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A note on the conditional correlation between energy prices: Evidence from future markets

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Abstract

We model the joint movements of daily returns on one-month futures for crude oil, heating oil and natural gas through the multivariate GARCH with dynamic conditional correlations and elliptical distributions introduced by Pelagatti and Rondena [Pelagatti, M.M., Rondena, S., 2007. "Dynamic Conditional Correlation with Elliptical Distributions", unpublished manuscript. Universitá di Milano — Bicocca, August]. Futures prices of crude and heating oil covary strongly. The conditional correlation between the futures prices of natural gas and crude oil has been rising over the last 5 years. However, this correlation has been low on average over two thirds of the sample, suggesting that future markets have no established tradition of pricing natural gas as a function of developments on oil markets.

JEL classification: C22; G19

Keywords: Multivariate GARCH; Kurtosis; Energy prices; Future markets

> "For decades, natural gas prices (as well as those of gasoline, heating oil, propane, et cet) have hinged off crude oil. But as more investors pile into an energy market that no longer holds the crude benchmark sacred, it looks like gas is poised to cut the cord."
>
> 'Crude Oil–Natural Gas Price Connection Unraveling?' in *Trader Daily*, May 2007.

1. Introduction

Energy commodities are widely priced in financial markets through futures on crude oil, natural gas and heating oil. Although a large amount of research has been devoted to studying the

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Table 1
Sample statistics

	Crude oil	Natural gas	Heating oil
Minimum	−40.04	−37.57	−39.09
Maximum	14.23	32.43	13.99
Mean	0.013	0.041	0.016
Standard deviation	2.30	3.61	2.38
Skewness	−15.52	−35.64	−1.75
Kurtosis	29.85	13.65	27.40
Jarque–Bera	1.2e5 [0.0]	1.9e4 [0.0]	9.9e4 [0.0]
Anderson–Darling	45.9413 [0.0]	n.a.	47.2272 [0.0]
BDS(2)	5.7092 [1.13e−8]	8.7307 [0]	6.7412 [1.57e−11]

Legend: *p*-values are in brackets. The BDS test was computed by setting the largest dimension to 2, and the length of the correlation integral to one times the standard deviation of the series. These values are chosen so that the first-order correlation integral estimate lies around 0.7

comovements between energy spot prices, little effort has been dedicated to the study of the joint movements among the prices of energy futures, an exception being Kirk (1996).

In this note, we model the conditional correlation between the futures prices of energy traded in the New York Mercantile Exchange. We use the dynamic conditional correlation – DCC – model with leptokurtic distributions proposed by Pelagatti and Rondena (in press). This choice allows to estimate time-varying correlations of returns with heavy tails.

The results indicate that the conditional correlation over the last 5 years between the futures prices of natural gas and crude oil has been rising. However, the correlation has been weak on average over two thirds of the sample. This suggests that future markets have no established tradition of pricing natural gas as a function of the developments on oil markets.

2. Results

We use daily data on future prices on light crude oil, natural gas and heating oil traded in the New York Mercantile Exchange between November 1, 1990 and November 22, 2005. The futures contracts have a maturity of one month. The sample includes 3929 observations. Returns are computed as the percentage per-period difference between the logarithms of the prices. Table 1 reports some descriptive statistics. Two facts stand out. First, the skewness and kurtosis coefficients show that the returns are skewed left with a fat-tailed distribution. The rejection of the null of normality is confirmed both by the Jarque–Bera test statistics, and the normality test of Anderson and Darling (1952), which is a modification of the Kolmogorov–Smirnov test that gives more weight to the tails. Second, the *p*-values of the test of Brock et al. (1996) provide strong evidence against the null of independent identically-distributed returns.[1]

Before modelling the conditional correlation, we need a joint model for the conditional mean of the three series. We have selected the order of a vector autoregression using both the Bayesian and the Schwartz Information criteria. A model of order 2 suffices. The subsequent issue concerns the selection of the distribution function for the volatility model.

[1] We have also run the test of the test of no ARCH of Engle (1982) and the test of Engle and Sheppard (2001) for dynamic conditional correlations. The results show strongly the presence of heteroskedasticity. They also indicate and that the correlation structure should be time-varying. However, since the normal distribution is a poor approximation to the empirical distribution, special care should be used to interpret the outcome of these tests despite the fact that the *p*-values are all zero. We are grateful to one of the referees for raising this point.