Dynamic price relationship in crude oil markets

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Motivation

Oil is a globally traded diverse commodity with a few important benchmarks.

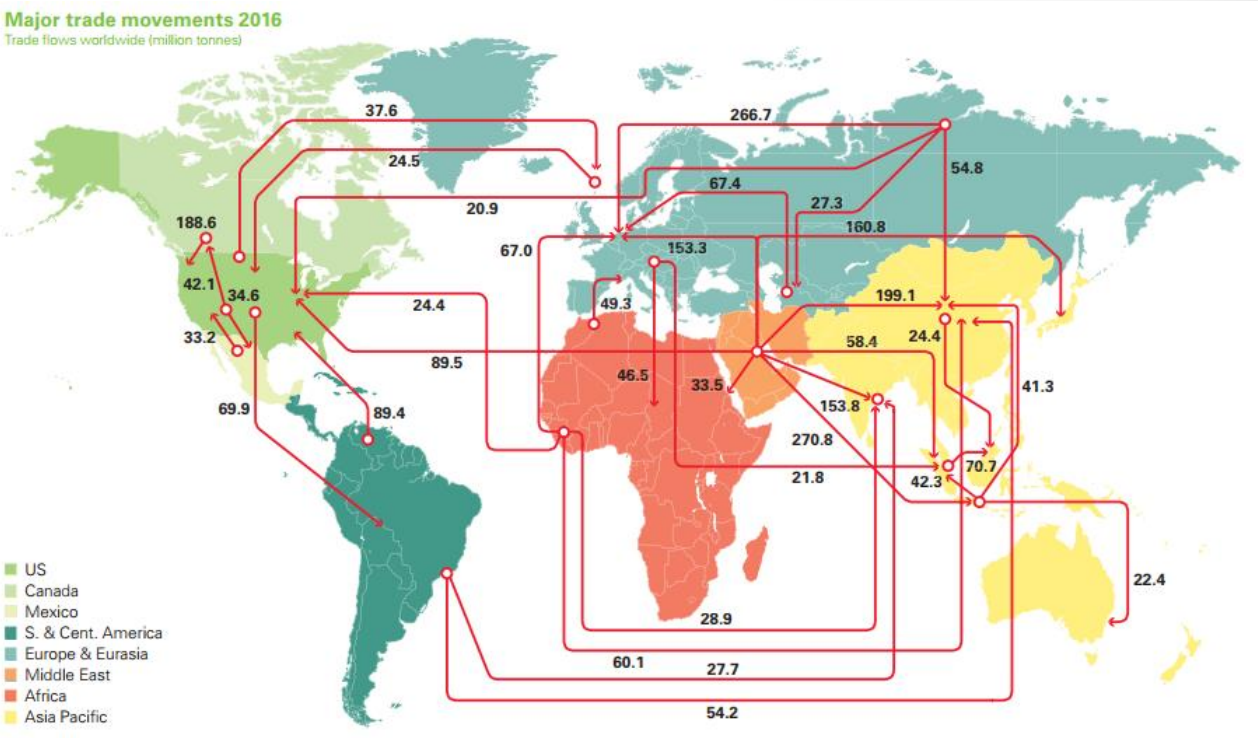
- Brent
- WTI
- Dubai

Oil is characterized by

- API gravity
- Sulfur
- Field location

In this paper we try to answer:

Is the pricing of regional crude oils dominated by the benchmarks?

