IS THERE ANY LINK BETWEEN THE EU ETS AND ENERGY STOCK MARKETS? A MULTIVARIATE GARCH APPROACH

Abstract

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Abstract

The objective of this paper is two-fold. First, we analyze whether the EUA price impulses the demand of clean energy stocks, which has important implications for policymakers as the objective of the EU ETS is to trigger the investment in clean energy. Secondly, given that the number of investors interested in energy markets is increasing day by day, we study whether EUA price has an impact of an energy portfolio integrated by clean energy stocks and oil&gas stocks. We also take into account several control variables. As we aim to analyze the simultaneous relationship among a set of variables and given the high frequency of the data we propose the use of the Vector Autoregressive Regression (VAR) with a GARCH structure to model the variance of the term error of the model.

1.- Introduction

Climate Change is a crucial concern nowadays and the reduction of CO_2 emissions is becoming an important issue for most of the governments in the world. Investors are more and more aware of these issues and the number of clean energy stock indexes is increasing significantly.

In this context, it is important to study whether environmental policies influence the behavior of investors. To address this question, we focus on the European climate change policy and, more specifically on the European Union Emissions Trading Scheme (EU ETS).

The EU ETS, known as the carbon market, was launched in 2005 and is defined by the European Commission as the cornerstone of the EU's policy to reduce CO_2 emissions. It limits emissions from 11000 industrial and power installations based in 31 European countries. At the end of each year (from 2005 until now) each company has to hold a number a European Union Allowances (EUA) equal to its level of emissions. Companies that keep their emissions below the level of their allowances[1] can sell their excess. On the contrary, those companies that want to emit more than what is permitted have to buy EUAs. This way the EUA is considered as a new asset which has a daily price determined by supply and demand.

The energy sector is responsible for most of the CO_2 emissions, thus, the evolution of energy markets influences the EU ETS situation and vice versa. This is in line with the work of Diaz-Rainey and Siems (2011), who concluded that financial risks of investing in energy and environmental markets also influence the goals of environmental policies.

Against this background, the objective of this paper is two-fold. First, we analyze whether the EUA price impulses the demand of clean energy stocks. This has extremely important implications for policymakers as the objective of the EU ETS is to trigger the investment in clean energy. This issue has already been studied by several researchers,

[1] During the period 2005-2012, CO_2 allowances were allocated for free among all the installations on a year on year basis. In 2013, the allocation system changed: the free-allocation is not the general rule anymore. In 2013, the allocation system changed: the free-allocation is not the general rule anymore. In this new scenario, installations have to buy the CO_2 allowances they need in an auction.

such as, Calel and Dechezleprêtre, 2012; Rogge et al, 2011; Sandoff and Schaad, 2009. They focus their attention to the investments made by companies in the EU ETS to reduce emissions and found there was little link between the EU ETS and companies green innovation. Nevertheless, we look at the same problem from another perspective: we aim to find out whether changes in EUA prices influence in the behavior of the in clean energy stock markets.

Secondly, given that the number of investors interested in energy markets is increasing day by day, we study whether EUA price has an impact of an energy portfolio integrated by clean energy stocks and oil&gas stocks. We find in the literature several papers which focus on environmental portfolio (for instance, Sadorsky, 2012 or Kumar et al., 2012). However, they focus on a portfolio integrated by clean energy and high technology company stocks and we consider the energy sector as we think it is extremely related to climate change policy.

As we aim to analyze the simultaneous relationship among a set of variables and given the high frequency of the data we propose the use of the Vector Autoregressive Regression (VAR) with a GARCH structure to model the variance of the term error.
We estimate two different VAR models (one per objective). With respect to the first objective, two endogenous variables are taken into account: the EUA and clean stock. With respect to the second one, an additional endogenous variable is considered: INDEX of the oil and gas producers stocks. In both models we take the prices of non renewable energy, economic status and climatology factors as exogenous variables. The election of these exogenous variables is based on studies by Alberola et al. (2008), Aatola (2013) and Lutz et al (2013), among others.
The VAR methodology provides not only results related to the relationship among the endogenous variables we are interested in (EUA, clean energy stocks, oil and gas producers stocks) but also the effect of each exogenous variable on each of the endogenous variables. These results may be useful for those investors interested in the energy sector, in terms of assets pricing or financial risks evaluation.

