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Short and long-term links between oil prices and stock markets in Europe

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Abstract

Although the assumption in the financial press is that fluctuations in the price of oil affect stock market prices, empirical evidence of the impact of these fluctuations on stock returns has been mixed. Unlike other empirical studies, which have focused largely on broad market indices (national and/or regional indices), our study adds to knowledge of the relationship between oil prices and stock markets in Europe by testing for short- and long-term links in the aggregate as well as sector by sector. We show that the response of stock returns to oil price changes differs greatly depending on the sector of activity. In particular, we show that changes in the price of oil have negative effects on short- and long-term stock prices in Food & Beverages.

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1. Introduction

Identifying the factors that affect the dynamics of stock returns is an interesting question since it has a decisive impact on a number of issues affecting problems addressed by financial market theory. Though many papers have investigated stock return dynamics, the nature and number of factors that affect stock returns remain elusive. As oil prices have swung wildly in recent years, it is now of interest to delve into the impact of these changes on stock return dynamics. One rationale for using oil price variations as a factor affecting stock returns is that the value of a stock equals the discounted sum of expected future cash-flows. These cash-flows are affected by macroeconomic events that may be influenced by oil shocks.

In the financial literature, there are many studies of the links between oil prices and macroeconomic variables. Most of these studies have shown that changes in oil prices have significant effects on economic activity in several developed and emerging economies [Cunado and Perez de Garcia (2005), Balaz and Londarev (2006), Gronwald (2008), Cologni and Manera (2008) and Kilian (2008)]. But investigation of the relationship between changes in oil and stock prices is far less developed.

The pioneering paper by Jones and Kaul (1996) tests the reaction of stock returns to oil price fluctuations on the basis of the standard cash-flow dividend valuation model in five developed markets (Canada, Japan, the UK, and the USA). They show that for the US and Canada this reaction can be accounted for entirely by the impact of the oil shocks on cash-flows. The results for Japan and the UK are inconclusive, however. Using an unrestricted vector autoregressive (VAR) model, Huang *et al.* (1996) suggest no evidence of a relationship between oil prices and the S&P500 market index. Sadorsky (1999), by contrast, applies an unrestricted VAR model with GARCH effects to US monthly data and shows a significant relationship between oil price changes and aggregate stock returns. Park and Ratti (2008) point out that oil prices have a negative impact on stock returns in the USA and in twelve European countries; stock markets in oil-exporting Norway, on the other hand, respond positively to rises in the oil price. More recently, Apergis and Miller (2009) have examined whether structural oil-market shocks affect stock prices in eight developed countries. They find that international stock market returns do not respond very significantly to oil price shocks. Finally, Arouri and Fouquau (2009) and Jawadi *et al*. (2010) have pointed out significant evidence of nonlinear relationships between oil and stock prices in developed and emerging countries.

However, only few studies have focused on the impact of oil price changes on the stocks of individual sectors, and those that have look exclusively at short-term relationships. In addition, most of these studies are country specific and thus do not provide a global perspective. For instance, Sadorsky (2001) and Boyer and Filion (2007) show that oil price increases positively affect the stock returns of Canadian oil and gas companies. El-Sharif *et al.* (2005) reach the same conclusion for oil and gas returns in the UK. However, the authors show that non-oil and gas sectors are weakly linked to oil price changes. More recently, Nandha and Faff (2008) study the short-term link between oil prices and thirty-five DataStream global industries and show that oil price rises have a negative impact on all but the oil and gas industries. Finally, Nandha and Brooks (2009) test the reaction of the transport sector to oil prices in thirty-eight countries and find that, in developed economies, oil prices have some influence on the returns to the sector. However, there appears to be no evidence of a significant role for oil in Asian and Latin American countries. Taken together, the results from the investigation of the relationships between oil prices and sector stock returns differ from country to country and from sector to sector.

