Physical Market Conditions, Paper Market Activity & the WTI-Brent Spread

1

Bahattin Büyükşahin

Thomas Lee

Jim Moser

Michel Robe[*]

Physical Market Conditions, Paper Market Activity & the WTI-Brent Spread

2

Bahattin Büyükşahin

Thomas Lee

Jim Moser

Michel Robe[*]

*THIS PRESENTATION REFLECTS THE OPINIONS OF ITS AUTHORS ONLY AND NOT THOSE OF THE INTERNATIONAL ENERGY AGENCY (OECD-IEA) OR MEMBER COUNTRIES, THE U.S. DEPARTMENT OF ENERGY (EIA), ITS ADMINISTRATOR, THE U.S. COMMODITIES FUTURES TRADING COMMISSION (CFTC), THE COMMISSIONERS, OR THE AUTHORS' COLLEAGUES UPON THE STAFFS OF ANY OF THESE INSTITUTIONS.
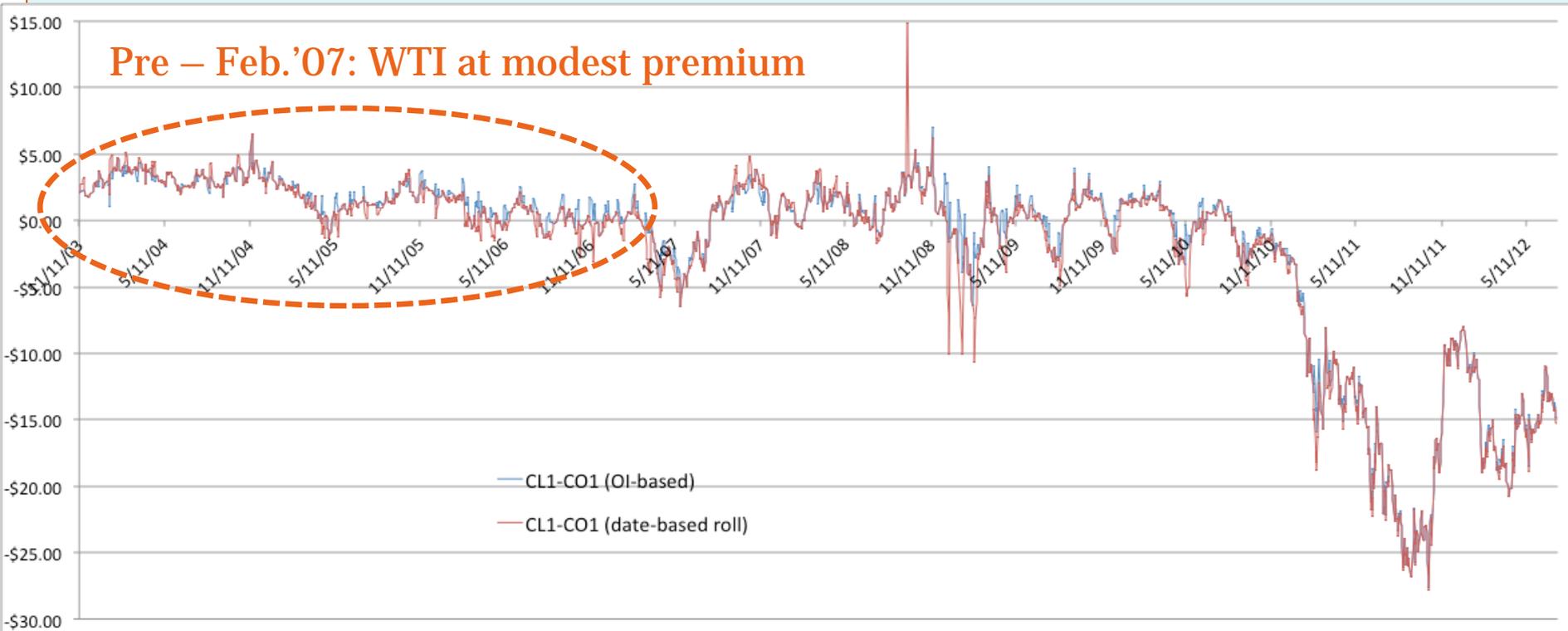
I. Outline of Today's Talk

○ **Provide visual & statistical evidence of <u>breaks</u> in crude oil benchmark price <u>Spreads</u>**

  ✗ WTI-Brent nearby futures spread = "Landlock" spread + "Transatlantic" Spread + Brent nearby spread

  ✗ → Question: Which of these three spreads have experienced structural breaks?

  ✗ → *Robustness checks:*   *Inland "quality" spread (WTI-WTS) ; Near-dated WTI calendar spread*

○ **Provide evidence on <u>Economic, Infrastructure and Financial Variables</u> linked to Spreads**

  ✗ Demand-side fundamentals: World, US

  ✗ Supply-side factors: Output capacity (OPEC, Brent); Output (Canada, US);

    ○ *Infrastructure bottlenecks*:   Storage capacity and utilization *(Cushing, OK)*; Pipelines *(land to sea)*

  ✗ Financial variables: Paper market liquidity; stress; CIT long positions; "insider" net positions

○ **<u>Econometric analysis</u>**

  ✗ Energy Fundamentals *or* Trading Activity?

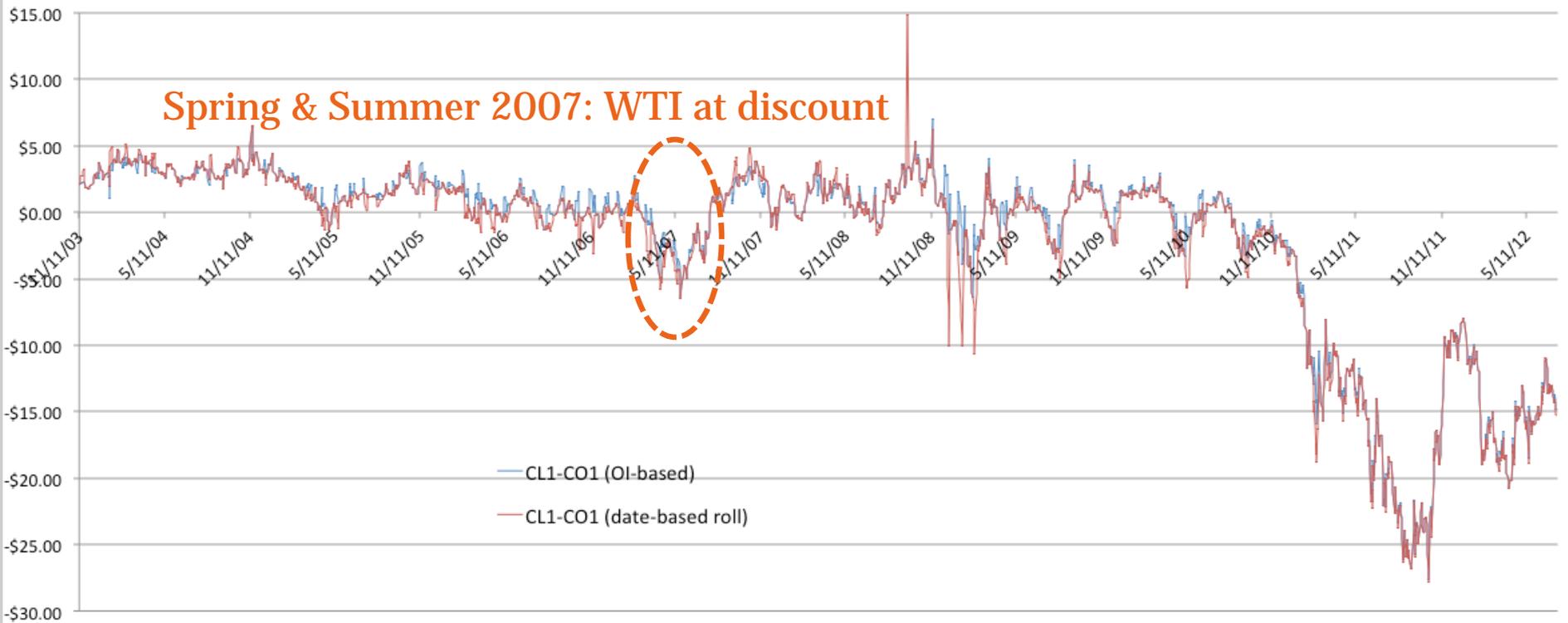   → Which of those variables help predict long run variations in WTI-Brent spreads?
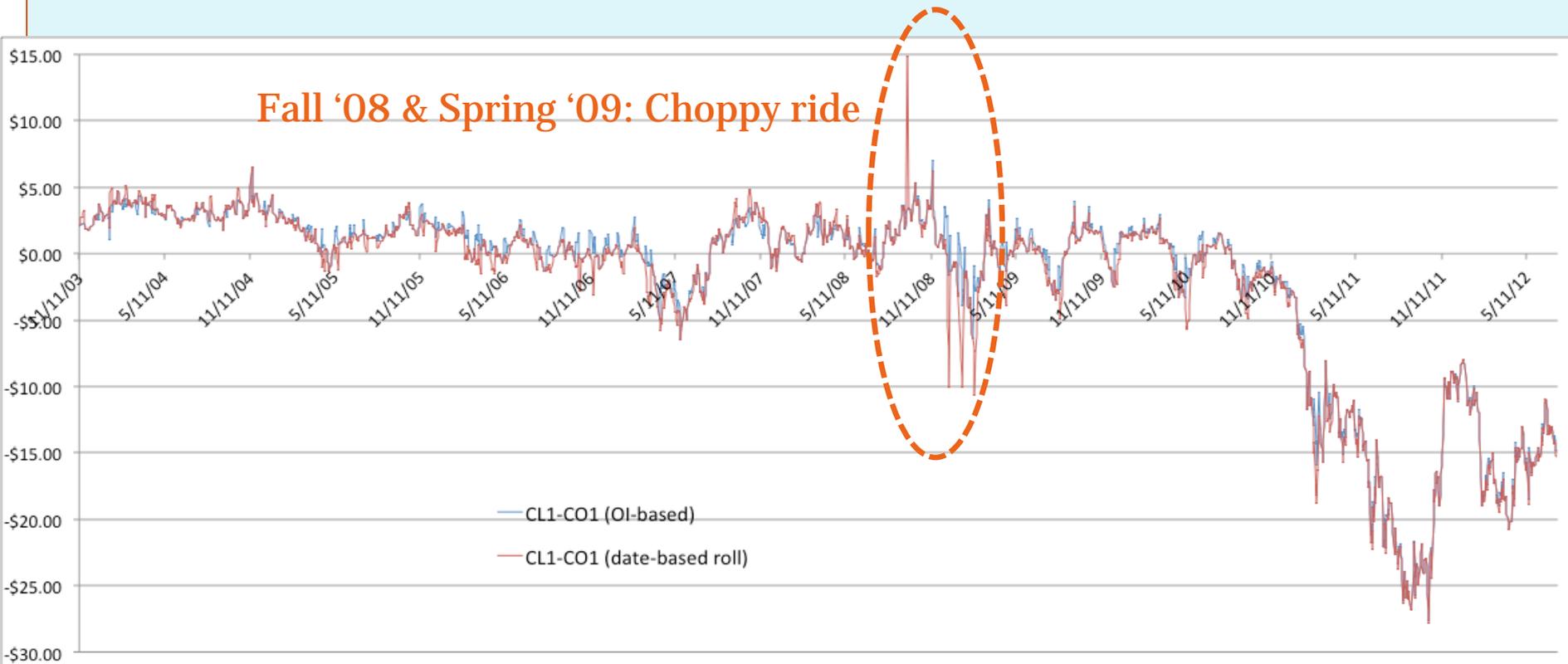
Background: *How Life Was*