The rest of the paper is organized as follows. Section 2 explains the exogenous variables, Section 3 describes the data, Section 4 presents the methodology and Section 5, our results and, finally, Section 6 shows our conclusions.

2. - Expected impact of exogenous on endogenous variables.

In this section we describe the expected sign of the exogenous variables coefficients on our main variables (EUA, clean energy firms stocks, oil&gas companies stocks).

As said in the introduction, exogenous variables were selected according to previous literature (papers by Alberola et al. (2008). Aatola (2013) and Lutz et al (2013) are a representative example of this). In this sense, variables affecting EUAs and stocks of energy markets were divided into three main groups: no renewable energy prices (Oil, gas and coal prices), economic situation of the companies in the industrial sector (the most pollutant sector) and climatology.

2.1. Prices of oil, gas and coal

Prices of nonrenewable energy positively influence both clean energy stocks and oil&gas. In the first case, if prices of pollutant companies go up is expected that more investors will be interested in renewable energy. In the second case, some investors will be more interested in stocks of oil and gas because they may predict that an increase in the price will be translated in an increase in companies' benefits.

Regarding EUA prices, If price of oil and gas goes up, companies will decide between two options: to use cheaper energy such as coal which emits more CO_2, or to invest in clean energy. If companies choose the first option, the EUA price will go up, whereas if the second option is chosen, EUA price will go down.

2.2. Industrial companies economic situation

To measure the economic situation of a company we use an industrial stock index, which varies depending on the expectations of investors related to the future economic status of companies. A positive expectative in the economic results of a company is linked to a forecast of an increase in the benefits of a firm.

When speaking of industrial companies an increase in business benefits usually goes together with an increase in firms production capacity which leads to an increase in energy consumption (increase in the price of stocks of oil& gas and clean energy companies). This, in turn leads to increased demand for emission allowances and a rise in their price.

2.3. Climatology

Thirdly, we focus on climatology variables, such as rain fall and wind speed. A lot of rain makes the energy production through hydropower easier as well as strong wind gusts which increase the effectiveness of wind power.

These variables have a great influence in the quantity of energy obtain through clean energy, therefore, more rain and wind is translated in high expectations in clean energy benefits and thus, investors will push clean energy stocks price up. This indirectly impacts negatively on oil&gas stocks (investors will prefer to invest in clean energy). Finally, if more energy is obtained in a clean way the level of emissions will go down and, therefore, the EUA will go down too.

3.- Data

The data for this study includes the daily closing prices of 7 economic variables (EUA, SPCLEAN) from the period 25th May 2009 to 31st December 2013 and daily data for 2 weather variables: the rainfall and the wind speed.

Data for EUA, OIL, GAS and COAL were obtained from SENDECO$_2$, the European bourse for European Unit Allowances (EUA) and Carbon Credits (CER's) specialized for Small and Medium companies.

EUA is the price of an allowance which gives the owner the right to emit a metric tonne of CO_2, OIL is the price of the barrel of brent; GAS is the price of natural gas and COAL is the price of coal. All of them are expressed in euros.

SPCLEAN is the S&P Global Clean Energy Index which provides liquid and tradable exposure to 30 companies from around the world that are involved in clean energy related businesses. This index comprises a diversified mix of clean energy production and clean energy equipment & technology companies. This data were taken from the official website of the S&P Dow Jones Indices[2].

INDSTX, OGSTX are two STOXX European Sector indices. The first one comprises of stocks of 256 european industrial companies and the second one is integrated by

[2] http://us.spindices.com/indices/equity/sp-global-clean-energy-index

european companies producing oil and gas. This data was taken from the official website of the STOXX[3] Indices.

