

Disentangling the Effects of Industrial Production and CO₂ Emissions on European Carbon Prices

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EUA Price Development

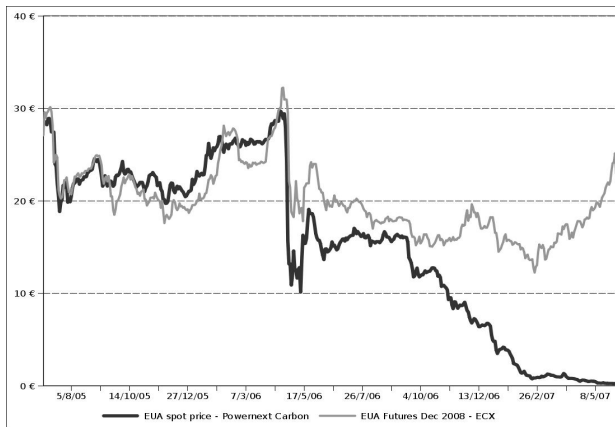


Fig.: EEA Price Development from July 1, 2005 to April 30, 2007

Source : Powernext carbon and ECX

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- ▶ (among other contributions)

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- ▶ Trends in industrial production of sectors covered by the EU ETS (2005-2007) ;
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- ▶ Linking the expected impacts of industrial production trends and emissions compliance on carbon price changes.

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- ▶ Why ? : disentangling the influence of compliance and industrial production peaks effects.

Industrial Production Trends of EU ETS Sectors 2005-2007 (1/2)

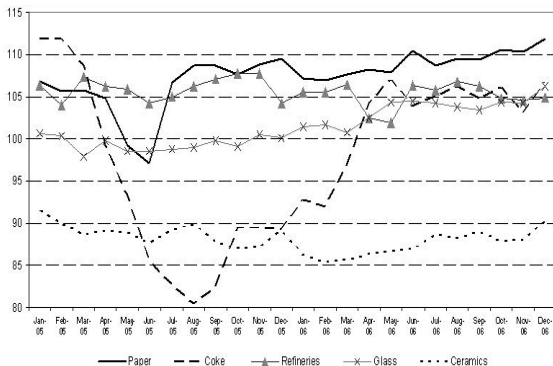


Figure 1 : Paper, Coke, Refineries, Glass and Ceramics Production Trends in 2005-2006

Source : Eurostat

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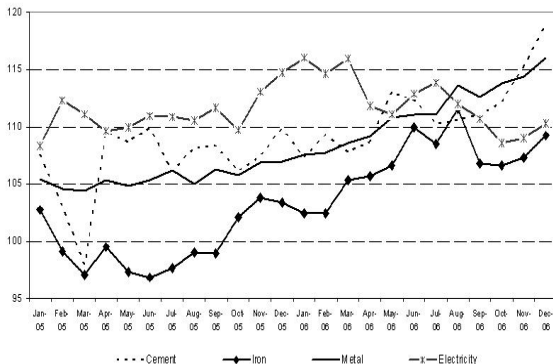


Figure 2 : Cement, Iron, Metal and Electricity Production Trends in 2005-2006

Source : Eurostat

EU Emissions Cap and Compliance Periods 2005-2006

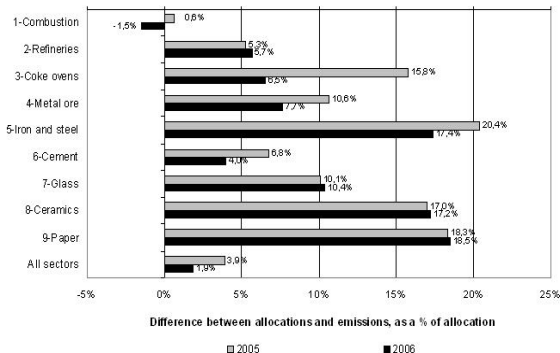


Figure 5 : EU ETS Sectoral Compliance^a in 2005-2006

Source : Trotignon *et al.* (2008)

^aComputed as the difference between allocation and emissions as a percentage of allocation.

