The Relationship between the Carbon Market and Financial Markets – a Frequency Domain Analysis

Marc Gronwald, ifo Institute, Munich, Germany
Stefan Trück, Macquire University Sydney, Australia

Keywords: Carbon market, Granger causality, Frequency Domain, EU ETS
JEL Codes: C12, C32, Q58

Overview

The urgent problem of climate change heads the political agenda now already for a number of years. The economic idea of internalizing external effects is of particular importance in this context. The preferred policy instrument to achieve this is establishing emission trading schemes. According to conventional wisdom, this approach is the cost-efficient way to reduce greenhouse gas emissions. The European Emission Trading Scheme (EU-ETS) is currently by far the largest existing trading scheme; certificates used in this scheme are called European Union Allowances (EUA). In addition to this multi-national trading scheme, e.g. Australia decided to start a national trading scheme. Moreover, different regional systems in the US are also currently established. It should be noted that the idea of emission trading schemes is based on economic reasoning and implies establishing entirely new markets. In that sense, this market is "artificial". This, naturally, involves various regulatory decisions, ranging from allowance allocation to banking and borrowing between different compliance periods, as in the EU-ETS.

As establishing emission trading schemes is the preferred policy instrument to tackle the problem of climate change, it is of particular importance to have a sufficient understanding of the determinants as well as the behaviour of the prices observed in this market. With the end of the first trading period of the European Emission Trading Scheme (EU-ETS), empirically analysing emission allowance prices receives growing attention in the literature. A number of recent papers investigate the relationship between European carbon prices on the one hand and commodity prices as well as financial market variables on the other. A key result that emerged from this research effort is that the relationship between these markets was stronger during the period of the financial crisis [Gronwald et al., 2011]. Other studies which focus on the relationship between carbon markets and other markets are the so-called "rockets and feathers" literature [Lo Prete and Norman, 2012] as well as those that study macroeconomic risk factors [Chevallier, 2009] and the fundamental value of carbon prices [Hintermann, 2009].

Methods

This paper is concerned with a frequency domain analysis of the relationship between prices of emission allowances in the EU ETS and those of various other commodities and financial market variables. It is well-known that the relationship between variables can differ across frequency bands. The paper applies two different techniques: first, a frequency domain correlation measure and, second, a frequency domain Granger causality test. This analysis yields insights as to whether the relationship is stronger between, for instance, short- or long-run components of the variables. Furthermore, these procedures are applied recursively in order to study whether or not these relationships change over time. Initially, Gronwald et al.'s (2011) data-set is used. This data-set comprises carbon prices on the one hand and the following variables on the other: coal futures prices, gas futures prices, oil futures prices,

electricity futures prices, Eurostoxx 50 spot contracts, DJ Europe Energy Stock Index spot contracts as well as European Renewable Energy Index spot contracts. Thus, the relationship between the carbon market and both "fundamental" influence factors and other financial markets is studied.

The frequency domain correlation measure is called coherency and is based on the Fourier transform of the cross correlation function of two variables; see e.g. Chatfield (2001). Testing for causality in the frequency domain has a long tradition and goes back to Granger (1969). Granger and Lin (1995) have shown that the extent and direction of causality can differ between frequency bands. This paper applies the testing procedure recently proposed by Breitung and Candelon (2006).

Among the key motivations of this study is the particular feature of markets for emission allowances that these markets are artificial. It is thus interesting to study whether or not the relationship between "artificial" markets and "normal", evolved markets is different to the relationship between "normal" markets.

Expected results

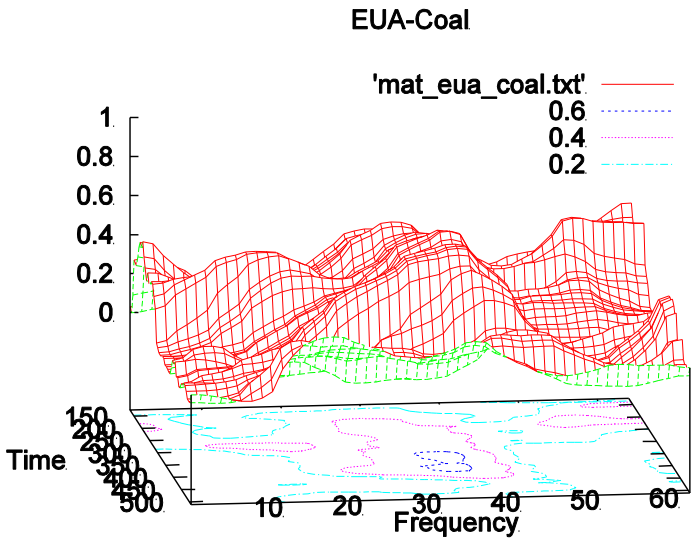
Preliminary results can be summarized as follows: first, the relationships under consideration here clearly differ across frequency bands. The differences between frequency bands are found to be particularly strong for the "fundamental" energy variables while those for the "financial market" variables are less pronounced. Second, the strongest coherency between carbon prices and "fundamentals" is found for medium-run components of the series. In contrast, for the financial market cases the coherency is found to be strong for the short-run components. Third, there is strong evidence of a time-varying relationship between all variables under consideration.