R and W are the mean daily European rainfall and wind speed, respectively. This data was taken from the website http://www.tutiempo.net/

4.- Methodology.

Let $\{r_{it};\ t=1,\ldots,T;\ i=1,\ldots,n\}$ be the series of daily returns corresponding to the endogeneous variables of the model where $r_{it} = \log(p_{it})-\log(p_{i,t-1})$ and $\{p_{it};\ t=0,\ldots,T;i=1,\ldots,n\}$ are the corresponding price series.

Let$\{x_{jt};\ t=1,\ldots,T;\ j=1,\ldots,q\}$ be the series of exogeneous variables

In order to achieve our two objectives we use the VAR(p) Diagonal VECH GARCH(1,1) model given by

$$r_{it} = c_i + \sum_{k=1}^{p} \phi_{ik} r_{it-k} + \sum_{j=1}^{q} \beta_{ij} x_{jt} + \varepsilon_{it};\ i=1,\ldots,n$$

where

$\mathbf{c} = (c_1, \ldots, c_n)'$ are constants

$\boldsymbol{\phi} = (\phi_{ik};\ k=1,\ldots,p;\ i=1,\ldots,n)'$ is the vector of autoregressive coefficients

$\boldsymbol{\beta} = (\beta_{ij};\ j=1,\ldots,q;\ i=1,\ldots n)'$ is the vector of regression coefficients which determine the influence of the exogenous covariates on the endogenous variables

$\boldsymbol{\varepsilon}_t = (\varepsilon_{1t}, \ldots, \varepsilon_{nt})'$ is a Diagonal VECH GARCH(1,1) process given by:

$$\boldsymbol{\varepsilon}_t \mid I_{t-1} \sim N_n(\mathbf{0}, \boldsymbol{\Sigma}_t) \text{ with } I_t = \{r_{iu};\ i=1,\ldots,n;\ x_{ju};j=1,\ldots,q;\ t=1,\ldots,T\}$$

with $\boldsymbol{\Sigma}_t = \mathbf{M} + \mathbf{A} \circ (\boldsymbol{\varepsilon}_t \boldsymbol{\varepsilon}_t') + \mathbf{B} \circ \boldsymbol{\Sigma}_{t-1}$ where $\circ$ denotes the Hadamard product and $\mathbf{M} = (m_{ij})$, $\mathbf{A} = (a_{ij})$ and $\mathbf{B} = (b_{ij})$ are constant nxn matrices.

The order p was estimated using BIC criterion and the parameters of the model were estimated using the maximum likelihood method.

[3] http://www.stoxx.com/indices/types/introduction.html

In the first objective we take n = 2, p = 1, q = 6, T = 1158 with

r_{1t} = daily return of EUA (DLEUA)

r_{2t} = daily return of SPCLEAN (DLSPCLEAN)

r_{3t} = daily return of OGSTX[4] (DLOGSTX)

x_{1t} = daily return of OIL (DLOIL)

x_{2t} = daily return of GAS (DLGAS)

x_{3t} = daily return of COAL (DLCOAL)

x_{4t} = daily return of the INDSTX (DLINDSTX)

x_{5t} = log daily W (LW)

x_{6t} = daily R

5.- Results

Before the estimation of the model we first have to take into account that the time series have to be stationary. After testing the augmented dickey fuller is demonstrated that all the series except for LV and R have to be differentiated once (see Figure 1 for a graph of differentiated series)

5.1. Model 1.

5.1.1. DLEUA equation

From Table 1 and with respect to the daily evolution of the DLEUA price, it can be seen that, as expected, only the Industrial Stoxx Index has a significant positive influence. Therefore the higher are the industrial prices, the higher is the DLEUA price.

It is clear that emitters buy allowances just looking at their production level, whereas the price of energy sources they use does not affect them. Climatology variables, which are linked to energy obtained through the use of alternative energy doesn't influence the price of DLEUA, either.