Linking the expected impacts of industrial production trends and emissions compliance on carbon price changes

Compliance and Production Growth Rate Linkages	2005	2006
Positive growth rate with a long compliance	Metal ore, Iron and steel, Cement, Pulp and paper	Coke ovens, Metal ore, Iron and steel, Cement, Glass, Ceramic, Pulp and paper
Positive growth rate with a short compliance	Electricity	-
Negative growth rate with a long compliance	Oil refineries, Coke ovens, Glass, Ceramic	Oil refineries
Negative growth rate with a short compliance	-	Electricity

Table : Emissions Compliance and Production Growth Rate Linkages in the EU ETS Sectors 2005-2006

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- ▶ $p_t = \ln(P_t/P_{t-1})$
- ▶ Usual unit root tests (ADF, PP, KPSS) are performed for all price series. All of them are characterized by a unit root and then converted to stationary taking first natural logarithm differences. When tests are applied on series in first differences, they are found to be stationary. In other words, all prices series are integrated of order 1 (I(1)).

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- ▶ Monthly industrial production indices are collected from Eurostat using the Classification NACE Rev.1 C-F. Data are obtained for the EU 27 countries.
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- ▶ Dummy variable capturing industrial production peaks for each sector.

▶ **Compliance Variables**

- ▶ Dummy variable for the yearly net short/long position.

Econometric specifications

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- ▶ Do EU ETS sectorial production indices influence CO₂ price changes?

$$\begin{aligned}
 p_t = & \alpha + \beta(L)p_t + \delta break_t + \varphi(L)ngas_t + \gamma(L)coal_t \\
 & + \iota(L)elec_t + \kappa(L)dark_t + \lambda(L)spark_t + \sigma Win07 \\
 & + \varsigma cement_t + \tau refin_t + \upsilon coke_t + \omega elecsect_t + \xi glass_t \\
 & + \psi metal_t + \zeta paper_t + \rho ceram_t + \chi iron_t + \epsilon_t
 \end{aligned} \tag{1}$$

Econometric specifications

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- ▶ Disentangling Production Peaks and Compliance Periods from Sectorial Activities

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 & + \iota(L)elec_t + \kappa(L)dark_t + \lambda(L)spark_t + \sigma Win07 \\
 & + \omega sect_{i,t} + sectpeak_{i,t} + \vartheta sectcompl_{i,t} \\
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- ▶ $sectcomplpeak_t = sectcompl_t * sectpeak_t$

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- ▶ Taking into account this quite dynamic behavior for allowance prices and volatilities, and the dependence of the variability of the time series on its own past, Borak et al. (2007) and Benz & Truck (2006) recommend to address the problem of heteroskedasticity with GARCH models.

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- ▶ Based on this discussion, we calibrate the data with the GARCH(p , q) model. After testing for various specifications, we identify as the best fit for the CO₂ return series the simple setup of a GARCH(1,1) model using Bollerslev-Wooldrige robust standard errors and covariance.

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- ▶ The model is estimated in Pseudo Maximum Likelihood. The estimates covariance matrix is estimated with the BHHH algorithm.

	(1a) ^a	(1b)
Pt(-1)	0.1976 (0.0272)	0.0385 (0.0288)
Pt(-2)	-0.0201 (0.0283)	-0.0521** (0.0243)
Constant	-0.0095*** (0.0005)	-0.0089*** (0.0008)
Break	0.0084*** (0.0010)	
Natural Gas	0.1349*** (0.0033)	0.1292*** (0.0076)
Coal	-0.1929*** (0.0108)	-0.1794*** (0.0100)
Electricity	0.0011*** (0.0004)	0.0013*** (0.0003)
Clean Dark	-0.0763*** (0.0014)	-0.0734*** (0.0042)
Clean Spark	0.0750*** (0.0018)	0.0720*** (0.0042)
Win07	-0.0069** (0.0030)	-0.0193*** (0.0060)
Elecsect		-0.0598*** (0.0046)
Iron		-0.0223*** (0.0049)
Paper		-0.0771*** (0.0167)
ARCH(1)	0.4302*** (0.0569)	0.4871*** (0.0955)
GARCH(1)	0.7323*** (0.0185)	0.6968*** (0.0400)
R-squ.	0.1782	0.1835
Adj. R-squ.	0.1549	0.1568
F-Stat	0.0000	0.0000
D.W.	1.4979	1.4804
AIC	-4.2815	-4.3727
SC	-4.1586	-4.2322

