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THE EFFECTS OF TERRORISM AND WAR ON THE OIL PRICES - STOCK INDICES RELATIONSHIP

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Abstract: This paper, investigates the effect war and terrorism, have on the covariance between oil prices and the indices of four major stock markets - the American S&P500 and the European DAX, CAC40 and FTSE100 - using non-linear BEKK-GARCH type models. Findings reported herein indicate that the covariance between stock and oil returns is affected by war. A tentative explanation is that the two wars examined here, predispose investors and market agents for more profound and longer lasting effects. On the other hand, in the case of terrorist incidents that, vis-à-vis war, are of a more transitory nature and one-off security shocks, only the co-movement between CAC40, DAX and oil returns is affected. No significant impact for the same terrorist events is observed in the relationship between the S&P500, FTSE100 and oil returns. This difference in the reaction may tentatively be interpreted as indicating that the latter markets are more efficient in absorbing the impact of terrorist attacks.

JEL Classification: G10, E0, C5

Key Words: war, terrorism, crude oil, stock market returns, co-movement.

1. INTRODUCTION

In an increasingly integrated world economy, globalized markets echo and reverberate major political events such as for instance political news and elections; coups; civil strife and popular uprisings; intra and inter state conflict and war; mega terrorist attacks etc. As many studies have shown, more often than not, the impact of such events is not confined to the sphere of politics but spreads to the economy with potentially significant direct and indirect effects on economic activity that, depending on the type of the event, can either be short lived or longer lasting (*inter alia*: Jong-A-Pin, 2009; Crain and Crain, 2006; Enders *et al*. 2006; Eckstein and Tsiddon, 2004; Abadie and Gardeazabal, 2008). Among other economic effects, they can bring about noteworthy changes and shifts in equity markets; in the cross country correlation of assets; in portfolio allocation and diversification and affect investor sentiment (*inter alia*: Frey and Kucher, 2000, 2001; Drakos, 2010; Schneider and Troeger, 2006; Kollias *et al*. 2010; Amihud and Wohl, 2004; Nikkinen and Vahamaa, 2010; Asteriou and Siriopoulos, 2003; Blomberg *et al*. 2009; Guidolin and La Ferrara, 2010).

In line with previous studies that have addressed markets' reaction to major political events, this paper examines how major international security shocks, in particular terrorism and war, have affected the volatility of stock and oil price returns and their covariance. To this end, non-linear BEKK-

GARCH type models are used to examine the covariance between oil prices and four major international stock market indices: the American S&P500 and the European DAX, CAC and FTSE100 covering a time period that includes major international terrorist incidents such as the 1988 Pan Am bombing, 9/11, the Madrid 2004 and London 2005 bomb attacks as well as the first and second Iraqi wars.

Undoubtedly, such momentous events were of global importance, having shaped and determined the course of modern history. To the best of our knowledge, the issue of how the relationship between major stock indices and oil prices has been affected by such history making events has not been addressed before using a non-linear empirical methodology. Hence, it is of interest to know how the markets in question have reacted to one-off events such as a terrorist attack vis-à-vis events of longer duration and perhaps of more permanent nature in terms of their outcome such as the two wars in Iraq and the eventual toppling of Saddam Hussein's regime. Also of interest is to examine whether any noteworthy differences in the reaction of European and US markets can be established. The rest of the paper is structured as follows. Section two is an epigrammatic literature review of the relationship between oil and stock prices as well as the impact security shocks such as terrorism and war have on global markets. The empirical methodology employed is briefly presented in section three, while in section four the empirical findings are presented and discussed. Finally, section five concludes the paper.

2. An Epigrammatic Literature Review

A growing literature addresses the relationship between stock markets and oil prices (*inter alia*: Park and Ratti, 2008; Mohanty *et al*. 2011; Apergis and Miller, 2009; Zhu *et al*. 2011; Miller and Ratti, 2009; Filis *et al*. 2011). In it, two predominant strands can be broadly identified. On a theoretical level of argumentation, the relationship between these two markets can be negative or positive. On the one hand, increases in oil prices invariably lead to higher transportation, production, and heating costs, which can put a drag on corporate earnings. In addition, higher oil prices affect inflation expectations and curtail consumers' discretionary spending. As a consequence, inflationary pressures may lead to upward pressures on interest rates and through this channel affect economic activity and stock prices valuations. On the other hand, however, investors may very well associate increasing oil prices with a booming economy. Thus, higher oil prices could reflect stronger business performance with the concomitant impact on stock markets.

Not surprisingly, the empirical evidence, that a growing number of papers have yielded, is mixed and does not seem to offer an unequivocal and universally applicable support in either direction. On the one hand, a significant number of papers report empirical findings in favour of a negative relation between these two markets and variables (*inter alia*: Sadorsky, 1999; Ciner, 2001; Papapetrou, 2001; O' Neil *et al*., 2008). For instance, Nahda and

Faff (2008) studying the short term link between oil prices and thirty–five mainstream global industries report findings of oil prices having a negative impact on all of them with the exception of the oil and gas industries. Similar different effects of oil prices to different stock sectors are also reported by Arouri and Nguyen (2010), suggesting that the introduction of an oil asset into a stock portfolio can have significant diversification benefits. The findings reported by Perk and Ratti (2008) show that increases in oil prices have a negative impact on stock returns in the US and twelve European countries. This however, is not the case for the stock market in Norway, an oil exporting country. Perhaps not surprisingly the results show a positive reaction to rises in the oil price. Inconclusive are also the findings reported by Jones and Kaul (1996). They indicate a negative relationship between stock and oil markets in the case of the USA and Canada but they are inconclusive for Japan and UK.

On the other hand, Huang *et al.* (1996), using an unrestricted vector autoregressive model (VAR), find no evidence of a relationship between oil prices and the S&P500 market index. Similar findings are also reported in an earlier paper by Chen *et al.* (1986). In a recent study, Apergis and Miller (2009) examine whether structural oil-market shocks affect stock returns in eight developed countries reporting no significant responses of international stock market returns.

Given this division and conflicting findings, a number of recent studies have argued that the relationship between oil and stock prices is not stable over time. For instance, Mohanty *et al.* (2010), using the Central and Eastern European countries as the vehicle of their empirical investigation, argue that even if there is no significant association between oil prices and the stock returns over the whole of their sample period (1998–2010), the sub-period analysis reveals that this relationship does vary across firms and over time. Miller and Ratti (2009), using a cointegration methodology that allows for endogenously identified structural breaks, report findings suggesting that the expected negative long run relationship appears to disintegrate after September of 1999. They attribute this result to the possible presence of several stock market and/or oil price bubbles since the turn of the century. Broadly similar findings are presented by Jammazi and Aloui (2010), arguing that the negative relationship appears to be more pronounced during the pre-1999 period. Finally, the findings of Alpanda and Peralta-Alva (2010), offer evidence in favour of the argument that the increase in energy prices was indeed an important contributor to the stock market crash of 1973-1974.