Pre – Feb.'07: WTI at modest premium

Legend:
- CL1-CO1 (OI-based)
- CL1-CO1 (date-based roll)

Fundamentals: *February/March 2007*

Spring & Summer 2007: WTI at discount

CL1-CO1 (OI-based)
CL1-CO1 (date-based roll)

Fundamentals: *2008 Crisis*

Fall '08 & Spring '09: Choppy ride

Legend:
- CL1-CO1 (OI-based)
- CL1-CO1 (date-based roll)

Fundamentals: *Political Shocks 2011-2012*
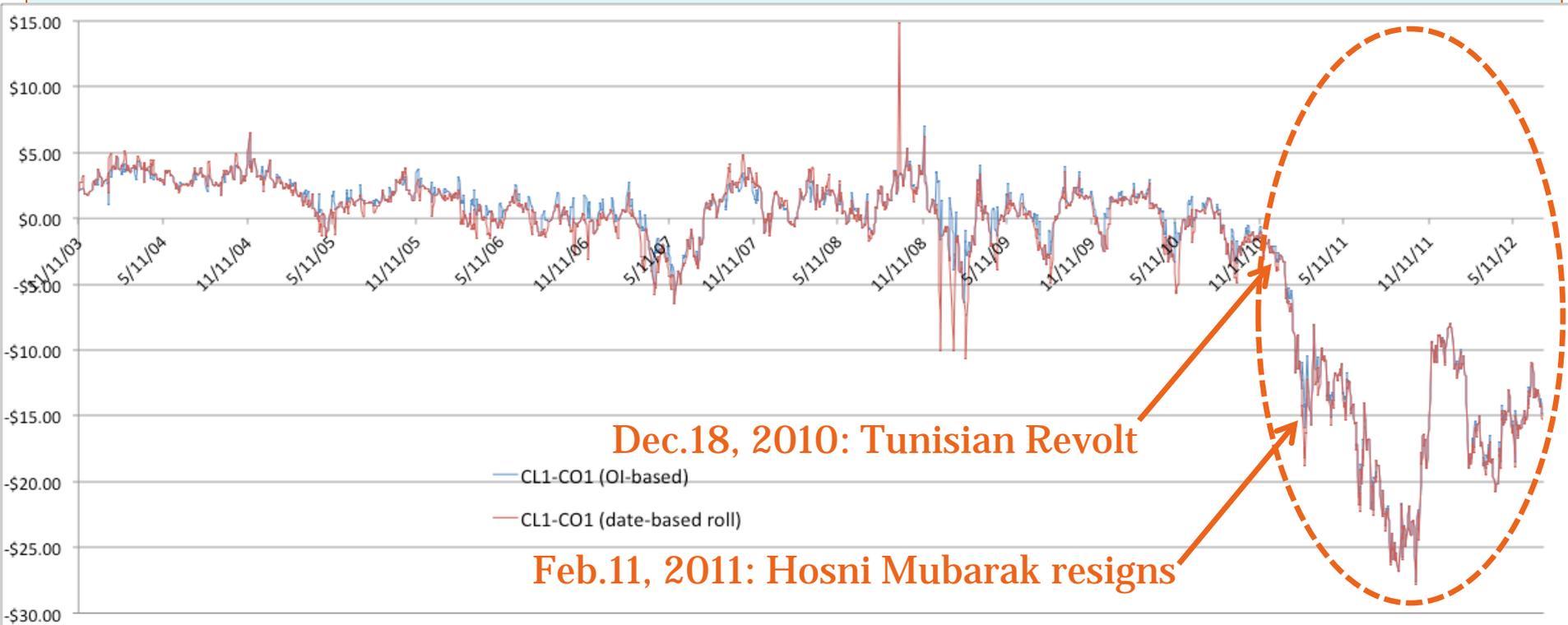
Dec.18, 2010: Tunisian Revolt

Feb.11, 2011: Hosni Mubarak resigns

Legend: CL1-CO1 (OI-based); CL1-CO1 (date-based roll)

Observation: *WTI Futures Expiry is Special*

Sept. 22, 2008

Dec. 19, 2008
(Jan. 2009 & Feb. 2009 too)

CL1-CO1 (OI-based)
CL1-CO1 (date-based roll)

Observation: *WTI Futures Expiry is Special*

CL1-CO1 (OI-based)

WTI-Brent Price Spread – Most Active Near-term Contracts

Legend: CL1-CO1 (OI-based)
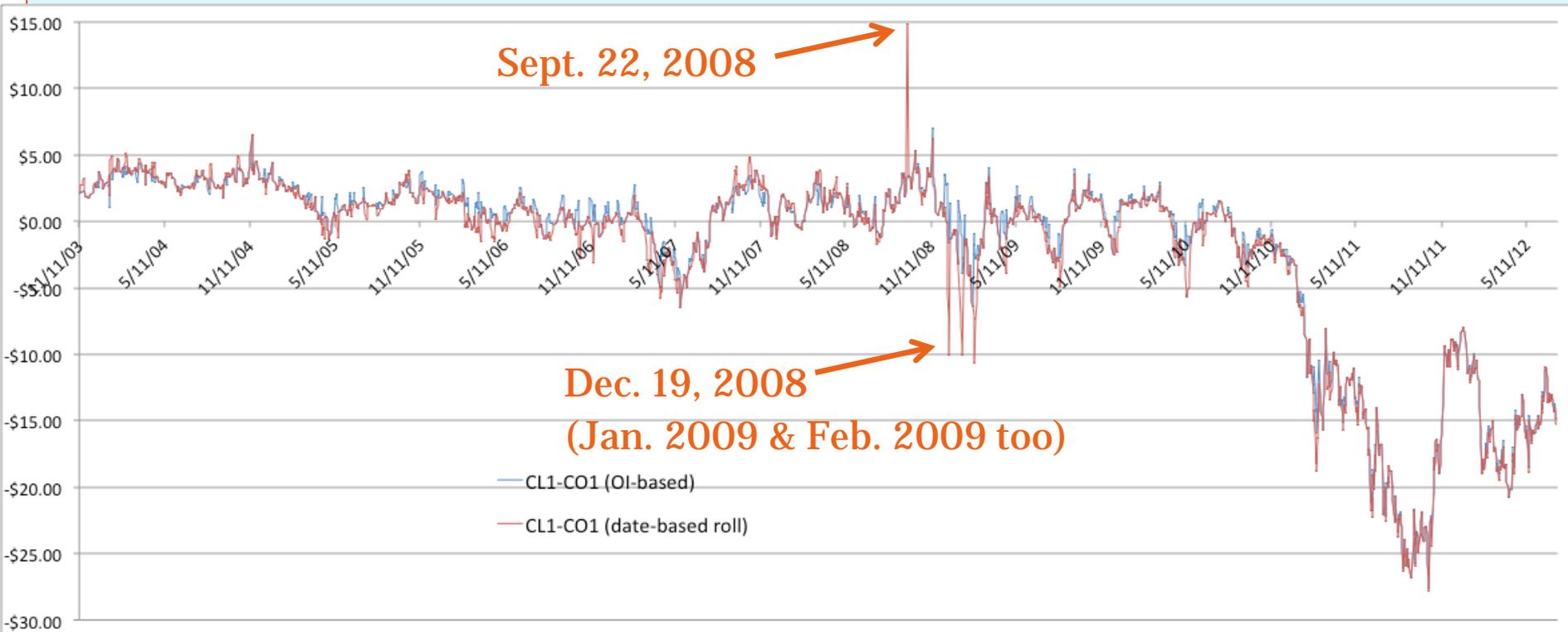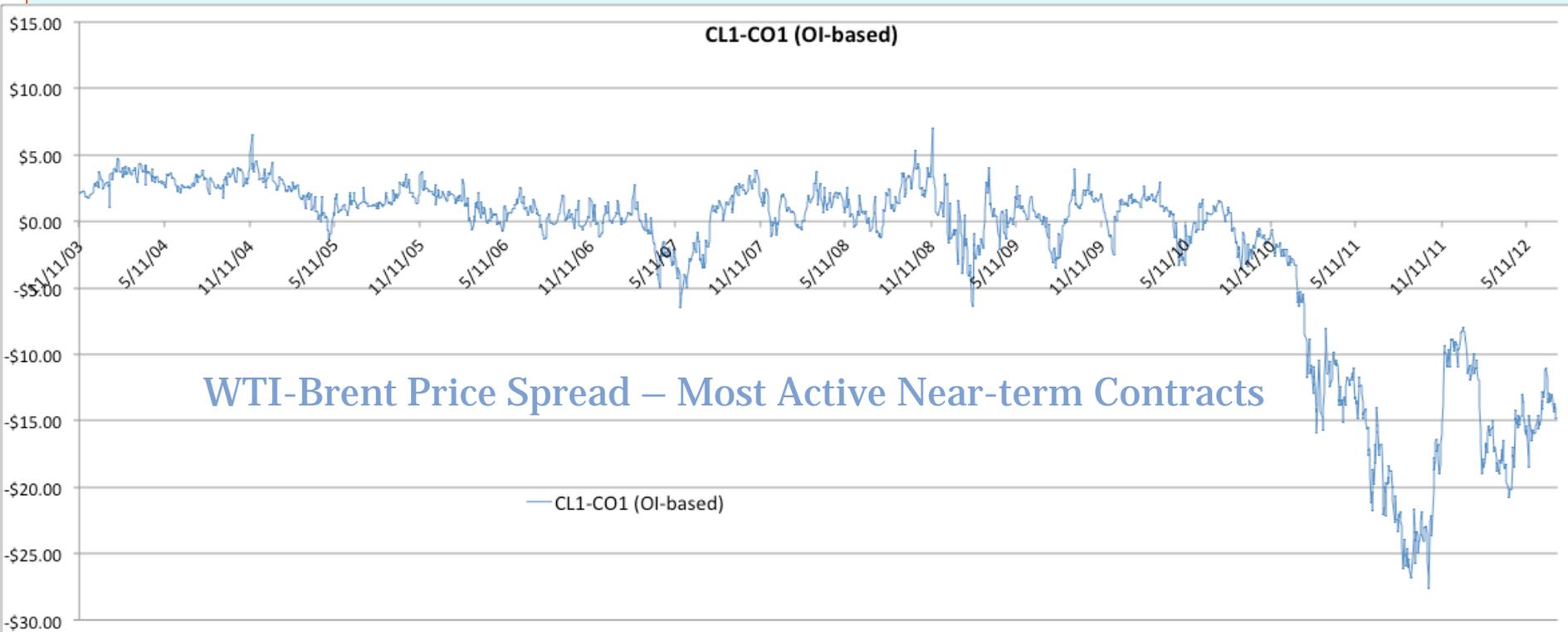
Observation: *Expiry Issues Matter...*

WTI-Brent Price Spread – Prompt Contracts (calendar-based roll)

