WTI (Brent travels by sea and is thus more expensive due to increased insurance and time to delivery than WTI which travels by pipeline), and D is the non-time varying, quality discount. As explained by Fattouh, if the differential, adjusted for transport cost and quality is greater than 0, this would instigate arbitrage in the futures market.

This model lends itself well to an ADF test as follows:

The ADF tests for the presence of a unit root ($\rho = 1$), if as theory predicts the process is stationary, the differential will be full explained by the quality and exogenous transportation costs differences that are constant between the two crudes.

4.3 Methodology

This paper will test cointegration using the Augmented Dickey-Fuller (Dickey & Fuller, 1979) test statistic and the Schwartz Information criterion. The null and alternative hypothesis are as follows:

- = The series has a unit root,
- = The series does not have a unit root (stationary)

The tests will be performed under the assumptions of Fattouh (2008), that oil prices are integrated and their difference should be stationary. When testing oil price differentials, if a quality discount naturally exists (ie between Brent and WCS) the theoretical differential should be greater than 0, as such the test will be performed with a constant, if no quality discount exists no constant will be used as the hypothesized mean of the difference should be 0. If the test yields a t-statistic leading to a rejection of the null hypothesis, the series can be considered stationary and support the globalized oil hypothesis at the specified confidence level. If the t-statistic fails to reject the null hypothesis, a unit root exists at the specified confidence level, pointing to a differential not fully explained by exogenous factors.

In order to isolate the true effects of the supply glut at Cushing, multiple oils of different qualities and distribution channels will be tested against each other. The full sample of monthly price data from January 2005-June 2013 were tested as well as the following subdivisions: January 2010 – December 2011, January 2010 – June 2012, January 2010 –July 2013. Theory dictates that in late 2011 crudes sourced at Cushing

Oklahoma began to face pipeline constraints leading to price discounts relative to sea-sourced crudes. Given this, differentials between sea-sourced crudes should be stationary throughout the time-series while crudes travelling through PADD II (Cushing) should have a break in the stationary process starting late 2011. Some analysis (TD Economics, 2012) indicated that price differentials were not accentuated until early 2012 hence multiple time frames are used.

The paper uses the following crudes and their hypothesized differentials as summarized in the Figure 4.1

Figure 4.1 Crudes used in analysis

Crude	Distribution Channel	Hypothesis
Brent International	Sea-Ports	Used as benchmark for sea-sourced oil
WTI	Through PADD II	Stationary differential relative to other crudes until a break at 2011
WCS	Through PADD II	Stationary differential relative to other crudes until a break at 2011.
ED Par	Through PADD II	Higher quality than WCS, thus not subjected to inherent price differentials caused by oil spike relative to Brent and WTI (see section 2)
ED Syn	Primarily domestic (Canada)	Should have stationary differential relative to Brent throughout time series – serves as control to see if there is some endogenous differential with respect to Alberta crudes exists
Maya	Sea-ports	Similar quality to WCS, serves as a control test to determine whether WCS differential due to infrastructure or general crude price increase.

The differentials tested and the theoretical hypothesis are listed below (figure 4.2):

Figure 4.2 Differentials tested

Differential	Hypothesis
Brent-WTI	Stationary with a differential mean <\$5 between 2005-December 2009, with subsequent series exhibiting a widening price differential and a unit root
Brent-WCS	Stationary with a differential mean >\$5 between 2005-December 2009, with subsequent series exhibiting a widening price differential and a unit root
Brent-EdPar	Stationary with a differential mean <\$5 between 2005-December

	2009, with subsequent series exhibiting a widening price differential and a unit root
	Stationary throughout the series with a differential mean <\$5
Brent-Ed SynCrude	
Brent-Maya	Stationary throughout the series with a differential mean >\$5
WTI-WCS	Stationary throughout the series with a differential mean >\$5, although given the general price increase, WCS could trade at an increasing differential thus the series would exhibit a unit root.
Maya-WCS	Stationary with a differential mean <\$5 between 2005-December 2009, with subsequent series exhibiting a widening price differential and a unit root

4.4 Results

Looking at Figure 4.3, we can see the graph of the time-series differentials for the various oils. Prior to dissecting the cointegration tests, it is clear that prior to 2011, the differentials of most crudes move randomly around a fairly constant mean, with a widening differential commencing in late 2011 for the PADD II transported crudes relative to sea-sourced oils. This break follows directly from theory and the results of the ADF tests (figure 4.4) point to the fact that the theoretical hypotheses bear merit.

Figure 4.3: Graphs of the differential time-series'

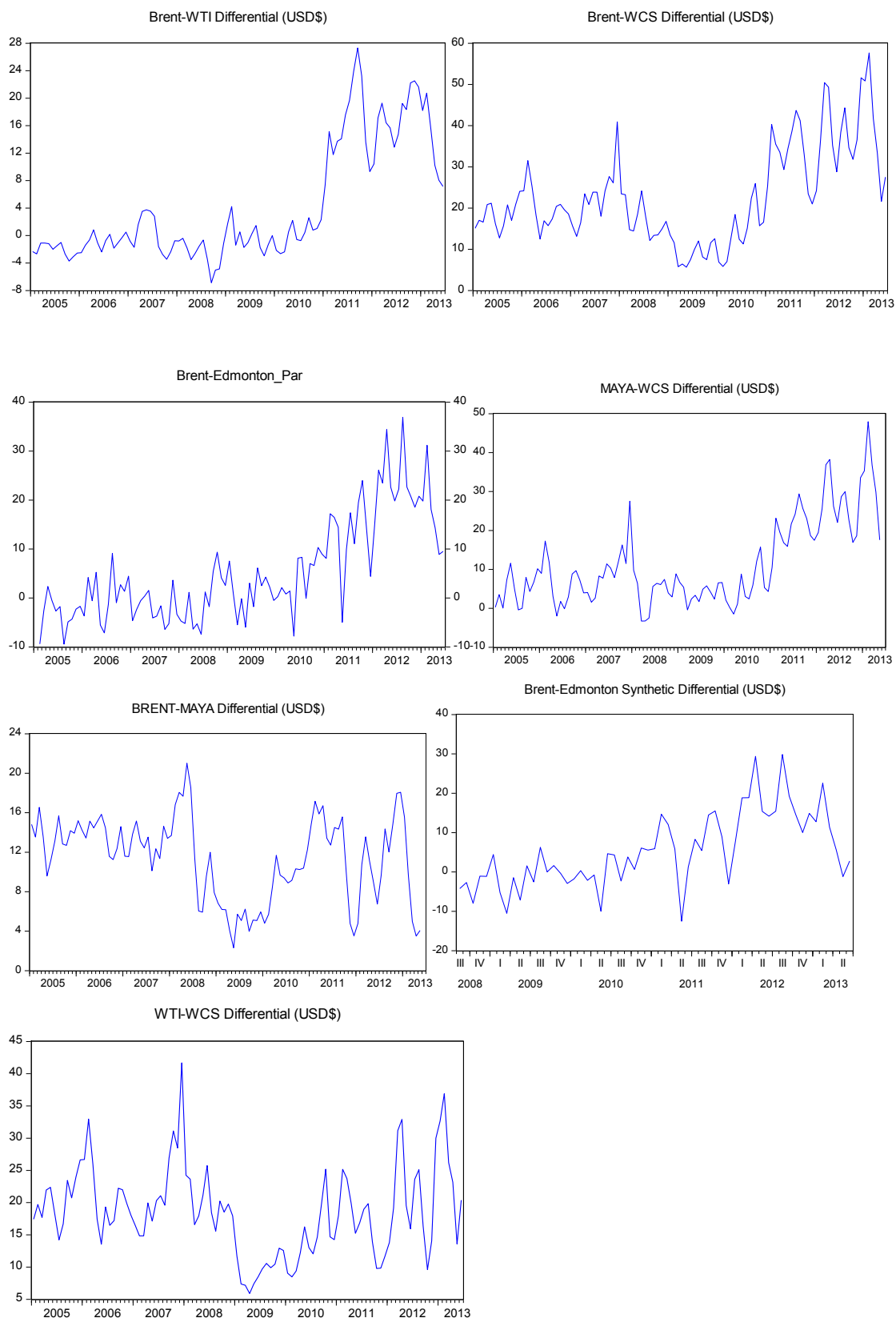


Figure 4.4: ADF test results

BRENT-WTI	n	Mean (std dev)	ADF Test* T-Stat	ADF P-value*	Unit Root**
Jan 2005- June 2013	100	4.12 (8.53)	-2.021	0.2772	yes
Jan 2005 - Dec 2009	59	5.815 (5.289)	-3.54	0.0102	no
Jan 2010 - June 2013	42	15.800 (10.894)	-1.951	0.3068	yes
Jan 2010 - June 2012	30	19.315 (11.967)	-1.696	0.423	yes
Jan 2010 - Dec 2011	24	12.735 (9.354)	-1.4917	0.5205	yes

Brent-EdPar	n	Mean (std dev)	ADF Test* T-Stat	ADF P-value*	Unit Root*
Jan 2005- June 2013	101	5.274 (10.29)	-1.029	0.271	yes
Jan 2005 - Dec 2009	59	-0.8464 (437)	-5.82	0.00	no
Jan 2010 - June 2013	42	13.871 (10.053)	-3.0217	0.041	no
Jan 2010 - June 2012	30	11.3 (9.749)	-2.573	0.1096	yes
Jan 2010 - Dec 2011	24	8.24 (7.84)	-1.808	0.067	yes

Brent-SynCrude	n	Mean (std dev)	ADF Test* T-Stat	ADF P-value*	Unit Root**
Aug 2008- June 2013	59	5.329 (9.3724)	-14.048	0.00	no
Aug 2008 - Dec 2009	17	-1,957 (4.293)	-30.4759	0.00	no
Jan 2010 - June 2013	42	8.279 (9,282)	-3.131	0.0318	no
Jan 2010 - June 2012	24	3.557 (7.096)	-3.098	0.0402	no
Jan 2010 - Dec 2011	30	6.326 (8.971)	-2.73	0.0808	yes

Brent-Maya	n	Mean (std dev)	ADF Test* T-Stat	ADF P-value*	Unit Root**
Jan 2005- June 2013	101	11.375 (4.204)	-3.858	0.0034	no
Jan 2005 - Dec 2009	60	11.731 (4.209)	-1.981	0.294	yes
Jan 2010 - June 2013	41	10.866 (4.193)	-3.578	0.001	no
Jan 2010 - June 2012	30	10.677 (3.53)	-2.888	0.0586	yes
Jan 2010 - Dec 2011	24	11.016 (3.881)	-1.789	0.377	yes

Brent-WCS	n	Mean (std dev)	ADF Test* T-Stat	ADF P-value*	Unit Root**
Jan 2005- June 2013	102	22.719 (11.622)	-1.556	0.501	yes
Jan 2005 - Dec 2009	60	17.546 (6.496)	-2.948	0.046	no
Jan 2010 - June 2013	41	10.856 (4.193)	-1.546	0.5009	yes
Jan 2010 - June 2012	30	26.478 (12.660)	-0.712	0.8292	yes
Jan 2010 - Dec 2011	24	23.75 (11.773)	-0.895	0.7721	yes

Maya-WCS	n	Mean (std dev)	ADF Test* T-Stat	ADF P-value*	Unit Root**
Jan 2005- June 2013	101	11.296 (10.870)	-2.808	0.0607	yes
Jan 2005 - Dec 2009	60	5.815 (5.289)	-4.273	0.0012	no
Jan 2010 - June 2013	41	19.315 (11.967)	-1.951	0.3068	yes
Jan 2010 - June 2012	30	15.800 (10.894)	-0.03057	0.9483	yes
Jan 2010 - Dec 2011	24	12.736 (9.356)	0.288	0.9723	yes

WTI-WCS	n	Mean (std dev)	ADF Test* T-Stat	ADF P-value*	Unit Root**
Jan 2005- June 2013	102	18.599 (6.882)	-4.0712	0.0017	no
Jan 2005 - Dec 2009	60	18.684 (6.691)	-2.692	0.0816	yes
Jan 2010 - June 2013	42	19.315 (11.967)	-4.093	-0.0026	no
Jan 2010 - June 2012	30	16.814 (6.166)	-3.691	0.0095	no
Jan 2010 - Dec 2011	24	15.497 (4.992)	-0.0984	0.7422	yes

* using bayesian (Schwartz) information criterion

** at 5% level

Figure 4.4 shows all the test results for the differentials tested. For the purpose of this discussion we will focus on the January 2005-Dec 2009 and the January 2010-June 2012 and 2013, owing to the fact that Jan 2010-Dec 2011 is a small sample size. The results generally follow the theoretical predictions outlined in figure 4.2 and suggest confirmation of the pipeline constraint based discount hypothesis. Brent-WTI is stationary until the break and widening differential when testing the sample from 2010 on, as with Brent-WCS. Maya-WCS also follows the theoretical prediction confirming that the WCS differential was not caused by a quality differential. Brent-

SynCrude, following the theory, does not exhibit a unit root, apart from the 2010-2011 sample, nor a widening differential, which supports the theory that exported Alberta oil, faced a discount based on pipeline constraints rather than some endogenous factor affecting all Alberta based oil.

The sole outlier from theory is the Brent-EdPar tests, which does not exhibit a unit root in the Jan 2010-June 2013 sub-sample. Despite this, the mean of the differential shows a clear increase from a mean of -0.864 in the months from January 2005 to December 2009 climbing to a mean of 13.871 in the following months. This follows the theory closely exhibiting a widening differential caused by a discount to Edmonton Par crude.

One potentially puzzling result, the unit root from the WTI-WCS Jan 2005-Dec 2009 sub-sample, can be explained by the spike in global oil prices in 2007 which, according to Fattouh (2008), drives up differentials between high and low quality crudes.

4.5 Alternative Explanations and Further Research

It is important however to recognize that, as stated in section 4.2, this analysis is based on the hypothesis that oil prices are globally integrated. This is a strong assumption and thus potentially weakens the analysis. Furthermore, the rejection and non-rejection of the ADF test in this case, does not confirm but rather suggests evidence of a supply constraint. While it is highly plausible given the results, other factors may be at play. One possible explanation is that in 2010-11 as the US was facing a period of slow growth, there may have been a negative shock to oil demand in the US and domestically sourced crudes may have faced a weaker demand than sea sourced crudes, which have direct access to other markets. This explanation would nullify our original hypothesis that oil prices are globally integrated. Given the research outlined in Section 4.2, while largely confirming the globally integrated crude hypothesis, admits a certain degree of short-term variability, this explanation is possible, although unlikely given the global nature of the economic slowdown. Another possible alternative explanation is that there was differential demand for oil of differing qualities. As the Bakken oilfield generated a large increase in supply, and Bakken oil

is lighter and sweeter than WCS (Holubnyak et. al, 2011) and given the heavier bitumen from Canada is largely used for road construction, and that in 2010 the US was in a period of slow growth, the demand for low quality crude may have lagged relative to the demand for high quality crude. The additional influx of light, sweet Bakken fuel may have additionally put downwards price pressure on WTI as it crowded the market. This explanation could potentially explain the results and the impact of Bakken oil supply increase on other Mid-West sourced crude prices warrants further investigation.