The current article extends the understanding of the relationship between oil prices and stock returns at the disaggregated sector level in Europe by investigating both short- and long-term links, an issue that has not yet been examined in the literature. Studying the short- and long-term effects of oil price fluctuations sector by sector is important for several reasons. First, any market-wide consequence may mask the performance, not necessarily uniform, of various sectors. Sector sensitivities to changes in oil prices can be asymmetric; some sectors may be more severely affected by these changes than others. Indeed, the sector sensitivities to oil depend on whether oil is an input or an output for the industry, on the indirect effect of oil prices on the industry, on the degree of competition and concentration in the industry, and on the capacity of the industry to transfer oil price shocks to its consumers and thus to minimise the impact of these shocks on its profitability. Second, the industrial base varies from one European market to another. Large, mature markets such as France and Germany are more diversified, whereas small markets such as Switzerland usually concentrate on a few industries. It is thus interesting to know whether sector indices rather than national indices are sensitive to oil price fluctuations. Finally, from the point of view of portfolio management, identifying the heterogeneity of sector sensitivities to oil implies that there are sectors that can still provide a channel for international diversification during large swings in oil prices.

The rest of the paper is organized as follows. Section 2 presents the data and discusses the empirical results. Summary conclusions and policy implications are provided in section 3.

2. Data and empirical results

2.1- Data and preliminary analysis

Our goal is to check for the existence of short- and long-term relationships between oil prices and sector stock returns in Europe. We use weekly stock market indices over the period 01/01/1998-11/13/2008. We think that weekly data may adequately capture the interaction of oil and stock prices in this region. We study the DJ Stoxx 600 and twelve European sector indices: *Automobile & Parts*, *Financials*, *Food & Beverages*, *Oil & Gas*, *Health Care*, *Industrials*, *Basic Materials*, *Personal & Household Goods*, *Consumer Services*, *Technology*, *Telecommunications* and *Utilities*. Data are sourced from International DataStream database.

For oil, we use the weekly Brent crude price obtained from the Energy Information Administration (EIA). We express Brent prices in euro using exchange rates also from DataStream.

Figure 1 depicts the historical paths of oil and the European index DJ Stoxx 600 (in logarithms). We may think that there is some long-run dependency. To determine the order of integration of our series, we run three standard unit root tests: augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski *et al*. (KPSS) tests. Results in Table I show that all the series appear to be integrated of order one, which is a standard result in the literature for such series. Thus, to examine the long-term dependencies between variables we use series in levels, while we use series in first difference (return series) when studying short-term links.

Descriptive statistics for return series are summarized in Table II. Oil prices have, on average, increased more than European stock prices over our sample period. Technology stocks, followed by oil and automobile stocks, have the highest volatility. Skewness is negative in most cases and the Jarque-Bera test statistic (JB) strongly rejects the null hypothesis of normality.

On average, the correlations of oil price changes and European sector returns is weak; in some instances, it is negative. *Oil & Gas* has the highest correlation with oil (33%), followed by *Basic Materials* (12%), whereas *Food & Beverages* has the highest negative correlation with oil (-10%). The correlation of the European market index (DJ Stoxx 600) and sector returns is, on average, high. *Personal & Household Goods* has the highest correlation (97%) and *Food & Beverages* the lowest (57%).

2.2- Short-term analysis (returns series)

In this part, we examine short-term links between oil prices and sector stock market returns in Europe. We then focus on the series in first logarithm differences (return series). In particular, we take the following augmented capital asset pricing model (CAPM):

$$r_{it} = a + b\ roil_t + c\ rdj_t + \varepsilon_{it} \qquad (1)$$

$$\varepsilon_{it} \rightarrow \mathrm{N}(0, h_{it})$$

$$h_{it}^2 = \alpha + \beta\ \varepsilon_{i,t-1}^2 + \gamma\ h_{i,t-1}^2$$

where r_{it} is the weekly excess stock return in sector *i*, $roil_{it}$ the weekly Brent oil price changes and rdj_t the weekly excess returns on DJ Stoxx 600 filtered by the oil price returns. ε_t is a stochastic error term assumed to follow a GARCH(1,1) model.

Table III presents the parameter estimates. The coefficients relating the sector return series to the European filtered returns (coefficients *c*) are highly significant for all sectors. More interestingly, the coefficients relating the return series to oil price changes (coefficients *b*) are significant in nine cases, suggesting that fluctuations in the price of oil have significant short-term effects on European sector stock prices. Oil price increases negatively affect sector returns in seven cases, and positively in two cases (the sectors *Oil & Gas* and *Basic Materials*). Our results also show that there is no short-term relationship between oil price changes and stock returns for three European sectors (*Industrials*, *Technology* and *Utilities*).