[4] Notice that this variable is introduced in Model 2

Finally the evolution of the stocks of companies "producing" removable energy has an inverse impact on EUA prices, indirectly highlighting the substitutive effects existing between the coal and clean energy prices.

5.1.2. DLSPCLEAN equation

On the contrary, most of the coefficients in the DLSPCLEAN equation are statistically significant. The impact of DLEUA on DLSPCLEAN is positive and statistically significant, that is, an increase in EUA prices is an incentive for the demand for stocks clean alternative energy companies. This is a positive signal regarding climate change policy, and, more specifically the role of EU ETS. With this result, we indirectly prove that the EU ETS has been useful to trigger investment in clean energy. Moreover, it seems that investors do pay attention to EUA prices when investing, that is, they considerate it as a relevant variable when making investing decisions.

The link between oil, gas and coal is positive and statistically significant. When prices of polluter energies go up, investors see their opportunity to invest in clean energy as it is an alternative source of energy. Also it is clear that, as expected, the evolution of the price of industrial companies stocks is highly correlated to the stocks of clean energy. Finally, it is clear that climatology aspects do not have an impact on clean energy stock prices. Thus, it seems that investors do not consider weather conditions to be relevant when investing in these kinds of stocks.

According to these results, it seems that the kinds of agents who buy EUAs and stocks of companies of the clean energy sector are quite different. In the first case it seems that the profile of the buyer is a company that emits CO_2 and buys CO_2 allowances for legal purposes and, consequently, the quantity of emissions allowances it buys is related to the level of production, not to anything else. However, the demand for clean energy companies stocks is composed of investors (speculators that look for profitability) that look at a bunch of macroeconomic indicators, i.e. no-renewable energy sources, EUA prices (climate change policy).

Finally, the analysis of the variance-covariance matrix evolution reveals the heteroscedasticity of the innovations of the daily evolution of the EUA price and the SPCLEAN index, highlighting the need to include GARCH process in the VAR model, and the absence of interactions between the evolution of the error terms because of the

non-significance of the covariance evolution parameters of the model, which highlights the absence of additional interrelations between both series.

5.2. Model 2.

As can be seen in Table 2, the sign of the effect of exogenous variables on DLEUA and DLSPCLEAN is the same as explained in Model 1, thus, we will focus directly on the DLOGSTXX equation.

Most exogenous variables are not statistically significant for DLOGSTX. Only DLINDSTXX and DLOIL have a remarkable impact. As expected in Section 2 of this paper, both have a positive effect. If oil prices go up, investors will be more interested in stocks of oil and gas because they may predict that an increase in the price will be translated in an increase in companies' benefits. If stocks of industrial companies go up, investors will see an increase in industrial production which, in turn, leads to an increase in energy consumption.

DLEUA does not have any influence on neither DLSPCLEAN nor DLOGSTXX. That is, for an investor holding an energy portfolio, price of EUA seems to not have any relevance regarding their investment decisions.

Finally, as can be seen in the GARCH process in the VAR there is a statistically significant interrelation between DLSPCLEAN and DLOGSTXX series. This means that oil&gas stocks and clean energy returns move in the same direction, so it does not seem to be much scope for diversification. In conclusion, according to our results, the simultaneous investment in clean energy and oil&gas stocks does not seem to be a good option in terms of diversification.

6.- Conclusions

The objective of this paper is two-fold. First, we analyze whether the EUA price impulses the demand of clean energy stocks. This has extremely important implications for policymakers as the objective of the EU ETS is to trigger the investment in clean energy.

Secondly, given that the number of investors interested in energy markets is increasing day by day, we study whether EUA price has an impact of an energy portfolio integrated by clean energy stocks and oil&gas stocks.

We conclude that EUA prices are an incentive for the demand for stocks clean alternative energy companies. This is a positive signal regarding climate change policy, and, more specifically the role of EU ETS. With this result, we indirectly prove that the EU ETS has been useful to trigger investment in clean energy and that clean energy markets are sensible to climate change European policy, which means that this policy seems to be credible for markets.

