[INTERACTIONS BETWEEN CARBON PRICES AND ELECTRICITY PRICE IN EUROPE: IN THE CASE OF FRANCE AND GERMANY]

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Overview

Since January 2005, as part of its commitment to the Kyoto Protocol, the European Union has implemented a trade plan to limit Carbon emissions. Allowances are allocated to industrial Carbon emitters at the end of each year. This climate change policy has resulted in a cap and trade program for Carbon and will result in increased business spending (Richard, 2008). Since the energy sector contributes 40% of Carbon emissions, such a policy will have a significant impact on the energy industry. Richard Newell, in a study on the impact of Carbon allowance prices on retail electricity prices, distinguished the factors likely to have an impact on electricity prices, namely: the price of Carbon emissions; the regulatory structure and the technology used. As electricity is a vital economic input, the impact of fluctuations in electricity prices could have an impact on the entire economy.

The main objective of this work will therefore be to describe the possible interactions between carbon prices and electricity prices. More specifically, we will quantify the mutual price interactions between electricity and carbon through an econometric model.

Methods

The implementation of the modelling of the interactions between the price of CO2 and the price of electricity will take place through the following steps. We will first determine the degree of integration of log variables, using the Dickey Fuller Augmented Unit Root Test. Then we will test the cointegration of log variables using the Engle and granger test or the Johansen test according to the integration order of the variables. Then we will estimate the error-corrected model by the ordinary least squares method. An interpretation of the error correction coefficient will be given by interpreting short-term and long-term elasticities. Tests on the linear model assumptions will then be performed.
Data comes from Epex Spot and start in 2010. It concerns Electricity prices and carbon prices in France and Germany.
We performed an econometric Error Corrected model using Eviews software.

With constancy: LCO2CER serie

Null Hypothesis: LCO2CER has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.185328	0.9980
Test critical values:	1% level	-3.487046	
	5% level	-2.886290	
	10% level	-2.580046	

The LCO2CER series is non-stationary, moving to the ADF test on first difference variables as follows :

Null Hypothesis: D(LCO2CER) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.908880	0.0000
Test critical values:	1% level	-3.487550	
	5% level	-2.886509	
	10% level	-2.580163	

The stationarity hypothesis is accepted, the D series (LCO2CER) is integrated in order 1.
We compute for our series the same test :
with constant and trend
without constant or trend

Cointegration test

After having carried out the stationarity tests it is found that the variables are stationary or integrated in level I(0) or in first difference I(1). The Johansen cointegration test will then be used, since the variables do not have the same order of integration. The cointegration hypothesis is accepted if the value of the statistic is greater than the critical value for at least one option.

Error Correction Model Approach

The estimation of the Ordinary Least Squares Error Corrected Model will be done at Hendry (one-step estimation). The equation of the model is written:

$$D(LELECFR_t)=\beta_0 + \beta_1 D(LCO2CER_t) + \beta_2 LELECFR_{t-1} + \beta_3 LCO2CER_{t-1} + \varepsilon_t$$

$$D(LELECFR_t)=\beta_0 + \beta_1 D(LCO2EUA_t) + \beta_2 LELECFR_{t-1} + \beta_3 LCO2EUA_{t-1} + \varepsilon_t$$

$$D(LELECDE_t)=\beta_0 + \beta_1 D(LCO2CER_t) + \beta_2 LELECDE_{t-1} + \beta_3 LCO2CER_{t-1} + \varepsilon_t$$

$$D(LELECDE_t)=\beta_0 + \beta_1 D(LCO2EUA_t) + \beta_2 LELECDE_{t-1} + \beta_3 LCO2EUA_{t-1} + \varepsilon_t$$