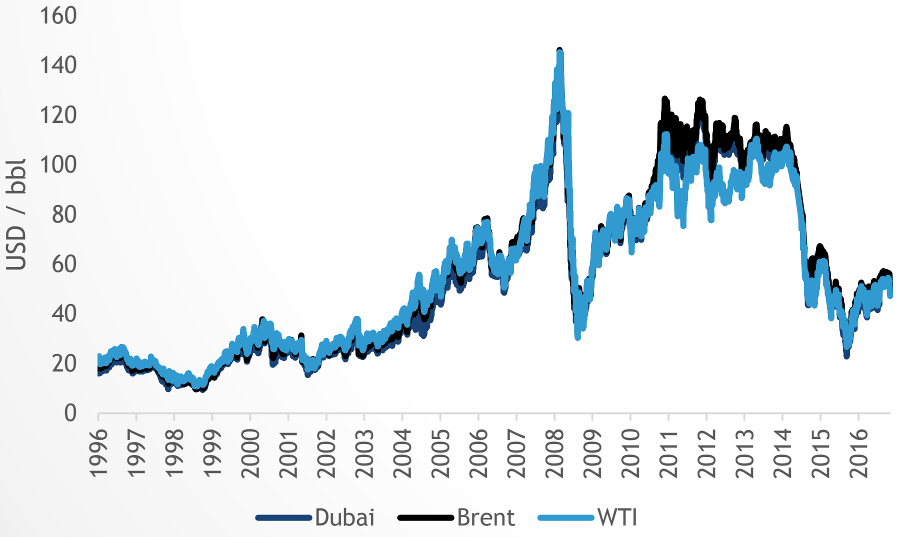


Source: BP Statistical Review of World Energy 2017

Data

Daily prices for a set of 18 crude oil prices

- May 1996 - March 2017
  4 820 observations per price series
- 3 crude oil benchmarks
- 15 other regional crude oils, covering Asia, Africa, Arab, North Sea and American.



Crude	Region	API gravity		Sulfur	
Brent	**North Sea**	**38,3**	**Light**	**0,37**	**Sweet**
Ekofisk	North Sea	37,5	Light	0,23	Sweet
Oseberg	North Sea	37,8	Light	0,27	Sweet
Statfjord	North Sea	39,1	Light	0,22	Sweet
Urals	Russia	31,7	Medium	1,35	Sour
Bonny	Nigeria	33,4	Medium	0,16	Sweet
Forcados	Nigeria	30,8	Medium	0,16	Sweet
Dubai	**UAE**	**31**	**Medium**	**2**	**Sour**
Murban	Malaysia	45,2	Light	0,03	Very sweet
Tapis	Indonesia	35,3	Medium	0,09	Very sweet
Minas	UAE	40,2	Light	0,79	Sour
Duri	Oman	34	Medium	2	Sour
Oman	Indonesia	20,8	Heavy	0,2	Sweet
North West Australian	Australia	61,2	Light	0,01	Very sweet
WTI	**US**	**39,6**	**Light**	**0,24**	**Sweet**
Louisiana Light Sweet	US	35,6	Medium	0,37	Sweet
West Texas Sour	US	31,7	Medium	1,28	Sour
Alaskan	US	31,9	Medium	0,93	Sour

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Data - price series

Crude	Region	Min	Mean	Median	Max	Std.dev	Correlation*
Brent	**North Sea**	**9.71**	**55.91**	**49.41**	**146.26**	**34.05**	**N/A**
Ekofisk	North Sea	9.19	55.97	48.75	146.30	34.62	0.999
Oseberg	North Sea	9.35	56.24	49.25	147.43	34.69	0.999
Statfjord	North Sea	9.25	56.47	49.65	148.70	34.85	0.999
Urals	Russia	8.48	53.74	46.33	139.88	33.97	0.999
Bonny	Nigeria	9.10	56.60	49.62	148.60	34.98	0.998
Forcados	Nigeria	9.13	56.68	49.24	148.60	35.36	0.998
Dubai	**UAE**	**9.39**	**53.06**	**45.65**	**140.56**	**33.27**	**N/A**
Murban	Malaysia	10.10	55.65	49.09	146.54	34.25	0.999
Tapis	Indonesia	10.53	58.80	51.01	152.38	36.07	0.997
Minas	UAE	9.55	56.76	51.69	152.83	35.71	0.995
Duri	Oman	8.55	52.77	45.05	135.03	34.00	0.989
Oman	Indonesia	9.28	53.61	46.67	139.89	33.48	0.999
North West Australian	Australia	10.53	55.49	48.76	140.16	33.66	0.989
WTI	**US**	**10.82**	**53.95**	**48.51**	**145.31**	**30.15**	**N/A**
Louisiana Light Sweet	US	10.64	57.07	50.15	149.42	33.81	0.998
West Texas Sour	US	9.31	51.19	46.46	142.64	29.32	0.987
Alaskan	US	8.72	55.00	47.56	144.72	33.98	0.998