WTI-Brent Price Spread – Most Active Near-term Contracts

CL1-CO1 (OI-based)
CL1-CO1 (date-based roll)
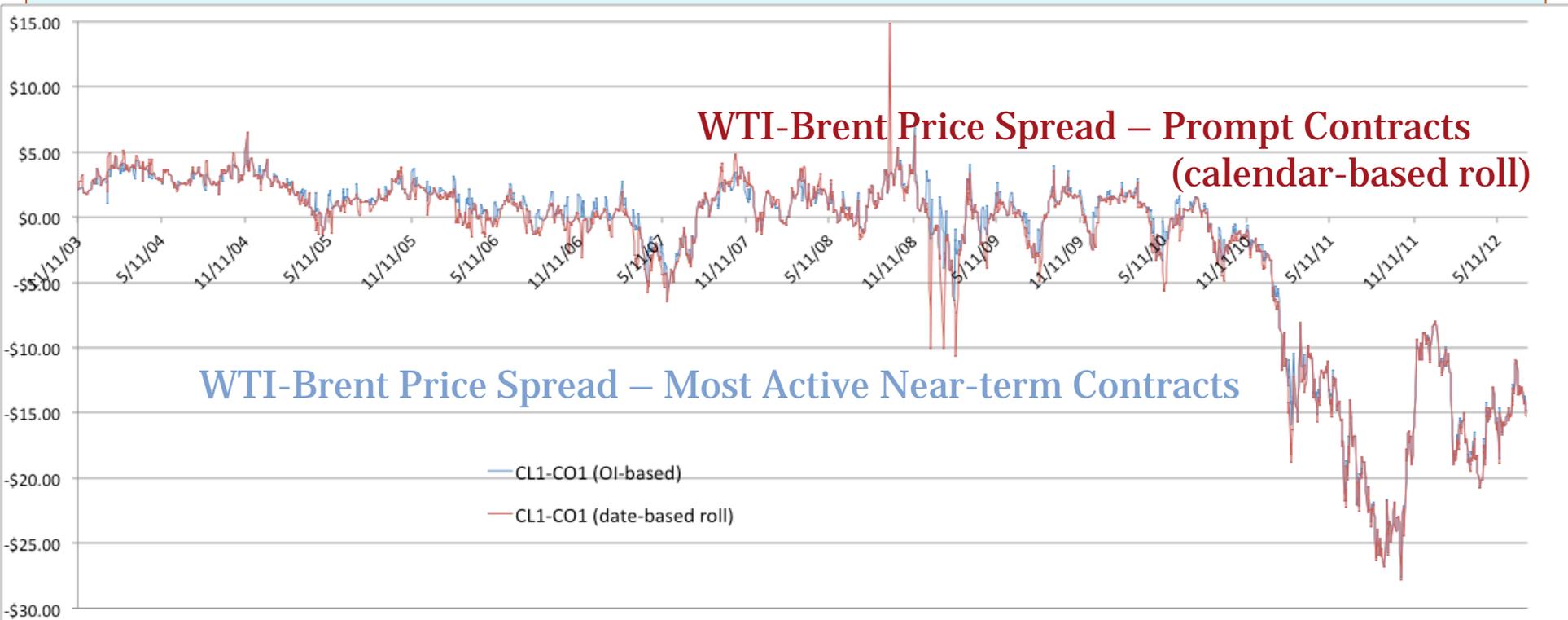
...*But* Something Extra Is Afoot in 2011-2012

Dec.18, 2010: Tunisian Revolt

Feb.11, 2011: Hosni Mubarak resigns

CL1-CO1 (OI-based)
CL1-CO1 (date-based roll)
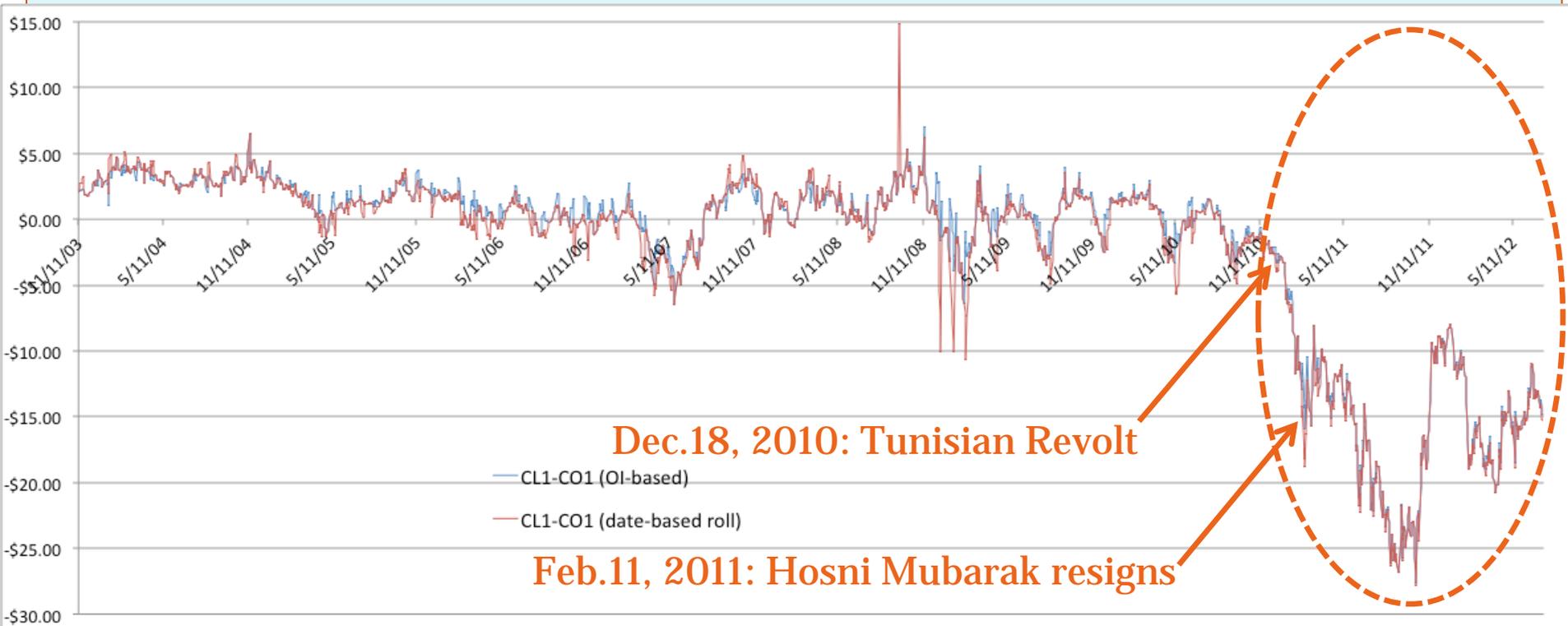
Background: *Landlocked vs. Seaborne Crudes*
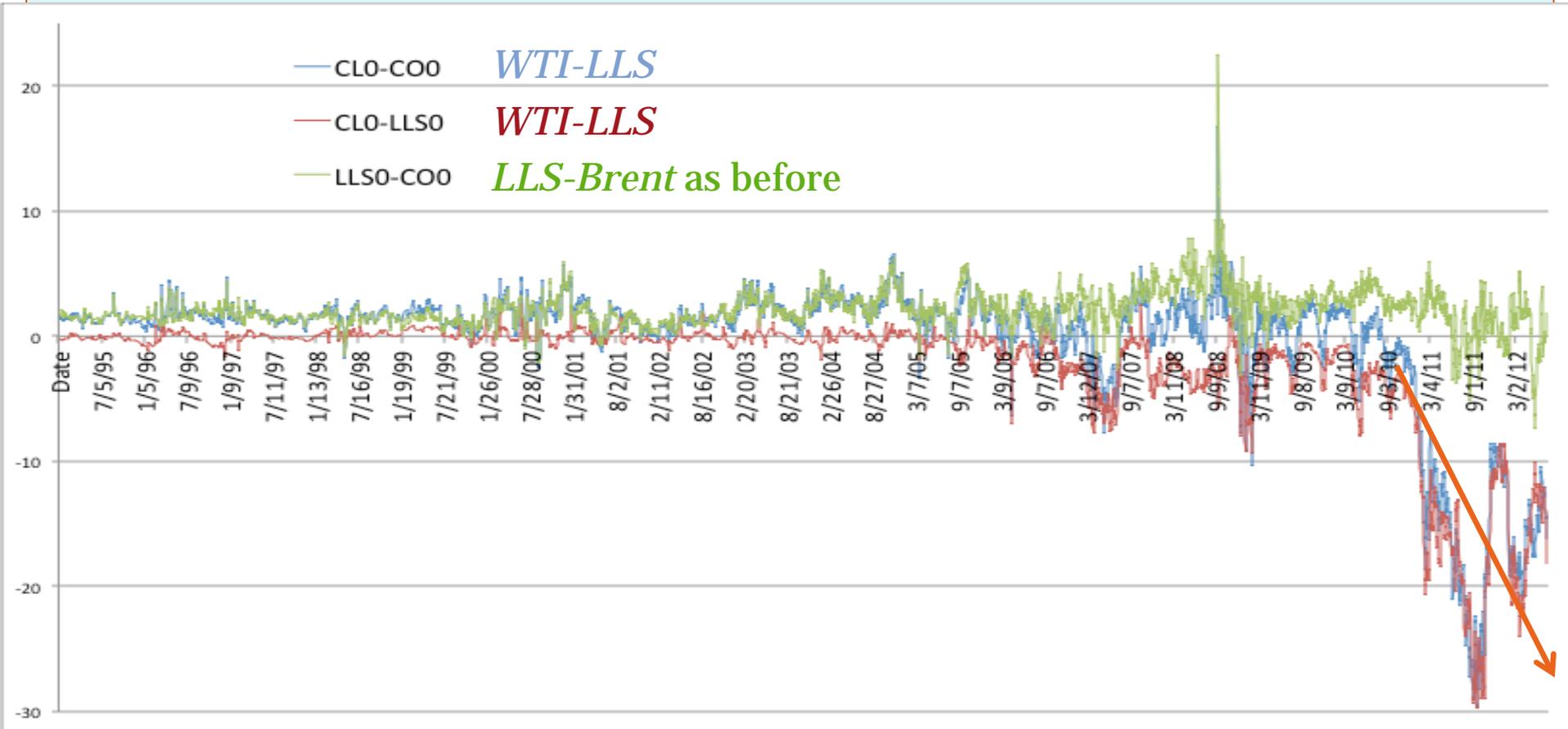
Legend:
- CL0-CO0 — *WTI-LLS*
- CL0-LLS0 — *WTI-LLS*
- LLS0-CO0 — *LLS-Brent* as before