Further issues arise in the interpretation of the results with respect to the ADF test. It is important to realize that given the few observations, rejection of non-stationarity does not necessarily imply stationarity, thus further testing with larger data sets would be beneficial. Also, additional investigation could be to test for ‘threshold cointegration.’ As demonstrated by Fattouh (2010) the two series’ will not move together unless a threshold, or spread between the series’ is crossed. In this case it could show that some short term shock allowed for two series of oil prices to not follow any meaningful cointegrated pattern before reverting back to the long term cointegrated pattern – this test could be useful in further examining and confirming the pipeline constraint hypothesis.

5. Implications

5.1 Economic Impact

The oil and gas sector is a major contributor to the Canadian economy, generating both corporate profits and government royalties from revenues from production as well as fueling a large portion of investment expenditure. Official Industry Canada estimates from 2006 (prior to the mass utilization of fracking) put the Oil and Gas industry as contributing approximately 4% of total GDP. Statistics Canada, in 2009 valued the Alberta Oil Sands to be \$441 Billion or about 6% of Canada’s total wealth.⁸ Some estimates have gone further valuing the oil sands at over \$1.4 Trillion (Sharpe et. al. 2008). Beyond the wealth of the natural resource itself, the Conference Board of Canada estimates that oil and gas investment constituted 15% of Canada’s total capital investment expenditure in 2011, and forecasts that between 2012-2035, the Alberta

⁸ <http://www.statcan.gc.ca/pub/11-402-x/2011000/chap/ener/ener02-eng.htm>

Oil Sands development alone will add \$364 Billion in price-adjusted investment, adding 1.45 million person years of employment (Burt et. al, 2012).

The impact of a discount on the price for crude however may not have a large impact on Canadian GDP growth. In the January 2013 Monetary Policy Report, the Bank of Canada estimated that the spread on WCS vs. Brent International reduced 2012 annualized GDP growth by 0.4 percentage points brought on by reduced revenues, but also by a reduction in investment, production and exports (Bank of Canada, 2013). The report singles out the discount on WCS as the single biggest factor to this reduction in GDP growth as the lower cash-flows have curtailed expansion due to uncertainty, export capacity and royalties leading to less provincial government revenues (Bank of Canada, 2013).

This sentiment is echoed in the Conference Board of Canada's Report on the Provincial outlook for Alberta, Autumn 2012, stating that due to the decline in prices for Western crude, the economic outlook could be downgraded due to major spending cuts by energy companies (Conference Board of Canada - 2, 2012). RBC Economics estimates that business investment in oil and gas, while slower than the 10-11% levels of 2010-11, will continue to grow at rates of about 5-7%, higher than for all other sectors of the Canadian economy (RBC Economics, 2013).

The nominal impact of the oil price differential in Canada however has been considerable. Corporate profits in the oil and gas sector reached their lowest annual turnaround since 1999, having declined by more than 50% to \$7.1 Billion in 2012 (TD Economics, 2013). Given that the majority of Canadian crude exports are of the heavy variety like WCS, the terms of trade have considerably weakened for Canada as Quebec, Ontario and the Maritimes, rely on imported crude Brent Prices (TD Economics, 2013). Alberta, where oil and gas contributes to 25% of its GDP and constitutes 75% of total oil production in Canada, has experienced significantly lower royalties and income taxes resulting in a revision of the deficit projection- an increase to \$4 Billion from \$3.5 Billion for 2012-13 (Finance Alberta, 2013), the third year of a budget deficit.

Saskatchewan is also facing a fall in royalties of \$300 Million in the current fiscal year coupled with a decline in investment of 10% for 2013 after the 30% decrease in

2012 (TD Economics, 2013). Conversely Newfoundland and Labrador, whose crude production does not face the supply glut, can trade oil at the global market rate, and are expected to see a surge in investment activity of 83% after the 2012 gain of 77% (TD Economics, 2013).

While it is difficult to isolate the macroeconomic impact of the oil price differential from other recessionary pressures created by the world economy, both real and nominal effects point to the discount as creating slower growth in Canada, specifically in the Western provinces which are subject to the supply constraints for oil exports.

5.2 Pipeline Expansion?

As we have argued, the discount of oil is being fueled by over supply, with crude production in Canada expected to expand in the next 7 years by nearly 1 Million barrels/day (CAPP, 2010). Either an increase in refining capacity or a reduction in transport bottlenecks could alleviate the discount (TD Economics, 2013). While there have been some improvements in infrastructure capacity recently, most notably the reversal of the Seaway pipeline from Cushing to the Gulf, there hasn't been enough infrastructure development to alleviate the pipeline constraints.

Futures markets point to the Keystone XL pipeline as a potential solution to the price differential (TD Economics, 2013). Should the Keystone XL pipeline be approved by Barack Obama, the spread on WCS to WTI will likely diminish to its natural level of \$5/Barrel (TD Economics, 2013).

6. Conclusion

It is clear that our empirical findings point to the theoretical hypothesis that Western Canadian crudes are in fact facing a price discount relative to the global crude market due to infrastructural constraints in the Mid-West U.S causing a supply glut. While alternative explanations for the price differential exist and confirmation of this hypothesis needs more investigation, the supply constraints argument is likely on both theoretical and empirical grounds. Producers from Alberta and Saskatchewan, whose oil is priced at Cushing, OK and must compete with other Mid-Western oil from the US, trade at a large discount relative to crudes of similar qualities (Maya and WCS;

Edmonton Par and Brent), which have direct exposure to seaports and can trade at the international crude price.

While the nominal effects of this discount are large, and certainly affect the economies of Alberta and Saskatchewan, the macro effects on Canadian real GDP and growth may not be as severe. Furthermore given plans to expand pipeline capacity via the Keystone XL, the Northern Gateway and further development in U.S refining capacity, this discount is expected to decrease to natural levels in the coming years.

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A. Annex: Regression Outputs and Descriptive Statistics

A.1 Brent - Edmonton PAR

2005-09

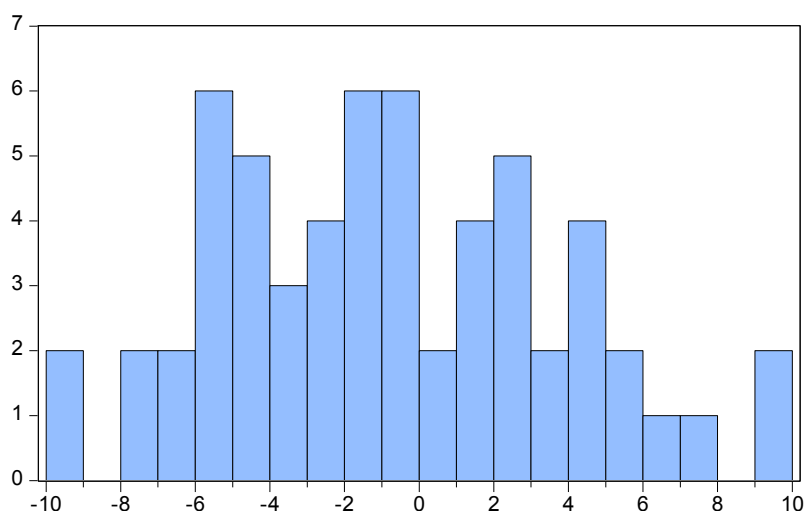
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.819657	0.0000
Test critical values:		
1% level	-2.606163	
5% level	-1.946654	
10% level	-1.613122	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENT_EDMONTON_PAR)
 Method: Least Squares
 Date: 08/29/13 Time: 20:25
 Sample (adjusted): 2005M03 2009M11
 Included observations: 57 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_EDMONTON_PAR(-1)	-0.716459	0.123110	-5.819657	0.0000
R-squared	0.375947	Mean dependent var		0.203778
Adjusted R-squared	0.375947	S.D. dependent var		5.351285
S.E. of regression	4.227356	Akaike info criterion		5.738419
Sum squared resid	1000.750	Schwarz criterion		5.774262
Log likelihood	-162.5449	Hannan-Quinn criter.		5.752348
Durbin-Watson stat	2.080754			



Series: BRENT_EDMONTON_PAR	
Sample 2005M02 2009M12	
Observations 59	
Mean	-0.846710
Median	-1.320782
Maximum	9.356510
Minimum	-9.426736
Std. Dev.	4.437195
Skewness	0.259880
Kurtosis	2.487441
Jarque-Bera	1.309964
Probability	0.519451

2010-11

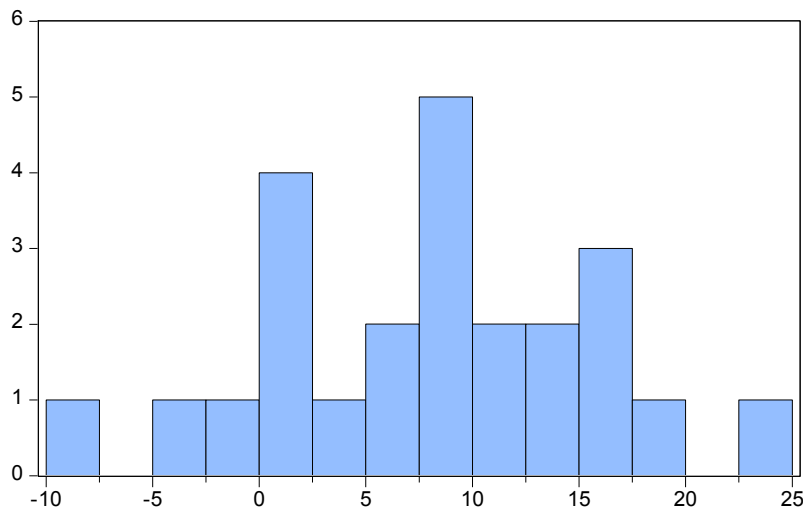
Null Hypothesis: BRENT_EDMONTON_PAR has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=5)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.807885	0.0678
Test critical values:		
1% level	-2.664853	
5% level	-1.955681	
10% level	-1.608793	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENT_EDMONTON_PAR)
 Method: Least Squares
 Date: 08/29/13 Time: 20:26
 Sample: 2010M01 2011M12
 Included observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_EDMONTON_PAR(-1)	-0.251993	0.139385	-1.807885	0.0837
R-squared	0.123852	Mean dependent var		0.205159
Adjusted R-squared	0.123852	S.D. dependent var		8.192917
S.E. of regression	7.668798	Akaike info criterion		6.952971
Sum squared resid	1352.641	Schwarz criterion		7.002056
Log likelihood	-82.43565	Hannan-Quinn criter.		6.965993
Durbin-Watson stat	2.164289			



Series: BRENT_EDMONTON_PAR	
Sample 2010M01 2011M12	
Observations 24	
Mean	8.240176
Median	8.220211
Maximum	23.99754
Minimum	-7.792431
Std. Dev.	7.848319
Skewness	-0.060182
Kurtosis	2.517506
Jarque-Bera	0.247288
Probability	0.883694

2010-13

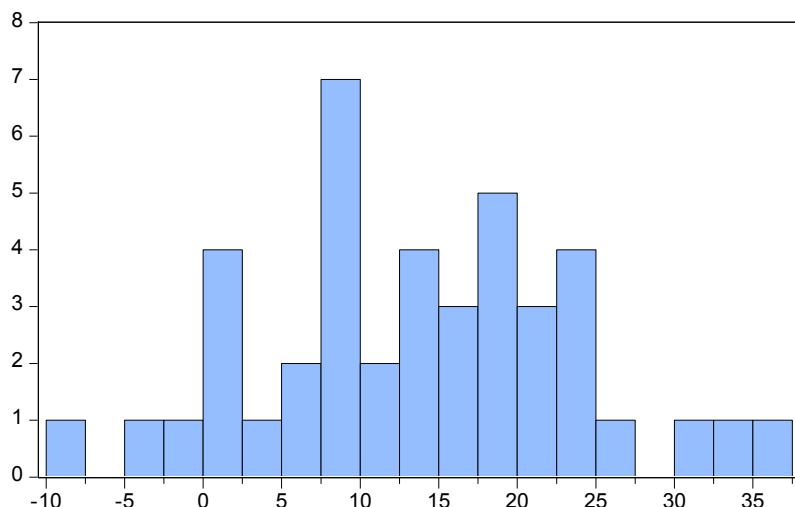
Null Hypothesis: BRENT_EDMONTON_PAR has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.021737	0.0409
Test critical values:		
1% level	-3.596616	
5% level	-2.933158	
10% level	-2.604867	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENT_EDMONTON_PAR)
 Method: Least Squares
 Date: 08/30/13 Time: 19:38
 Sample: 2010M01 2013M06
 Included observations: 42

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_EDMONTON_PAR(-1)	-0.348898	0.115463	-3.021737	0.0044
C	4.995060	1.962651	2.545058	0.0149
R-squared	0.185848	Mean dependent var		0.238448
Adjusted R-squared	0.165495	S.D. dependent var		8.316114
S.E. of regression	7.596875	Akaike info criterion		6.939799
Sum squared resid	2308.501	Schwarz criterion		7.022545
Log likelihood	-143.7358	Hannan-Quinn criter.		6.970129
F-statistic	9.130897	Durbin-Watson stat		2.184059
Prob(F-statistic)	0.004368			



Series: BRENT_EDMONTON_PAR	
Sample 2010M01 2013M06	
Observations 42	
Mean	13.87168
Median	14.40475
Maximum	36.89067
Minimum	-7.792431
Std. Dev.	10.05315
Skewness	0.069557
Kurtosis	2.749364
Jarque-Bera	0.143799
Probability	0.930624

2010- June 2012

Null Hypothesis: BRENT_EDMONTON_PAR has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=7)

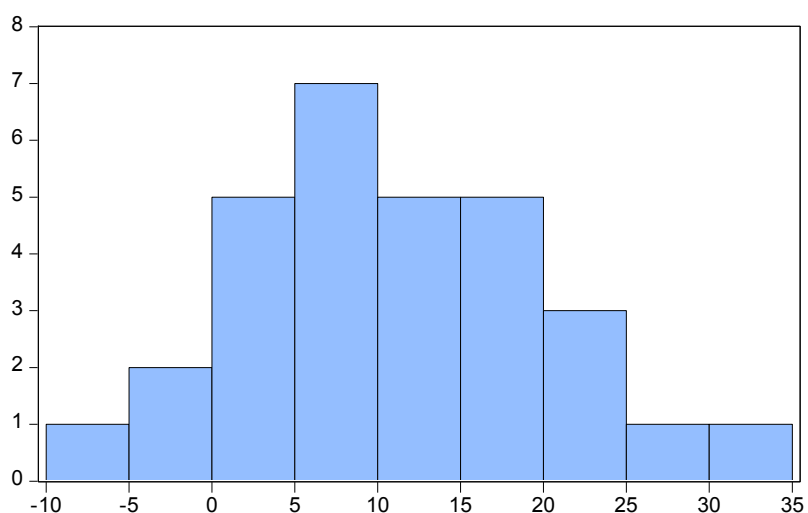
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.572596	0.1096
Test critical values:		
1% level	-3.670170	
5% level	-2.963972	
10% level	-2.621007	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENT_EDMONTON_PAR)
 Method: Least Squares
 Date: 08/29/13 Time: 20:27