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Data – log-return series

Crude	Region	Min (%)	Mean (%)	Median (%)	Max (%)	Std.dev (%)	Correlation*
Brent	**North Sea**	**-14.93**	**0.02**	**0.00**	**15.10**	**2.45**	**N/A**
Ekofisk	North Sea	-20.11	0.02	0.05	18.01	2.44	0.634
Oseberg	North Sea	-20.20	0.02	0.04	17.88	2.41	0.638
Statfjord	North Sea	-20.07	0.02	0.04	17.81	2.42	0.634
Urals	Russia	-20.62	0.02	0.07	18.63	2.58	0.733
Bonny	Nigeria	-19.75	0.02	0.04	17.29	2.38	0.746
Forcados	Nigeria	-19.83	0.02	0.04	16.98	2.38	0.746
Dubai	**UAE**	**-16.60**	**0.02**	**0.04**	**18.28**	**2.52**	**N/A**
Murban	Malaysia	-16.29	0.02	0.00	14.29	2.38	0.303
Tapis	Indonesia	-14.07	0.02	0.00	14.14	2.17	0.244
Minas	UAE	-39.47	0.02	0.00	38.02	2.49	0.188
Duri	Oman	-35.36	0.02	0.00	34.09	2.81	0.184
Oman	Indonesia	-19.53	0.02	0.01	15.05	2.53	0.297
North West Australian	Australia	-34.13	0.02	0.00	78.49	3.00	0.219
WTI	**US**	**-21.59**	**0.02**	**0.06**	**19.14**	**2.61**	**N/A**
Louisiana Light Sweet	US	-18.94	0.02	0.06	14.86	2.55	0.921
West Texas Sour	US	-15.91	0.02	0.03	17.70	2.86	0.908
Alaskan	US	-21.39	0.02	0.07	20.86	2.75	0.917

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Empirical results

- We apply a vector error correction model and create a rolling cointegration matrix using an observation period of 250 days.

$$\Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-1} + \varepsilon_t$$

$$\Pi = \alpha\beta'$$

- Estimate the rolling alpha for short run relation between changes in the oil price and valuation of companies in a sector.

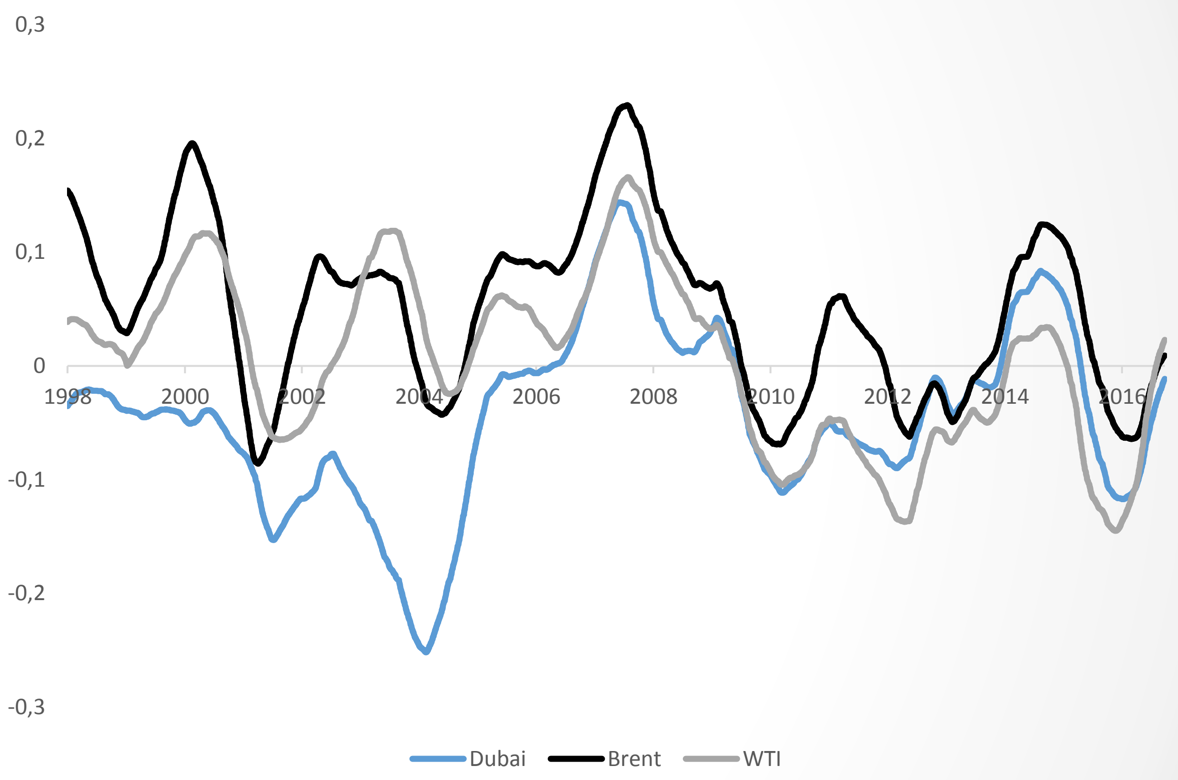

Figure 3. Panel A: Rolling speed of adjustment (a(t)) for Ekofisk crude oils to Dubai, Brent and WTI crude oil 1997 – 2017.