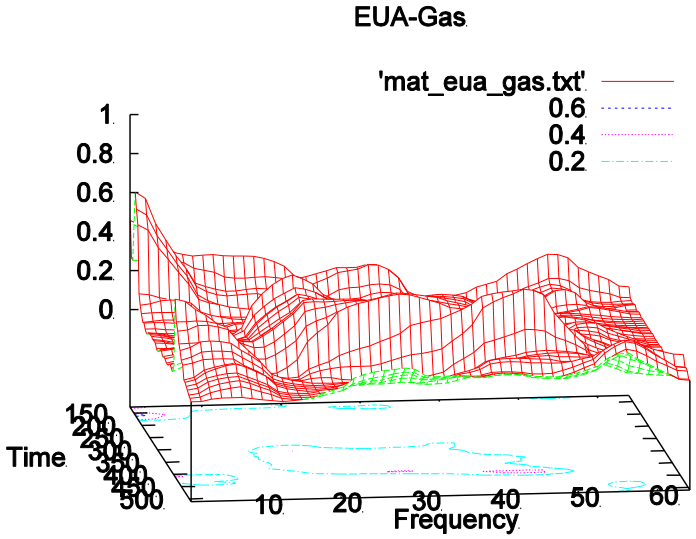
Figure 1 below presents preliminary rolling coherency estimates. For each pair of variables, the coherency is estimated repeatedly using a rolling window of 125 observations. Daily data from 2008 and 2009 is used; the total number of observations is 514. On the time-axis the end of each subsample is plotted, the frequency-axis plots frequencies at which the correlation is evaluated. As with the correlation coefficient, the coherency also takes values between 0 and 1, and is plotted on the vertical axis.

References:

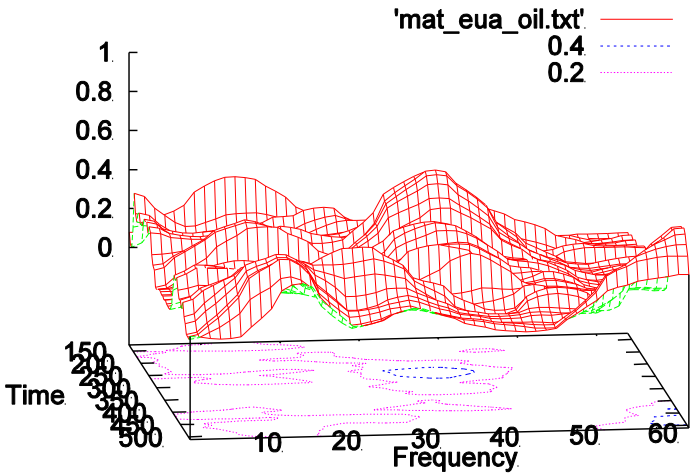
Breitung, J. and B.Candelon (2006), "Testing for short and long-run causality – a frequency domain approach", Journal of Econometrics, 132, 363-378
Chevallier, J. (2009), "Carbon futures and macroeconomic risk factors: a view from the EU ETS", Energy Economics, 31, 614-625
Granger, C.W.J. (1969), "Investigating causal relationships by econometric models and cross-spectral methods", Econometrica, 37, 424-438
Granger, C.W.J. and J.L.Lin (1995), "Causality in the long-run", Econometric theory, 11, 530-536
Gronwald, M., J.Ketterer and S.Trück (2011), "The relationship between carbon, commodity and financial markets – a copula analysis", Economic Record, 105-124
Hintermann, B. (2009), "Allowance price drivers in the first phase of the EU ETS", Journal of Environmental Economics and Management, 59, 43-56
Lo Prete, C. and C.S.Norman (2012), "Rockets and feathers in the EU ETS?" mimeo
Chatfield, C. (2004), "The analysis of time series – an introduction", 6th Ed., Chapman&Hall