Sample: 2010M01 2012M06
 Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_EDMONTON_PAR(-1)	-0.372689	0.144869	-2.572596	0.0157
C	4.636198	2.081586	2.227244	0.0341
R-squared	0.191178	Mean dependent var		0.677579
Adjusted R-squared	0.162292	S.D. dependent var		8.389148
S.E. of regression	7.678287	Akaike info criterion		6.979010
Sum squared resid	1650.770	Schwarz criterion		7.072424
Log likelihood	-102.6852	Hannan-Quinn criter.		7.008894
F-statistic	6.618250	Durbin-Watson stat		2.126999
Prob(F-statistic)	0.015686			



Series: BRENT_EDMONTON_PAR	
Sample 2010M01 2012M06	
Observations 30	
Mean	11.29934
Median	10.10979
Maximum	34.41844
Minimum	-7.792431
Std. Dev.	9.748971
Skewness	0.196004
Kurtosis	2.676751
Jarque-Bera	0.322701
Probability	0.850994

Full sample

Null Hypothesis: BRENT_EDMONTON_PAR has a unit root
 Exogenous: None
 Lag Length: 3 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.029275	0.2713
Test critical values:		
1% level	-2.589020	
5% level	-1.944175	
10% level	-1.614554	

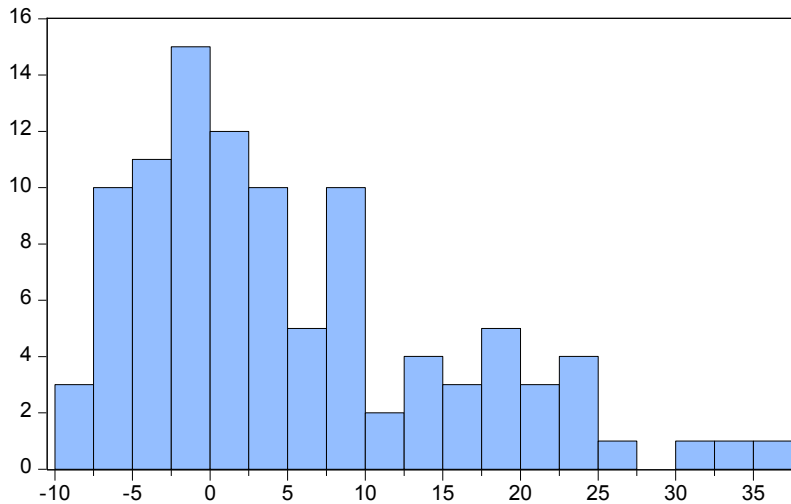
*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENT_EDMONTON_PAR)
 Method: Least Squares
 Date: 08/29/13 Time: 20:25
 Sample (adjusted): 2005M06 2013M06
 Included observations: 97 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
----------	-------------	------------	-------------	-------

BRENT_EDMONTON_PAR(-1)	-0.058447	0.056785	-1.029275	0.3060
D(BRENT_EDMONTON_PAR(-1))	-0.453007	0.107583	-4.210782	0.0001
D(BRENT_EDMONTON_PAR(-2))	-0.340071	0.109233	-3.113269	0.0025
D(BRENT_EDMONTON_PAR(-3))	-0.255601	0.100638	-2.539809	0.0127

R-squared	0.243689	Mean dependent var	0.102928
Adjusted R-squared	0.219292	S.D. dependent var	6.747877
S.E. of regression	5.962267	Akaike info criterion	6.449141
Sum squared resid	3306.022	Schwarz criterion	6.555315
Log likelihood	-308.7834	Hannan-Quinn criter.	6.492073
Durbin-Watson stat	2.008812		



Series: BRENT_EDMONTON_PAR	
Sample 2005M02 2013M06	
Observations 101	
Mean	5.273809
Median	2.361856
Maximum	36.89067
Minimum	-9.426736
Std. Dev.	10.29593
Skewness	0.950711
Kurtosis	3.282689
Jarque-Bera	15.55114
Probability	0.000420

A.2 Brent – Edmonton Syncrude

August 2008-13

Null Hypothesis: BRENT_EDMONTON_SYN has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=10)

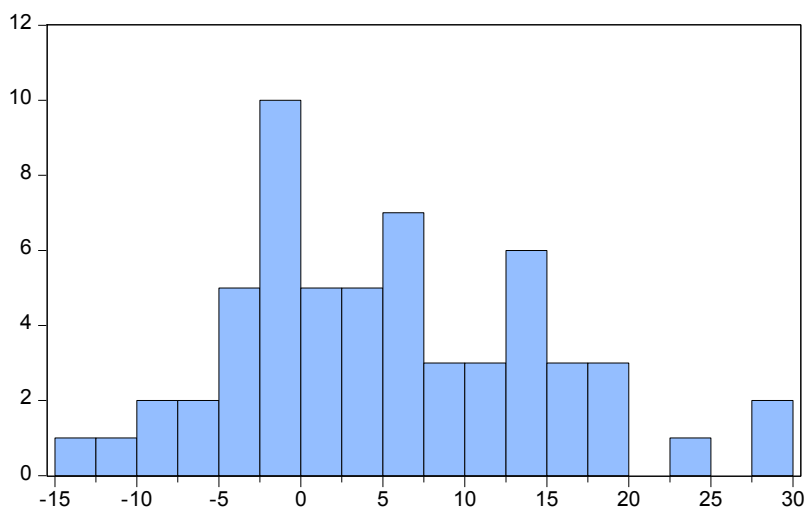
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-14.04893	0.0000
Test critical values:		
1% level	-3.546099	
5% level	-2.911730	
10% level	-2.593551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENT_EDMONTON_SYN)
 Method: Least Squares
 Date: 08/29/13 Time: 20:14
 Sample: 2008M08 2013M06
 Included observations: 59

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_EDMONTON_SYN(-1)	-0.894685	0.063684	-14.04893	0.0000
C	4.536544	1.294485	3.504515	0.0009

R-squared	0.775919	Mean dependent var	-2.202282
Adjusted R-squared	0.771988	S.D. dependent var	19.34073
S.E. of regression	9.235315	Akaike info criterion	7.317257
Sum squared resid	4861.590	Schwarz criterion	7.387682
Log likelihood	-213.8591	Hannan-Quinn criter.	7.344748
F-statistic	197.3725	Durbin-Watson stat	0.761450
Prob(F-statistic)	0.000000		



Series: BRENTEDMONTON_SYN	
Sample 2008M08 2013M06	
Observations 59	
Mean	5.329780
Median	4.436048
Maximum	29.86808
Minimum	-12.50574
Std. Dev.	9.372412
Skewness	0.520379
Kurtosis	2.952268
Jarque-Bera	2.668414
Probability	0.263367

2008-09

Null Hypothesis: BRENTEDMONTON_SYN has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=3)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-30.47597	0.0000
Test critical values:		
1% level	-3.886751	
5% level	-3.052169	
10% level	-2.666593	

*MacKinnon (1996) one-sided p-values.

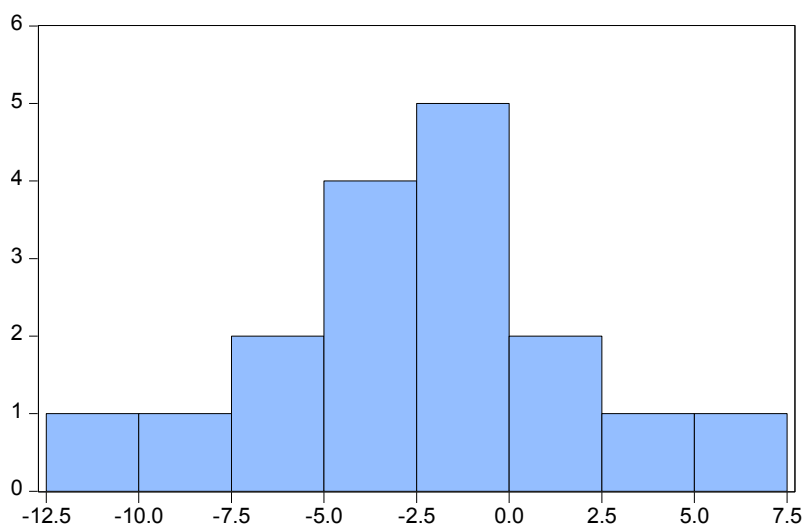
Warning: Probabilities and critical values calculated for 20 observations and may not be accurate for a sample size of 17

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENTEDMONTON_SYN)
 Method: Least Squares
 Date: 08/30/13 Time: 19:44
 Sample: 2008M08 2009M12
 Included observations: 17

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENTEDMONTON_SYN(-1)	-1.017027	0.033371	-30.47597	0.0000
C	-1.854174	1.084868	-1.709124	0.1080

R-squared	0.984107	Mean dependent var	-7.978600
Adjusted R-squared	0.983047	S.D. dependent var	33.75949
S.E. of regression	4.395612	Akaike info criterion	5.909222
Sum squared resid	289.8211	Schwarz criterion	6.007247
Log likelihood	-48.22838	Hannan-Quinn criter.	5.918965
F-statistic	928.7848	Durbin-Watson stat	1.909037

Prob(F-statistic) 0.000000



Series: BRENTEDMONTON_SYN	
Sample 2008M08 2009M12	
Observations 17	
Mean	-1.956711
Median	-1.444738
Maximum	6.252400
Minimum	-10.49403
Std. Dev.	4.292809
Skewness	-0.088840
Kurtosis	2.742928
Jarque-Bera	0.069173
Probability	0.966005

2010-11

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=5)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.098016	0.0402
Test critical values:		
1% level	-3.737853	
5% level	-2.991878	
10% level	-2.635542	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(BRENTEDMONTON_SYN)

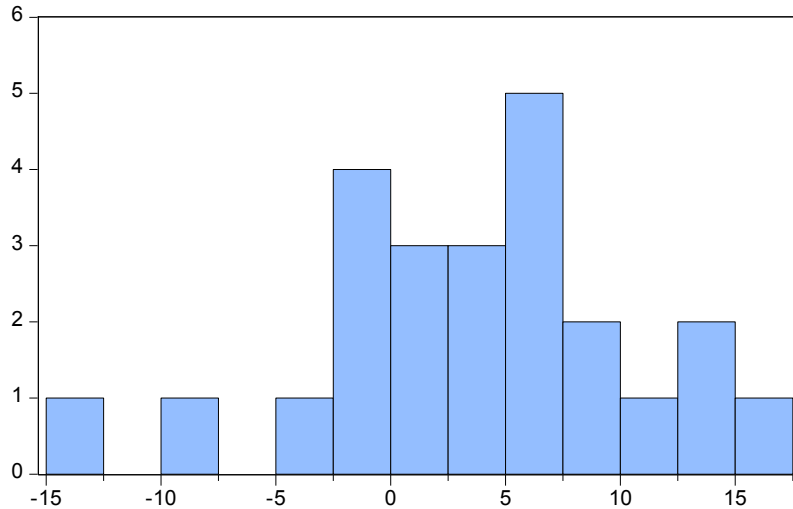
Method: Least Squares

Date: 08/29/13 Time: 20:21

Sample: 2010M01 2011M12

Included observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENTEDMONTON_SYN(-1)	-0.608096	0.196285	-3.098016	0.0052
C	2.161524	1.531566	1.411316	0.1721
R-squared	0.303747	Mean dependent var		-0.004446
Adjusted R-squared	0.272099	S.D. dependent var		7.824601
S.E. of regression	6.675724	Akaike info criterion		6.714488
Sum squared resid	980.4363	Schwarz criterion		6.812659
Log likelihood	-78.57385	Hannan-Quinn criter.		6.740532
F-statistic	9.597704	Durbin-Watson stat		1.829411
Prob(F-statistic)	0.005249			



Series: BRENT_EDMONTON_SYN
 Sample 2010M01 2011M12
 Observations 24

Mean 3.557446
 Median 4.478377
 Maximum 15.51305
 Minimum -12.50574
 Std. Dev. 7.095904
 Skewness -0.281811
 Kurtosis 2.902453

Jarque-Bera 0.327186
 Probability 0.849088

2011-12

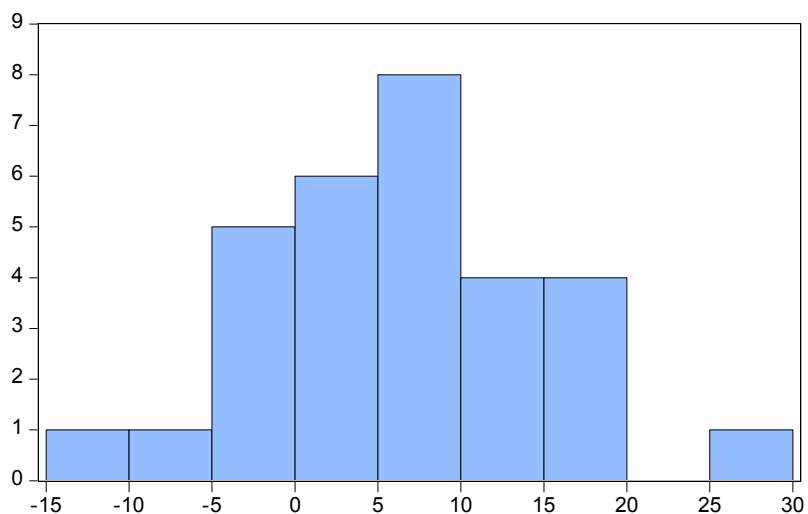
Null Hypothesis: BRENT_EDMONTON_SYN has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.730032	0.0808
Test critical values:		
1% level	-3.670170	
5% level	-2.963972	
10% level	-2.621007	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENT_EDMONTON_SYN)
 Method: Least Squares
 Date: 08/29/13 Time: 20:19
 Sample: 2010M01 2012M06
 Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_EDMONTON_SYN(-1)	-0.417419	0.152899	-2.730032	0.0108
C	2.972385	1.613771	1.841888	0.0761
R-squared	0.210224	Mean dependent var		0.569609
Adjusted R-squared	0.182017	S.D. dependent var		8.191635
S.E. of regression	7.408711	Akaike info criterion		6.907530
Sum squared resid	1536.892	Schwarz criterion		7.000944
Log likelihood	-101.6130	Hannan-Quinn criter.		6.937414
F-statistic	7.453073	Durbin-Watson stat		1.994717
Prob(F-statistic)	0.010827			



Series: BRENT_EDMONTON_SYN	
Sample 2010M01 2012M06	
Observations 30	
Mean	6.325884
Median	5.696433
Maximum	29.38690
Minimum	-12.50574
Std. Dev.	8.970771
Skewness	0.244784
Kurtosis	3.220614
Jarque-Bera Probability	0.360435
	0.835088

2010-13

Null Hypothesis: BRENT_EDMONTON_SYN has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.131298	0.0318
Test critical values:		
1% level	-3.596616	
5% level	-2.933158	
10% level	-2.604867	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(BRENT_EDMONTON_SYN)