Thus, given this background of evidence on the relationship between oil prices and stock markets, it would be interesting to include in the *equation* of their association the effects of major political events and incidents such as the two Iraqi wars and mega terrorist hits such as 9/11 or the more recent Madrid and London bomb attacks. As already pointed out, there is ample evidence indicating that socio-political events in general and war, armed conflict and terrorism in particular, often exert considerable influence on markets' behaviour albeit the extent, duration and depth of the latter's reaction may vary significantly (*inter allia*: Frey and Kucher, 2000, 2001; Amihud and Wohl, 2004; Schneider and Troeger, 2006; Drakos, 2010; Kollias *et al*. 2010, 2011; Guidolin and La Ferrara, 2010). As Bialkowski *et al*. (2008) note, markets can be unsettled by important political events and changes due to the risk and uncertainty they may potentially represent. From their perspective, major political developments, such as terrorism and war, represent external events that can directly affect market risk premium and investors' sentiment highly increasing volatility and thus exert an adverse impact on asset valuation, investment decisions and portfolio allocation. Given the global nature of financial markets, an increase in the risk emanating from the actions of a government or non-governmental actor, such as a terrorist organisation in our case, can bring about noteworthy changes and shifts in markets, in the cross country correlation of assets, in portfolio allocation and diversification. Furthermore, as political events, for instance an armed conflict or war, unfold; market agents will adjust their position depending on the anticipated result of the conflict as this is determined by various incidents during the military operations that can affect the course and the final outcome of the fighting. For instance, Frey and Kucher (2000, 2001) and Choudhry (2010) report such evidence in the case of World War II. Results by Amihud and Wohl (2004) also show that markets, during the second Gulf War, adjusted their behaviour to the probability of Saddam's fall from power and hence the final outcome of the war.

Obviously this is not the case when it comes to terrorist incidents. Although the threat of terrorism is to some extent omnipresent, terrorist attacks are unexpected when they actually occur. Thus, they can act as exogenous shocks to markets. Among others, Abadie and Gardeazabal (2008) point out that through increased uncertainty, terrorism reduces the expected return to investment and may cause significant movements of capital across countries. Terrorist actions can affect expected profitability and since asset values respond to such changes, adversely affect stock markets and through them the economy. Nevertheless, although many studies have identified a negative impact of terrorist attacks on markets, such effects are, as Brounrn and Derwall (2010) point, generally mild with markets tending to rebound fairly quickly, with the lower returns being generally limited around the day(s) of the event (Drakos, 2010). When it comes to the oil market, Blomberg *et al*. (2009), investigate the relationship between oil profitability and conflict and in particular the effects of terrorism on global oil prices. Their findings show that in the later part of their sample, as conflict and terrorist actions have become more regular oil stock prices do not increase in response to conflict. This, however, does not appear to be the case is periods characterised by capacity constraints.

Against this background of the findings reported by earlier studies, we now turn to examine how the two wars in Iraq and mega terrorist incidents have affected the volatility of stock and oil price returns and their covariance. Given the findings of previous studies cited earlier, one expects that the correlation between stock market prices and oil prices is not stable over time. The question is whether the covariance between the two markets is affected by temporary, one-off security shocks such as a terrorist attack, or events that produce results of a more permanent nature as in the case of the two armed conflicts in Iraq. This is particularly interesting since by identifying periods when the relationship becomes weaker, this has potentially useful implications for portfolio managers and possible diversification benefits.

3. THE METHODOLOGY

The first version is the simple BEKK model of Engle and Kroner (1995). In particular, the expressions for the conditional mean and variance-covariance are

$$R_{i,t} = \varepsilon_{\iota,t} \qquad (1)$$

with $\varepsilon_t | \Phi_{t-1} \sim N(0, H_t)$ and

$$H_t = C_0^{'} C_0 + \sum_{k=1}^{K} C_{1k}^{'} x_t x_t^{'} C_{1k} + \sum_{k=1}^{K}\sum_{i=1}^{q} \Gamma_{ik}^{'} \varepsilon_{t-i} \varepsilon_{t-i}^{'} \Gamma_{ik} + \sum_{k=1}^{K}\sum_{i=1}^{p} B_{ik}^{'} H_{t-i} B_{ik} \qquad (2)$$

i=A, M where A and M designate the asset and market returns respectively. $R_{i,t}$, and $\varepsilon_{\iota,t}$ are the return vector, and the residual vector respectively. C_0, Γ_{ik}

and B_{ik} are n×n parameter matrices with C_0 lower triangular, C_{1k} are J×n parameter matrices and the summation limit K determines the generality of the process. x_t is a J×1 vector of exogenous variables as defined by Engle et al. (1983). Eq. (1) gives the expression for the conditional mean. Eq. (2) is the conditional variance-covariance matrix. It depends on its past values and on past values of ε_t, parameter. The BEKK-GARCH model guarantees by construction that the covariance matrices in the system are positive definite. The vast majority of empirical applications uses k=p=q=1. Therefore, from now on the equation of the conditional variance will be specified as follows:

$$H_t = C_0^{'}C_0 + \Gamma_{11}^{'}\varepsilon_{t-1}\varepsilon_{t-1}^{'}\Gamma_{11} + B_{11}^{'}H_{t-1}B_{11} \quad (3)$$

In an attempt to identify possible impacts of terrorist attacks on the oil and stock index returns comovement we employ the unrestricted version of the BEKK-GARCH model including a dummy in the construction of variances and covariance matrices recently presented by Karagianni *et al.* (2010). More specifically:

$$H_t = C_0^{'}C_0 + \Gamma_{11}^{'}\varepsilon_{t-1}\varepsilon_{t-1}^{'}\Gamma_{11} + B_{11}^{'}H_{t-1}B_{11} + D_{11}^{'}\omega_t\omega_t^{'}D_{11} =$$

$$\begin{pmatrix} c_{11} & 0 \\ c_{21} & c_{22} \end{pmatrix}^{'} \begin{pmatrix} c_{11} & 0 \\ c_{21} & c_{22} \end{pmatrix} + \begin{pmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{pmatrix}^{'} \varepsilon_{t-1}\varepsilon_{t-1}^{'} \begin{pmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{pmatrix} + \begin{pmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{pmatrix}^{'} H_{t-1} \begin{pmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{pmatrix} +$$

$$\begin{pmatrix} d_{11} & d_{12} \\ d_{21} & d_{22} \end{pmatrix}^{'} \omega_t\omega_t^{'} \begin{pmatrix} d_{11} & d_{12} \\ d_{21} & d_{22} \end{pmatrix} \quad (4)$$

More analytically:

$$h_{11,t} = c_{11}^2 + \gamma_{11}^2\varepsilon_{1,t-1}^2 + 2\gamma_{11}\gamma_{21}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + \gamma_{21}^2\varepsilon_{2,t-1}^2 + \beta_{11}^2 h_{11,t-1} + 2\beta_{11}\beta_{21}h_{12,t-1} + \beta_{21}^2 h_{22,t-1}$$
$$+ d_{11}^2\omega(i)_{1,t-1}^2 + 2d_{11}d_{21}\omega(i)_{1,t-1}\omega(i)_{2,t-1} + d_{21}^2\omega(i)_{2,t-1}^2$$

$$h_{12,t} = c_{11}c_{21} + \gamma_{11}\gamma_{12}\varepsilon_{1,t-1}^2 + (\gamma_{21}\gamma_{12} + \gamma_{11}\gamma_{22})\varepsilon_{1,t-1}\varepsilon_{2,t-1} + \gamma_{21}\gamma_{22}\varepsilon_{2,t-1}^2 + \beta_{11}\beta_{12}h_{11,t-1}$$
$$+ (\beta_{21}\beta_{12} + \beta_{11}\beta_{22})h_{12,t-1} + \beta_{21}\beta_{22}h_{22,t-1} + d_{11}d_{12}\omega(i)_{1,t-1}^2 + (d_{21}d_{12} + d_{11}d_{22})\omega(i)_{1,t-1}\omega(i)_{2,t-1}$$
$$+ d_{21}d_{22}\omega(i)_{2,t-1}^2$$

$$h_{22,t} = c_{21}^2 + c_{22}^2 + \gamma_{12}^2\varepsilon_{1,t-1}^2 + 2\gamma_{12}\gamma_{22}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + \gamma_{22}^2\varepsilon_{2,t-1}^2 + \beta_{12}^2 h_{11,t-1} + 2\beta_{12}\beta_{22}h_{12,t-1} + \beta_{22}^2 h_{22,t-1}$$
$$+ d_{12}^2\omega(i)_{1,t-1}^2 + 2d_{12}d_{22}\omega(i)_{1.t-1}\omega(i)_{2,t-1} + d_{22}^2\omega(i)_{2,t-1}^2$$

