

Stability in an Era of Instability

Regime Changes in the Market Relationship Between LPG, Oil, and Natural Gas

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Balancing the oil market could be jeopardized by shale

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Energy consultant sees difficult task in balancing oil markets

Rise of US, Canadian shales complicates OPEC efforts



#BUSINESS NEWS SEPTEMBER 29, 2016 / 6:20 AM / A YEAR AGO

Relief arrives for U.S. shale firms as OPEC folds in price battle

Objective

- Introduce the Markov Switching model of Hamilton [1989, 1990] in the Engle-Granger [1981, 1987] cointegration methodology
- If cointegration relationships are established in a bivariate setup, we continue by estimating a Vector Error Correction Model

Data

- Propane, Butane, WTI, NG

Previous Research

- [Asche et al., 2006] [Brown and Yücel, 2008] [Neumann, 2008]

Markov Switching Model

- Original Engle-Granger (1981, 1987)

$$y_t = \alpha_0 + \phi_1 x_t + \varepsilon_t \quad (1)$$

- Following Brigida (2014) we incorporate the Hamilton (1989, 1990) MS method with the EG model:

$$y_t = \alpha_{0,S_t} + \phi_{1,S_t} x_t + \varepsilon_t \quad (2)$$

with transition probabilities:

$$\mathbf{P} = \begin{pmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{pmatrix} \quad (3)$$

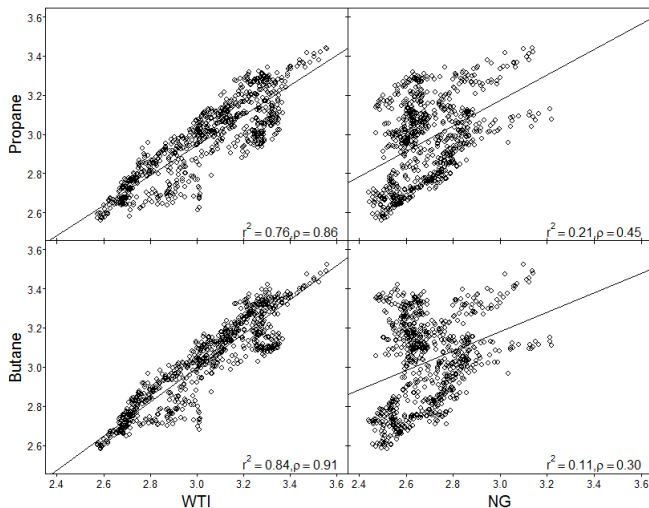
- Model parameters: $\theta = (\alpha_1, \phi_{1,1}, \sigma_1, \alpha_2, \phi_{1,2}, \sigma_2, p_{11}, p_{22})$
- VECM model:

$$\Delta y_t = \alpha_1 + \alpha_y \hat{\varepsilon}_{t-1} + \sum_{i=1} \alpha_{11}(i) \Delta y_{t-i} + \sum_{i=1} \alpha_{12}(i) \Delta x_{t-i} + \epsilon_{yt} \quad (4)$$

	Mean	Std.	Ex.Kurt	Skew.
Propane	-0.048	0.027	17.26	-1.90
Butane	-0.001	0.026	4.46	-0.71
WTI	0.166	0.025	3.43	-0.47
NG	-0.173	0.031	8.47	0.18

	ADF (1979)		Zivot-Andrews (1992)	
	Levels (lag)	First diff.	Teststat. (lag)	Breakmonth
Propane	-0.18 (12)	-7.57***	-3.51 (1)	02.2014
Butane	-0.18 (8)	-8.65***	-3.02 (1)	01.2014
WTI	-0.03 (8)	-7.76***	-3.57 (1)	07.2014
NG	-0.19 (11)	-8.81***	-3.82 (5)	07.2008