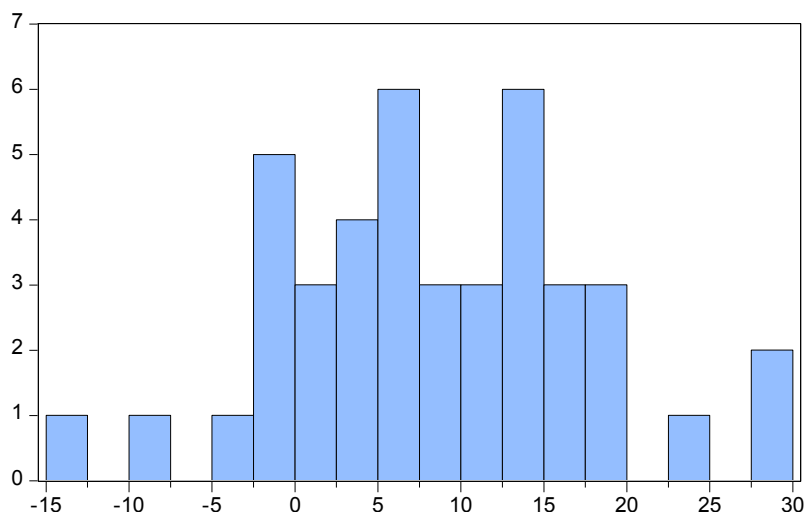
Method: Least Squares

Date: 08/29/13 Time: 20:18

Sample: 2010M01 2013M06

Included observations: 42

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_EDMONTON_SYN(-1)	-0.380263	0.121439	-3.131298	0.0032
C	3.232354	1.500442	2.154268	0.0373
R-squared	0.196868	Mean dependent var		0.135751
Adjusted R-squared	0.176790	S.D. dependent var		8.060196
S.E. of regression	7.313090	Akaike info criterion		6.863657
Sum squared resid	2139.251	Schwarz criterion		6.946403
Log likelihood	-142.1368	Hannan-Quinn criter.		6.893987
F-statistic	9.805029	Durbin-Watson stat		2.029915
Prob(F-statistic)	0.003248			



Series: BRENT_EDMONTON_SYN	
Sample 2010M01 2013M06	
Observations 42	
Mean	8.279074
Median	6.902585
Maximum	29.86808
Minimum	-12.50574
Std. Dev.	9.281611
Skewness	0.167926
Kurtosis	2.989951
Jarque-Bera	0.197571
Probability	0.905937

A.3 Brent-Maya

Full Sample

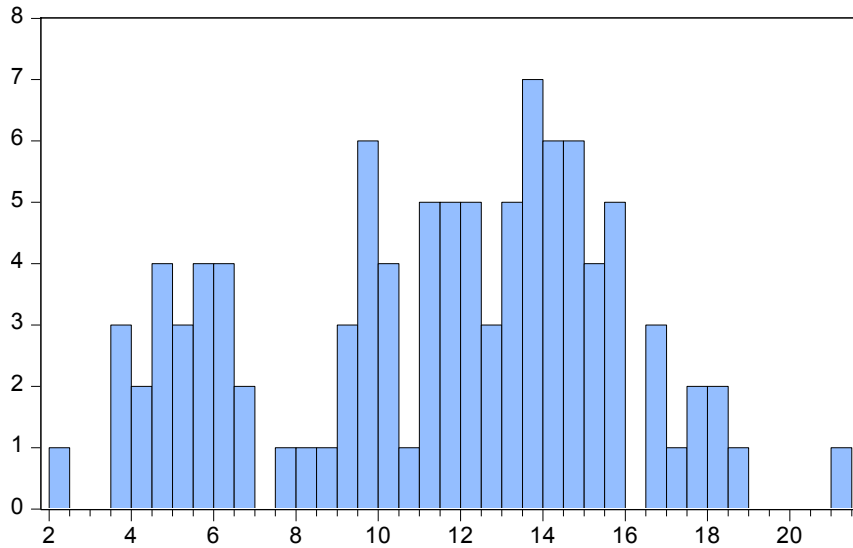
Null Hypothesis: BRENT_MAYA has a unit root
 Exogenous: Constant
 Lag Length: 1 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.857580	0.0034
Test critical values:		
1% level	-3.497727	
5% level	-2.890926	
10% level	-2.582514	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENT_MAYA)
 Method: Least Squares
 Date: 08/29/13 Time: 19:56
 Sample (adjusted): 2005M03 2013M05
 Included observations: 99 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_MAYA(-1)	-0.226267	0.058655	-3.857580	0.0002
D(BRENT_MAYA(-1))	0.323772	0.098259	3.295081	0.0014
C	2.524282	0.711492	3.547871	0.0006
R-squared	0.169207	Mean dependent var		-0.095556
Adjusted R-squared	0.151899	S.D. dependent var		2.485508
S.E. of regression	2.288964	Akaike info criterion		4.523910
Sum squared resid	502.9784	Schwarz criterion		4.602550
Log likelihood	-220.9336	Hannan-Quinn criter.		4.555728
F-statistic	9.776106	Durbin-Watson stat		1.898474
Prob(F-statistic)	0.000137			



Series: BREN_T_MAYA
Sample 2005M01 2013M06
Observations 101

Mean 11.37604
Median 12.03000
Maximum 21.01000
Minimum 2.310000
Std. Dev. 4.203667
Skewness -0.295525
Kurtosis 2.248861

Jarque-Bera 3.844521
Probability 0.146276

2005-09

Null Hypothesis: BREN_T_MAYA has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

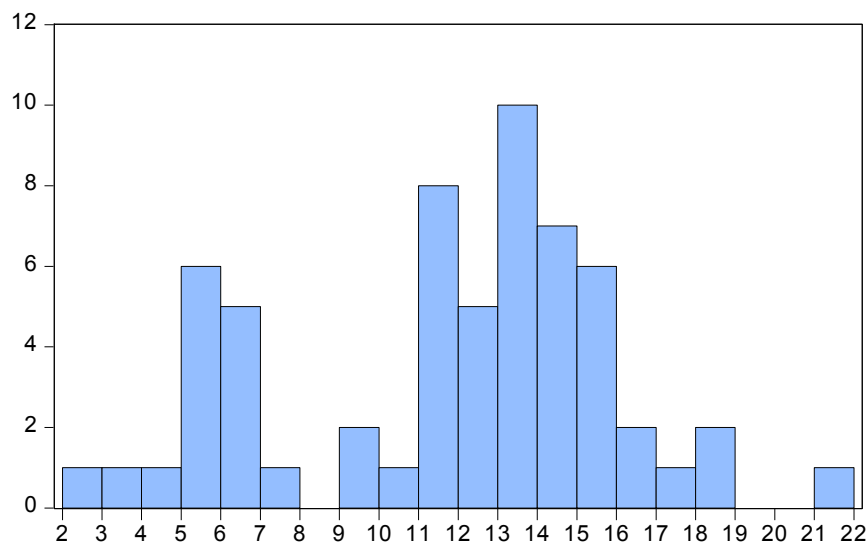
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.981466	0.2940
Test critical values:		
1% level	-3.546099	
5% level	-2.911730	
10% level	-2.593551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(BREN_T_MAYA)
Method: Least Squares
Date: 08/30/13 Time: 19:47
Sample (adjusted): 2005M02 2009M12
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BREN_T_MAYA(-1)	-0.139947	0.070628	-1.981466	0.0524
C	1.505158	0.885175	1.700408	0.0945

R-squared	0.064442	Mean dependent var	-0.150339
Adjusted R-squared	0.048029	S.D. dependent var	2.301814
S.E. of regression	2.245857	Akaike info criterion	4.489362
Sum squared resid	287.5009	Schwarz criterion	4.559787
Log likelihood	-130.4362	Hannan-Quinn criter.	4.516853
F-statistic	3.926209	Durbin-Watson stat	1.780815
Prob(F-statistic)	0.052370		



Series: BRENT_MAYA	
Sample 2005M01 2009M12	
Observations 60	
Mean	11.73150
Median	12.76000
Maximum	21.01000
Minimum	2.310000
Std. Dev.	4.208822
Skewness	-0.413688
Kurtosis	2.436696
Jarque-Bera	2.504656
Probability	0.285839

2010-11

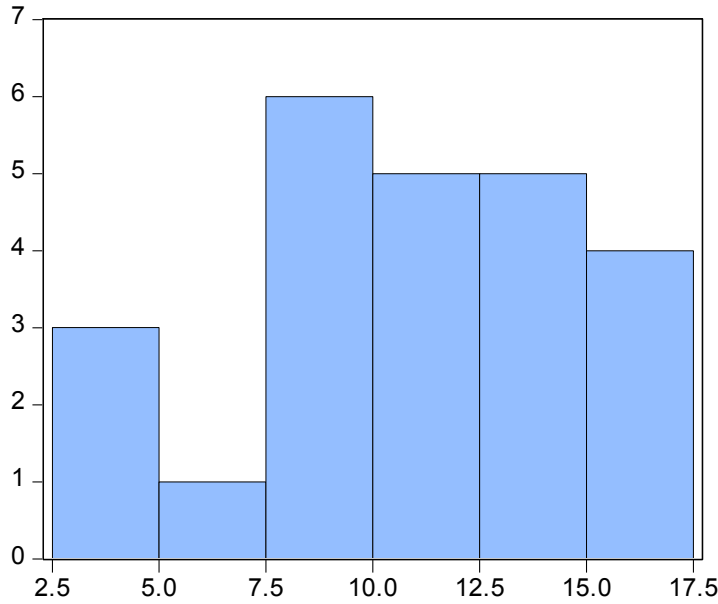
Null Hypothesis: BRENT_MAYA has a unit root
 Exogenous: Constant
 Lag Length: 1 (Automatic - based on SIC, maxlag=5)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.788018	0.3770
Test critical values:		
1% level	-3.737853	
5% level	-2.991878	
10% level	-2.635542	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENT_MAYA)
 Method: Least Squares
 Date: 08/29/13 Time: 19:55
 Sample: 2010M01 2011M12
 Included observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_MAYA(-1)	-0.224177	0.125378	-1.788018	0.0882
D(BRENT_MAYA(-1))	0.427660	0.204151	2.094824	0.0485
C	2.396618	1.459803	1.641741	0.1155
R-squared	0.216248	Mean dependent var		-0.100833
Adjusted R-squared	0.141605	S.D. dependent var		2.281298
S.E. of regression	2.113614	Akaike info criterion		4.451144
Sum squared resid	93.81463	Schwarz criterion		4.598401
Log likelihood	-50.41373	Hannan-Quinn criter.		4.490211
F-statistic	2.897095	Durbin-Watson stat		1.947027
Prob(F-statistic)	0.077424			



Series: BRENT_MAYA
Sample 2010M01 2011M12
Observations 24

Mean 11.01583
Median 10.35000
Maximum 17.16000
Minimum 3.530000
Std. Dev. 3.881287
Skewness -0.236327
Kurtosis 2.204477

Jarque-Bera 0.856258
Probability 0.651727

2010-12

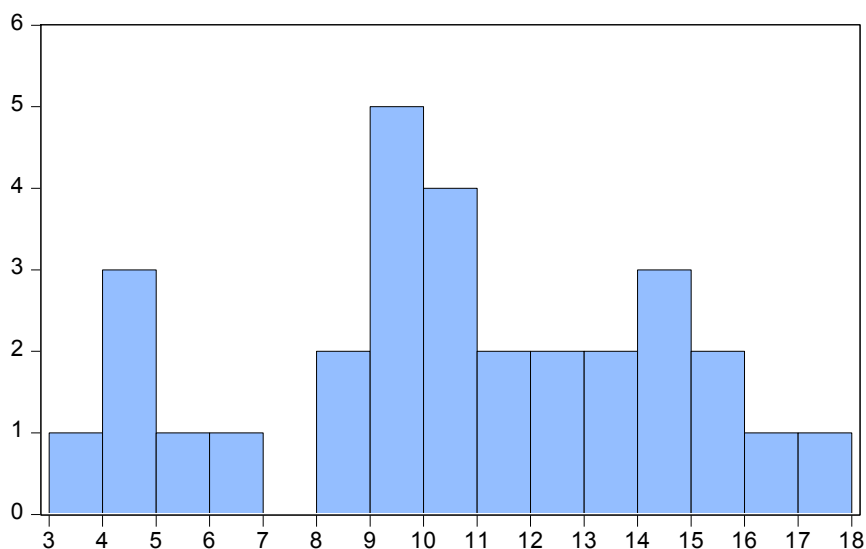
Null Hypothesis: BRENT_MAYA has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.888327	0.0586
Test critical values:		
1% level	-3.670170	
5% level	-2.963972	
10% level	-2.621007	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(BRENT_MAYA)
Method: Least Squares
Date: 08/30/13 Time: 19:48
Sample: 2010M01 2012M06
Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_MAYA(-1)	-0.310580	0.107529	-2.888327	0.0075
D(BRENT_MAYA(-1))	0.488531	0.165868	2.945302	0.0066
C	3.270262	1.203167	2.718045	0.0113
R-squared	0.331223	Mean dependent var		0.026333
Adjusted R-squared	0.281683	S.D. dependent var		2.494242
S.E. of regression	2.113959	Akaike info criterion		4.429642
Sum squared resid	120.6582	Schwarz criterion		4.569761
Log likelihood	-63.44462	Hannan-Quinn criter.		4.474467
F-statistic	6.686087	Durbin-Watson stat		1.825800
Prob(F-statistic)	0.004378			



Series: BRENT_MAYA	
Sample 2010M01 2012M06	
Observations 30	
Mean	10.67767
Median	10.35000
Maximum	17.16000
Minimum	3.530000
Std. Dev.	3.763303
Skewness	-0.135325
Kurtosis	2.199977
Jarque-Bera	0.891611
Probability	0.640308

2010-13

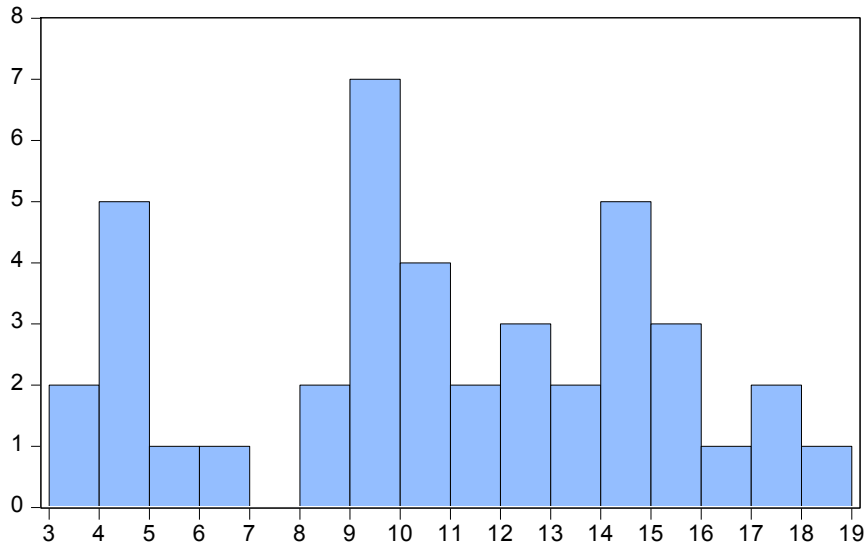
Null Hypothesis: BRENT_MAYA has a unit root
 Exogenous: Constant
 Lag Length: 1 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.577998	0.0106
Test critical values:		
1% level	-3.600987	
5% level	-2.935001	
10% level	-2.605836	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENT_MAYA)
 Method: Least Squares
 Date: 08/29/13 Time: 18:28
 Sample (adjusted): 2010M01 2013M05
 Included observations: 41 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_MAYA(-1)	-0.331170	0.092557	-3.577998	0.0010
D(BRENT_MAYA(-1))	0.542807	0.139534	3.890130	0.0004
C	3.585246	1.070714	3.348464	0.0018
R-squared	0.352207	Mean dependent var		-0.045854
Adjusted R-squared	0.318112	S.D. dependent var		2.735250
S.E. of regression	2.258673	Akaike info criterion		4.537788
Sum squared resid	193.8610	Schwarz criterion		4.663171
Log likelihood	-90.02465	Hannan-Quinn criter.		4.583445
F-statistic	10.33034	Durbin-Watson stat		1.931405
Prob(F-statistic)	0.000261			