We define $\omega(i)_t = \begin{cases} 0 & \text{if no attack occurs} \\ \varepsilon_t & \text{if an attack occurs} \end{cases}$

where *i*=P,T defines the type of the event, and ε_t the residuals. Given the previous definition of $\omega(i)_t$ it derives that the residuals ε_t are multiplied by a dummy giving one in the present of event and zero otherwise. Depending on the nature of the incident the construction of the dummy variable is different. If the event produces an outcome of a more permanent nature (with *i*=P), i.e. it impacts more than one day the market, then the entire period of shock is used. Clearly this is the case for the two Iraq conflicts. The second type of dummy includes transitory events (with *i*=T) i.e. events that take place and end the same day, as terrorist attacks do. In that case we are only interested in the short-term record of the event, so a -/+ 2 days window is selected. The simple BEKK model (eq.2) can be viewed as a special case of eq.4 where all the elements of matrix D11 are zero. A list and short description of these events is presented in Table 1. All terrorist incidents are drawn from Enders and Sandler (2011) and they are selected on the basis of their significance and magnitude both in terms of casualties, damages and costs as well as the symbolic importance of the target hit.

Table 1: The Events

Wars	Terrorist Events
1. Persian Gulf War from **02/08/1990** to **28/02/1991** 2. War in Iraq from **20/03/2003** to **01/05/2003**	1. **21 Dec. 1988** Downing of Pan Am flight 103, en route from London to New York. (Libyan intelligence agent) 2. **19 Sept. 1989** Downing of Union des Transports (UTA) flight 772 en route from Brazzaville to Paris. (Hezbollah) 3. **19 April 1995** Truck bombing of the Alfred P. Murrah Federal Building in Oklahoma. (Timothy McVeigh) 4. **7 Aug. 1998** Simultaneous bombings of US embassies in Nairobi, Kenya, and Dar es Salaam, Tanzania. (al-Qaida) 5. **11 Sept. 2001** Four suicide hijackings that crashed into the World Trade Center towers, the Pentagon, and a field in rural Pennsylvania.(al-Qaida) 6. **11 March 2004** Bombing of commuter trains and stations during morning rush hour in Madrid. (al-Qaida) 7. **7 July 2005** London subway and bus bombings by four suicide terrorists. (Homegrown terrorists with al-Qaida sympathy)

Source: Terrorist events drawn from Enders & Sandler (2011), Table 12.2

4. DATA AND EMPIRICAL RESULTS

For the purposes of the analysis that follows, daily prices of major stock indices (DAX, CAC-40, FTSE-100, S&P 500) and daily prices of crude oil indices (Europe Brent Spot Price and Cushing, Oklahoma WTI Spot Price indices) are used. Due to data availability constraints, for the DAX index the sample covers the period 28/11/1990 to 01/08/2008, for CAC index the period 18/08/1988 to 18/06-2008, FTSE-100 index the period 20/5/1987 to 01/08/2008 and for the S&P 500 index the period 02/01/1986 to 01/08/2008.

Following standard unit root procedures the time series are found to be non-stationary and so first differences of logarithms are used giving returns (see figures 1-4). Preliminary econometric analysis confirmed well-known stylized facts of financial markets including significant autocorrelations, asymmetry, and heteroskedasticity[1]. More specifically the high levels of kurtosis justify the use of a GARCH type model as a tool to appropriately take into account non-normal covariations between oil and stock index returns. The results from estimating model 4 are reported in Table 2.

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[1] Data Source Thomson Reuters.

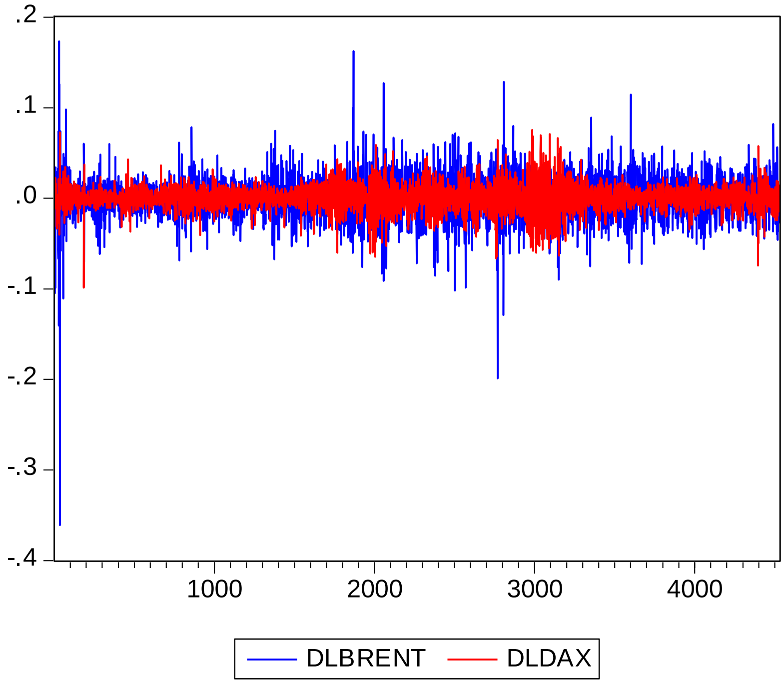

Figure 1: Brent and DAX returns (28/11/1990-01/08/2008)

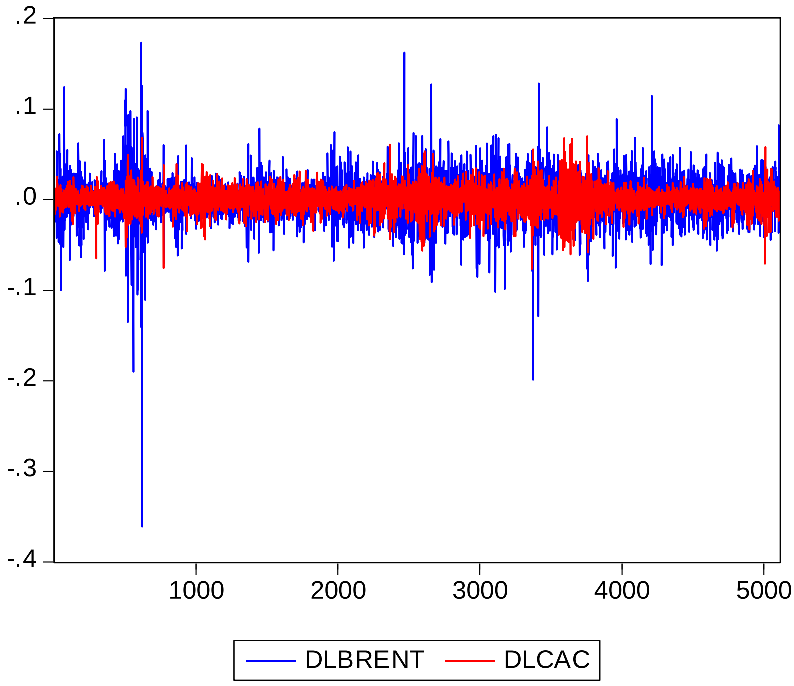

Figure 2: Brent and CAC40 returns (18/08/1988-18/06/2008)

