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Abstract

This paper investigates the short term relationship between the three major European electricity markets: France, Germany and Italy. Using a multivariate analysis, we study the impact of each electricity price changes in one country on the electricity price of the others two countries. Empirical results show that there is a positive impact of common reforms in Europe. Indeed, there is an interdependence of electricity prices especially between Germany and Italy.

Keywords: Electricity prices, Europeans countries, VAR model.

Introduction

In the recent years, electricity markets integration is perceived like a challenge for Europeans countries. Until 1990s, electricity market was a monopoly in most countries. But it is known that the monopoly does not provide the best prices for consumers. So the creation of a common electricity market seems to be necessary in order to introduce the perfect competition. Under the condition of perfect competition there will be an economic efficiency in the sector and result in lower prices of electricity (Joskow (2008)).
The reforms in the European electricity industry have been introduced by the first and the second Electricity Directives of 1996 and 2003. This integration should be realised at many stage as the European commission announced. The full integration needs harmonization of the rules in Europe. In this context the increased interconnectedness of European electric systems results in higher interdependence between prices electricity markets. This means that the price of electricity in each country may be influenced by others prices. Because in the past, the electricity price has been regulated by the Europeans governments but, today, electricity price is deregulated in Europe (Harris (2007), Creti, Fumagalli and Fumagalli (2010)).
In electricity market, all consumers submit hourly bids a day-ahead market he market operator allocates quantities by a procedure that minimizes the cost of despatch. So, there are the operators witch determine which generator will produce what amount of electricity and at what price. For this reason, the majority of these studies have focused on electricity prices as the important variable to indicate the integration degree. Indeed, since of the beginning reforms of electricity markets in Europe, there are many studies which have treated electricity prices as study subject (Bower (2002), Armstrong and Galli (2005), Boisselau (2004), Zachmann (2008), Bunn and Gianfreda (2010)). The majority of these studies have focused on prices volatility. Others studies have investigated the electricity consumption –economic activity relationships (Hossain and Saeki (2012), Nawaz, M and al. (2012)).

In this paper, we analyses the short term interdependencies existing in market European electricity prices. Although, the majority studies concentrate on the long term interdependencies but interesting the short term analysis can also led weather there is a harmony reforms between the electricity markets in Europe.

The paper is organized as follows. In section 2 we present a preliminary data analysis of the electricity prices and the methods that we use for processing the price series. Section 3 focuses on the econometrics results, while section 4 includes conclusion.

Empirical Methodology

In order to study the impact of electricity sector reforms in Europe in term of interdependence between prices, we will follow following methodology. As the first stage of econometrics study, we will check a stochastic propriety of variables by using Unit root tests. Then, after having examined the optimal lag length of the VAR model, we will estimate a VAR model and present the orthogonalised impulse response functions and forecast error variance decomposition. The data covers the period from 06 July 2009 to 15 April 2011 (T=648 observations).

Vector Autoregressive Model (*VAR*)

We use the VAR model to analyze the interdependences between electricity prices in Europe. The VAR (P) model is presented by:

$$Y = c + \sum_{i=1}^{p} \phi_i Y_{t-i} + u$$

Where c is the $(nx1)$ intercept vector of the VAR, Y_t is a $(nx1)$ vector of endogenous variables, Φ is the ith (nxn) matrix of the autoregressive coefficients for $i = 1, 2 \ldots p$, and u_t is the $(nx1)$ generalization of a white noise process.

The VAR system can be transformed into its moving average representation in order to analyze the system's response to an electricity price shock, that is:

$$Y_t = \varepsilon + \sum_{i=0}^{\infty} \theta_i \mu_{t-i}$$

Where θ_0 is the identity matrix, ε is the mean of the process. The MA representation is used to obtain the forecast error variance decomposition and the impulse-response function.

Empirical Results

Data, descriptive analysis and unit roots tests

The data used in this study consists of time series of daily electricity prices of the three majors European economies: France, Germany and Italy (LFRA LGER and LITA). The sample covers the period from 06 July 2009 to 15 April 2011 (T=648 observations). Table 1 below provides information about the mean, standard deviation, skewness coefficient, Kurtosis coefficient, the Jarque–Bera Normality test (JB), and Ljung–Box test (LB) for the level and squared series.