Series: BREN_T_MAYA
Sample 2010M01 2013M06
Observations 41

Mean 10.85585
Median 10.39000
Maximum 18.07000
Minimum 3.510000
Std. Dev. 4.193058
Skewness -0.135194
Kurtosis 2.070355

Jarque-Bera 1.601304
Probability 0.449036

A.5 Brent-WCS

Full Sample

Null Hypothesis: BREN_T_WCS has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=12)

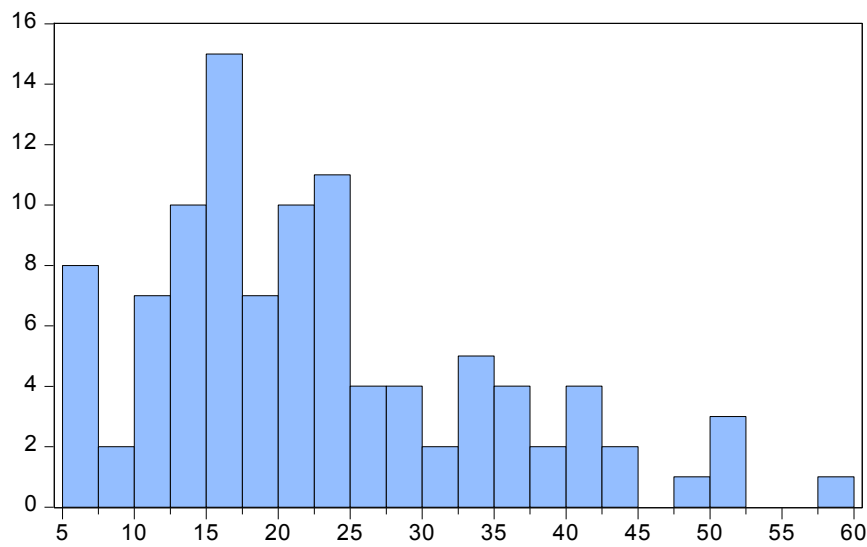
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.556341	0.5010
Test critical values:		
1% level	-3.498439	
5% level	-2.891234	
10% level	-2.582678	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(BREN_T_WCS)
Method: Least Squares
Date: 08/29/13 Time: 20:05
Sample (adjusted): 2005M05 2013M06
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BREN_T_WCS(-1)	-0.085066	0.054657	-1.556341	0.1230
D(BREN_T_WCS(-1))	0.073437	0.097065	0.756576	0.4512
D(BREN_T_WCS(-2))	-0.118826	0.097520	-1.218480	0.2261
D(BREN_T_WCS(-3))	-0.396124	0.098930	-4.004093	0.0001
C	2.137153	1.359952	1.571492	0.1195

R-squared	0.241411	Mean dependent var	0.068061
Adjusted R-squared	0.208784	S.D. dependent var	6.297183
S.E. of regression	5.601365	Akaike info criterion	6.333571
Sum squared resid	2917.902	Schwarz criterion	6.465457
Log likelihood	-305.3450	Hannan-Quinn criter.	6.386916
F-statistic	7.399019	Durbin-Watson stat	2.060121
Prob(F-statistic)	0.000032		



Series: BRENT_WCS
 Sample 2005M01 2013M06
 Observations 102

Mean 22.71892
 Median 20.82000
 Maximum 57.64000
 Minimum 5.660000
 Std. Dev. 11.62244
 Skewness 0.880791
 Kurtosis 3.251297

Jarque-Bera 13.45686
 Probability 0.001196

2005-2009

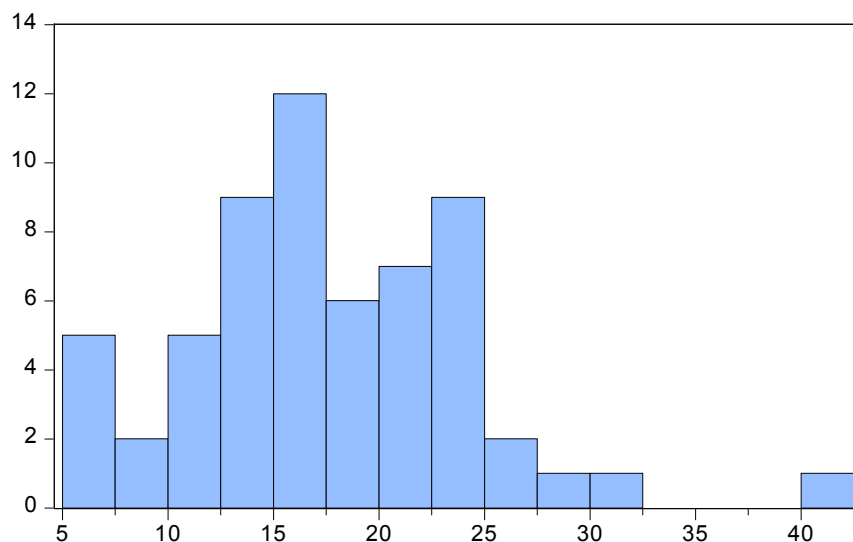
Null Hypothesis: BRENT_WCS has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.947875	0.0460
Test critical values:		
1% level	-3.546099	
5% level	-2.911730	
10% level	-2.593551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENT_WCS)
 Method: Least Squares
 Date: 08/29/13 Time: 20:06
 Sample (adjusted): 2005M02 2009M12
 Included observations: 59 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_WCS(-1)	-0.268385	0.091044	-2.947875	0.0046
C	4.689234	1.709665	2.742780	0.0081
R-squared	0.132288	Mean dependent var		-0.042712
Adjusted R-squared	0.117065	S.D. dependent var		4.810256
S.E. of regression	4.519940	Akaike info criterion		5.888185
Sum squared resid	1164.502	Schwarz criterion		5.958610
Log likelihood	-171.7015	Hannan-Quinn criter.		5.915676
F-statistic	8.689969	Durbin-Watson stat		2.082480
Prob(F-statistic)	0.004631			



Series: BRENT_WCS
Sample 2005M01 2009M12
Observations 60

Mean 17.54683
Median 16.97500
Maximum 40.91000
Minimum 5.660000
Std. Dev. 6.496291
Skewness 0.661808
Kurtosis 4.496748

Jarque-Bera 9.980540
Probability 0.006804

2010-11

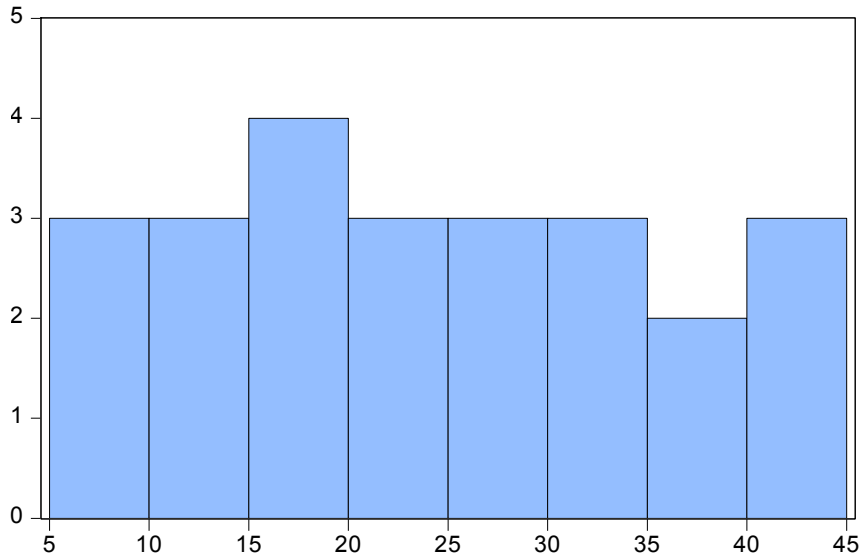
Null Hypothesis: BRENT_WCS has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=5)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-0.894824	0.7721
Test critical values:		
1% level	-3.737853	
5% level	-2.991878	
10% level	-2.635542	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(BRENT_WCS)
Method: Least Squares
Date: 08/29/13 Time: 20:07
Sample: 2010M01 2011M12
Included observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_WCS(-1)	-0.086920	0.097136	-0.894824	0.3821
D(BRENT_WCS(-1))	0.166201	0.202483	0.820814	0.4219
D(BRENT_WCS(-2))	-0.305445	0.196322	-1.555841	0.1362
D(BRENT_WCS(-3))	-0.511900	0.220831	-2.318065	0.0318
C	3.334065	2.394685	1.392277	0.1799
R-squared	0.461777	Mean dependent var		0.351667
Adjusted R-squared	0.348466	S.D. dependent var		6.279746
S.E. of regression	5.068862	Akaike info criterion		6.267162
Sum squared resid	488.1739	Schwarz criterion		6.512590
Log likelihood	-70.20594	Hannan-Quinn criter.		6.332274
F-statistic	4.075332	Durbin-Watson stat		1.694507
Prob(F-statistic)	0.014979			



Series: BRENT_WCS	
Sample 2010M01 2011M12	
Observations 24	
Mean	23.75042
Median	22.92500
Maximum	43.71000
Minimum	5.840000
Std. Dev.	11.77491
Skewness	0.116346
Kurtosis	1.785100
Jarque-Bera	1.530127
Probability	0.465304

2010-12

Null Hypothesis: BRENT_WCS has a unit root
 Exogenous: Constant
 Lag Length: 3 (Automatic - based on SIC, maxlag=7)

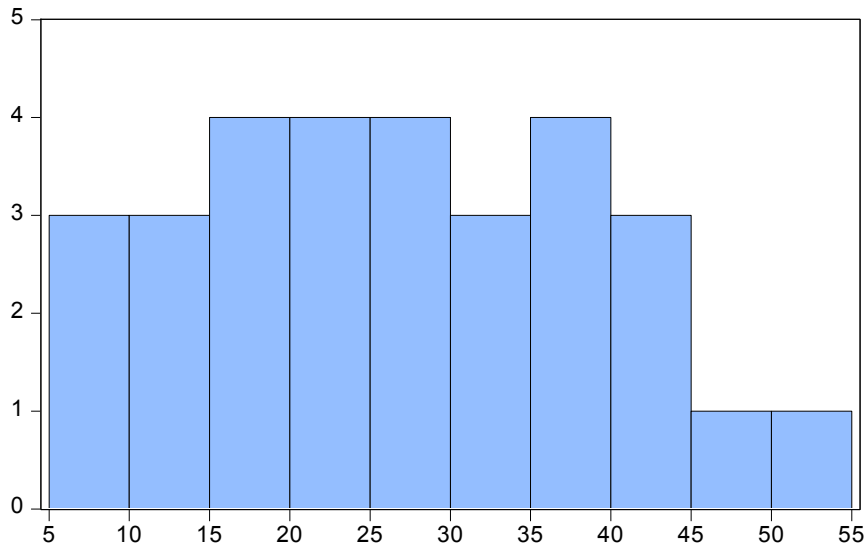
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-0.710503	0.8292
Test critical values:		
1% level	-3.670170	
5% level	-2.963972	
10% level	-2.621007	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENT_WCS)
 Method: Least Squares
 Date: 08/29/13 Time: 20:08
 Sample: 2010M01 2012M06
 Included observations: 30

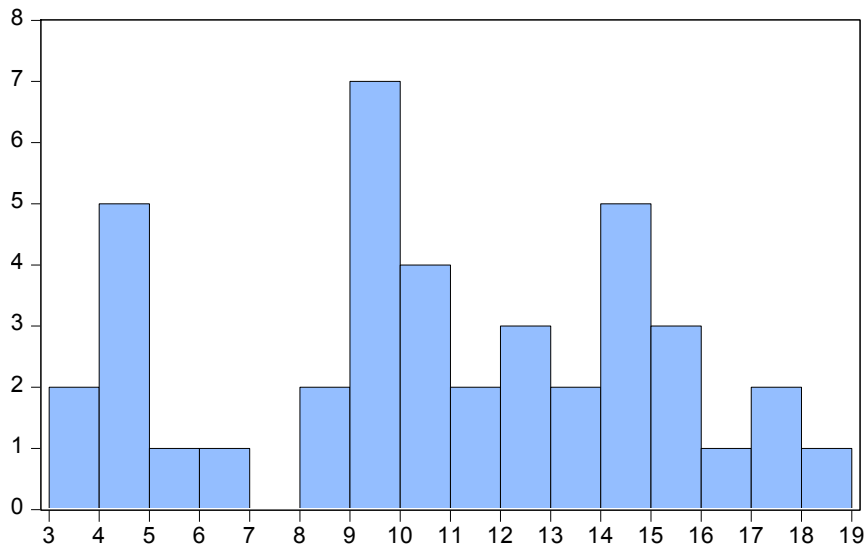
Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_WCS(-1)	-0.063479	0.089344	-0.710503	0.4840
D(BRENT_WCS(-1))	0.283271	0.178222	1.589431	0.1245
D(BRENT_WCS(-2))	-0.329683	0.185119	-1.780926	0.0871
D(BRENT_WCS(-3))	-0.494059	0.194161	-2.544580	0.0175
C	3.120822	2.344830	1.330938	0.1952

R-squared	0.556707	Mean dependent var	0.540667
Adjusted R-squared	0.485780	S.D. dependent var	7.190277
S.E. of regression	5.156083	Akaike info criterion	6.269243
Sum squared resid	664.6299	Schwarz criterion	6.502776
Log likelihood	-89.03865	Hannan-Quinn criter.	6.343953
F-statistic	7.849036	Durbin-Watson stat	1.898949
Prob(F-statistic)	0.000305		



Series: BRENT_WCS	
Sample 2010M01 2012M06	
Observations 30	
Mean	26.47800
Median	25.65000
Maximum	50.44000
Minimum	5.840000
Std. Dev.	12.66037
Skewness	0.087059
Kurtosis	2.043774
Jarque-Bera	1.180858
Probability	0.554090