Further Background: *Crude Quality*
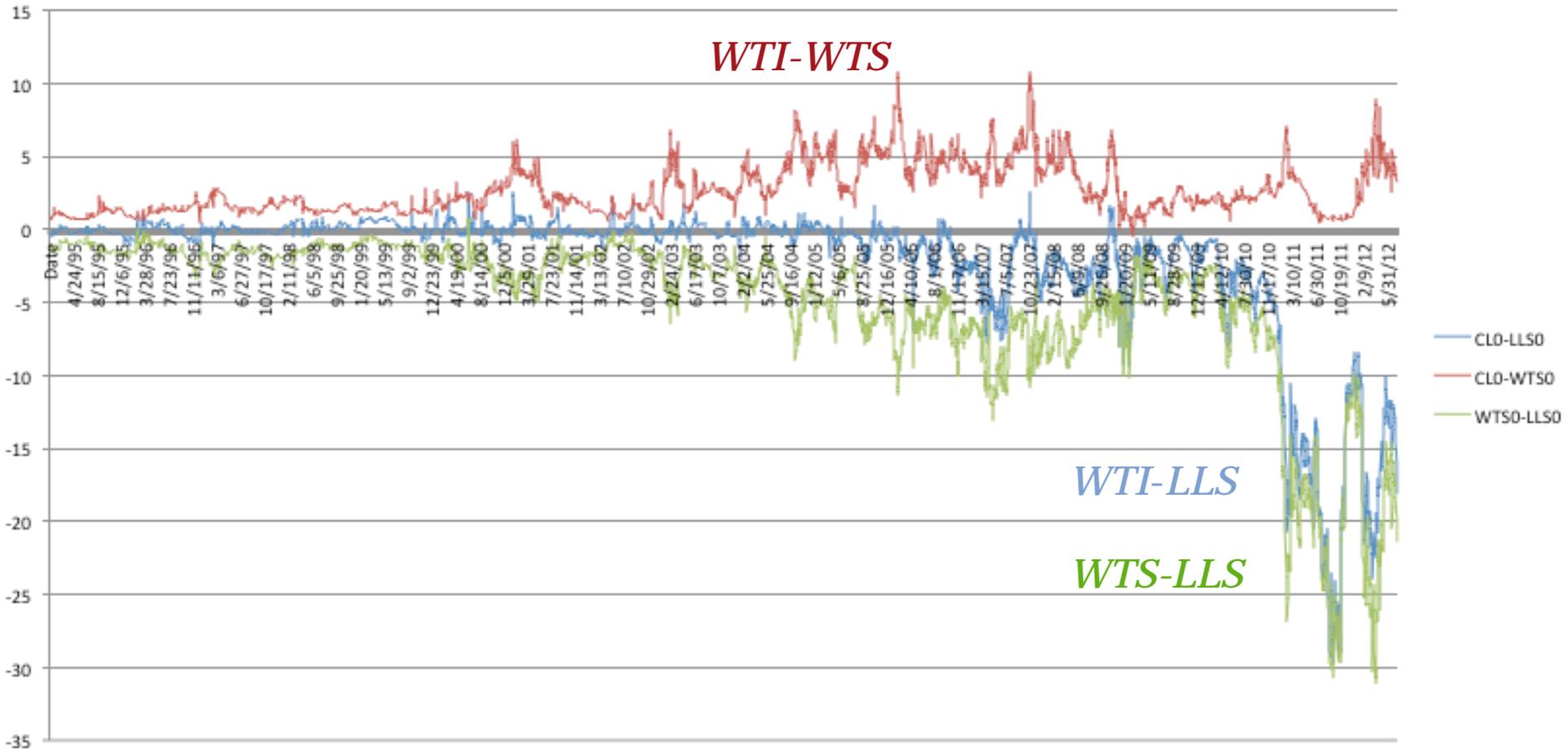
Further Background: *Crude Quality*

Quality spread *WTI-WTS* is positive throughout

Further Background: *Crude Quality*

Quality spread *WTI-WTS* is positive throughout

Early in 2007, *WTI* starts
Trading at discount to *LLS*

Legend:
- CL0-LLS0
- CL0-WTS0
- WTS0-LLS0

Further Background: *Crude Quality*

Quality spread *WTI-WTS* is positive throughout

Early in 2007, *WTI* starts Trading at discount to *LLS*

WTS-LLS discount is also huge after Dec. 2010

CL0-LLS0
CL0-WTS0
WTS0-LLS0
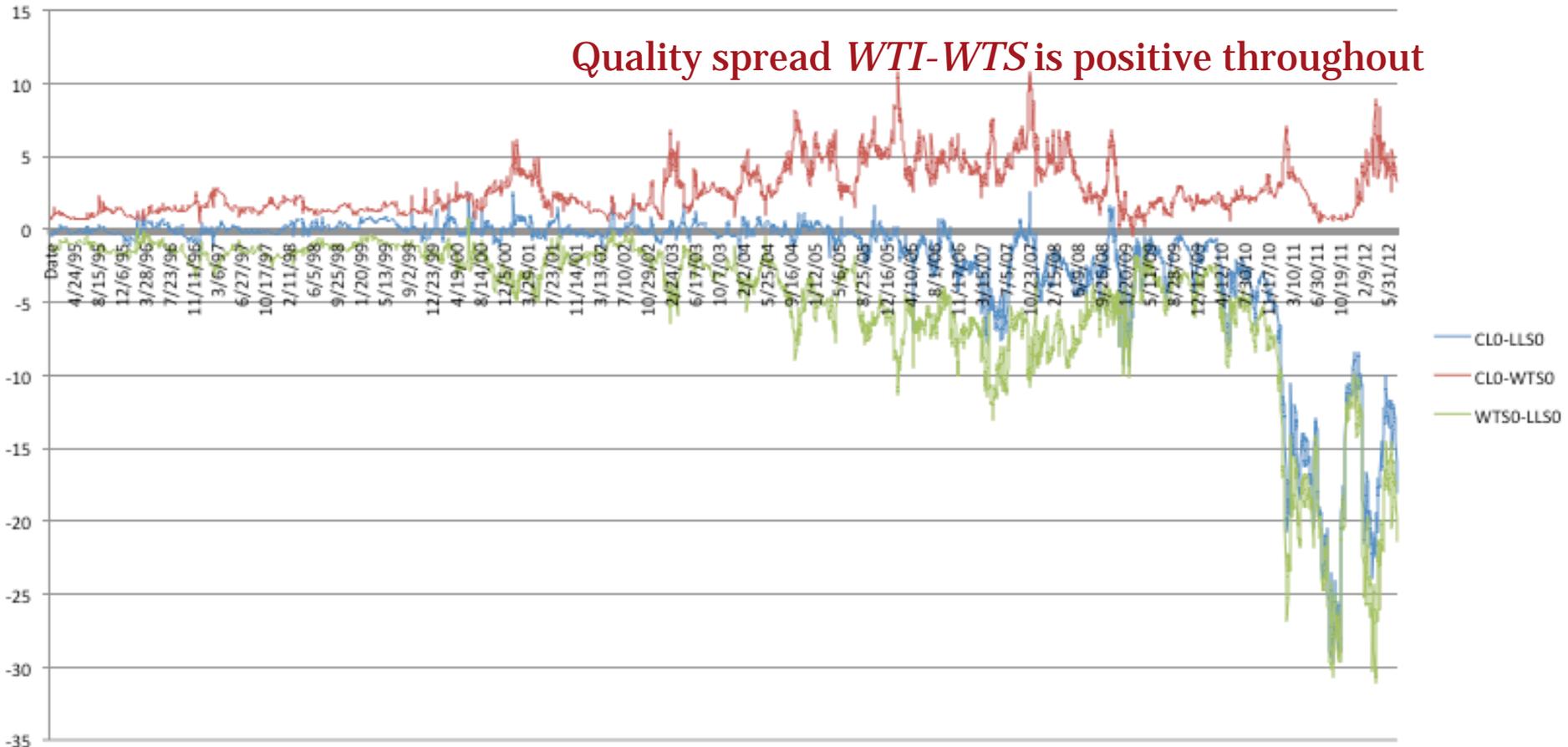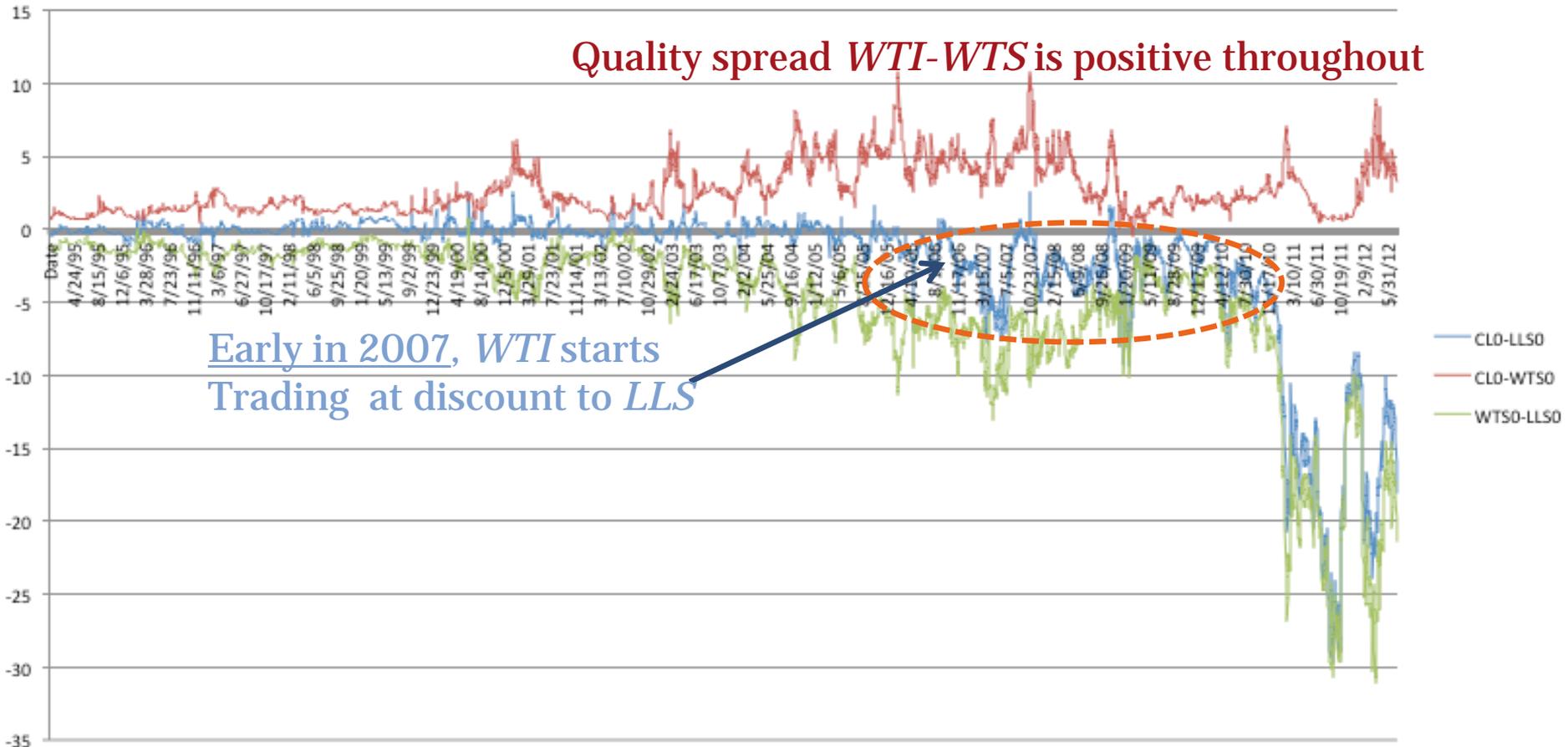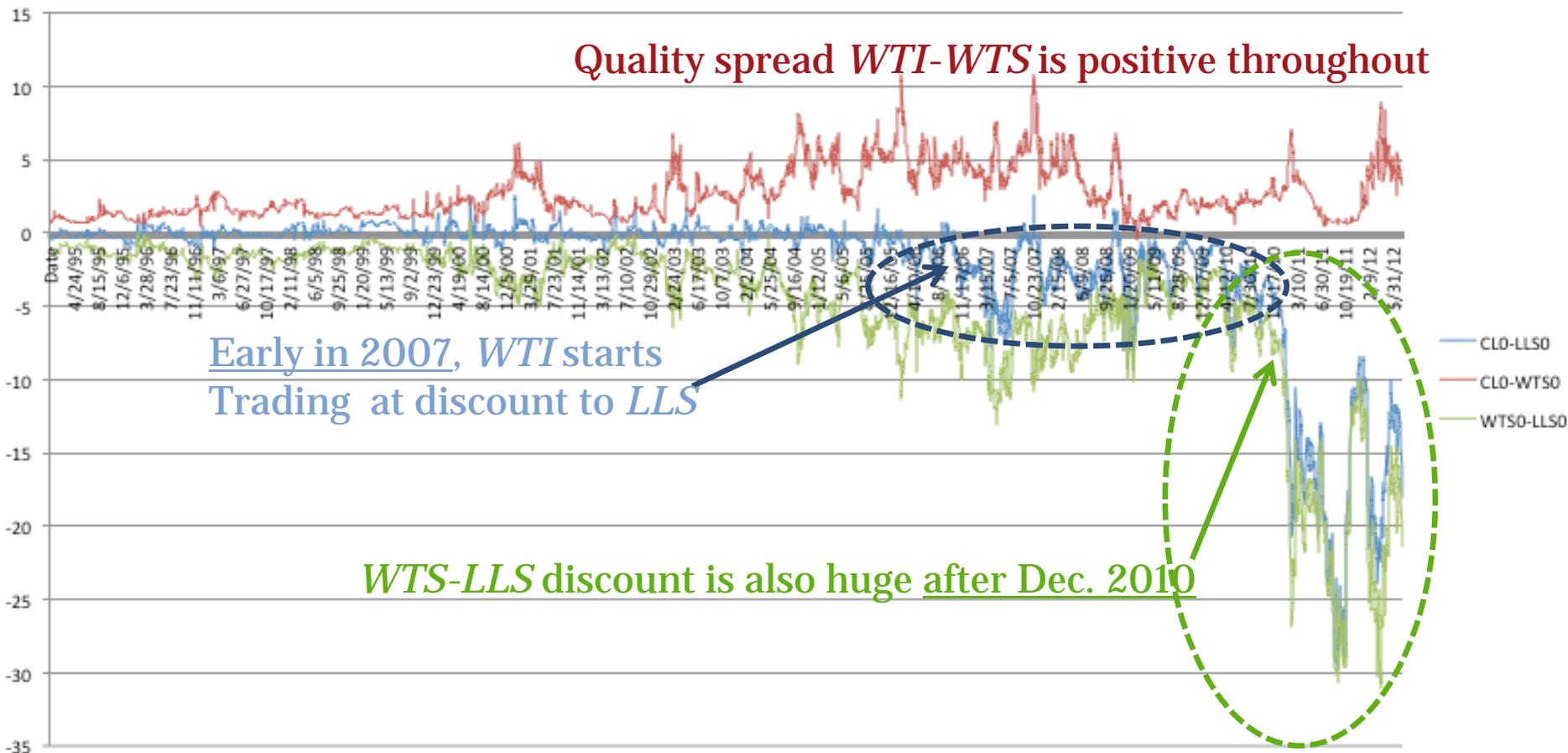
Remainder of the Presentation