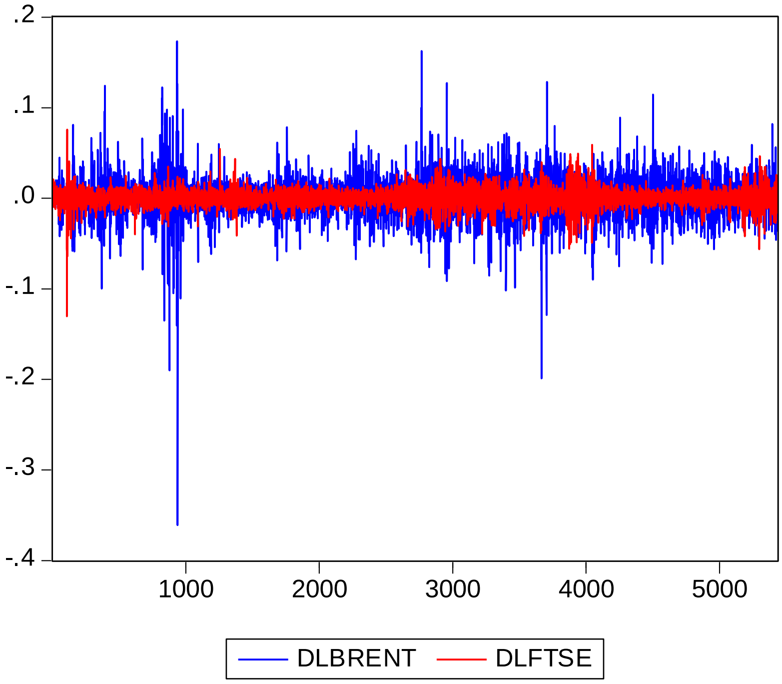

Figure 3: Brent and FTSE100 returns (20/05/1987-01/08/2008)

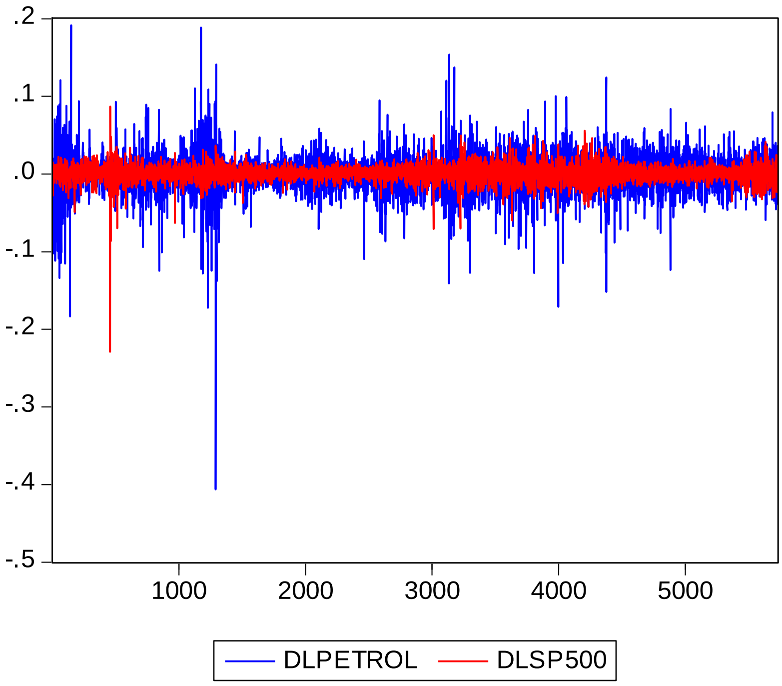

Figure 4: Petrol and SP500 returns (02/01/1986-01/08/2008)

As it can be seen in the relevant table, the parameters of the BEKK-GARCH model are significant giving positive definite matrices. However, the interpretation of the dummies varies depending on the nature of the incident. In the case of the two armed conflicts in Iraq, the covariance between the German, French, US, UK stock indexes and oil returns decreases, meaning that when we take these events into account a greater negative comovement arises. Looking closely at Table 2 we can see that the statistical importance of coefficients d_{11} and d_{12} for the DAX and CAC series is translated into increasing variances ($h_{11,t}$, $h_{22,t}$) and decreasing covariance ($h_{12,t}$). The same holds for the coefficients d_{11}, d_{21} and d_{22} when model 4 is regressed over the pair of petrol and S&P500 returns. Plotting the covariances between the above series helps us localize the incident. Concerning the SP500 series decreasing covariance can be graphically validated (Figure 8, i=P). It follows, that one of the components $d_{11}d_{22}(\omega_{1,t-1}\omega_{2,t-1})$ and $d_{21}d_{22}(\omega^2_{2,t-1})$ offsets part of the other, so that the net effect in $h_{1,2,t}$ is not clear enough. As it can be seen in Figures 5-8 (i=P) the most prominent decreasing covariation is indeed detected around 1991 where the first permanent type event (i.e. war) is located. This result is in accordance with Sadorsky (1999) who found that the negative association between oil prices and stock returns in 1991 is significantly due to the sudden increase in oil prices that occurred after the Iraqi invasion of Kuwait on August 2, 1990. A conflict incident affects the oil prices through its effect on the demand-supply chain. In turn, it will undermine the consumers as well as investors' confidence and lead to an overreaction mechanisms. This feedback-related dynamics are efficiently taken into consideration by the non-linear nature of our model. If oil prices continue upward and remain high for a long period, energy-dependent businesses inevitably will suffer. Production will be more costly giving high prices and inflation. As Hess and Lee (1999) have shown, during supply shocks inflation is negatively related with stock returns. So, increasing inflation will be associated with downward sloping stock returns. More recently, Karagianni and Kyrtsou (2011) and Hristu-Varsakelis and Kyrtsou, (2008) provided evidence that this relationship is in fact nonlinear. In the light of this finding, the policy implication is that there is a need for policy makers and market agents to take into account the complexity of the underlying dynamics and the evolving character of the variables concerned. Finally, at first sight the covariance between oil and FTSE returns remains untouched by the shock induced by the two armed conflicts. Only the variance of oil returns seems to be reacting (significant d_{11} coefficient). However plotting covariances in Figure 7 (i=P) shows that there is an indirect effect of $h_{11,t}$ (oil variance) into $h_{12,t}$ (covariance) caused by the statistically significant coefficients β_{11} and β_{12}. As for the rest of indexes, a noticeable variation is observed around 1991.