The ARCH and GARCH coefficients are also significant in most cases. In addition, the ARCH coefficients are relatively small, which indicates that conditional volatility does not change very rapidly. However, the GARCH coefficients are large, indicating gradual fluctuations over time. On the other hand, the estimated coefficients γ and β satisfy the stationary conditions.

To sum up, our analysis shows strong short-term links between oil price changes and most European sector returns over the period under consideration. The sign and intensity of this relationship differ from one sector to another. Indeed, though an increase in oil prices seems generally to be bad news for the economy, the significance and direction of its effects on sector stock market prices may vary for other reasons. In particular, the impact of oil price changes on an industry depends on whether oil is an input or an output for the industry, on the competition and concentration in the industry, and on the capacity of the industry to pass on

increases in the price of oil to its consumers and thus to optimize its profitability, and finally on the effectiveness with which the industry uses futures contacts and other hedging techniques. In addition, related oil products are also linked to oil prices and have a direct impact on other industries such as *Food & Beverages*. Finally, oil price changes also have indirect effects on some industries. For instance, oil price increases influence the financial sector through their effects on monetary policy, interest rates, employment and consumer confidence. In the rest of the article, we investigate the long-term links between oil prices and sector stock prices in Europe.

2.3- Long-term analysis (level series)

To examine the long-term links between oil prices and sector stock prices in Europe, we first apply cointegration tests. If the series are cointegrated, we then examine convergence toward the long-term target. To do so, for each sector, we regress the stock market price (in logarithms) on the oil price (in logarithms) and on an intercept. We apply three tests of the null hypothesis of no cointegration: ADF, PP and Johansen tests. Results are summarized in Table IV.

The results for the aggregate European stock market index (DJ Stoxx) indicate that there is no significant long-term relationship between oil prices and stock returns in Europe. However, these results must be taken with great caution. In fact, the DJ Euro Stoxx is an aggregate index that attempts to represent sector leaders in eighteen European countries. These sectors may have different negative and positive sensitivities to changes in the price of oil. Thus, aggregation of these sectors may mute equity sensitivities to oil. For this reason, we have applied the co-integration tests to twelve European sector indices. With the ADF and PP tests, the co-integration hypothesis is not rejected for the sector *Food & Beverages*. For all other sectors, and with all three tests, the cointegration hypothesis is rejected.

Thus, only *Food & Beverages* appears to be cointegrated with oil prices. There is a long-term relationship between Brent prices and stock prices in *Food & Beverages*. The estimation of this long-term relationship leads to the following results:

$$LFood\ \&\ Bev._t = \underset{(0.986)}{-4.701} - \underset{(0.071)}{0.201} * LOil_t \qquad (2)$$

where $LFood\ \&\ Bev$ and $LOil$ are the *Food & Beverages* stock price index and oil price in logarithms. Standard errors are reported into parentheses.

There is a negative long-term relationship between oil prices and stock prices in *Food & Beverages*. Unlike the other sectors for which there are only short-term links between oil price shocks and stock prices, *Food & Beverages* stock prices are influenced, for several reasons, in both the short and the long term by changes in the price of oil. Indeed, it is argued that commodity markets are strongly influenced by oil and petroleum-product markets in both the short- and the long-term. Food supplies in industrialized countries rely on fossil fuels. Oil, gas and oil-related products are widely used as raw materials and energy in the manufacture of fertilizers and pesticides at all stages of food production. For example, agriculture is completely dependent on oil and oil-related products for cultivation and for pumping water. Thus, significant swings in oil prices should have strong short- and long-term effects on commodity and food markets. The reason is that changes in oil prices may directly and indirectly affect the production costs of commodities as well as transportation and commercialization costs. Consequently, exuberance in oil and energy markets has often implied agricultural and food crises and crashes. Finally, the sector response to oil price changes depends not only on the possible increases in marginal cost of production (cost-side effects) but also on the possible shifts in consumer expenditures (demand-side effects). Indeed, the possibility of a future reduction in demand stemming from cutbacks in consumer expenditures alone is an important factor in determining industry sensitivities to oil price changes.