✓ **Provide visual & statistical evidence of <u>breaks</u> in crude oil benchmark price <u>Spreads</u>**

  ✗ WTI-Brent nearby futures spread = "Landlock" spread + "Transatlantic" Spread + Brent nearby spread

  ✗ → Question: Which of these three spreads have experienced structural breaks?

  ✗ → Robustness checks: Inland "quality" spread *(WTI-WTS)* ; Near-dated *WTI* calendar spread

○ **Provide evidence on <u>Economic, Infrastructure and Financial Variables</u> linked to Spreads**

  ✗ Demand-side fundamentals: World, US

  ✗ Supply-side factors: Output capacity (OPEC, Brent); Output (Canada, US);

    ○ *Infrastructure bottlenecks*:   Storage capacity and utilization *(Cushing, OK)*; Pipelines *(land to sea)*

  ✗ Financial variables: Paper market liquidity; stress; CIT long positions; "insider" net positions

○ **<u>Econometric analysis</u>**

  ✗ Energy Fundamentals *or* Trading Activity?

    → Which of those variables help predict long run variations in WTI-Brent spreads?

II. Structural Break Tests

- **Structural break tests**
  - *Spread decomposition:*

    $$WTI_1 - Brent_1 = (WTI_1 - LLS_0) + (LLS_0 - BRENT_0) - (BRENT_1 - BRENT_0)$$

    WTI-Brent nearby futures spread =

    "Landlock" spread

    + "Transatlantic" Spread

    + Brent nearby spread

  - *Interpretation?*

  - *Statistical approach:*

    Simple *(deterministic)* time trend in the spread, Look for single break per test

  → Choose date *(based on graphs and known events)*, Test for break in mean

Commodity Spreads: Fall 2008

Hypothesis 1: The Brent-WTI ($BRENT_1 - WTI_1$) spread levels experience structural breaks in late Fall 2008; so does the "landlock" spread ($WTI_1 - LLS_0$). Neither the Transatlantic spreads ($LLS_0 - BRENT_1$ or $LLS_0 - BRENT_0$) nor the West Texas quality spreads ($WTI_1 - WTS_0$ or $WTI_0 - WTS_0$) do.

- Rationale:
  - LLS, Brent seaborne → easy to transport/store *(Plante & Yucel '11)*
  - Cushing storage OK for sweet&sour *(Pirrong '10, Genscape 2012)*
  - WTI landlocked after 2007 *(Cushing bottleneck – Fattouh '07)*
  - Recession starts in Fall 2008

Table 1A: Commodity Spreads *(calendar roll)*

	November 2008 Break	
	Constant Time Trend	Time Trend With Weekends
$Brent_1 - WTI_1$	8.37*** (0.0002)	7.56*** (0.0005)
$WTI_1 - LLS_0$	5.83*** (0.0030)	4.40** (0.0123)
$LLS_0 - Brent_1$	0.83 (0.4365)	2.58* (0.0759)
$WTI_1 - WTS_0$	1.83 (0.1611)	0.75 (0.4708)

Table 1A: Commodity Spreads *(Open Int. roll)*

	November 2008 Break	
	Constant Time Trend	Time Trend With Weekends
$Brent_1 - WTI_1$	**6.51***** **(0.0015)**	**4.71***** **(0.0091)**
$WTI_1 - LLS_0$	**6.56***** **(0.0014)**	**5.26***** **(0.0053)**
$LLS_0 - Brent_1$	1.00 (0.3671)	2.71* (0.0667)
$WTI_1 - WTS_0$	1.38 (0.2519)	1.17 (0.3120)

Calendar Spreads: Fall 2008

Hypothesis 2: The level of the WTI time spread (measured as the slope of the near-dated term structure of crude oil futures prices, net of interest costs) experiences a structural break in Fall 2008. The structural break is less significant for contracts further along the WTI futures maturity curve.

- Rationale:
  - Cushing storage is limited *(Pirrong '10, Borenstein & Kellog '12, Genscape 2012)*
  - Dearth of storage matters

Table 1D: Calendar Spreads *(calendar roll)*

	November 2008 Break	
	Constant Time Trend	**Time Trend With Weekends**
$\dfrac{WTI_2 - WTI_1}{WTI_1}$	5.17*** (0.0050)	5.53*** (0.0040)
$\dfrac{WTI_2 - WTI_1}{WTI_1} - LIBOR$	6.62*** (0.0014)	7.05*** (0.0009)
$\dfrac{WTI_3 - WTI_2}{WTI_2}$	3.64** (0.0263)	3.91** (0.0202)
$\dfrac{WTI_3 - WTI_2}{WTI_2} - LIBOR$	3.86** (0.0213)	4.52** (0.0110)

Table 1E: Calendar Spreads *(Open Int. roll)*

	November 2008 Break	
	Constant Time Trend	**Time Trend With Weekends**
$\dfrac{WTI_2 - WTI_1}{WTI_1}$	4.81*** (0.0082)	5.22*** (0.0055)
$\dfrac{WTI_2 - WTI_1}{WTI_1} - LIBOR$	6.37*** (0.0017)	6.02*** (0.0025)

Commodity Spreads: Dec. 2010

Hypothesis 3: The Brent-WTI spread level experienced a structural break in December 2010.

- Rationales:
  - Physical: Revolution in Tunisia (Dec. 18, 2010)

    Fukushima disaster (February 2011)

    Libya goes offline (February 2011)

    Cushing still "landlocked"

  - Financial: WTI *(Brent)* weight in S&P GSCI drops *(increases)*

    Brent included for 1st time in DJ-UBS

Table 1A: Commodity Spreads *(calendar roll)*

	December 2010 Break	
	Constant Time Trend	Time Trend With Weekends
$Brent_1 - WTI_1$	**8.10***** **(0.0003)**	**4.25**** **(0.0143)**
$WTI_1 - LLS_0$	**10.78***** **(0.0000)**	**8.02***** **(0.0003)**
$LLS_0 - Brent_1$	2.96* (0.0522)	1.77 (0.1712)
$WTI_1 - WTS_0$	0.21 (0.8127)	0.04 (0.9571)
$Brent_1 - Brent_0$	**8.09***** **(0.0003)**	**11.45***** **(0.0000)**
$\dfrac{Brent_1 - WTI_1}{Brent_1}$	**8.14***** **(0.0003)**	**4.69***** **(0.0093)**

Table 1A: Commodity Spreads *(Open Int. roll)*

|	December 2010 Break	
	Constant Time Trend	Time Trend With Weekends
$Brent_1 - WTI_1$	**10.98***** **(0.0000)**	**5.85***** **(0.0029)**
$WTI_1 - LLS_0$	**6.94***** **(0.0010)**	**6.01***** **(0.0025)**
$LLS_0 - Brent_1$	1.28 (0.2781)	0.53 (0.5869)
$WTI_1 - WTS_0$	0.38 (0.6852)	0.55 (0.5787)
$Brent_1 - Brent_0$	**11.59***** **(0.0000)**	**17.95***** **(0.0000)**
$\dfrac{Brent_1 - WTI_1}{Brent_1}$	**9.78***** **(0.0001)**	**4.42**** **(0.0121)**

III. Fundamentals & Financials

○ **Evidence on <u>Economic, Infrastructure and Financial Variables</u> linked to Spread**

- ✗ Demand-side fundamentals: World, USA

- ✗ Supply-side factors:

  - ○ Brent-relevant output capacity (OPEC, Brent)

  - ○ WTI-relevant production (US output + Canadian imports to PADD2)

    - • *Infrastructure bottlenecks*:

      - • Storage capacity and utilization *(Cushing, OK)*

      - • Pipelines *(land to sea)*

- ✗ Financial variables:

  - ○ Paper market liquidity

  - ○ Stress

  - ○ CIT long positions

  - ○ "Insider" net positions
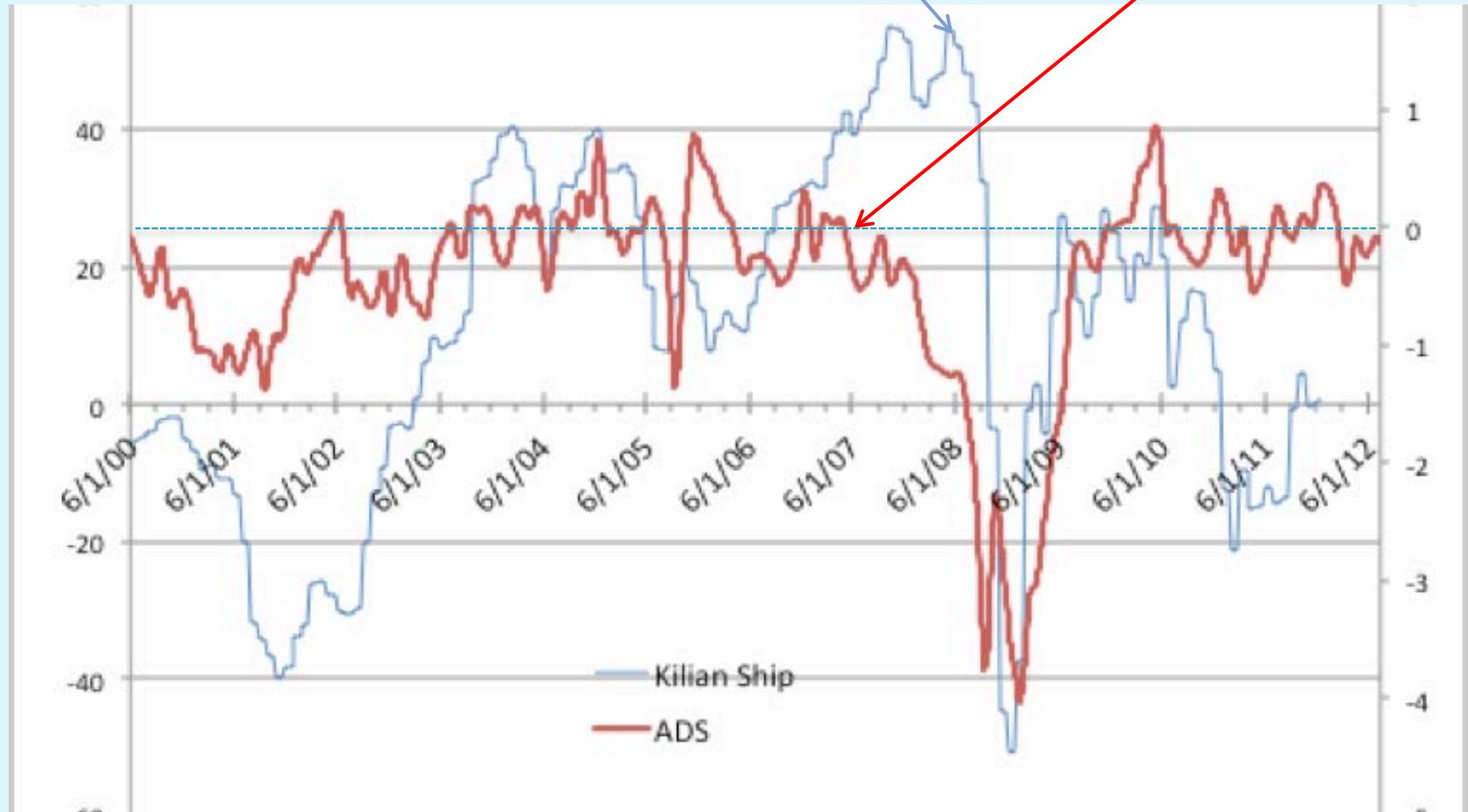
Figure 3: Crude Oil Prices and OPEC Effective Surplus Production Capacity
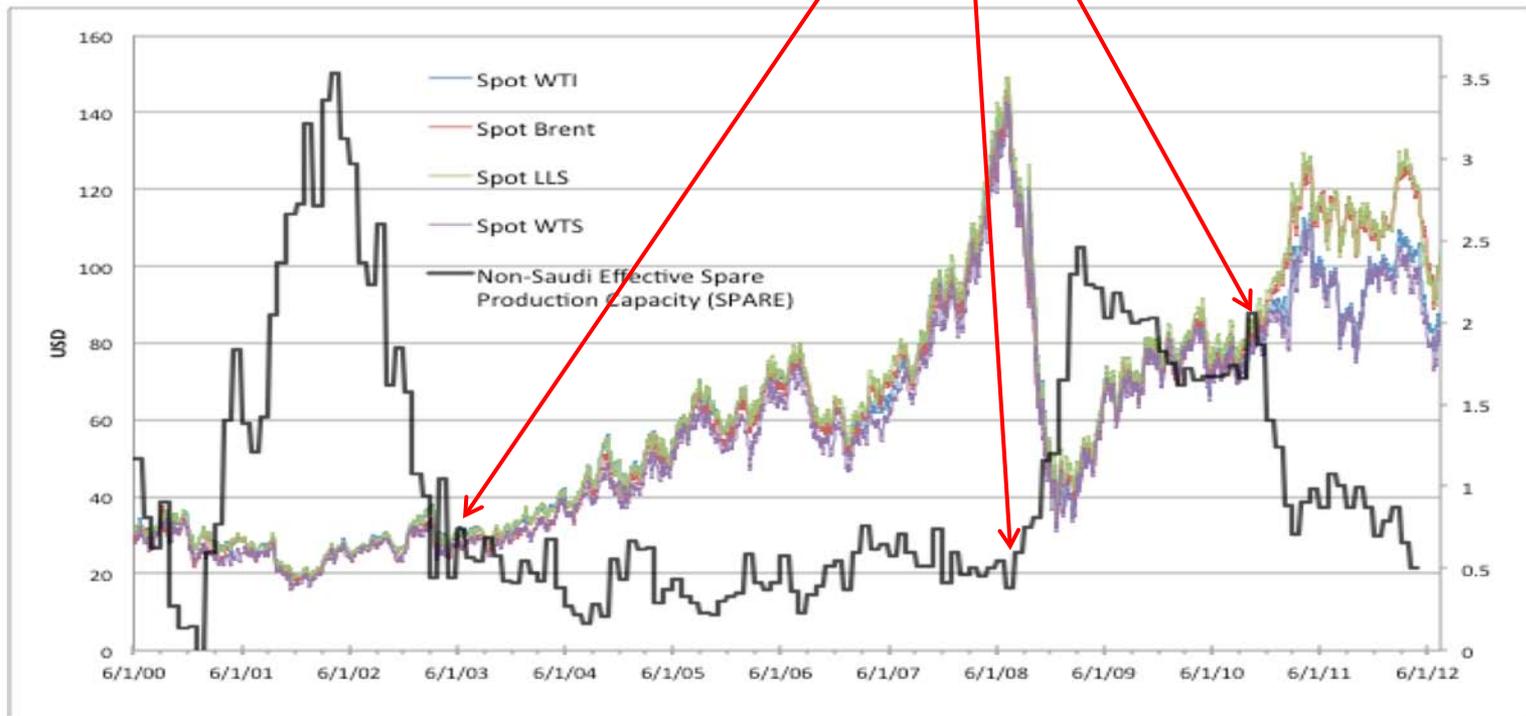
- Rationale: matters for Brent once Cushing is landlocked
  - → Interact with dummy for directionality of Cushing bottleneck

2b. Oil Supply: Brent Output

North Sea Crude Oil Production
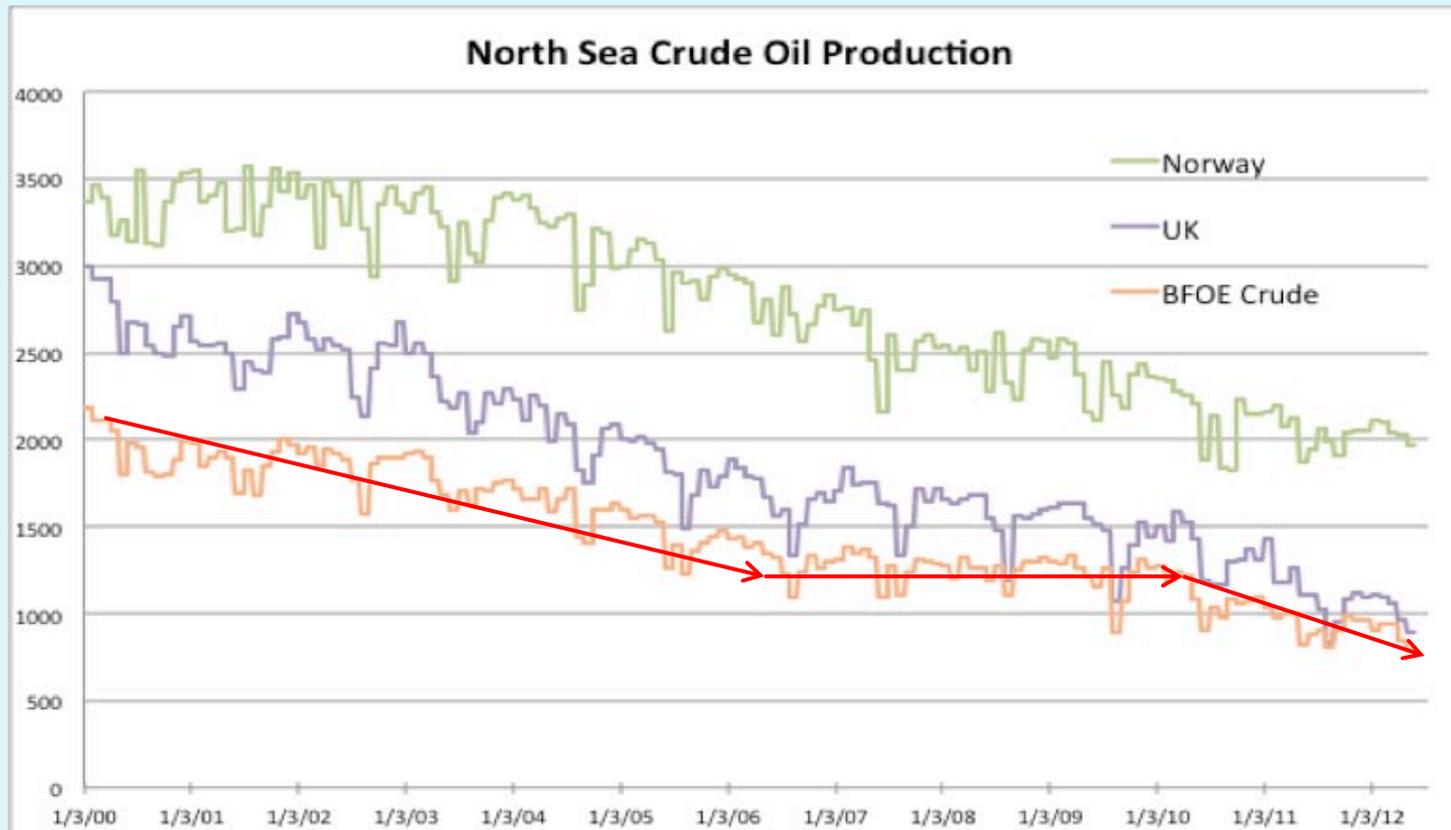
- Rationale: "BFOE" output drops matter, especially if ROW substitutable output is constrained.