In the case of the terrorist attacks examined here, the conclusion in favor of negative covariation does not change for the DAX and CAC40 stock returns. Nevertheless, the covariation area is located at a posterior observation. If we compare the graphical representations of cases i=P and i=T (Figures 5-6), we can easily detect as expected a smaller impact of the transitory component around 1991 (beginning of the graph) and a larger one around September 2001 (middle of the graph). Instead, the comovement between FTSE100, S&P500 and oil returns is left unaffected by the inclusion of terrorist attacks. Regarding the FTSE100, the dummy variables involved are only significant in the variance equation of oil returns ($h_{1,t}$), whereas for the S&P500 we follow the argumentation we gave in the case of permanent shocks. The same conclusion is reached by looking at Figures 7 and 8 (i=T). The covariances are similar with those of model 2 (i=0). It turns out that both the UK and US markets are more efficient in responding to one-off terrorist incidents included in the empirical investigation here hence the co-dependence with oil remained intact. Indeed, as Johnston and Nedelescu (2005) argue, effective reaction of the relevant supervising authorities and coordinated efforts among them can help financial markets to be more efficient in absorbing the shocks caused by terrorist attacks. A similar argumentation is also put forward by Kollias *et al*. (2011) when explaining the observed differences in the reaction of the Madrid and London stock exchanges to the corresponding bombings in 2004 and 2005 respectively, with the latter emerging with a more sober and efficient reaction to this major terrorist incident.

Table 2: BEKK-GARCH estimation results

Coefficients	Model with permanent attack (*i*=P)				Model with transitory attack (*i*=T)			
	Brent-DAX	Brent-CAC	Brent-FTSE100	WTI-SP500	Brent-DAX	Brent-CAC	Brent-FTSE100	WTI-SP500
c11	0.0023 *(10.559)*	0.0023 *(11.229)*	0.002 *(15.557)*	0.0027 *(16.897)*	0.0021 *(10.369)*	0.00203 *(10.594)*	0.0025 *(14.916)*	0.0024 *(15.556)*
c21	-0.0007 *(-4.300)*	-0.0006 *(-3.681)*	-0.000072 (-0.503)	-0.00007 (-0.684)	-0.0006 *(-3.671)*	-0.000671 *(-3.641)*	-0.0001 (-0.714)	-0.000012 (-0.1083)
c22	0.0015 *(11.441)*	0.0016 *(14.767)*	0.0012 *(13.486)*	0.001 *(18.467)*	0.0015 *(12.111)*	0.0016 *(13.716)*	0.0012 *(13.529)*	0.0009 *(17.965)*
γ11	0.225 *(30.322)*	0.2317 *(32.432)*	0.256 *(37.148)*	0.265 *(37.544)*	0.2203 *(31.889)*	0.2231 *(33.293)*	0.248 *(36.909)*	0.2695 *(42.966)*
γ21	-0.078 *(-6.798)*	-0.0856 *(-6.847)*	0.0168 (1.371)	0.036 *(3.015)*	-0.0581 *(-4.747)*	-0.0782 *(-6.288)*	0.0244 *(1.933)*	0.0429 *(3.615)*
γ12	0.0107 *(2.100)*	0.0034 (0.811)	-0.0062 *(-2.0758)*	-0.0015 (0.573)	0.002 (0.704)	0.0017 (0.4609)	-0.0057 *(-1.953)*	-0.0042 *(-1.7061)*
γ22	0.255 *(25.890)*	0.254 *(27.608)*	0.274 *(32.825)*	0.2514 *(50.108)*	0.251 *(25.571)*	0.254 *(26.449)*	0.273 *(32.662)*	0.242 *(52.446)*
β11	0.967 *(40.264)*	0.966 *(43.255)*	0.958 *(38.924)*	0.958 *(46.019)*	0.969 *(44.552)*	0.969 *(49.92)*	0.962 *(43.667)*	0.959 *(50.114)*
β21	0.026 *(6.679)*	0.0286 *(6.129)*	-0.0026 (-0.521)	-0.0086 *(-2.140)*	0.0201 *(5.398)*	0.0266 *(6.0655)*	-0.0059 (-1.2028)	-0.0112 *(-2.991)*
β12	-0.0004 (-0.348)	0.0001 (0.195)	0.00154 (1.918)	0.0007 (1.051)	0.0006 (0.508)	0.0005 (0.509)	0.0018 *(2.029)*	0.00134 *(1.897)*
β22	0.957 *(28.341)*	0.956 *(30.838)*	0.954 *(33.022)*	0.964 *(59.806)*	0.958 *(28.912)*	0.956 *(30.112)*	0.954 *(33.136)*	0.9668 *(67.585)*
d11	**0.174** ***(6.088)***	**0.1431** ***(3.263)***	**0.158** ***(5.722)***	**-0.114** ***(-2.677)***	0.0146 (0.115)	0.177 (1.411)	0.0278 (0.1607)	-0.037 (-0.283)
d21	0.127 (0.525)	0.0484 (0.208)	0.071 (0.205)	**-0.933** ***(-9.436)***	**-0.574** ***(-11.802)***	**-0.451** ***(-3.82)***	**-0.898** ***(-11.189)***	**-0.6802** ***(-4.648)***
d12	**-0.059** ***(-3.626)***	**-0.0354** ***(-2.146)***	-0.0098 (-0.635)	0.0179 (1.306)	**0.155** ***(3.257)***	**-0.200** ***(-5.573)***	0.0368 (0.775)	**0.1019** ***(2.823)***
d22	-0.108 (-0.977)	-0.0711 (-1.133)	-0.039 (-0.304)	**0.0989** ***(1.939)***	**0.169** ***(2.395)***	-0.046 (-0.676)	0.0905 (1.351)	**0.550** ***(9.0515)***

Within parentheses the t-statistic is reported. Values in italics denote statistical significance at either α=5 or 10%. In bold and italics are represented the statistically significant t-statistics of the dummy variables.