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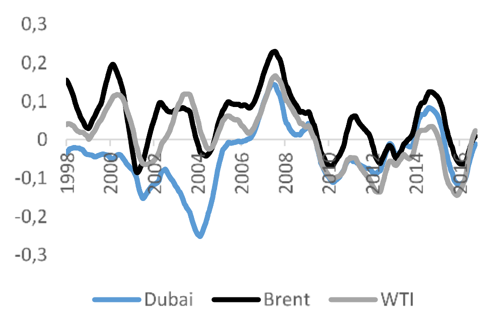
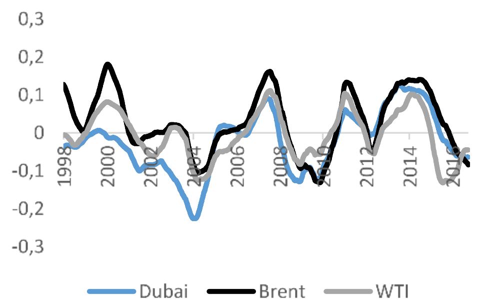
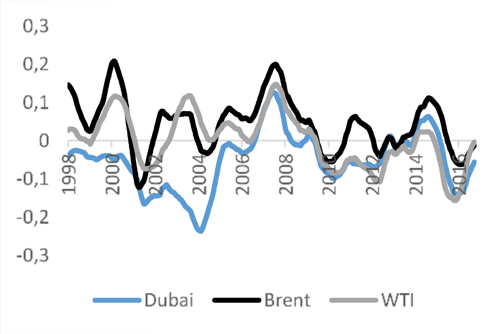
European regional crude oils



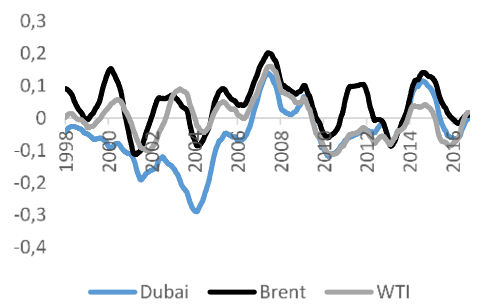
Panel A: Ekofisk



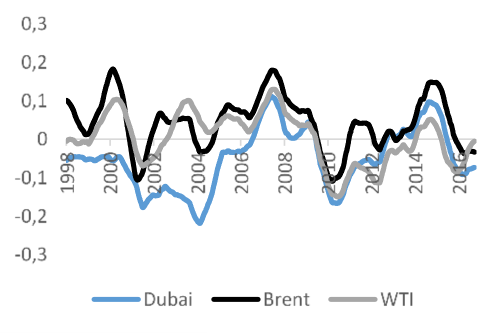
Panel B: Urals



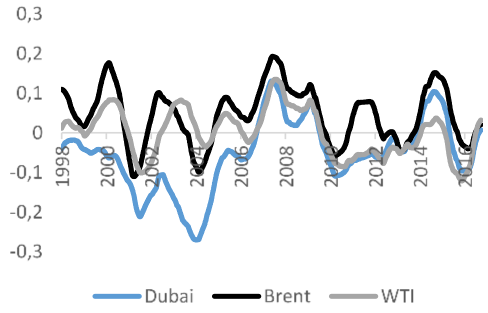
Panel C: Oseberg



Panel D: Forcados



Panel E: Statfjord



Panel F: Bonny

- Similar results for all European/African regional crude oils:
  - Brent and WTI follow each other
  - Dubai deviates in the beginning of the data sample (1999 – 2006)