However, the EUA price does not seem to have an impact on the returns of a portfolio integrated by both clean and pollutant energy. That is, for an investor holding an energy portfolio, price of EUA seems to not have any relevance regarding their investment decisions. In this scenario, investors seem to give more importance to other variables such as the price of oil or the evolution of industrial companies stocks.

Finally, we conclude that oil&gas stocks and clean energy returns move in the same direction, so it does not seem to be much scope for diversification. In conclusion, according to our results, the simultaneous investment in clean energy and oil&gas stocks does not seem to be a good option in terms of diversification.

We must say that this work is the first draft of a paper we would like to publish. Thus, we have to study in more depth our results to develop the present conclusions. Moreover, regarding methodology, we consider more GARCH models should be estimated and, also a less restrictive methodology, such as statistical copulas should be implemented.

7.- References

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Figure 1.

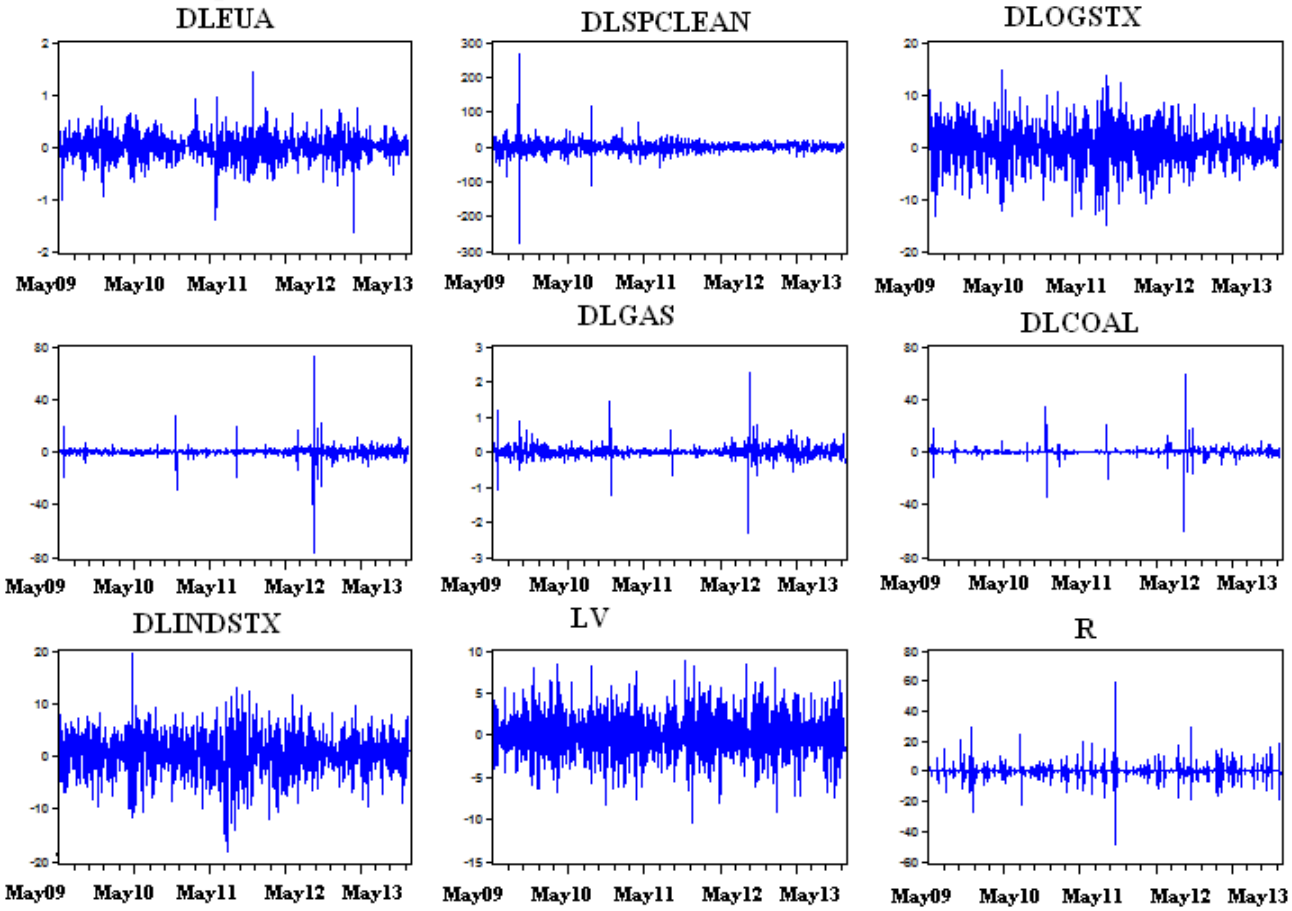
DLEUA
DLSPCLEAN
DLOGSTX
DLGAS
DLCOAL
DLINDSTX
LV
R
May09
May10
May11
May12
May13