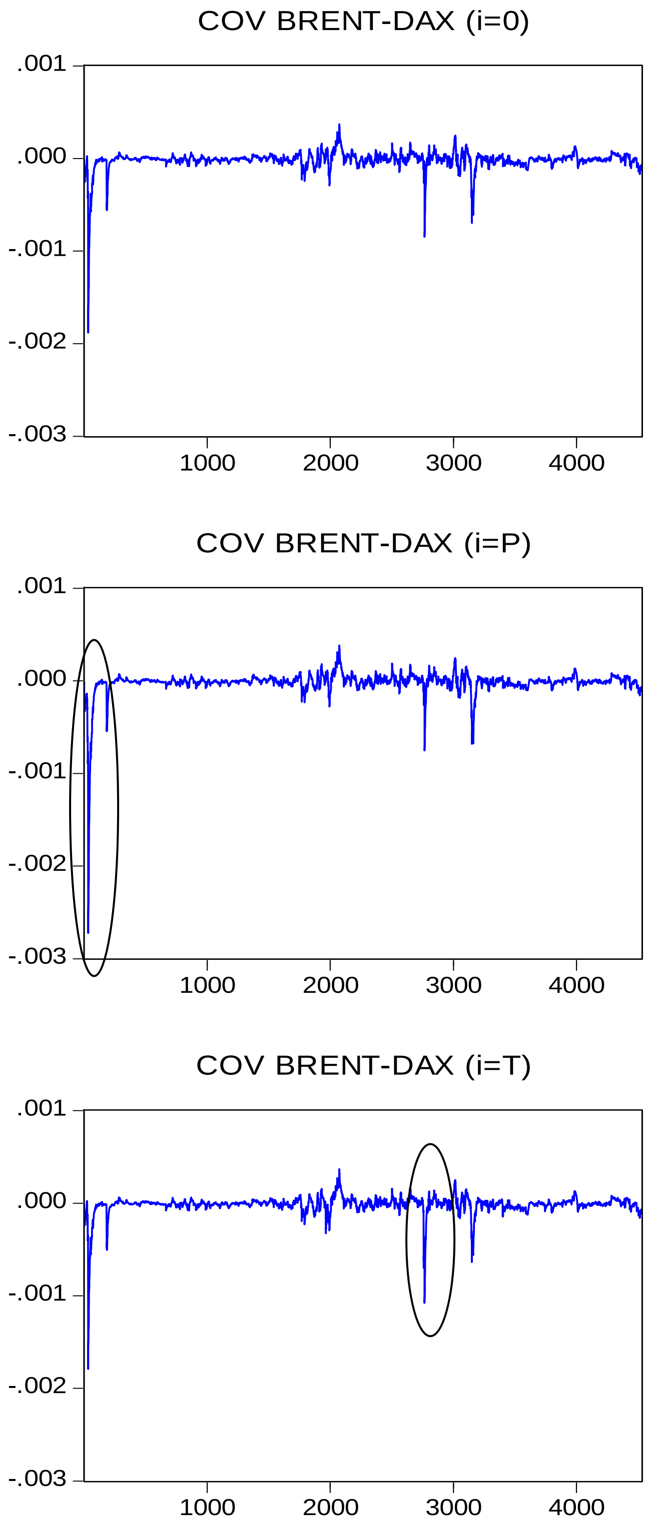

Figure 5: Comparison of co-movement (BEKK covariance) between Brent and DAX with no attack (i=0), with permanent attack (i=P) and transitory attack (i=T).

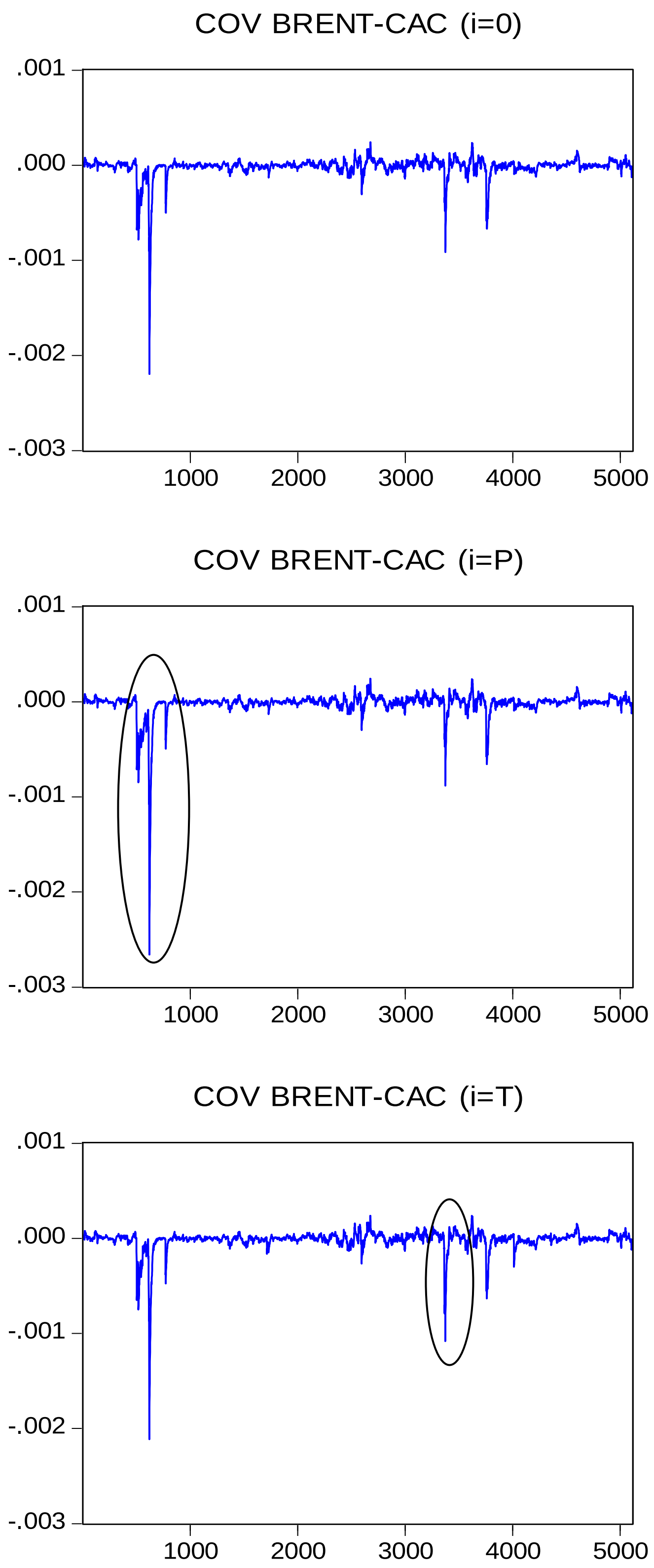

Figure 6: Comparison of co-movement (BEKK covariance) between Brent and CAC with no attack (i=0), with permanent attack (i=P) and transitory attack (i=T).