2010-13



Series: BRENT_MAYA	
Sample 2010M01 2013M06	
Observations 41	
Mean	10.85585
Median	10.39000
Maximum	18.07000
Minimum	3.510000
Std. Dev.	4.193058
Skewness	-0.135194
Kurtosis	2.070355
Jarque-Bera	1.601304
Probability	0.449036

Null Hypothesis: BRENT_WCS has a unit root
 Exogenous: Constant
 Lag Length: 3 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.545841	0.5009
Test critical values:		
1% level	-3.596616	
5% level	-2.933158	
10% level	-2.604867	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENT_WCS)
 Method: Least Squares
 Date: 08/29/13 Time: 20:07
 Sample: 2010M01 2013M06
 Included observations: 42

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_WCS(-1)	-0.122805	0.079442	-1.545841	0.1307
D(BRENT_WCS(-1))	0.197539	0.141102	1.399967	0.1699
D(BRENT_WCS(-2))	-0.158624	0.143831	-1.102848	0.2772
D(BRENT_WCS(-3))	-0.499846	0.145406	-3.437594	0.0015
C	4.460584	2.495908	1.787159	0.0821
R-squared	0.448776	Mean dependent var		0.356190
Adjusted R-squared	0.389184	S.D. dependent var		7.842368
S.E. of regression	6.129180	Akaike info criterion		6.575343
Sum squared resid	1389.973	Schwarz criterion		6.782208
Log likelihood	-133.0822	Hannan-Quinn criter.		6.651167
F-statistic	7.530835	Durbin-Watson stat		1.794998
Prob(F-statistic)	0.000152			

A.6 Brent-WTI

Full Sample

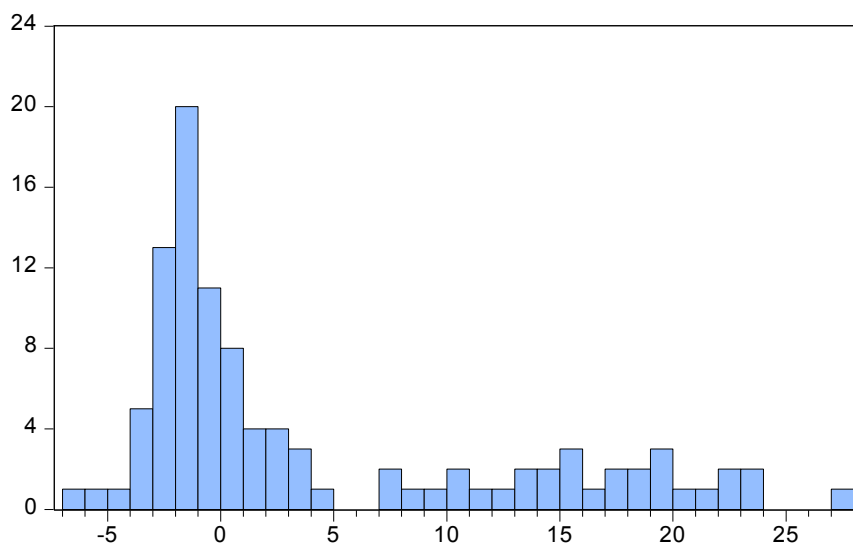
BRENT WTI full
 Exogenous: Constant
 Lag Length: 1 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.021755	0.2772
Test critical values:		
1% level	-3.497029	
5% level	-2.890623	
10% level	-2.582353	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENT_WTI)
 Method: Least Squares
 Date: 08/29/13 Time: 19:57
 Sample (adjusted): 2005M03 2013M06
 Included observations: 100 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_WTI(-1)	-0.060794	0.030070	-2.021755	0.0460
D(BRENT_WTI(-1))	0.248099	0.098182	2.526942	0.0131
C	0.324987	0.282687	1.149637	0.2531
R-squared	0.086338	Mean dependent var		0.098200
Adjusted R-squared	0.067500	S.D. dependent var		2.631637
S.E. of regression	2.541267	Akaike info criterion		4.732744
Sum squared resid	626.4298	Schwarz criterion		4.810899
Log likelihood	-233.6372	Hannan-Quinn criter.		4.764374
F-statistic	4.583112	Durbin-Watson stat		1.925882
Prob(F-statistic)	0.012534			



Series: BREN_TWTI
 Sample 2005M01 2013M06
 Observations 102

Mean 4.119804
 Median -0.165000
 Maximum 27.31000
 Minimum -6.880000
 Std. Dev. 8.531605
 Skewness 1.096640
 Kurtosis 2.820848

Jarque-Bera 20.58094
 Probability 0.000034

2005-2009

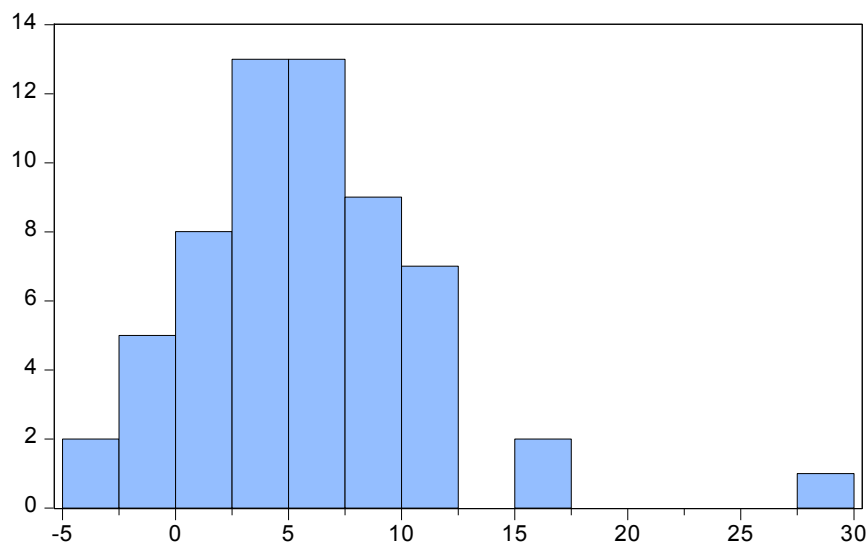
Null Hypothesis: BREN_TWTI has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.540433	0.0102
Test critical values:		
1% level	-3.546099	
5% level	-2.911730	
10% level	-2.593551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BREN_TWTI)
 Method: Least Squares
 Date: 08/29/13 Time: 19:58
 Sample: 2005M02 2009M12
 Included observations: 59

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BREN_TWTI(-1)	-0.360238	0.101750	-3.540433	0.0008
C	-0.377333	0.244982	-1.540249	0.1290
R-squared	0.180265	Mean dependent var		0.039322
Adjusted R-squared	0.165884	S.D. dependent var		1.807074
S.E. of regression	1.650400	Akaike info criterion		3.873223
Sum squared resid	155.2578	Schwarz criterion		3.943648
Log likelihood	-112.2601	Hannan-Quinn criter.		3.900714
F-statistic	12.53467	Durbin-Watson stat		1.659789
Prob(F-statistic)	0.000804			



Series: MAYA_WCS
 Sample 2005M01 2009M12
 Observations 60

Mean 5.815333
 Median 5.695000
 Maximum 27.51000
 Minimum -3.290000
 Std. Dev. 5.288952
 Skewness 1.162081
 Kurtosis 6.371814

Jarque-Bera 41.92714
 Probability 0.000000

2010-11

Null Hypothesis: BRENT_WTI has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic - based on SIC, maxlag=5)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.491655	0.5205
Test critical values:		
1% level	-3.737853	
5% level	-2.991878	
10% level	-2.635542	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(BRENT_WTI)

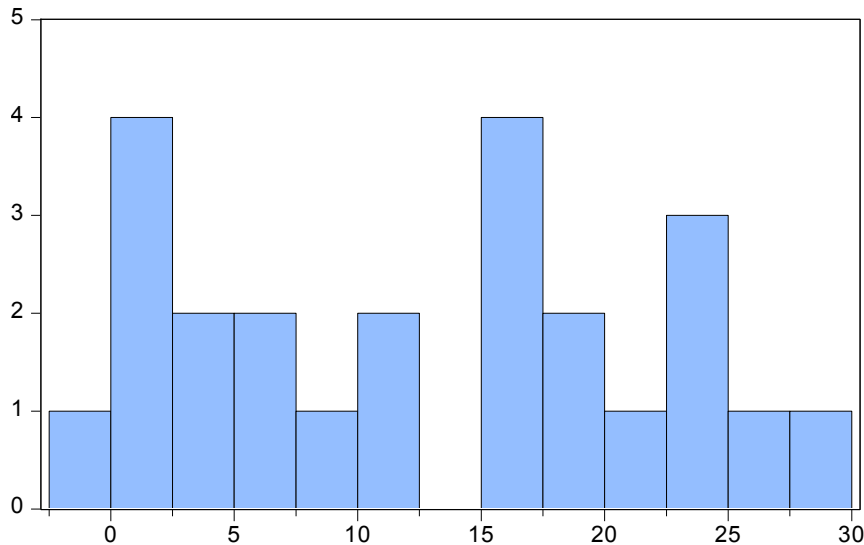
Method: Least Squares

Date: 08/29/13 Time: 20:03

Sample: 2010M01 2011M12

Included observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_WTI(-1)	-0.112046	0.075115	-1.491655	0.1507
D(BRENT_WTI(-1))	0.414540	0.204167	2.030394	0.0552
C	1.011527	0.907173	1.115032	0.2774
R-squared	0.208583	Mean dependent var		0.388333
Adjusted R-squared	0.133210	S.D. dependent var		3.650543
S.E. of regression	3.398713	Akaike info criterion		5.401139
Sum squared resid	242.5762	Schwarz criterion		5.548396
Log likelihood	-61.81367	Hannan-Quinn criter.		5.440206
F-statistic	2.767342	Durbin-Watson stat		1.879127
Prob(F-statistic)	0.085754			



Series: MAYA_WCS	
Sample 2010M01 2011M12	
Observations 24	
Mean	12.73458
Median	13.90500
Maximum	29.38000
Minimum	-1.470000
Std. Dev.	9.353514
Skewness	0.050965
Kurtosis	1.677675
Jarque-Bera	1.758934
Probability	0.415004

2010-12

Null Hypothesis: BRENT_WTI has a unit root
 Exogenous: Constant
 Lag Length: 1 (Automatic - based on SIC, maxlag=7)

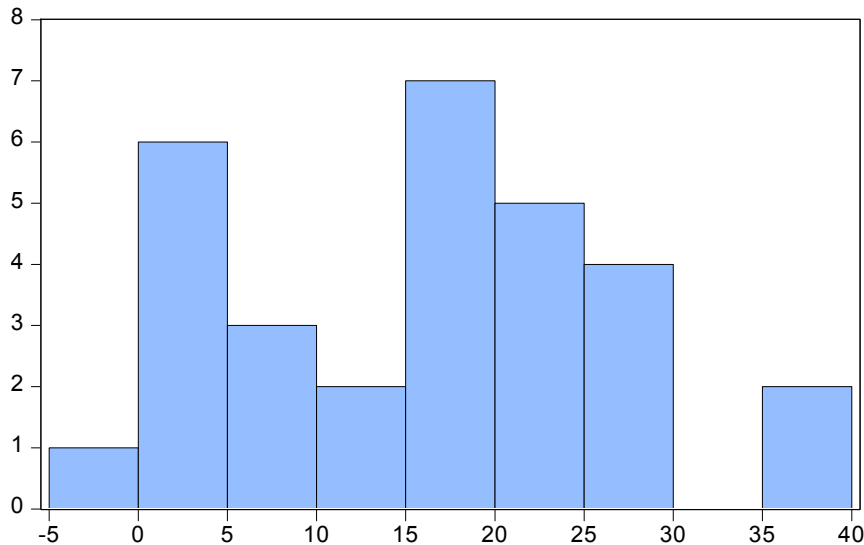
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.696002	0.4230
Test critical values:		
1% level	-3.670170	
5% level	-2.963972	
10% level	-2.621007	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(BRENT_WTI)
 Method: Least Squares
 Date: 08/29/13 Time: 20:01
 Sample: 2010M01 2012M06
 Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_WTI(-1)	-0.117208	0.069108	-1.696002	0.1014
D(BRENT_WTI(-1))	0.374805	0.178042	2.105150	0.0447
C	1.298785	0.876914	1.481087	0.1502

R-squared	0.189645	Mean dependent var	0.429000
Adjusted R-squared	0.129618	S.D. dependent var	3.582636
S.E. of regression	3.342393	Akaike info criterion	5.345891
Sum squared resid	301.6329	Schwarz criterion	5.486010
Log likelihood	-77.18836	Hannan-Quinn criter.	5.390716
F-statistic	3.159359	Durbin-Watson stat	1.739173
Prob(F-statistic)	0.058495		



Series: MAYA_WCS
Sample 2010M01 2012M06
Observations 30

Mean 15.80033
Median 17.16500
Maximum 38.23000
Minimum -1.470000
Std. Dev. 10.89384
Skewness 0.128998
Kurtosis 2.179655

Jarque-Bera 0.924411
Probability 0.629893

2010-13

Null Hypothesis: BRENT_WTI has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

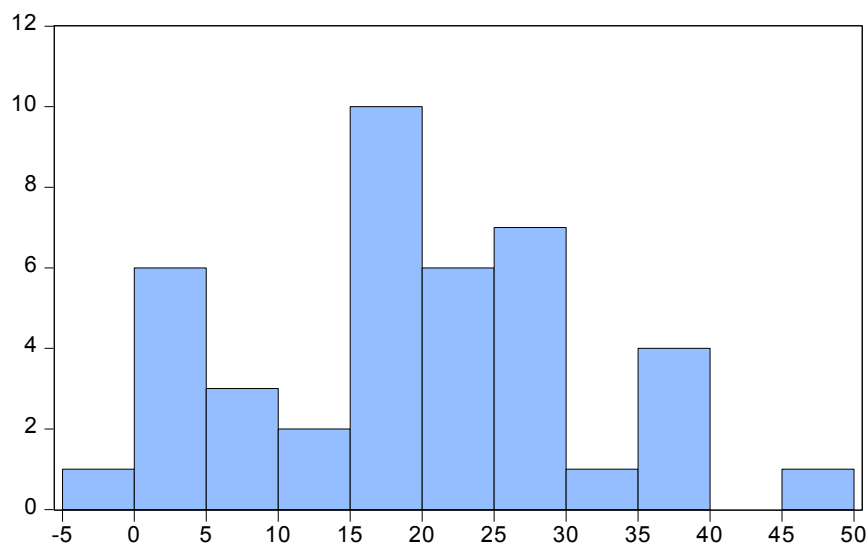
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.950677	0.3068
Test critical values:		
1% level	-3.596616	
5% level	-2.933158	
10% level	-2.604867	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(BRENT_WTI)
Method: Least Squares
Date: 08/29/13 Time: 19:59
Sample: 2010M01 2013M06
Included observations: 42

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_WTI(-1)	-0.113974	0.058428	-1.950677	0.0583
D(BRENT_WTI(-1))	0.327297	0.147795	2.214539	0.0327
C	1.403491	0.834500	1.681835	0.1006