Table 1.

Dependent variable: DLEUA	Coefficient	P-value
DLEUA(-1)	**0.067016**	**0.0334**
DLSPCLEAN(-1)	-0.049087	0.1385
C	-0.002448	0.7013
DLOIL	0.014832	0.6502
DLGAS	0.002365	0.8760
DLCOAL	-0.011408	0.7855
DLINDSTX	**0.287035**	**0.0000**
LW	0.001019	0.7020
R	-0.000102	0.6321
Adjusted R Squared	0.027407	
Dependent variable: DLSPCLEAN	**Coefficient**	**P-value**
DLEUA(-1)	**0.015745**	**0.0768**
DLSP_G_ALT(-1)	**-0.090707**	**0.0005**
C	-0.001834	0.5704
DLOIL	**0.184475**	**0.0000**
DLGAS	**0.039829**	**0.0001**
DLCOAL	**0.134839**	**0.0000**
DLIND_STX	**0.544231**	**0.0000**
LW	0.000443	0.7498
R	2.15E-05	0.8261
Adjusted R Squared	0.473324	

Table 2.

Dependent variable: DLEUA	Coefficient	P-value
C	-0.002545	0.6973
DLEUA(-1)	0.077079	0.0167
DLSPCLEAN(-1)	-0.012316	0.7799
DLOGSTXX(-1)	**-0.109326**	**0.0634**
DLOIL	0.021139	0.5204
DLGAS	0.002232	0.8861
DLCOAL	-0.005117	0.9071
DLINDSTXX(-1)	**0.282065**	**0.0000**
LW	0.001096	0.6877
R	-0.000129	0.5518
Adjusted R Squared	0.027545	
Dependent variable: DLSPCLEAN		
DLEUA(-1)	0.011259	0.1967
DLSPCLEAN(-1)	-0.197049	0.0000
DLOGSTXX(-1)	0.176088	0.0000
C	**-0.003059**	**0.3446**
DLOIL	0.185828	0.0000
DLGAS	0.035214	0.0003
DLCOAL	0.118597	0.0000
DLINDSTXX	**0.550988**	**0.0000**
LW	0.000921	0.5058
R	-6.51E-06	0.9453
Adjusted R Squared	0.497997	
Dependent variable: DLOGSTXX		
DLEUA(-1)	0.004488	0.4609
DLSP_G_ALT(-1)	0.009972	0.5290
DLO_G_STX(-1)	-0.019691	0.2941
C	**0.002654**	**0.1942**
DLOIL	0.058074	0.0000
DLGAS	0.004707	0.4656
DLCOAL	-0.010899	0.3854
DLIND_STX	**0.757699**	**0.0000**
LV	-0.001296	0.1360
PP	5.70E-05	0.3141
Adjusted R Squared	0.693110	