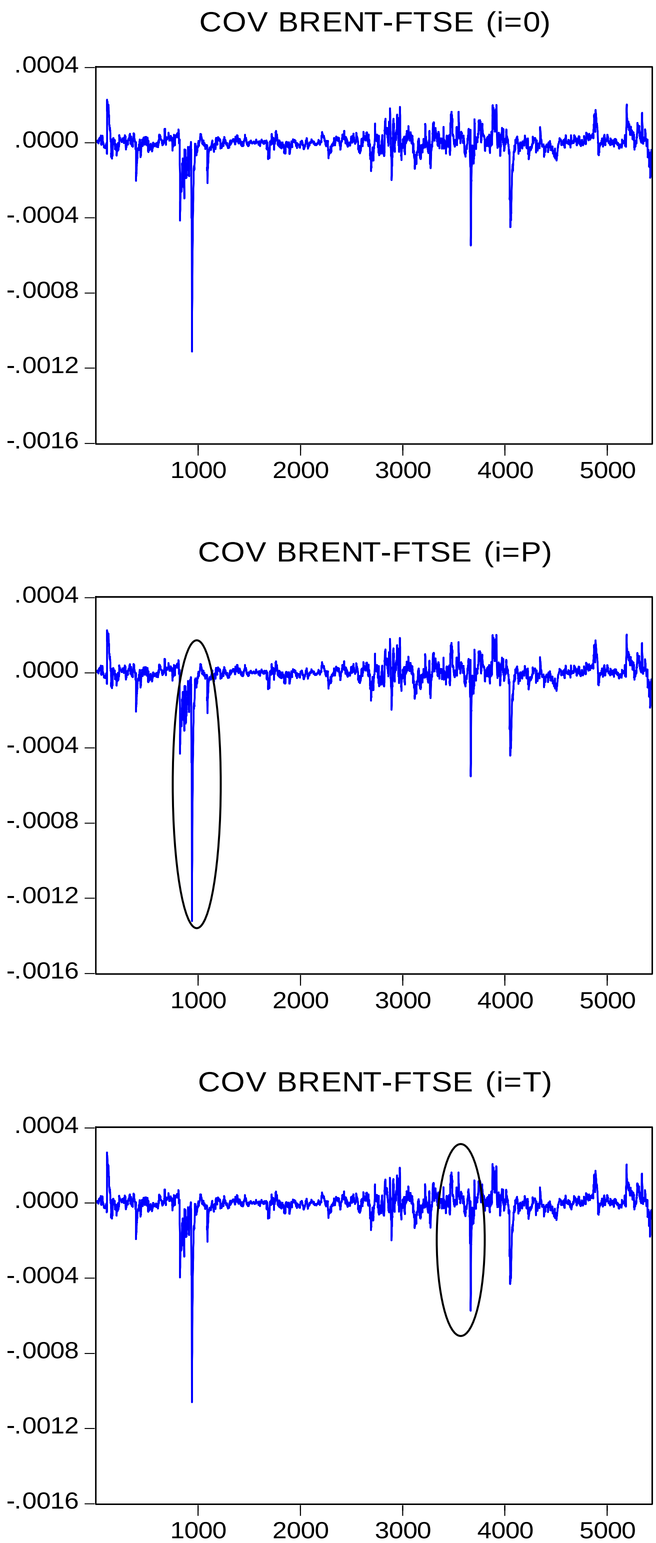

Figure 7: Comparison of co-movement (BEKK covariance) between Brent and FTSE with no attack (i=0), with permanent attack (i=P) and transitory attack (i=T).

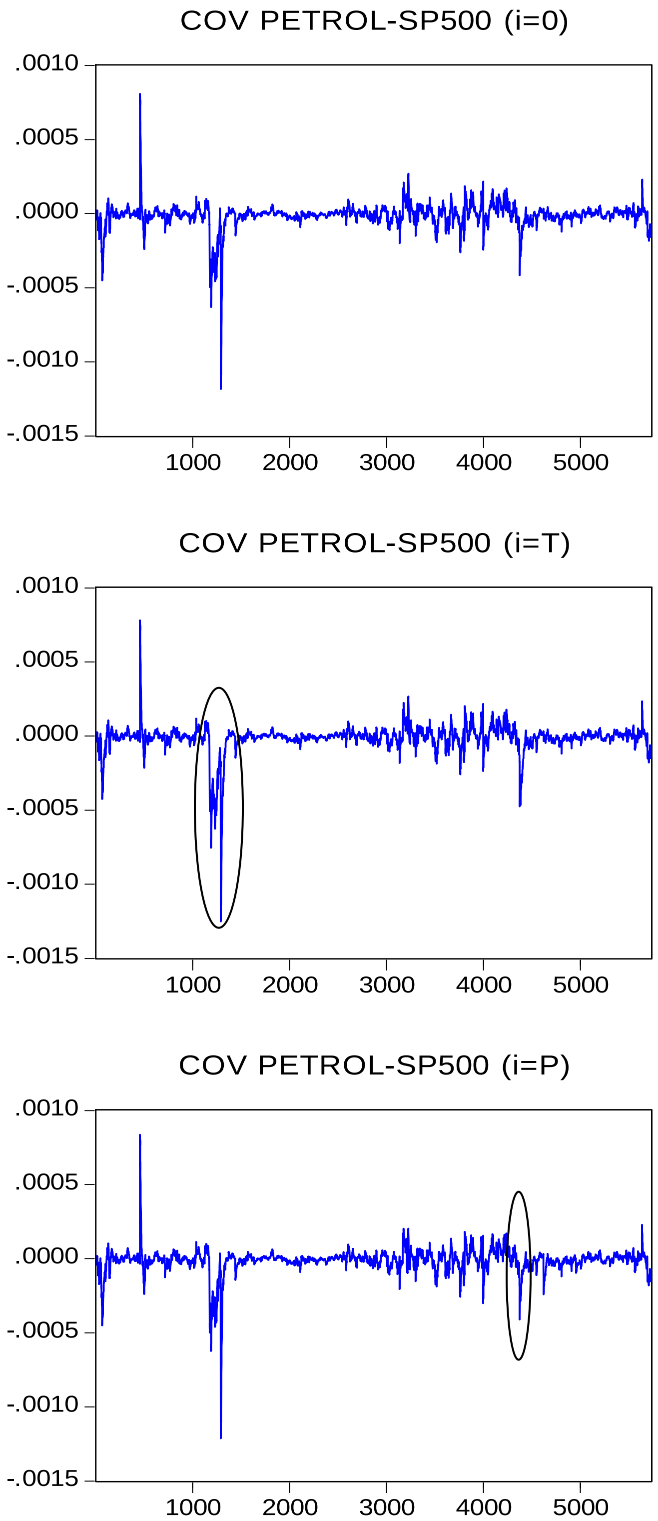

Figure 8: Comparison of co-movement (BEKK covariance) between Brent and SP500 with no attack (i=0), with permanent attack (i=P) and transitory attack (i=T).

5. Concluding Remarks

Through a BEKK-GARCH model extended with the inclusion of dummy variables we tried to investigate the impact of terrorist attacks and wars in the oil-stock returns relationship and provide further empirical evidence on how markets respond to major security related events. On the basis of the findings reported herein, it would appear that the nature of the event emerges as a factor of crucial importance. We found that distinguishing between permanent (wars) and transitory components (terrorist attacks) in the construction of our model contributes to a better understanding of the effects of different incidents in US and European stock indexes through the oil market's response and vice versa. In a nutshell, it appears that the relationship between all the four stock indexes and oil returns are less or more responsive to shocks that bring about results of a more permanent nature as wars invariably do. This suggests an asymmetric interpretation of, and reaction to these events between the stock and oil markets. This asymmetric interpretation and/or reaction destroy the common pattern driving the observed relationship during more tranquil periods. This change in the covariance may also be suggesting diversification benefits for portfolios and institutional investors. A tentative explanation is that such events predispose investors and market agents for more profound and longer lasting effects. On the other hand however, events of one-off nature as in the case of the terrorist attacks, the picture that emerges varies. Two of the four major stock markets indices - the S&P500 and FTSE100 - appear to stay neutral vis-à-vis the terrorist events whereas in the case of the other two – the CAC and DAX indices – their relationship with oil seems to be affected. This difference in the reaction, may tentatively be interpreted as indicating that the latter are more efficient in integrating the news of terrorist attacks, exhibiting a more resilient and stout behaviour.

Overall, it appears that according to the specific characteristics as well as the intensity of the shock the market values asymmetrically the information. Otherwise, the type of the incident deeply affects the oil-stock returns comovement through the demand-supply mechanism of oil price determination. In broad terms, this finding is in line with Kilian (2008a, b, c; 2009) and the approach that the origin of an oil shock determines its propagation dynamics within the economic and financial spheres.

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REFERENCES

Abadie, A., Gardeazabal, J., 2008. Terrorism and the world economy, *European Economic Review* 52, 1-27.

Alpanta, S., Peralta-Alva, A., 2010. Oil crisis, energy-saving technological change and the stock market crash, *Review of Economic Dynamics* 13, 824-842

Amihud, Y., Wohl A., 2004. Political news and stock prices: the case of Saddam Hussein contracts, *Journal of Banking and Finance* 28, 1185-1200.

Apergis, N., Miller, S.M., 2009. Do structural oil-market shocks affect stock prices? *Energy Economics* 31, 569–575.

Arin, P., Ciferri, D., Spagnolo, N., 2008. The price of terror: the effects of terrorism on stock market returns and volatility, *Economics Letters* 101, 164-167

Arouri, M. E.H., Nguyen, D.K., 2010. Oil prices, stock markets and portfolio investment: Evidence from sector analysis in Europe over the last decade. *Energy Policy* 38, 4528-4539

Asteriou, D., Siriopoulos, C., 2003. The role of political instability in stock market development and economic growth: the case of Greece, *Economic Notes* 29, 355 – 374.