R-squared	0.164225	Mean dependent var	0.170476
Adjusted R-squared	0.121365	S.D. dependent var	3.478133
S.E. of regression	3.260246	Akaike info criterion	5.270232
Sum squared resid	414.5390	Schwarz criterion	5.394351
Log likelihood	-107.6749	Hannan-Quinn criter.	5.315726
F-statistic	3.831651	Durbin-Watson stat	1.869710
Prob(F-statistic)	0.030251		



Series: MAYA_WCS
Sample 2010M01 2013M06
Observations 41

Mean 19.31463
Median 19.44000
Maximum 47.95000
Minimum -1.470000
Std. Dev. 11.96671
Skewness 0.091100
Kurtosis 2.446930

Jarque-Bera 0.579267
Probability 0.748538

A.6 Maya WCS

Full Sample

Null Hypothesis: MAYA_WCS has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.807873	0.0607
Test critical values: 1% level	-3.497029	
5% level	-2.890623	
10% level	-2.582353	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(MAYA_WCS)

Method: Least Squares

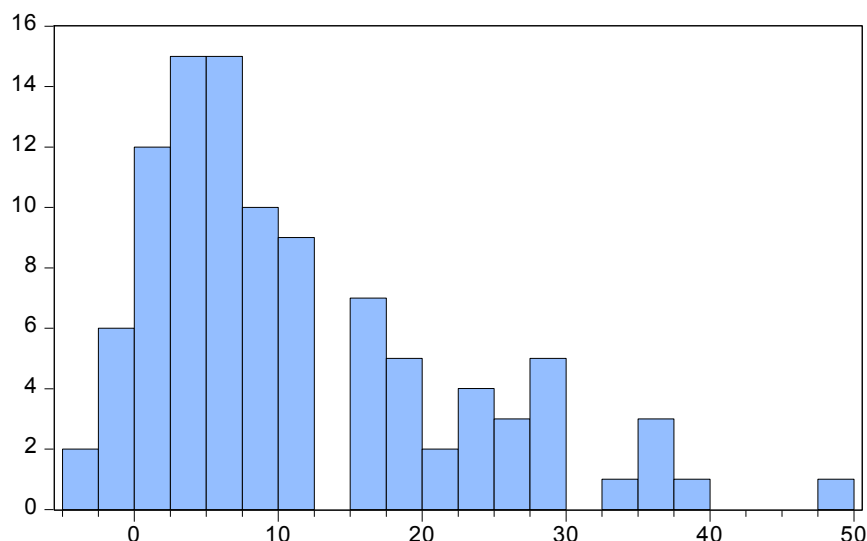
Date: 08/29/13 Time: 20:34

Sample (adjusted): 2005M02 2013M05

Included observations: 100 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MAYA_WCS(-1)	-0.145303	0.051748	-2.807873	0.0060
C	1.805033	0.808246	2.233272	0.0278

R-squared	0.074460	Mean dependent var	0.172900
Adjusted R-squared	0.065016	S.D. dependent var	5.807902
S.E. of regression	5.615927	Akaike info criterion	6.308888
Sum squared resid	3090.786	Schwarz criterion	6.360991
Log likelihood	-313.4444	Hannan-Quinn criter.	6.329975
F-statistic	7.884153	Durbin-Watson stat	1.837214
Prob(F-statistic)	0.006019		



Series: MAYA_WCS
 Sample 2005M01 2013M06
 Observations 101

Mean 11.29525
 Median 7.760000
 Maximum 47.95000
 Minimum -3.290000
 Std. Dev. 10.87060
 Skewness 1.080995
 Kurtosis 3.584676

Jarque-Bera 21.10920
 Probability 0.000026

2005-09

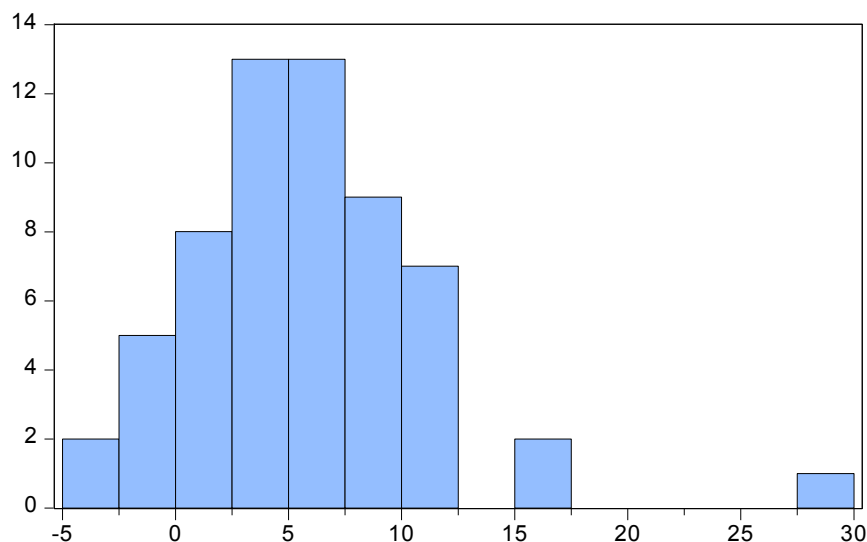
Null Hypothesis: MAYA_WCS has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.272777	0.0012
Test critical values:		
1% level	-3.546099	
5% level	-2.911730	
10% level	-2.593551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(MAYA_WCS)
 Method: Least Squares
 Date: 08/29/13 Time: 20:32
 Sample (adjusted): 2005M02 2009M12
 Included observations: 59 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MAYA_WCS(-1)	-0.475720	0.111338	-4.272777	0.0001
C	2.867612	0.873993	3.281048	0.0018
R-squared	0.242592	Mean dependent var		0.107627
Adjusted R-squared	0.229304	S.D. dependent var		5.151206
S.E. of regression	4.522208	Akaike info criterion		5.889188
Sum squared resid	1165.671	Schwarz criterion		5.959613
Log likelihood	-171.7310	Hannan-Quinn criter.		5.916679
F-statistic	18.25662	Durbin-Watson stat		1.949077
Prob(F-statistic)	0.000074			



Series: MAYA_WCS
 Sample 2005M01 2009M12
 Observations 60

Mean 5.815333
 Median 5.695000
 Maximum 27.51000
 Minimum -3.290000
 Std. Dev. 5.288952
 Skewness 1.162081
 Kurtosis 6.371814

Jarque-Bera 41.92714
 Probability 0.000000

2010-11

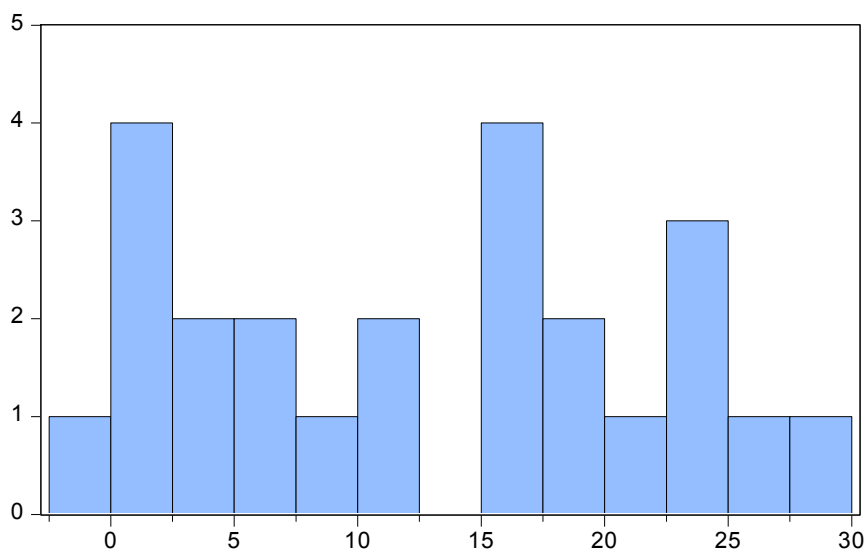
Null Hypothesis: MAYA_WCS has a unit root
 Exogenous: Constant
 Lag Length: 3 (Automatic - based on SIC, maxlag=4)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	0.288305	0.9723
Test critical values:		
1% level	-3.752946	
5% level	-2.998064	
10% level	-2.638752	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(MAYA_WCS)
 Method: Least Squares
 Date: 08/29/13 Time: 20:32
 Sample: 2010M01 2011M11
 Included observations: 23

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MAYA_WCS(-1)	0.034801	0.120707	0.288305	0.7764
D(MAYA_WCS(-1))	-0.204470	0.231231	-0.884268	0.3882
D(MAYA_WCS(-2))	-0.446865	0.191618	-2.332063	0.0315
D(MAYA_WCS(-3))	-0.631201	0.225353	-2.800943	0.0118
C	1.397529	1.529859	0.913502	0.3731
R-squared	0.466165	Mean dependent var		0.523913
Adjusted R-squared	0.347535	S.D. dependent var		5.299270
S.E. of regression	4.280500	Akaike info criterion		5.935677
Sum squared resid	329.8083	Schwarz criterion		6.182523
Log likelihood	-63.26028	Hannan-Quinn criter.		5.997758
F-statistic	3.929576	Durbin-Watson stat		1.897197
Prob(F-statistic)	0.018293			



Series: MAYA_WCS
Sample 2010M01 2011M12
Observations 24

Mean 12.73458
Median 13.90500
Maximum 29.38000
Minimum -1.470000
Std. Dev. 9.353514
Skewness 0.050965
Kurtosis 1.677675

Jarque-Bera 1.758934
Probability 0.415004

2010-12

Null Hypothesis: MAYA_WCS has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=7)

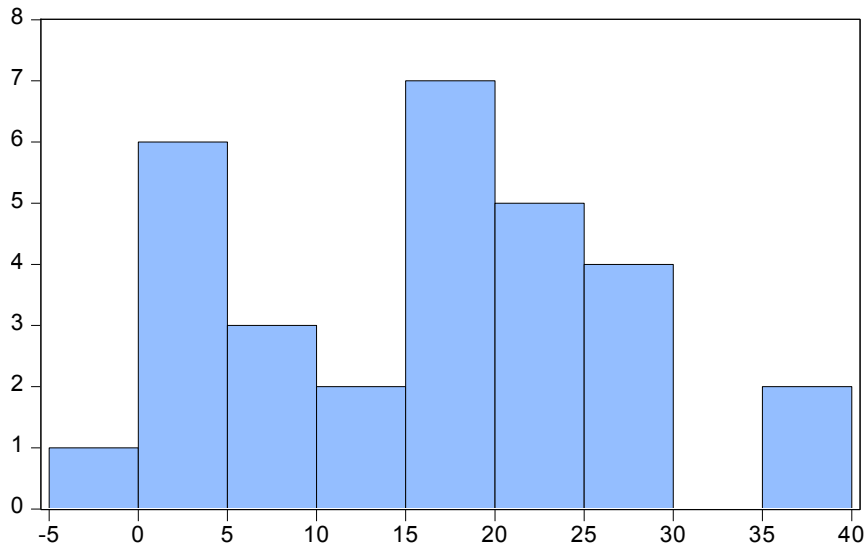
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-0.030571	0.9483
Test critical values:		
1% level	-3.670170	
5% level	-2.963972	
10% level	-2.621007	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MAYA_WCS)
Method: Least Squares
Date: 08/29/13 Time: 20:31
Sample: 2010M01 2012M06
Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MAYA_WCS(-1)	-0.002927	0.095740	-0.030571	0.9759
D(MAYA_WCS(-1))	0.048750	0.189752	0.256912	0.7993
D(MAYA_WCS(-2))	-0.440083	0.186431	-2.360573	0.0264
D(MAYA_WCS(-3))	-0.505533	0.204454	-2.472606	0.0206
C	1.604828	1.542626	1.040322	0.3081

R-squared	0.441907	Mean dependent var	0.514333
Adjusted R-squared	0.352612	S.D. dependent var	5.725914
S.E. of regression	4.607094	Akaike info criterion	6.044084
Sum squared resid	530.6330	Schwarz criterion	6.277616
Log likelihood	-85.66125	Hannan-Quinn criter.	6.118793
F-statistic	4.948851	Durbin-Watson stat	2.029289
Prob(F-statistic)	0.004450		



Series: MAYA_WCS
Sample 2010M01 2012M06
Observations 30

Mean 15.80033
Median 17.16500
Maximum 38.23000
Minimum -1.470000
Std. Dev. 10.89384
Skewness 0.128998
Kurtosis 2.179655

Jarque-Bera 0.924411
Probability 0.629893

2010-13

Null Hypothesis: BRENT_WTI has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

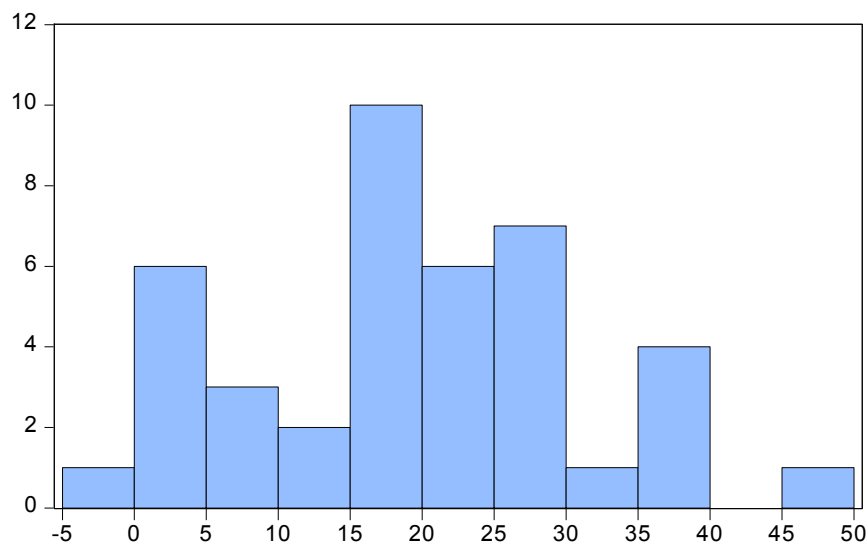
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.950677	0.3068
Test critical values:		
1% level	-3.596616	
5% level	-2.933158	
10% level	-2.604867	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(BRENT_WTI)
Method: Least Squares
Date: 08/29/13 Time: 19:59
Sample: 2010M01 2013M06
Included observations: 42

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRENT_WTI(-1)	-0.113974	0.058428	-1.950677	0.0583
D(BRENT_WTI(-1))	0.327297	0.147795	2.214539	0.0327
C	1.403491	0.834500	1.681835	0.1006

R-squared	0.164225	Mean dependent var	0.170476
Adjusted R-squared	0.121365	S.D. dependent var	3.478133
S.E. of regression	3.260246	Akaike info criterion	5.270232
Sum squared resid	414.5390	Schwarz criterion	5.394351
Log likelihood	-107.6749	Hannan-Quinn criter.	5.315726
F-statistic	3.831651	Durbin-Watson stat	1.869710
Prob(F-statistic)	0.030251		