Table-1 : descriptive statistics

	DLFRA	DLFER	DLITA
Mean	0.0065	0.0022	0.0190
Median	-0.0251	-0.0426	0.0000
Std. Dev.	0.7375	0.6615	0.3896
Skewness	0.1986	0.9542	-0.1328
Kurtosis	6.6558	11.465	8.3410
Jarque-Bera	365.12	2033.23	772.11
LB(6)	15.278	31.132	80.820
LB(12)	21.499	39.170	82.777
LB2(6)	14.696	4.4105	48.575
LB2(12)	31.892	11.147	50.196
Probability	0.0000	0.0000	0.0000

Table (1) shows that all series are non-normally distributed, a behavior largely observed on financial time series and which characterizes here the returns of the three electricity series, see JB test results. The high kurtosis coefficient is also typical of high frequency financial time series, and it is behind the rejection of normality. In addition, the Ljung–Box LB statistics for the level and squared series suggest significant autocorrelation. The high dependence in the squared returns series indicates the presence of ARCH effects.

To test the stationary of the electricity prices used in our study, we have carried out the ADF, PP and KPSS unit roots tests. Empirical results for all the BRIC countries are reported in table (2) below. In our cases neither the trend nor the intercept are significant. Following this table, the electricity prices series are not stationary in level but they are in first difference. This means also that all series have a same order of integration. They are integrated with order one I(1).

Table -2: Unit Roots tests

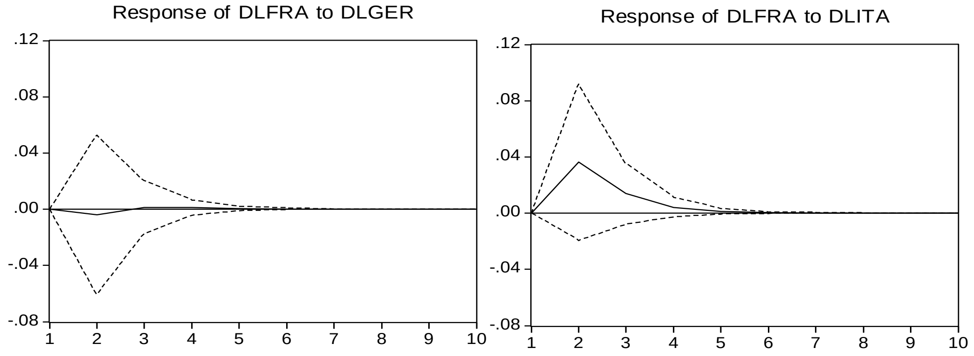
	level			First difference		
	PP	KPSS	ERS	PP	KPSS	ERS
France	0.184 (7)	0.446 (21)	5.635 (1)	-22.350 (6)	0.188 (7)	0.133 (0)
Germany	0.045 (9)	1.002 (21)	8.675 (1)	-20.855 (8)	0.212 (9)	0.109 (0)
Italy	0.857 (10)	0.995 (21)	10.047 (2)	-19.373 (7)	0.126 (10)	0.389 (1)

Criticals values for the PP, ERS and KPSS tests are -2.862, 3.260 and 0.463 respectively for the 5% level. In parenthesis (.) are the Newey-West Bandwith for the PP test, the lag length using the Schwartz criteria and the Newey West Bandwith.

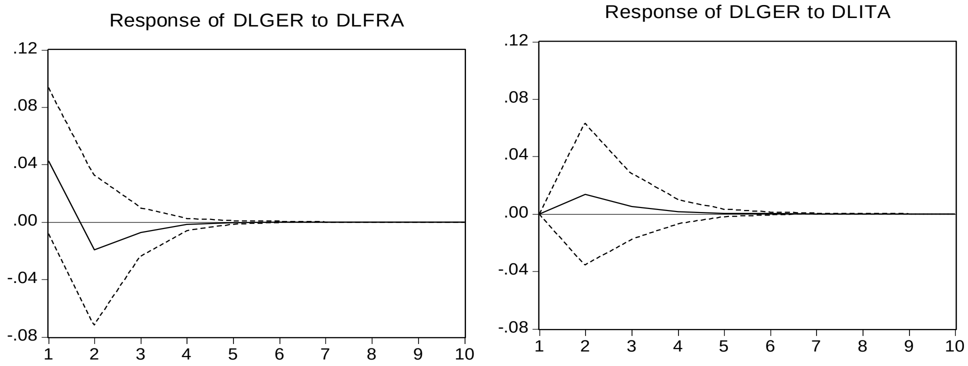
Impulses responses functions

In this subsection, we will study the impact of electricity prices of one country to electricity prices of others countries by analyzing both orthogonalised impulse response functions and forecast error variance decomposition. Cholesky decomposition Ordering is electricity price in France, Germany and Italy (DLFRA, DLGER and DLITA). The figures bellows present the response of the three variables to positive one-standard-deviation of etch variable. We can conclude from these figures, that there is only a positive and significant response of electricity price in Italy to one deviation of electricity price of Germany. The horizon of impact is somewhat limited nearly five days. This means that the increase of electricity price in Germany leads to an increase of electricity price in Italy. The two confidence bands confirm these results. So, these results show the partially success of the commons Europeans reforms in term of prices convergence.