Figure 5:
Operational Oil Rigs & Canadian Oil Imports
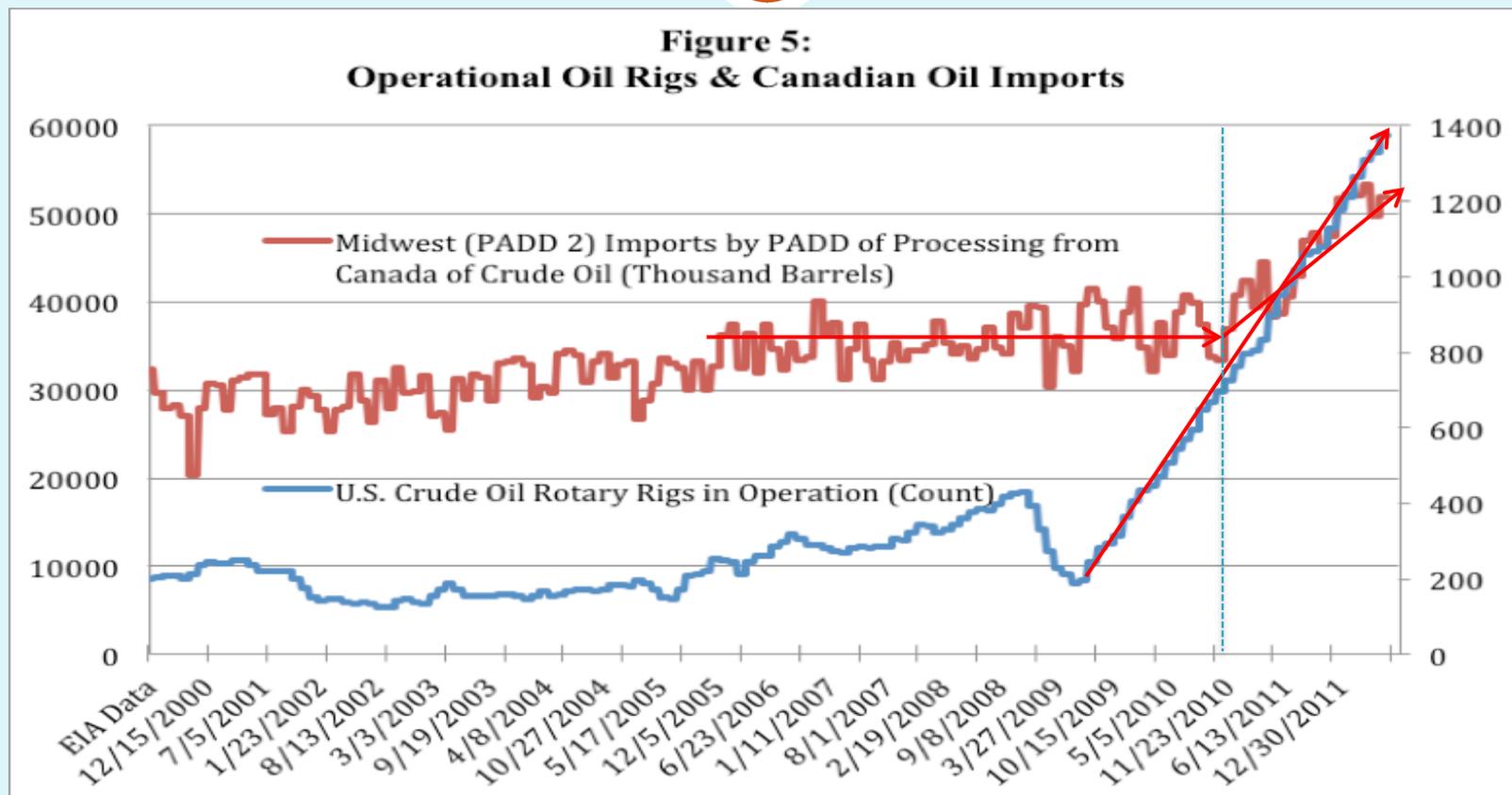
- Rationale: Domestic output & imports end up in Cushing → glut *(e.g., Fattouh '07, Pirrong '10, Borenstein & Kellog '12)*
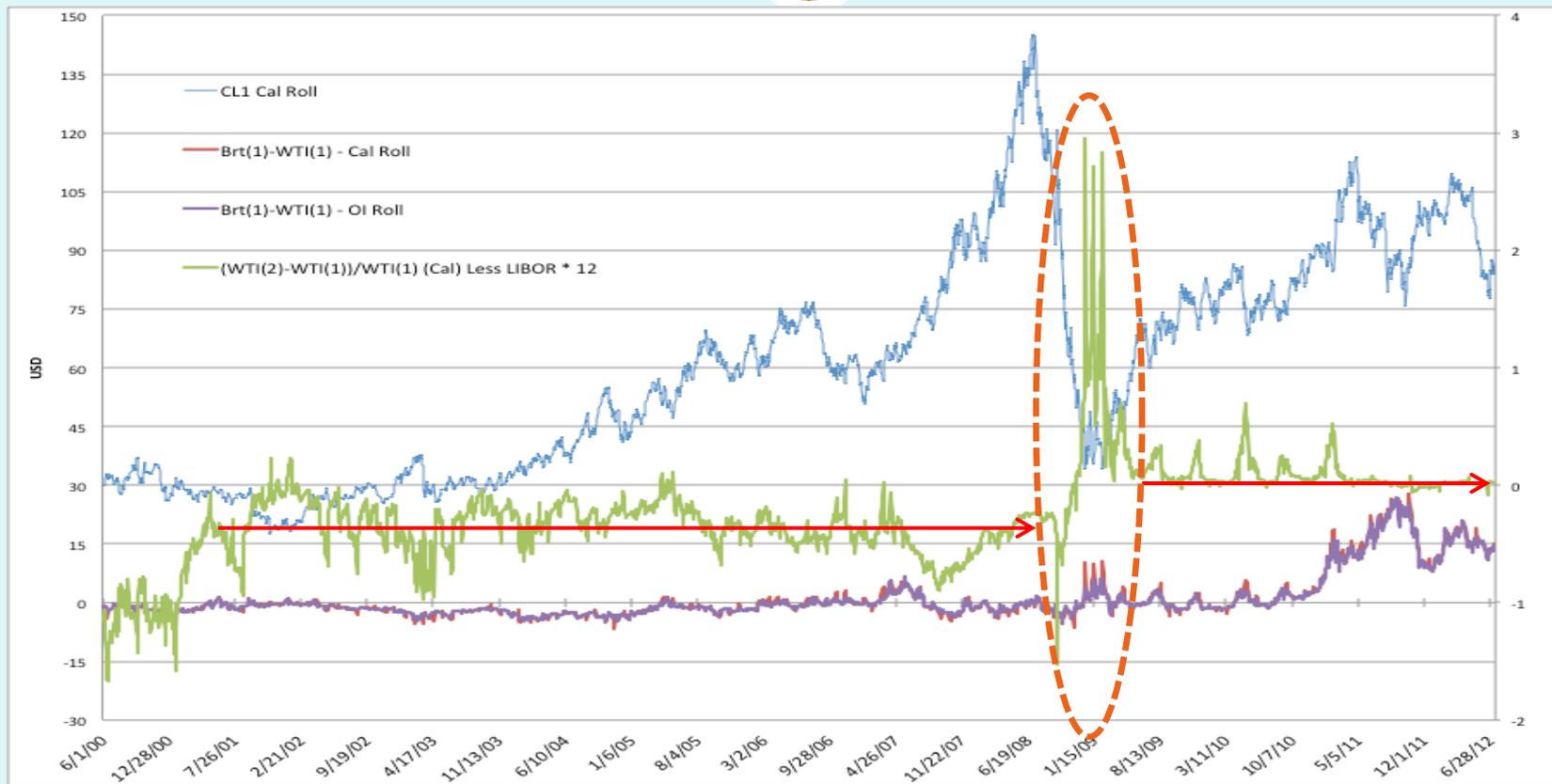
- **Rationale**: Genscape data exist only since 2009 → we use a proxy = slope of the WTI term structure *(Fama-French '88)*

Figure 7: WTI and Brent Near-Dated Open Interest
(First three Calendar Months)
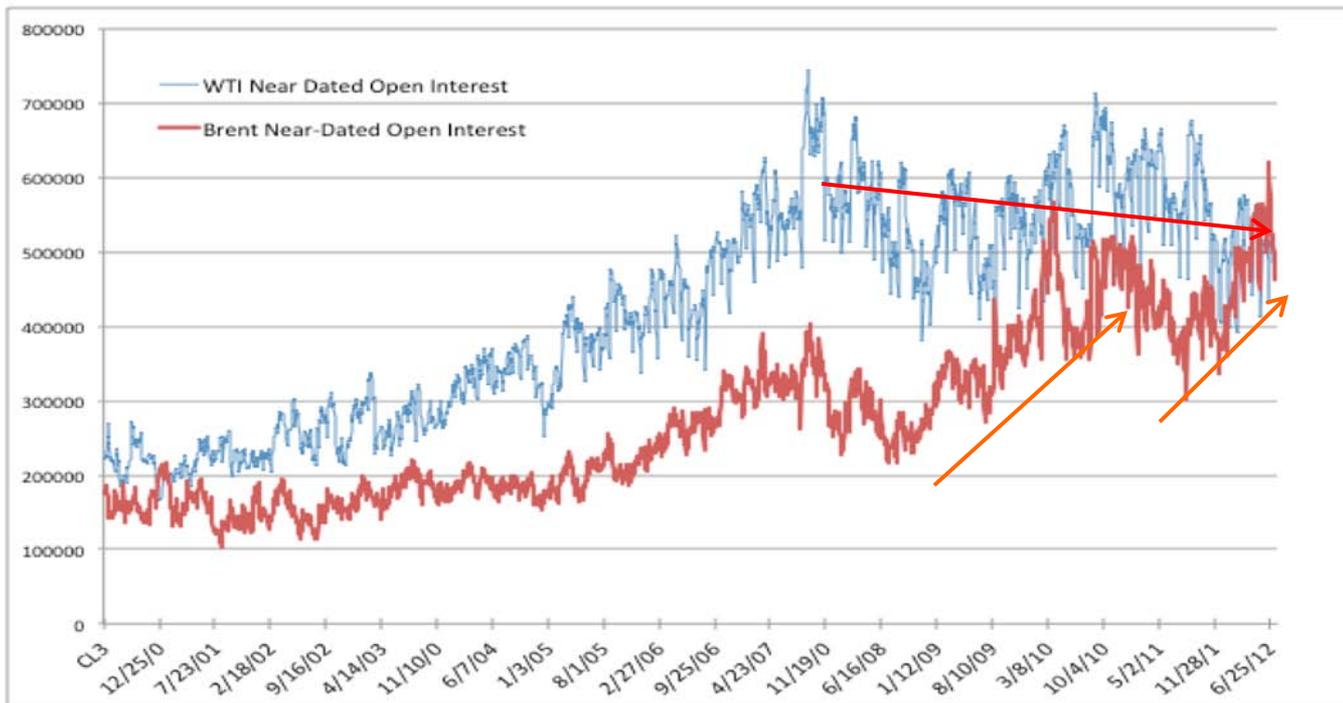
- Rationale: OI is a signal of rising commodity prices *(Hong & Yogo '11)* – different patterns for WTI (-) *vs.* Brent (+)

4b. Paper Market: Financial Stress

○ Theory

- Arrival of less-constrained traders (value arbitrageurs) should reduce mispricing

  ○ e.g., Rahi & Zigrand (*RFS* 2009); Başak & Croitoru (*JFE* 2006)

- Limits to arbitrage

  →Questions about such traders' behavior in periods of market stress

  ○ Leverage constraints, wealth effects, portfolio rebalancing needs, etc.