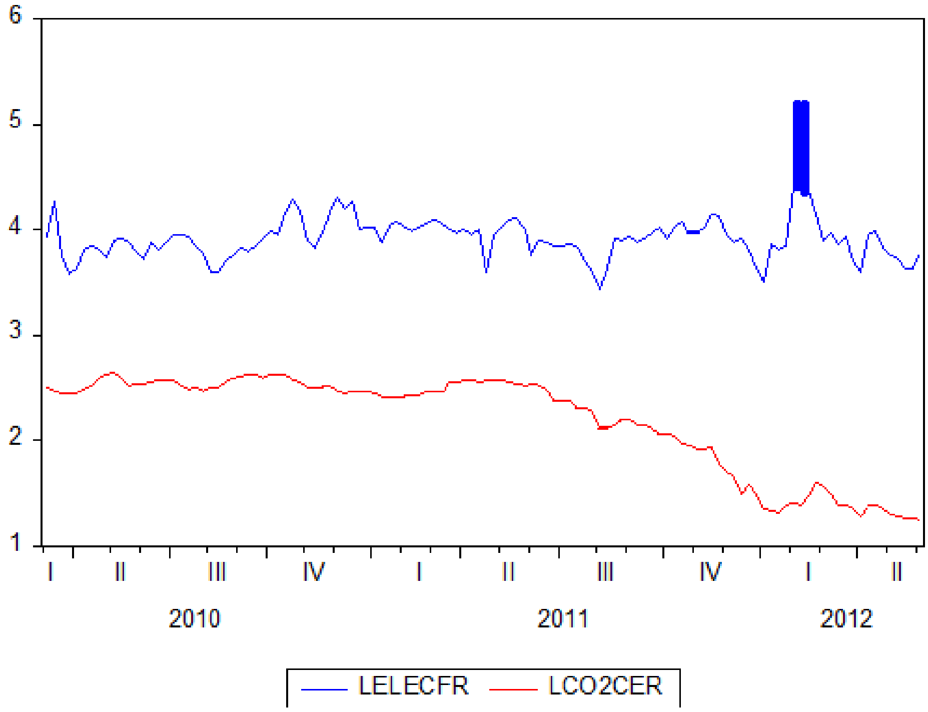
The results of the model estimates for France are given in the following table:

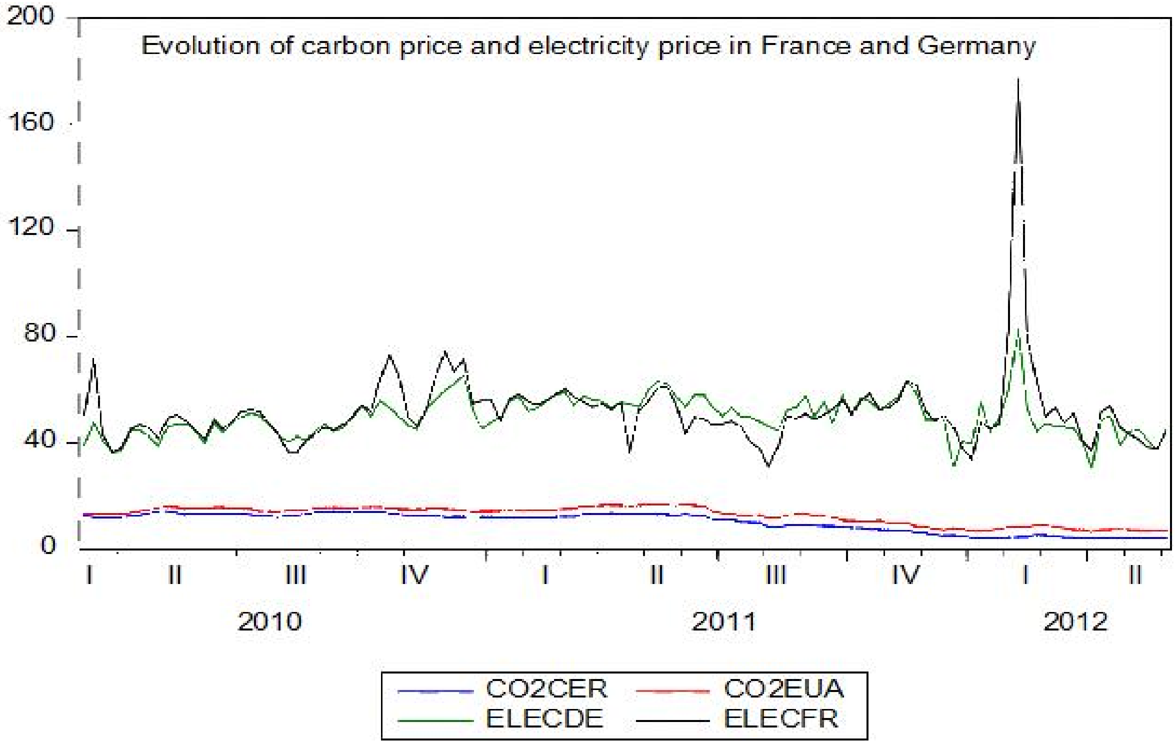
Dependent Variable: D(LELECDE)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.376771	0.279127	4.932421	0.0000
D(LCO2EUA)	0.319956	0.242297	1.320510	0.1893
LELECDE(-1)	-0.392302	0.074989	-5.231481	0.0000
LCO2EUA(-1)	0.062329	0.037742	1.651461	0.1014