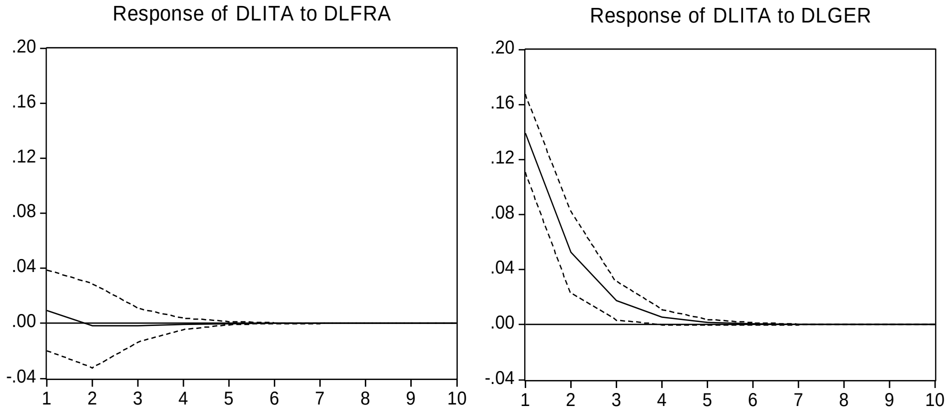
Impulses reponses functions of the DLFRA serie



Impulses responses functions of DLGER series



Impulses responses functions of DLITA series



Variance decomposition results

The variance decomposition shows the proportion of the unanticipated change of a variable that is attributable to its own innovations and shocks to other variables in the system. Table3 presents the results of the forecast error variance decomposition of the variables for the VAR model.

For Italian electricity price, the largest source of its violability is the electricity price in Germany. Electricity price of Germany contributed to Italian electricity price fluctuations with about 14.731% in ten days. Whereas, the contribution of French electricity price is weak (0.0621%).

For electricity prices of France and Germany, the Italian electricity price does not seem the main source of their variation. The largest share of their violability is explained by its own variations.

Table-3:Variance decomposition results

Variance decomposition of DLITA

Period	S.E.	DLFRA	DLGER	DLITA
1	0.7331	0.0628	13.849	86.087
2	0.7395	0.0604	14.614	85.324
3	0.7397	0.0618	14.719	85.218
4	0.7397	0.0621	14.730	85.207
5	0.7397	0.0621	14.731	85.206
6	0.7397	0.0621	14.731	85.206
7	0.7397	0.0621	14.731	85.206
8	0.7397	0.0621	14.731	85.206
9	0.7397	0.0621	14.731	85.206
10	0.7397	0.0621	14.731	85.206
Cholesky Ordering: DLFRA DLGER DLITA				

Variance decomposition of DLGER

Period	S.E.	DLFRA	DLGER	DLITA
1	0.7331	0.4318	99.568	0.0000
2	0.7395	0.5022	99.454	0.0429
3	0.7397	0.5133	99.438	0.0484
4	0.7397	0.5141	99.436	0.0489
5	0.7397	0.5141	99.436	0.0489
6	0.7397	0.5141	99.436	0.0489
7	0.7397	0.5141	99.436	0.0489
8	0.7397	0.5141	99.436	0.0489
9	0.7397	0.5141	99.436	0.0489
10	0.7397	0.5141	99.436	0.0489
Cholesky Ordering: DLFRA DLGER DLITA				

Variance decomposition of DLFRA

Period	S.E.	DLFRA	DLGER	DLITA
1	0.7331	100.00	0.0000	0.0000
2	0.7395	99.757	0.0028	0.2397
3	0.7397	99.722	0.0031	0.2747
4	0.7397	99.718	0.0033	0.2780
5	0.7397	99.718	0.0034	0.2782
6	0.7397	99.718	0.0034	0.2782
7	0.7397	99.718	0.0034	0.2783
8	0.7397	99.718	0.0034	0.2783
9	0.7397	99.718	0.0034	0.2783
10	0.7397	99.718	0.0034	0.2783
Cholesky Ordering: DLFRA DLGER DLITA				

Conclusion

The short term interdependence between electricity prices in Europe has been studied in this paper using VAR model. Our findings indicate that there is a positive impact of electricity price in Germany to electricity price in Italy and there is no impact between others prices. This is may be true because until today the Italian electricity price still the lower price in Europe. This may reflect and explain the importance of the efforts provided by Europeans countries in particular Italy and Germany for integration of European electricity market.

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