Figure 1: Rolling coherency estimates

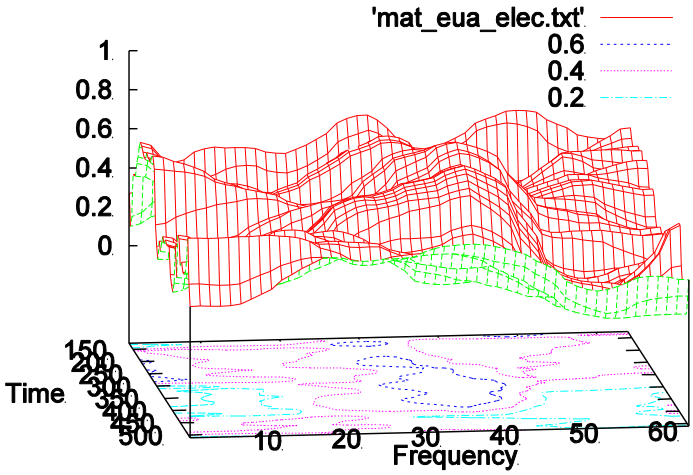




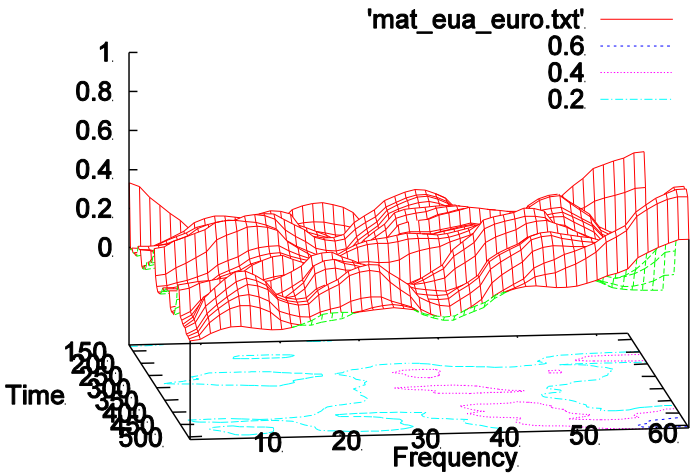
EUA-Oil



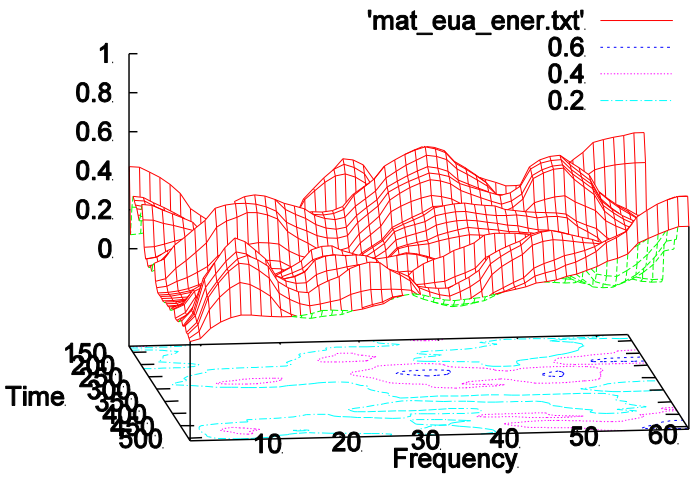
EUA-Electricity

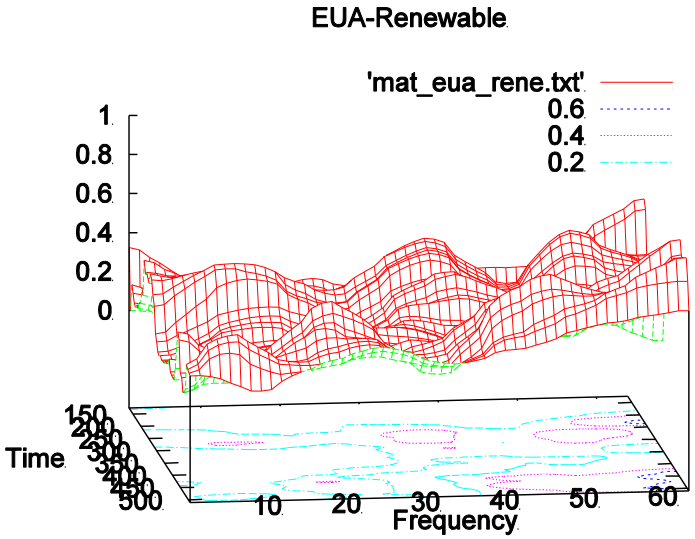


EUA-Euro Stoxx



EUA-Energy




EUA-Renewable
'mat_eua_rene.txt'
0.6
0.4
0.2
1
0.8
0.6
0.4
0.2
0
Time
150
200
250
300
350
400
450
500
10
20
30
40
50
60
Frequency