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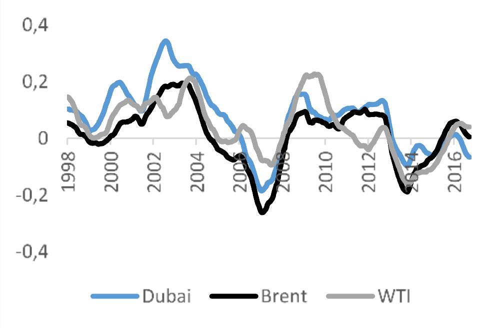
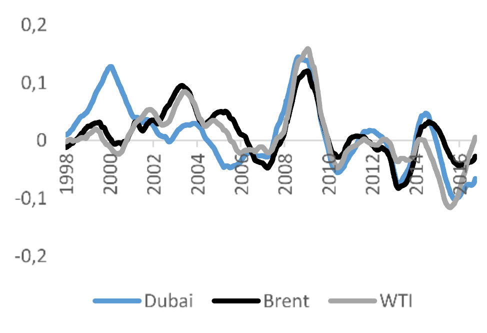
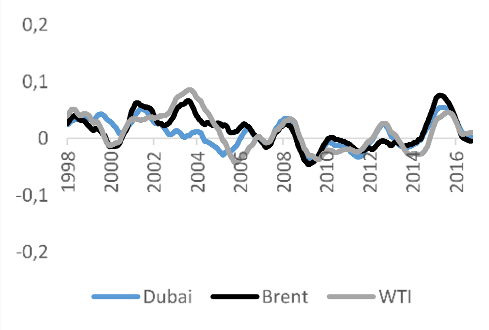
Arab regional crude oils



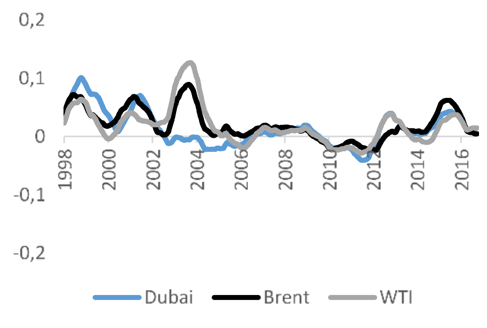
Panel A: Murban



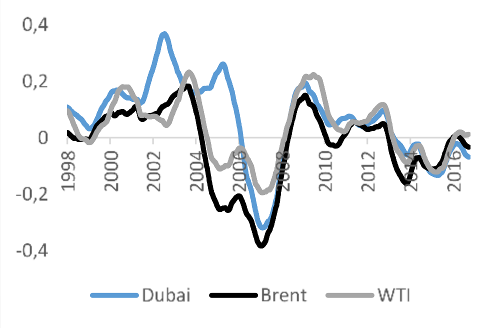
Panel B: Tapis



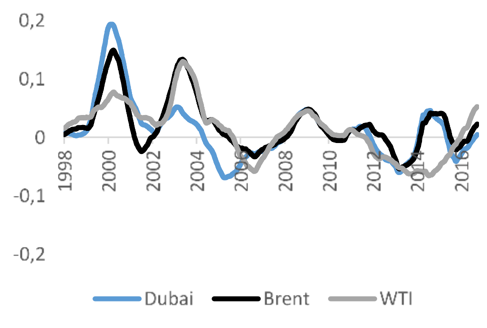
Panel C: Minas



Panel D: Duri



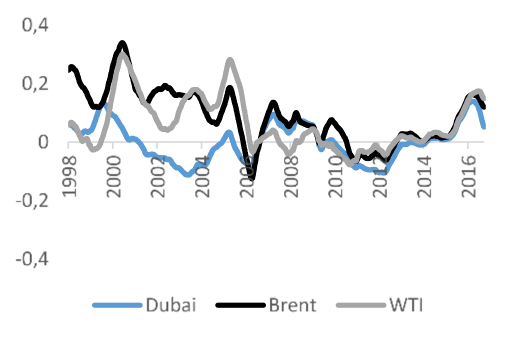
Panel E: Oman



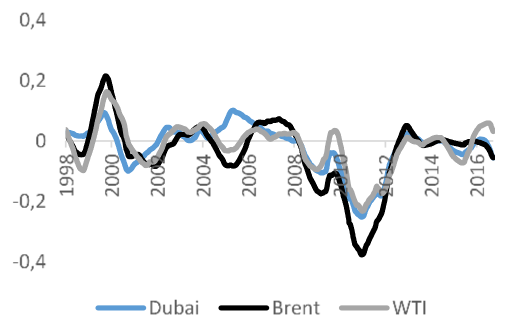
Panel F: Australia

- Arab regional prices relate equally to all benchmarks
- Some exceptions in the beginning of the sample period with Dubai benchmark more positive