R-squared	0.224141	Mean dependent var	0.001158
Adjusted R-squared	0.203543	S.D. dependent var	0.130217
S.E. of regression	0.116212	Akaike info criterion	-1.433214
Sum squared resid	1.526087	Schwarz criterion	-1.338781
Log likelihood	87.84303	Hannan-Quinn criter.	-1.394875
F-statistic	10.88165	Durbin-Watson stat	2.049422
Prob(F-statistic)	0.000002		

We note that the coefficient associated with the force of return to equilibrium is negative (- 0.392302) and significantly different from zero at the 5% threshold. There is therefore a correction mechanism: in the long term the imbalances between EU2C prices and electricity prices in Germany are offset so that the two series have similar developments.
We thus manage to adjust 39.23% of the imbalance between the desired price and actual electricity. 39.23% of the effects of a shock in a given year are eliminated in the year following any shock.
Thus the shocks on electricity prices in France corrected to 39.23% by the effect of
"feed back". In other words, a shock during a year is completely absorbed after (1/0.392302 years) or 2 years.


6
5
4
3
2
1
I
II
III
IV
I
II
III
IV
I
II
2010
2011
2012
LELECFR
LCO2CER


Evolution of carbon price and electricity price in France and Germany
200
160
120
80
40
0
I
II
III
IV
I
II
III
IV
I
II
2010
2011
2012
CO2CER
CO2EUA
ELECDE
ELECFR

Results

The following results were obtained:

In France

The short-term elasticity is 0.373. If the price of CO2CER increases by 10%, then electricity prices in France in the short term increase by 3.73%.

The long-term elasticity is 0.0051. If the price of CO2CER increases by 10%, then the long-term electricity prices in France increase by 0.051%.

The short-term elasticity is 0.726. If the price of CO2EUA rises by 10%, then electricity prices in France in the short term increase by 7.26%.

The long-term elasticity is 0.03305. If the price of CO2EUA increases by 10%, then the long-term electricity prices in France increase by 0.3051%.

In Germany

The short-term elasticity is 0.0306. If the price of CO2CER increases by 10%, then electricity prices in Germany in the short term increase by 0.306%.

The long-term elasticity is 0.08175. If the price of CO2CER increases by 10% then the long-term electricity prices in Germany increases by 0.8175%.

The short-term elasticity is 0.319. If the price of CO2EUA rises by 10% then electricity prices in Germany in the short term increase by 3.19%.

The long-term elasticity is 0.15886. If the price of CO2EUA rises by 10 % then the long-term electricity prices in Germany increase by 1.5586 %.

Conclusions

Overall the work aimed to quantify the interactions between carbon prices and electricity prices in Europe. Depending on the availability of the information collected a case study was carried out on the French and German electricity markets.

It emerges that in the short and long term carbon prices has an impact on electricity prices in France and Germany. When carbon prices rises, electricity price increase.

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