The cointegration of oil and stock prices in *Food & Beverages* makes it possible to estimate a vector error-correction model (VECM) to look into the adjustment dynamic of the variables to the long-term equilibrium. Table V shows that the error-correction term is negative and significant for the sector *Food & Beverages*, indicating mean-reversion of the stock prices of *Food & Beverages* to their long-term target. The error-correction term is not significant for the oil price equation. Therefore, there is no mean-reversion for the oil price to the long-term target defined by stock prices in the *Food & Beverages* sector.

In short, except for the sector *Food & Beverages*, there is no long-term relationship between oil prices and sector stock prices in Europe. In *Food & Beverages*, the long-term link between oil price and stock prices is negative.

3. Conclusion and policy implications

In this article, we examined the short- and long-term relationships between oil and stock prices. Unlike other empirical studies, which have focused largely on broad market indices

(national and/or regional indices), our study adds to knowledge of the relationship between oil prices and the stock markets in Europe by testing for short- and long-term links in the aggregate as well as sector by sector. Concerning the short-term analysis, strong significant links between oil price changes and stock markets have been found for most European sectors. Our long-term analysis shows that, except for the sector *Food & Beverages*, there is no long-term link between Brent prices and sector stock prices in Europe. For *Food & Beverages*, the relationship between oil and stock prices is negative.

Our findings should be of interest to researchers, regulators and market participants. First, traders who are interested in investing in oil-sensitive stocks in Europe may, when oil prices are expected to remain high, select stocks from sectors, such as *Oil & Gas*, with high positive sensitivity to oil prices. They can also use oil-related derivatives. Thus, our results can be used to build profitable speculation strategies. Second, that sectors have different sensitivities to oil price changes in Europe means great risk diversification possibilities across industries in Europe. Selecting portfolios across rather than within sectors would be more efficient. Third, investors and portfolio managers should rebalance their portfolios in keeping with their views of the sign of coming changes in oil prices (rises or falls), and our findings suggest that diversification can be achieved across sectors in all cases of oil price changes. Finally, the negative short- and long-term effects of oil price changes on stock prices in *Food & Beverages* leads us to recommend that governments invest in and use renewable energy sources if they want to reduce the sensitivity of *Food & Beverages* to swings in the price of oil.

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Figure 1: Oil prices and DJ Stoxx

