

Changes affecting the Relationship Fossil Fuels and Electricity Prices

- Are Fossil Fuels important for price determination in electricity markets?
- Did the major changes to the electricity market affect the relationship?
- Impact of the energy transition in Germany – Increased capacity of renewables
- Merit Order Effect of renewables – especially important for hours of peak demand, because of high production from photovoltaic.
- Analysis in a Vector Error Correction (VECM) framework to analyse possible cointegration relations (1/8)

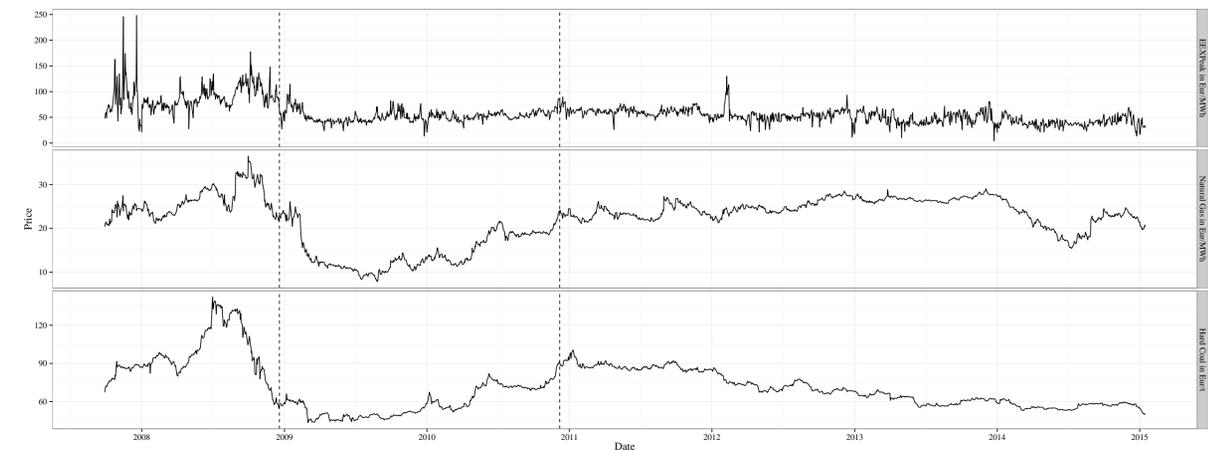
Endogenous and Exogenous Variables in the Analysis

- EEX Peak, Natural Gas and Hard Coal Prices
- Weather – Heating and Cooling Degree Days, Index for River Temperature and the sunshine duration
- Seasonality – Dummies for weekdays and holidays

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Time Series – Endogenous Variables

Figure 1: Time Series Plot with Structural Breaks determined by Minimum LM – Stationarity Test



(dashed vertical lines indicate the break dates on 19th Dec 2008 and 07th Dec 2010 as determined by the minimum LM stationarity test)

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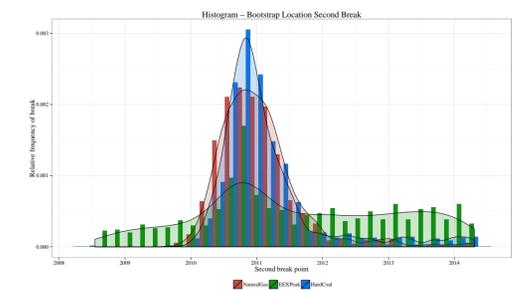
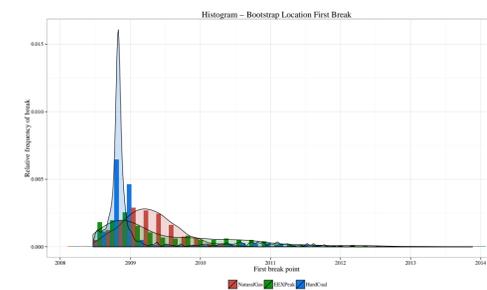
Cointegration Analysis

- Test for Stability of the Cointegration Relationship with Hansen and Johansen (1999) test
 - Results allow to reject the null hypothesis of a stable cointegration relationship, with a test statistic of 4.797
- Johansen et al. (2000) VECM with Structural Breaks in the Cointegration Relationship according to the two preliminary tests

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Minimum Lagrange Multiplier (LM) – Stationarity Test

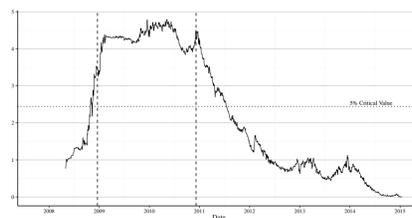
- Endogenous Structural Break Detection by Lee and Strazicich (2003, 2013)
- Minimum LM test allows up to two structural breaks – both in intercept or in intercept and trend
- Bootstrapped Results – to determine if structural breaks in intercept and trend are different across the time series



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Stability of Cointegration Relation

Figure 2: Recursively estimated test statistic for β constancy according to Hansen and Johansen (1999)



- dotted horizontal line indicates 5% critical value at 2.44
- dashed vertical lines indicate the break dates on 19th Dec 2008 and 07th Dec 2010
- first 150 observations not used in the recursive calculation

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Results of Cointegration Analysis

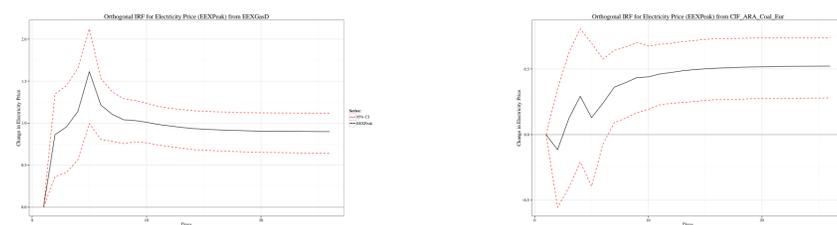
Table 1: Trace test statistic to determine the cointegration rank

Rank	Trace Test Statistic	10%	5%	1%
$r \leq 2$	4.69	7.52	9.24	12.97
$r \leq 1$	21.89	42.20	45.54	52.27
$r = 0$	231.13***	67.02	71.08	79.11

Table 2: α and β vector of the estimated VECM

	α -vector		β -vector	
	Parameter	t-stat	Parameter	t-stat
EEXPeak	-0.3204***	-14.88	1.0000	—
EEXGas	-0.0003	-0.31	-1.7568***	-7.24
Hard Coal	0.0001	0.04	-0.3988***	-6.11
$tD_{1,t-k}$	—	—	0.0156*	1.90
$tD_{2,t-k}$	—	—	0.004	1.23

Figure 3: IRF – Natural Gas & Hard Coal \rightarrow EEX Peak



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Conclusion & Future Research

Conclusion:

- cointegration relationship exists, but not stable over the whole sample period
- deviations from the equilibrium are corrected
- difficult to identify exogenous events triggering the structural breaks
- impact of fossil fuels weakened by changes to the whole electricity market

Future Research:

- Threshold cointegration with production from renewables affecting the threshold
- explicitly consider production from renewables, e.g. electricity generated from photovoltaic or wind
- VECM-GARCH to account for observable volatility clustering

Further information:

github repository with R code

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