Series: MAYA_WCS
Sample 2010M01 2013M06
Observations 41

Mean 19.31463
Median 19.44000
Maximum 47.95000
Minimum -1.470000
Std. Dev. 11.96671
Skewness 0.091100
Kurtosis 2.446930

Jarque-Bera 0.579267
Probability 0.748538

A.7 WTI-WCS

Full

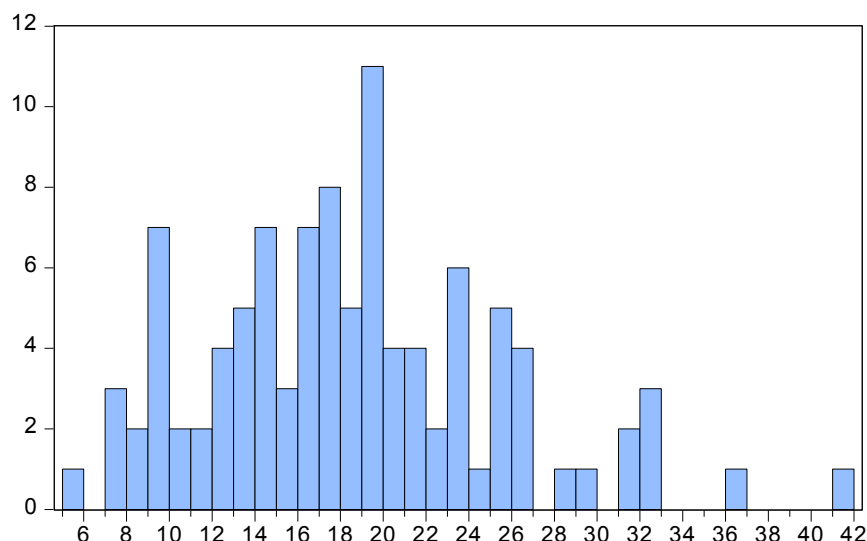
Null Hypothesis: WTI_WCS has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.071700	0.0017
Test critical values: 1% level	-3.496346	
5% level	-2.890327	
10% level	-2.582196	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(WTI_WCS)
Method: Least Squares
Date: 08/30/13 Time: 17:37
Sample (adjusted): 2005M02 2013M06
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
WTI_WCS(-1)	-0.287070	0.070504	-4.071700	0.0001
C	5.363498	1.396972	3.839374	0.0002
R-squared	0.143441	Mean dependent var		0.029307
Adjusted R-squared	0.134789	S.D. dependent var		5.240519
S.E. of regression	4.874559	Akaike info criterion		6.025540
Sum squared resid	2352.371	Schwarz criterion		6.077324
Log likelihood	-302.2897	Hannan-Quinn criter.		6.046503
F-statistic	16.57874	Durbin-Watson stat		1.741209
Prob(F-statistic)	0.000094			



Series: WTI_WCS	
Sample 2005M01 2013M06	
Observations 102	
Mean	18.59912
Median	18.02500
Maximum	41.67000
Minimum	5.890000
Std. Dev.	6.881890
Skewness	0.635662
Kurtosis	3.540383
Jarque-Bera	8.110195
Probability	0.017334

2005-09

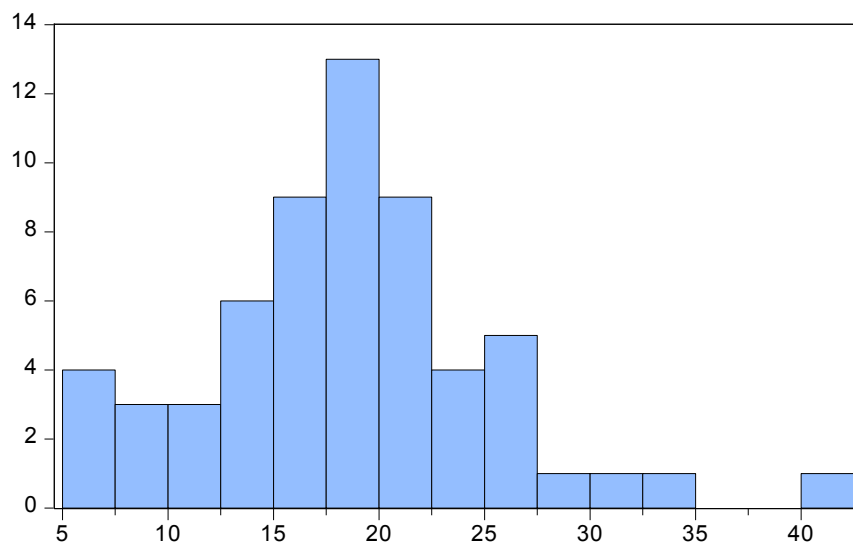
Null Hypothesis: WTI_WCS has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.691762	0.0816
Test critical values:		
1% level	-3.548208	
5% level	-2.912631	
10% level	-2.594027	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(WTI_WCS)
 Method: Least Squares
 Date: 08/30/13 Time: 17:38
 Sample (adjusted): 2005M02 2009M11
 Included observations: 58 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
WTI_WCS(-1)	-0.235356	0.087436	-2.691762	0.0094
C	4.368308	1.751056	2.494671	0.0156
R-squared	0.114563	Mean dependent var		-0.077241
Adjusted R-squared	0.098751	S.D. dependent var		4.668145
S.E. of regression	4.431662	Akaike info criterion		5.849301
Sum squared resid	1099.819	Schwarz criterion		5.920350
Log likelihood	-167.6297	Hannan-Quinn criter.		5.876976
F-statistic	7.245581	Durbin-Watson stat		2.112257
Prob(F-statistic)	0.009355			



Series: WTI_WCS	
Sample 2005M01 2009M12	
Observations 60	
Mean	18.68433
Median	18.30500
Maximum	41.67000
Minimum	5.890000
Std. Dev.	6.691296
Skewness	0.555266
Kurtosis	4.220836
Jarque-Bera	6.809302
Probability	0.033218

2010-11

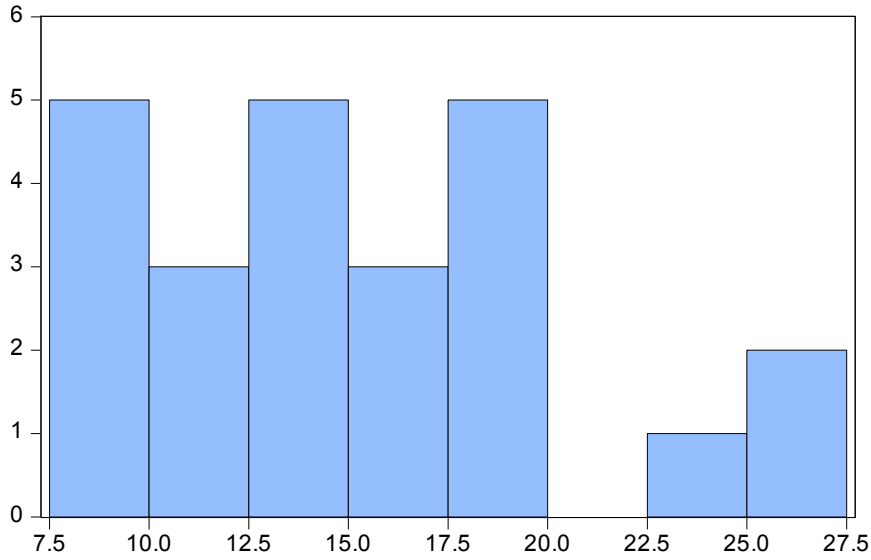
Null Hypothesis: WTI_WCS has a unit root
 Exogenous: Constant
 Lag Length: 3 (Automatic - based on SIC, maxlag=5)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-0.983699	0.7422
Test critical values:		
1% level	-3.737853	
5% level	-2.991878	
10% level	-2.635542	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(WTI_WCS)
 Method: Least Squares
 Date: 08/30/13 Time: 17:38
 Sample: 2010M01 2011M12
 Included observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
WTI_WCS(-1)	-0.183483	0.186524	-0.983699	0.3376
D(WTI_WCS(-1))	0.043988	0.223232	0.197051	0.8459
D(WTI_WCS(-2))	-0.304964	0.192407	-1.584997	0.1295
D(WTI_WCS(-3))	-0.474790	0.203190	-2.336678	0.0306
C	2.890334	2.977308	0.970788	0.3439
R-squared	0.497376	Mean dependent var		-0.036667
Adjusted R-squared	0.391560	S.D. dependent var		4.110903
S.E. of regression	3.206609	Akaike info criterion		5.351357
Sum squared resid	195.3645	Schwarz criterion		5.596785
Log likelihood	-59.21628	Hannan-Quinn criter.		5.416469
F-statistic	4.700405	Durbin-Watson stat		1.805940
Prob(F-statistic)	0.008310			



Series: WTI_WCS
 Sample 2010M01 2011M12
 Observations 24

Mean 15.49708
 Median 14.68000
 Maximum 25.18000
 Minimum 8.480000
 Std. Dev. 4.991942
 Skewness 0.468262
 Kurtosis 2.303293

Jarque-Bera 1.362477
 Probability 0.505990

2010-12

Null Hypothesis: WTI_WCS has a unit root
 Exogenous: Constant
 Lag Length: 1 (Automatic - based on SIC, maxlag=7)

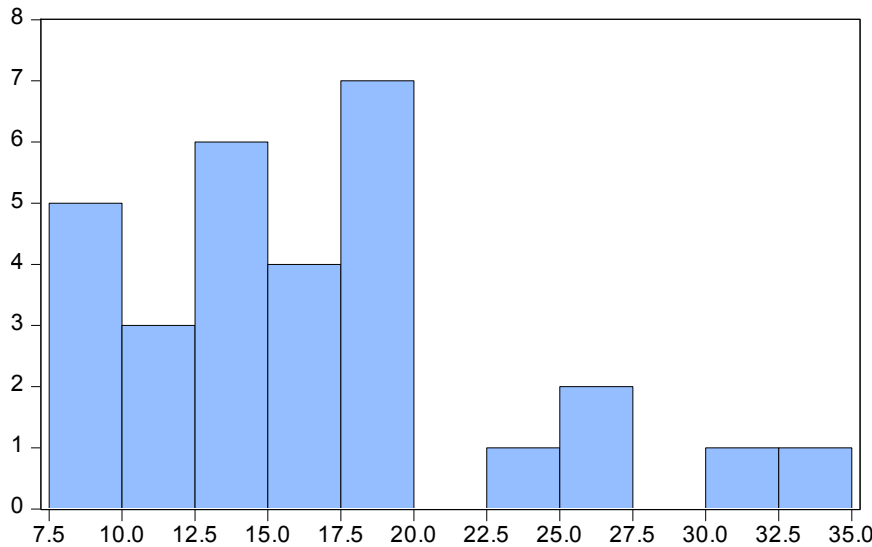
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.690537	0.0095
Test critical values:		
1% level	-3.670170	
5% level	-2.963972	
10% level	-2.621007	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(WTI_WCS)
 Method: Least Squares
 Date: 08/30/13 Time: 17:39
 Sample: 2010M01 2012M06
 Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
WTI_WCS(-1)	-0.507876	0.137616	-3.690537	0.0010
D(WTI_WCS(-1))	0.485845	0.168583	2.881932	0.0077
C	8.487683	2.409586	3.522465	0.0015

R-squared	0.370856	Mean dependent var	0.111667
Adjusted R-squared	0.324253	S.D. dependent var	5.119424
S.E. of regression	4.208362	Akaike info criterion	5.806664
Sum squared resid	478.1785	Schwarz criterion	5.946783
Log likelihood	-84.09996	Hannan-Quinn criter.	5.851489
F-statistic	7.957734	Durbin-Watson stat	1.769630
Prob(F-statistic)	0.001919		



Series: WTI_WCS	
Sample 2010M01 2012M06	
Observations 30	
Mean	16.81500
Median	15.58500
Maximum	32.92000
Minimum	8.480000
Std. Dev.	6.166105
Skewness	0.915386
Kurtosis	3.462795
Jarque-Bera	4.457386
Probability	0.107669

2010-13

Null Hypothesis: WTI_WCS has a unit root
 Exogenous: Constant
 Lag Length: 1 (Automatic - based on SIC, maxlag=9)

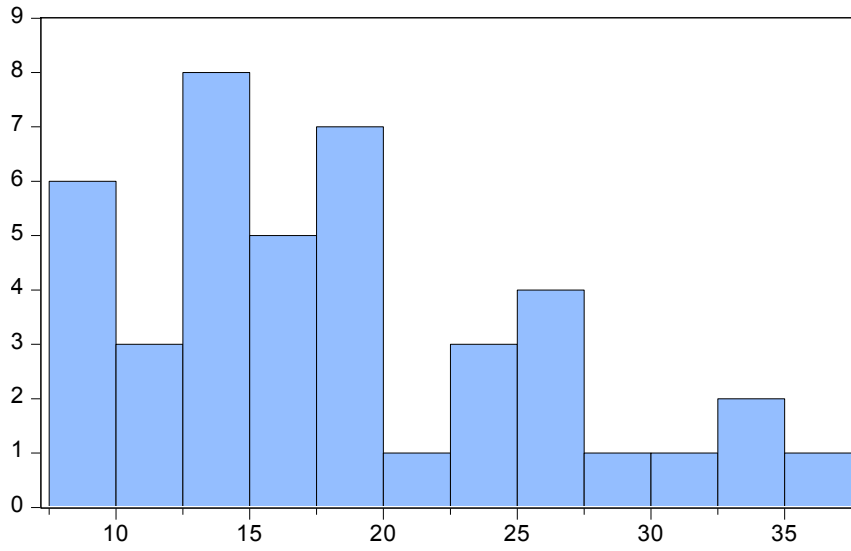
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.093379	0.0026
Test critical values:		
1% level	-3.596616	
5% level	-2.933158	
10% level	-2.604867	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(WTI_WCS)
 Method: Least Squares
 Date: 08/30/13 Time: 17:39
 Sample: 2010M01 2013M06
 Included observations: 42

Variable	Coefficient	Std. Error	t-Statistic	Prob.
WTI_WCS(-1)	-0.492338	0.120277	-4.093379	0.0002
D(WTI_WCS(-1))	0.416954	0.146765	2.840962	0.0071
C	9.185037	2.336539	3.931044	0.0003

R-squared	0.320569	Mean dependent var	0.185714
Adjusted R-squared	0.285726	S.D. dependent var	6.053313
S.E. of regression	5.115942	Akaike info criterion	6.171349
Sum squared resid	1020.741	Schwarz criterion	6.295468
Log likelihood	-126.5983	Hannan-Quinn criter.	6.216844
F-statistic	9.200470	Durbin-Watson stat	1.806091
Prob(F-statistic)	0.000533		



Series: WTI_WCS
 Sample 2010M01 2013M06
 Observations 42

Mean 18.47738
 Median 16.59000
 Maximum 36.90000
 Minimum 8.480000
 Std. Dev. 7.225817
 Skewness 0.732589
 Kurtosis 2.796420

Jarque-Bera 3.829334
 Probability 0.147391