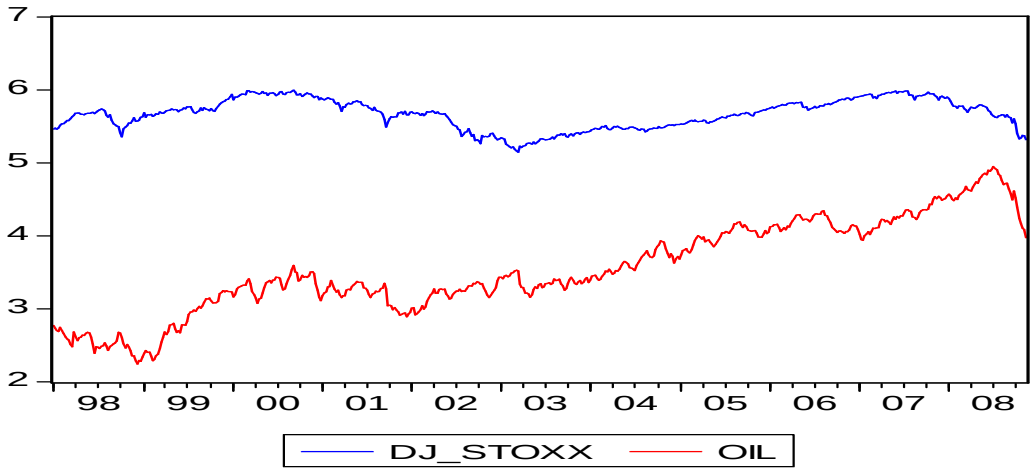

Table I: Unit root tests

	Levels			First difference		
	ADF	**PP**	**KPSS**	**ADF**	**PP**	**KPSS**
Oil Brent	0.60a	-2.68b	0.69**b	-11.48*a	-18.35*a	0.08b
DJ Stoxx	-0.38a	-0.26a	0.37*b	-9.16*a	-23.6*a	0.27b
Automobile & Parts	0.03a	-2.14b	0.67**b	-27.48*a	-27.46*a	0.058b
Financials	-0.78a	-0.66c	0.26b	-8.29*a	-23.91*c	0.35*b
Food & Beverages	0.43a	-2.11b	1.55*b	-21.83*a	21.83*a	0.08b
Oil & Gas	0.09a	-2.01b	1.14*b	-15.54*a	-23.38*a	0.139b
Health Care	0.02a	-2.07b	0.221b	-25.85*a	-25.87*a	0.12b
Industrials	-0.48a	-0.25a	0.495**b	-5.83*a	-22.12*a	0.199b
Basic Materials	0.34a	0.322a	2.03*b	-22.29*a	-22.47*a	0.139b
Personal & Household Goods	0.30a	1.87a	1.55*b	-23.19*a	-23.23*a	0.178b
Consumer Services	-0.91a	1.34c	1.00*b	-6.21*a	-22.76*a	0.23b
Technology	-0.66a	2.00b	1.25*b	-6.49*a	-24.07*a	0.206b
Telecommunications	-0.30a	-2.1c	1.09*b	-7.79*a	-23.89*a	0.218b
Utilities	0.75a	0.76a	1.45*b	17.4*a	22.78*a	0.19b

Notes: All variables are in natural logarithm. ADF is the augmented Dickey-Fuller test, PP denotes the Phillips-Perron test and KPSS is the Kwiatkowski-Phillips-Schmidt-Shin test. (a) model without constant and deterministic trend, (b) model with constant but without deterministic trend, (c) model with neither constant nor deterministic trend. *, ** and *** denote rejection of the null hypothesis at 1%, 5% and 10% respectively.

Table II: Descriptive statistics of return series

	Mean	**Std. errors**	**Skewness**	**Kurtosis**	**JB**	**Correlation with Oil**	**Correlation with DJ Stoxx**
Oil Brent	0.21	4.61	-0.47	4.72	91.36	1.00	0.10
DJ Stoxx	-0.02	2.56	-0.68	6.21	291.89	0.10	1.00
Automobile & Parts	0.02	4.32	0.54	18.80	5930.1	-0.02	0.67
Financials	-0.09	3.29	-0.53	7.53	512.7	0.04	0.92
Food & Beverages	0.05	2.18	-0.54	5.82	217.0	-0.10	0.57
Oil & Gas	0.01	3.18	-0.52	4.66	91.31	0.33	0.63
Health Care	0.01	2.54	-0.03	5.23	118.5	-0.07	0.63
Industrials	-0.02	2.90	-0.71	6.52	341.6	0.10	0.91
Basic Materials	0.06	3.34	-0.90	7.02	459.5	0.12	0.76
Personal & Household Goods	0.04	2.57	-0.76	6.70	378.6	0.03	0.97
Consumer Services	-0.09	2.65	-0.48	5.25	142.9	0.04	0.88
Technology	-0.11	5.62	-0.24	4.70	73.78	0.08	0.81
Telecommunications	-0.01	3.63	-0.07	4.01	24.70	0.04	0.73
Utilities	0.07	2.25	-1.57	13.08	2635.3	0.08	0.72

Notes: The test for Kurtosis coefficient has been normalized to zero. JB is the Jarque-Bera test for normality based on excess skewness and Kurtosis.