  ○ Kyle & Xiong (*JF* 2001), Gromb & Vayanos (*JF* 2001), Kodres & Pristker (*JF* 2002), Broner, Gelos & Reinhart (*JIE* 2006), Pavlova & Rigobon (*REStud* 2008), …

  → <u>Our paper:</u> empirical analysis, using energy benchmark spreads

4b. Paper Market: Financial Stress

○ Empirics

    ✗ Financial stress should matter – evidence on extreme linkages:

       ○ *Bond-equity* returns extreme linkages in G-5 countries

       ○ *International equity* market correlations increase in bear markets

       ○ *Commodity-equity* linkages went up in Fall 2008

○ <u>Our measure</u>: TED Spread

    ✗ *Robustness: VIX?*
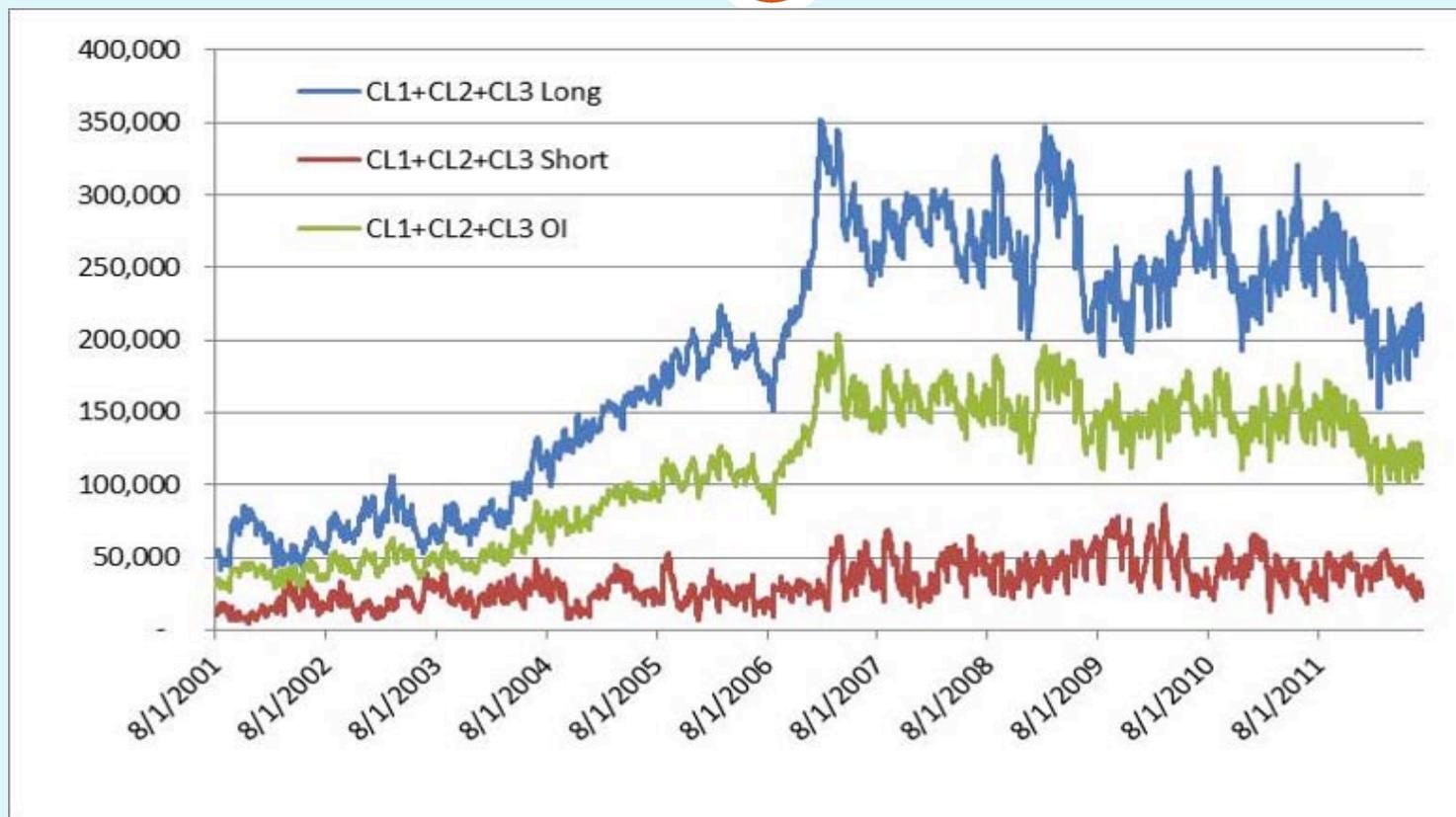
- Rationale: Commodity Index Traders (CITs) contribute to liquidity *(Büyükşahin et al, 2009; Brunetti & Reiffen, 2011)*

Source of the data?

- Evidence that *who* trades helps predict oil price spreads

  → In general, difficult to test the theory

  → Unlike most authors, <u>we have access</u> to comprehensive daily data on

    (i) trader-level (i.e., individual) positions

    (ii) each trader's main of business & underlying motive for trading

      (i.e., hedging or not)

    (iii) over an entire decade (July 2000 to July 2012)

  → The composition of the open interest helps predict an important aspect of the distribution of energy returns

4d. Paper Market: Commercials *(<3 months)*

- **Idea?**

  - Identify 89 companies linked to Cushing infrastructure

    - Owners of refineries, pipelines, storage, etc. linked to Cushing

    - Related entities

  - A majority of those companies hold reportable positions in WTI futures

  - Test whether, as a whole, their net short position helps predict the WTI-Brent spread

  - Findings: in the aggregate, no predictive power → not reported

IV. Econometric Analysis

- **Evidence on <u>Economic, Infrastructure and Financial Variables</u> linked to Spread**
  - Demand-side fundamentals:
    - World, USA
  - Supply-side factors:
    - Brent-relevant output capacity (OPEC, Brent)
    - WTI-relevant production (US output + Canadian imports to PADD2)
      - *Infrastructure bottlenecks*:
        - Storage capacity and utilization *(Cushing, OK)*
        - Pipelines *(land to sea)*
  - Financial variables:
    - Paper market liquidity
    - Stress
    - CIT long positions
    - "Insider" net positions

A. Dependent Variable:
WTI-Brent Nearby Futures Spread (calendar-based roll)

43

B. What Predicts the Spread: Trading Activity *or* Fundamentals?

C. What Really Matters?
ARDL Regressions

- Regress the spread on…
  - …trader position data
    - Each trader category entered separately
      - WTI actual & Brent imputed positions($\leq$ 3 months)
  - …real-sector variables
  - …market stress proxies

- Technical issue
  - Some series are I(0), others I(1); also, endogeneity?
    - $\rightarrow$ ARDL model, Pesaran-Shin (1999) approach
    - $\rightarrow$ Lagged values of variables to deal with AC and endogeneity

A. Fundamentals Matter

47

Economy, Supply side, Cushing *(Table 4)*

| | Fundamentals + Financials + CIT | | |
	I-FC	II-FC	III-FC
Intercept	-292.839 (259.4)	-202.840 (296.8)	-209.944 (255.8)
TIME	**-0.004779** (0.002437)**	-0.00319242 (0.002936)	**-0.004414*** (0.001524)**
SHIP	-0.0493147 (0.03559)	-0.0543983 (0.04083)	-0.0398034 (0.03529)
ADS	**0.655218* (0.3543)**	0.364546 (0.4378)	0.509077 (0.3543)
SPARE	-0.600090 (0.4885)	-0.638268 (0.5597)	**-1.02213** (0.4609)**
BFOE	-0.615093 (2.303)	0.586638 (2.663)	1.37549 (2.589)
US STOCKS	–	–	0.0127566 (0.007882)
LAND	**-5.92892*** (1.526)**	**-6.55721*** (1.751)**	**-4.84989*** (1.696)**
LAND x SHIP	0.0542900 (0.03958)	0.0483747 (0.4528)	0.0402615 (0.03886)
Canada Imports	**-0.149349** (0.07370)**	-0.129496 (0.08416)	–
RIGS	0.00353558 (0.003469)	0.000379972 (0.004503)	–
Cushing STOCKS	–	–	-0.076846 (0.06587)
WTI SLOPE	–	**-56.5533* (31.86)**	–

Trading Matters! *Expected Signs*

	Fundamentals + Financials			Fundamentals + Financials + CIT		
	I-FF	**II-FF**	**III-FF**	**I-FFS**	**II-FFS**	**III-FFS**
DISCOUNT	213.857 (371.7)	105.619 (411.8)	82.3511 (373.6)	311.057 (259.4)	217.412 (296.8)	200.277 (256.6)
WTI OI	**-0.033770*** (0.007096)**	**-0.030512*** (0.007665)**	**-0.034574*** (0.00718)**	**-0.01704*** (0.005352)**	**-0.016209*** (0.006245)**	**-0.017398*** (0.005313)**
Brent OI	**0.043394*** (0.008563)**	**0.041662*** (0.009393)**	**0.046081*** (0.008922)**	**0.027802*** (0.005764)**	**0.027523*** (0.006622)**	**0.030197*** (0.005864)**
TED	0.678246 (0.7292)	0.577481 (0.8291)	0.561489 (0.7910)	**0.888889* (0.4866)**	0.802149 (0.5781)	0.746660 (0.5161)
WTI CIT Long	–	–	–	**0.173028*** (0.01753)**	**0.167156*** (0.02037)**	**0.160408*** (0.01376)**
Brent CIT Long	–	–	–	**-0.434916*** (0.03677)**	**-0.413675*** (0.04566)**	**-0.405326*** (0.03023)**
Brent *vs.* WTI Weights	**18.5229*** (2.750)**	**16.4915*** (3.442)**	**16.44883*** (2.139)**	–	–	–

VI. Conclusion

Findings

- "Breaks"
  - Breaks in Fall-2008 and End-2010
  - *Drivers appear different*

- "Financialization"

  - Increase in overall OI predict increases in the WTI-Brent spread

  - CIT activity inversely related with relevant component of spread

    - *Liquidity? Causality?*

- Information on OI composition is relevant
  - CFTC decision to disaggregate more – trader type & maturity

Further Work

- Technical:
  - Out-of-sample predictions
  - Causality
  - Short-term responses
    - Individual traders?

- Conceptual:
  - Storage utilization and capacity constraints
    - Longer sample with Genscape data
    - Physical quantities *vs.* price signals (slope)

II. Trading Facts
Financialization of Energy Futures Markets

A. Position Data

- Publicly available data
  - CFTC Commitments of Traders (COT) Reports (Weekly since 1990's)
  - Highly aggregated
    - All maturities are lumped together
    - Traders grouped in just 2 bins *("Commercials" vs. "Non-Commercials")*

- *vs*. Our data: Large Trader Reporting System (LTRS)
  - End-of-day positions of every individual large trader (Daily)
    - Non-public, CFTC only
      - For every contract maturity
      - Every day from July 1, 2000 to February 26, 2010
  - Information on each trader's line of business

Our Detailed Data: Main Sub-Categories *(Oil)*

- Non-commercials
  - **Hedge Funds** (includes Commodity Pool Operators (CPOs), Commodity Trading Advisors (CTAs), Associated Persons who control customer accounts, and other Managed Money traders)
  - **Floor Brokers & Traders**
  - **Non-Registered Participants** (Traders not registered under the Commodity Exchange Act (CEA); category includes non-MMT financial traders)
- Commercials
  - **"Traditional"**
    - **Producers**
    - **Manufacturers** (refiners, etc.)
    - **Dealers** (energy wholesalers, exporter/importers, marketers, etc.)
  - **Commodity Swap Dealers** (includes arbitrageurs and CITs)

B. Measurement Issues

- Traders' shares in short-term & long-term contracts
  - For each category of traders, we get
    - Share of the total open interest (all contract months)
      - Average of long & short positions divided by open interest
    - Share of the open interest in first 3 contract months
      - Commodity indices focus on near-dated contract
- Speculators
  - Hedge funds?
    - Register with CFTC → detailed data
  - CITs (Commodity Index Traders)?
    - Detailed data at quarterly frequency & only since 2008.
      → we proxy their market share by share of commodity swap dealers
      - Best we can do (*Why?*), but imperfect
        - Approximation is better for short-term contracts (why?)
  - Overall importance?

TECHNICAL

Swap Dealing & Commodity Index Trading

- Overall *vs.* Near-dated Swap Dealer Positions (% of OI), 2000-2010