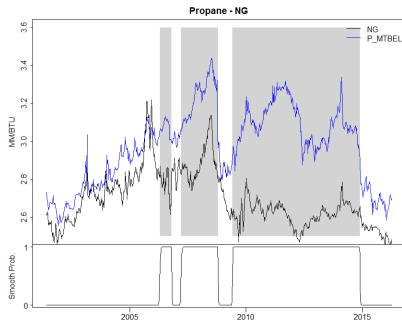
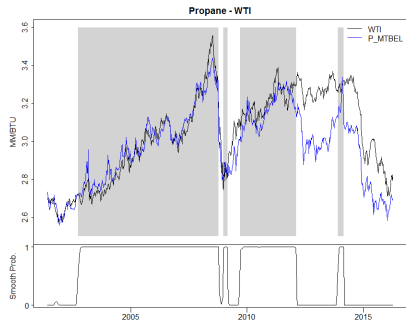
Scatter Plot log-returns



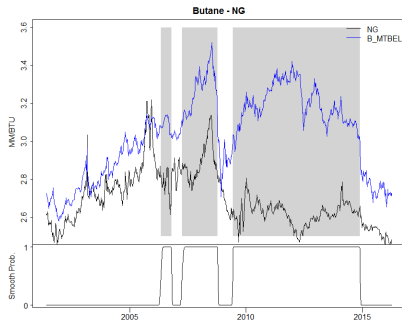
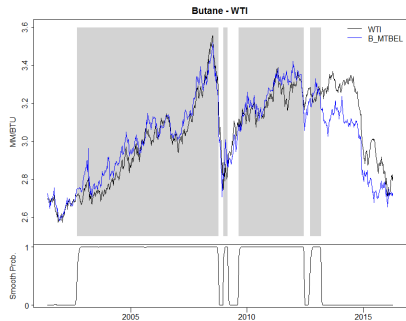
EG and MS Cointegration Models

	Propane - WTI	Propane - NG	Butane - WTI	Butane - NG
ADF (EG model)	-2.68	1.96	3.11*	1.87
ADF (MS model)	-7.13***	-4.39***	-6.12***	-4.86***
AIC (EG model)	-1371.34	-452.17	-1580.82	-234.54
AIC (MS model)	-2360.86	-2360.86	-2474.51	-1467.89
$P(S_t = 1 P_{t-1} = 1)$	0.9913	0.9924	0.9853	0.9922
$E[S_t = 1]$	115.20	132.20	68.00	127.9
$P(S_t = 2 P_{t-1} = 2)$	0.9867	0.9921	0.9919	0.9923
$E[S_t = 2]$	75.40	126.00	123.80	130.40

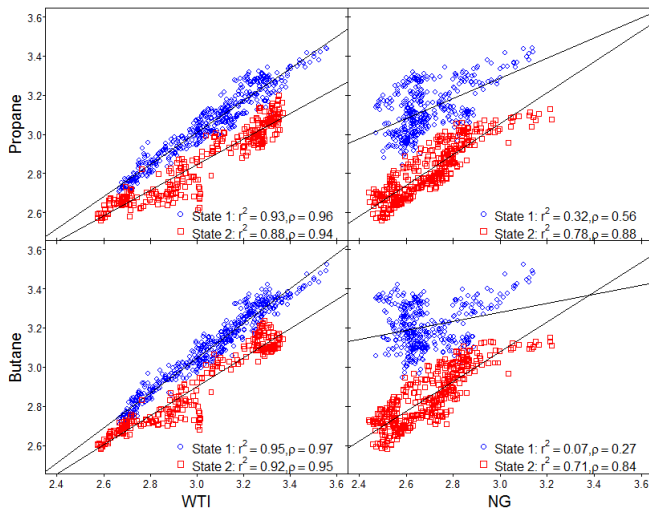
Regime Models Propane



Regime Models Butane



Scatter Plot MS Adjusted



	Propane - WTI	Butane - WTI	Propane - NG	Butane - NG
$\hat{\varepsilon}_{t-1}(\text{EG})$	-0.01	-0.01	-0.01	-0.01
$\hat{\varepsilon}_{t-1}(\text{MS})$	-0.08***	-0.05**	-0.04***	-0.03***
Half-life (MS)	8.87	14.24	18.95	25.62

- Incorporate the Hamilton MS model in a bivariate cointegration setup
- Open up for the possibility of estimating bivariate market integrations despite changing market conditions
- Prove $CI(1, 1)$ between LPG, oil and NG between 2001 and 2016 with the MS model

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