Table III: Estimates results

	a	b	c	α	β	γ	$\overline{R^2}$	Log Likelihood	AIC
Automobile & Parts	0.071	-0.033**	1.234*	0.315*	0.175*	0.796*	0.450	-1278.070	4.529
	(0.086)	(0.019)	(0.035)	(0.112)	(0.031)	(0.038)			
Financials	-0.028	-0.031**	1.167*	0.035**	0.107*	0.904*	0.848	-797.537	2.834
	(0.031)	(0/008)	(0.015)	(0.017)	(0/019)	(0.013)			
Food & Beverages	0.099***	-0.046*	0.565*	0.015**	0.137*	0.874*	0.334	-1035.077	3.673
	(0.052)	(0.010)	(0.021)	(0.008)	(0.026)	(0.022)			
Oil & Gas	-0.071	0.195*	0.806*	0.050**	0.076*	0.919*	0.474	-1235.876	4.380
	(0.080)	(0.016)	(0.034)	(0.027)	(0.019)	(0.019)			
Health Care	0.037	-0.076*	0.608*	0.046*	0.068*	0.921*	0.420	-1133.518	4.019
	(0.063)	(0.014)	(0.024)	(0.018)	(0.018)	(0.019)			
Industrials	0.056	0.008	1.091*	0.013***	0.090*	0.907*	0.823	-867.543	3.081
	(0.042)	(0.010)	(0.016)	(0.007)	(0.020)	(0.019)			
Basic Materials	0.137**	0.031**	1.081*	0.033	0.092*	0.909*	0.579	-1160.090	4.113
	(0.069)	(0.015)	(0.025)	(0.030)	(0.021)	(0.020)			
Personal & Household	0.100**	-0.037*	0.909*	0.027***	0.095*	0.890*	0.760	-868.284	3.129
Goods	(0.041)	(0.009)	(0.015)	(0.014)	(0.017)	(0.022)			
Consumer Services	-0.050	-0.021**	0.933*	0.021***	0.083*	0.908*	0.787	-873.253	3.147
	(0.042)	(0.011)	(0.019)	(0.011)	(0.014)	(0.017)			
Technology	-0725	-0.009	1.482*	0.151*	0.078*	0.906*	0.661	-1356.355	4.805
	(0.095)	(0.024)	(0.034)	(0.052)	(0.024)	(0.023)			
Telecommunications	0.085	-0.034*	0.988*	0.051*	0.069*	0.926*	0.533	-1251.374	4.435
	(0.090)	(0.020)	(0.037)	(0.020)	(0.014)	(0.012)			
Utilities	0.107***	-0.009	0.601*	0.333*	0.172*	0.698*	0.523	-1026.403	3.641
	(0.059)	(0.013)	(0.022)	(0.121)	(0.043)	(0.082)			

*Notes: *, ** and *** indicate significance of coefficients at 1%, 5% and 10% respectively. Robust standard errors are in parentheses.*

Table IV: Cointegration tests

	ADF	PP	Johansen
DJ Stoxx	-1.32	-1.25	7.09
Automobile & Parts	-2.08	2.22	8.14
Financials	-0.65	-1.25	6.62
Food & Beverages	-2.69*	-2.76**	12.26
Oil & Gas	-2.31	-2.24	9.5
Health Care	-2.00	-2.05	6.06
Industrials	-1.44	-1.26	6.62
Basic Materials	-2.39	-2.35	9.53
Personal & Household Goods	-2.37	-2.34	12.4
Consumer Services	-1.23	-0.91	7.55
Technology	-1.68	-1.39	6.52
Telecommunications	-1.61	-1.58	7.03
Utilities	-1.59	-1.57	5.37

*Notes: ADF is the augmented Dickey-Fuller test, PP the Phillips-Perron test and Johansen the trace statistics. *, ** and *** denote rejection of the null hypothesis at 1%, 5% and 10% respectively. We apply unit root tests on residual series* ε_t .

Table V: ***Convergence to the long-term target***

	DL Food & Bev.	**DLOIL**
z_{t-1}	-0.016**	0.028
	(0.007)	(0.019)
$DLFood\ \&\ Bev._{t-1}$	0.084**	0.149***
	(0.042)	(0.086)
$DLoil_{t-1}$	-0.033***	0.254*
	(0.020)	(0.041)
Constant	0.001	0.002
	(0.001)	(0.002)
$\overline{R^2}$	0.014	0.066
Log likelihood	1365.894	959.062
AIC	-4.812	-3.373

*Notes: *, ** and *** indicate significance of coefficients at 1%, 5% and 10% respectively. Robust standard errors are in parentheses.*