Bialkowski, J., Gottschalk, K., Wisniewski, T., 2008. Stock market volatility around national elections. *Journal of Banking and Finance* 32, 1941-1953

Blomberg, B., Hess, G., Jackson, H., 2009. Terrorism and the Returns to Oil, *Economics and Politics* 21, 409-432.

Brounrn, D., Derwall, J., 2010. The impact of terrorist attacks on international stock markets, *European Financial Management*, 16, 585-598

Chen, A., Siems, T., 2004. The effects on terrorism on global capital markets. *European Journal of Political Economy* 20, 435-446.

Chen, N.F., Roll, R., Ross, S.A., 1986. Economic forces and the stock market. *Journal of Business* 59, 383–403.

Chesney, M., Reshetar, G., Karaman, M., 2011. The impact of terrorism on financial markets: an empirical study, *Journal of Banking and Finance*, 35, 253-267

Choudhry, T., 2010. World War II events and the Dow Jones industrial index. *Journal of Banking and Finance* 34, 1022-1031

Ciner, C., 2001. Energy shocks and financial markets: nonlinear linkages. *Studies in Nonlinear Dynamics and Econometrics* 5, 203–212.

Crain, N. Crain, W. M., 2006. Terrorised economies. *Public Choice*, 128, 317-349

Drakos, K., 2010. Terrorism activity, investor sentiment and stock returns, *Review of Financial Economics*, 19, 128-135

Eckstein, Z., Tsiddon, D., 2004. Macroeconomic consequences of terror: theory and the case of Israel. *Journal of Monetary Economics* 51, 971-1002.

Eldor, R., Melnick, R., 2004. Financial markets and terrorism. *European Journal of Political Economy*, 20, 367-386.

Enders, W. Sandler, T., 2011. *The Political Economy of Terrorism*, 2nd edition, Cambridge: Cambridge University Press,

Enders, W., Sachsida, A., Sandler, T., 2006. The impact of Transnational Terrorism on U.S. Foreign direct investment, *Political Research Quarterly*, 59, 517-531.

Filis, G., Degiannakis, S., Floros, C., 2011. Dynamic correlation between stock markets and oil prices: the case od oil-importing and oil-exporting countries. *International Review of Financial Analysis* 20, 152-164

Frey, B., Kucher, M., 2000. World War II as reflected on capital markets, *Economics Letters* 69, 187-191.

Frey, B., Kucher, M., 2001. Wars and markets: How bond values reflect the Second World War, *Economica* 68, 317-333.

Guidolin, M., La Ferrara, E., 2010. The economic effects of violent conflict: evidence from asset market reactions, *Journal of Peace Research*, 47, 671-684

Hess, P., Lee, B-S., 1999. Stock returns and inflation with supply and demand disturbances, *Review of Financial Studies*, 12, 1203-1218.

Hristu-Varsakelis, D., Kyrtsou, C., 2008. Evidence for nonlinear asymmetric causality in US inflation, metal and stock returns, Discrete Dynamics in Nature and Society, Article ID 138547, 7 pages, doi:10.1155/2008/138547.

Huang, R.D., Masulis, R.W., Stoll, H.R., 1996. Energy shocks and financial markets. *Journal of Futures Markets*, 16, 1–27.

Jammazi, R., Aloui, C., 2010. Wavelet decomposition and regime shifts: Assessing the effects of crude oil. *Energy Policy*, 38, 1415-1435.

Jones, C.M., Kaul, G., 1996. Oil and the stock market. *Journal of Finance* 51, 463–491.

Jong-A-Pin, R., 2009. On the measurement of political instability and its impact on economic growth. *European Journal of Political Economy* 25, 15-29.

Karagianni S., Kyrtsou, C., 2011. Analysing the dynamics between US inflation and Dow Jones index using non-linear methods, *Studies in Nonlinear Dynamics and Econometrics* 15, article 4.

Karagianni S., Kyrtsou, C., Saraidaris, A., 2010. Effects of Tax policy announcements in Athens Stock Exchange, Proceedings of International Conference on Economic Modeling, (EcoMod 2010), Istanbul, 7-10 July.

Kilian, L. A., 2008a. Exogenous Oil Supply Shocks: How Big Are They and How Much Do They Matter for the US Economy? *Review of Economics and Statistics* 90 , 216–40.

Kilian, L. A., 2008b. Comparison of the Effects of Exogenous Oil Supply Shocks on Output and Inflation in the G7 Countries, *Journal of the European Economic Association* 6, 78–121.

Kilian, L. A., 2008c. The Economic Effects of Energy Price Shocks, *Journal of Economic Literature* 46, 871–909.

Kilian, L. A., 2009. Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market, *American Economic Review* 19, 1053–69.

Kollias, C., Papadamou, S., Stagiannis, A., 2011. Terrorism and capital markets: the effects of the Madrid and London bomb attacks, *International Review of Economics and Finance* 20, 532-541

Kollias, C., Papadamou, S., Stagiannis, A., 2010. Armed Conflicts and Capital Markets: the Case of the Israeli Military Offensive in the Gaza Strip, *Defence and Peace Economics* 21, 357-365

Levy, O., Gallili, I., 2006. Terror and trade of individual investors. *The Journal of Socio-Economics* 35, 980-991.

Malik, F., 2003. Sudden changes in variance and volatility persistence in foreign exchange markets, *Journal of Multinational Financial Management*, 13, 217-230.

Miller, J. I., Ratti, R., 2009. Crude oil and stock markets: Stability, instability, and bubbles. *Energy Economics*, 31, 559-568.

Mohanty S., Nandha, M., Bota, G., 2010. Oil shocks and stock returns: The case of the Central and Eastern European (CEE) oil and gas sectors. *Emerging Markets Review*, 11, 358-372.

Mohanty S., Nandha, M., Turkistani, A., Alaitani, M., 2011. Oil price movements and stock market returns: Evidence from Gulf Cooperation Council (GCC) countries. *Global Finance Journal* 22, 42-55

Nandha, M., Faff, R., 2008. Does oil move equity prices? A global view. *Energy Economics* 30, 986–997.

Nelson, D., 1991. Conditional heteroscedasticity in asset pricing: a new approach. *Econometrica* 59, 347-370.

Nikkinen, J., Vahamaa, S., 2010. Terrorism and stock market sentiment. *The Financial Review*, 45, 263-275

O'Neill, T.J., Penm, J., Terrell, R.D., 2008. The role of higher oil prices: a case of major developed countries. *Research in Finance* 24, 287–299.

Papapetrou, E., 2001. Oil price shocks, stock market, economic activity and employment in Greece. *Energy Economics* 23, 511–532.

Park, J., Ratti, R.A., 2008. Oil price shocks and stock markets in the U.S. and 13 European countries. *Energy Economics* 30, 2587–2608.

Sadorsky, P., 1999. Oil price shocks and stock market activity, *Energy Economics*, 21, 449-469.

Schneider, G., Troeger, V., 2006. War and the world economy, Stock market reactions to international conflicts, *Journal of Conflict Resolution* 50, 623-645.

Zhu, H-M., Li, S-F., Yu, K., 2001. Crude oil shocks and stock markets: a panel threshold cointegration approach, *Energy Economics*, doi:10.1016/j.eneco.2011.07.002