	(2a)	(2b)
Pt(-1)	0.0329 (0.0226)	0.0445** (0.0230)
Pt(-2)	-0.0391* (0.0211)	-0.0401* (0.0217)
Constant	-0.0119*** (0.0006)	-0.0121*** (0.0006)
Break	-	-
Natural Gas	0.1313*** (0.0046)	0.1320*** (0.0041)
Coal	-0.1842*** (0.0064)	-0.1852*** (0.0060)
Electricity	0.0009*** (0.0003)	0.0010*** (0.0003)
Clean Dark	-0.0740*** (0.0024)	-0.0746*** (0.0021)
Clean Spark	0.0732*** (0.0026)	0.0735*** (0.0023)
Win07	-0.0230*** (0.0060)	-0.0236*** (0.0060)
Elecsect	-0.0788*** (0.0041)	-0.0786*** (0.0039)
Elecsectpeak	0.0198*** (0.0021)	0.0512*** (0.0030)
Elecsectcompl	0.0052*** (0.0019)	0.0063*** (0.0020)
Elecsectpeakcompl		-0.0345*** (0.0046)
ARCH(1)	0.6001*** (0.1046)	0.6386*** (0.1186)
GARCH(1)	0.6329*** (0.0453)	0.6173*** (0.0449)
R-squ.	0.1833	0.2151
Adj. R-squ.	0.1566	0.1876
F-Stat	0.0000	0.0000
D.W.	1.5170	1.5950
AIC	-4.4844	-4.5444
SC	-4.3439	-4.3951

	(3)	(4)
Pt(-1)	0.0154 (0.0261)	-0.0265 (0.0273)
Pt(-2)	-0.0450* (0.0242)	-0.0420* (0.0243)
Constant	-0.0095*** (0.0006)	-0.0073*** (0.0003)
Break	-	-
Natural Gas	0.1358*** (0.0037)	0.1365*** (0.0057)
Coal	-0.1878*** (0.0070)	-0.1918*** (0.0098)
Electricity	0.0009*** (0.0003)	0.0006** (0.0003)
Clean Dark	-0.0766*** (0.0019)	-0.0758*** (0.0030)
Clean Spark	0.0759** (0.0020)	0.0763*** (0.0032)
Win07	-0.0046* (0.0028)	-0.0300*** (0.0049)
Iron	-0.0320*** (0.0035)	
Paper		-0.0465*** (0.0055)
Ironpeak	0.0088*** (0.0011)	
Paperpeak		0.0112*** (0.0024)
ARCH(1)	0.6944*** (0.1443)	1.2110*** (0.2584)
GARCH(1)	0.6066*** (0.0463)	0.3892*** (0.0684)
R-squ.	0.1999	0.0733
Adj. R-squ.	0.1755	0.0450
F-Stat	0.0000	0.0000
D.W.	1.5334	1.3548
AIC	-4.3839	-4.3415
SC	-4.2522	-4.2098

Discussion (1/2)

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- ▶ Losing significance on *break* between rows (1a) and (1b) suggests that the inclusion of sectorial production indices contributes to a sharper explanation of carbon price changes;

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Discussion (1/2)

- ▶ Losing significance on *break* between rows (1a) and (1b) suggests that the inclusion of sectorial production indices contributes to a sharper explanation of carbon price changes ;
- ▶ Three sectors among nine do have an impact on EUA price changes : *comb*, *iron*, *paper* which represent roughly 80% of allowance allocated ;
- ▶ The negative signs of these sectorial variables seems *a priori* counter-intuitive. This needs a more careful analysis with production peaks and compliance variables ;

Discussion (2/2)

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- ▶ Positive coefficients for production peaks tend to confirm that when a sector has an increasing activity peak, then firms in this sector are net buyers which yields to a positive impact on the allowance price ;

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- ▶ Positive coefficient for *elecsectcomp/c* tends to prove that if a sector exhibit a net short (long) position, then firms in this sector are net buyers (sellers) of allowances and the impact on the allowance price shall be positive (negative).

Next step

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- ▶ An evaluation of the impact of the emissions compliances at firm-level/by country on EUA prices.