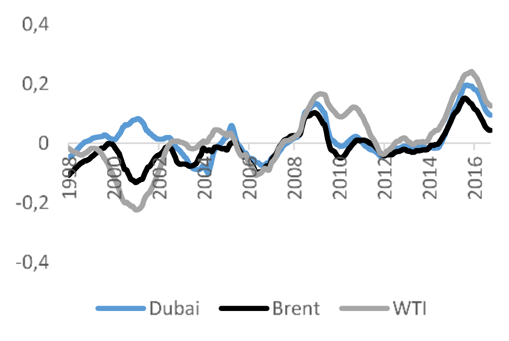
US regional crude oils



Panel A: Louisiana Light Sweet



Panel B: West Texas Sour



Panel A: Alaskan

- Equal relationship to global benchmarks, with one exception for LLS in 1999 – 2005.

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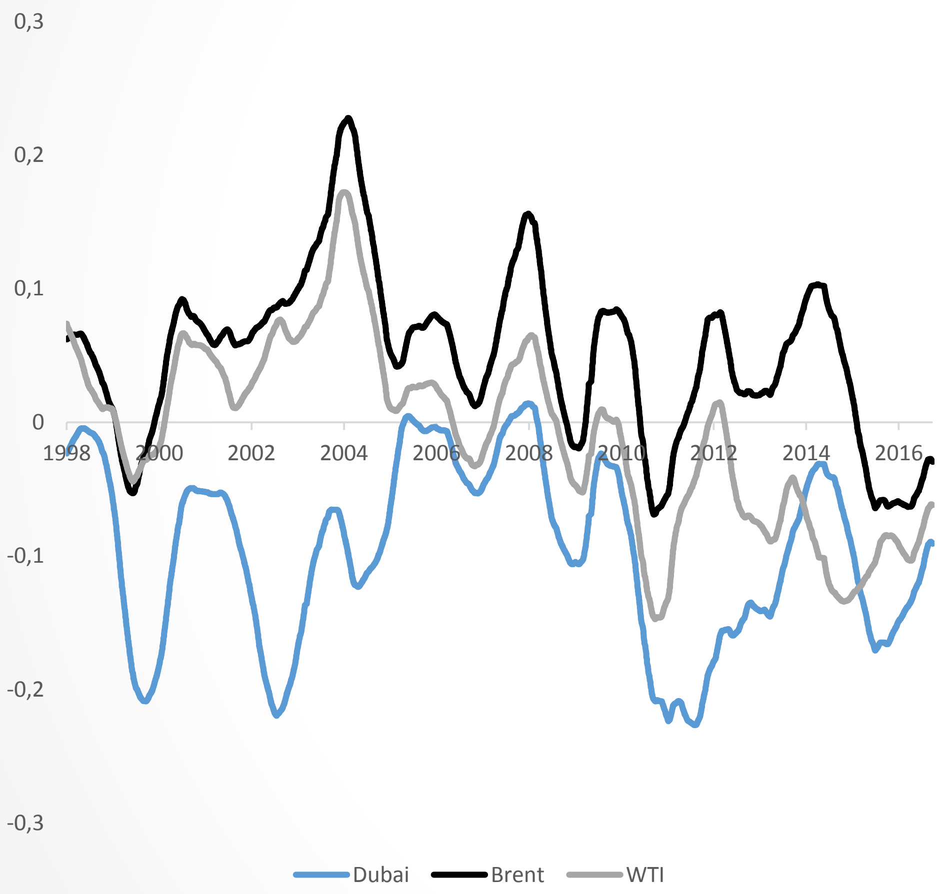
Benchmarks



- Aggregating the results provide a comparison between the global benchmarks.
- This indicates a higher influence by Brent on regional crude oil prices (in the sample).

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Concluding remarks

- Time-varying influence from the benchmarks on regional crude oils.
- Less deviation in benchmark influence since 2005.
  This may indicate a higher level of market integration.
- On average, Brent and WTI has more influence on the regional benchmarks compared to Dubai crude oil. Less difference since 2005.
- Today's analysis focus on geographical location.
  May apply the analysis considering API gravity and sulfur content.

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