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Do OPEC announcements influence oil prices?

Amine Loutia [a], Constantin Mellios [b,*], Kostas Andriosopoulos [c]

[a] Université Paris 1 Panthéon-Sorbonne, PRISM-Sorbonne and LabEx "Financial Regulation", 17, place de la Sorbonne, 75231 Paris, Cedex 05, France
[b] Université Paris 1 Panthéon-Sorbonne, PRISM-Sorbonne and LabEx "Financial Regulation", 17, place de la Sorbonne, 75231 Paris, Cedex 05, France
[c] ESCP Europe Business School, Research Centre for Energy Management, London, 527 Finchley Road, London NW3 7BG, United Kingdom

HIGHLIGHTS

- The impact of OPEC's production decisions on both BRENT and WTI is examined.
- We adopt the event study methodology.
- An EGARCH model is used to capture some features characterizing oil prices volatility.
- OPEC decisions effect changes over time and depends on production decisions and oil prices.
- OPEC is less influential when prices are high and unconventional resources are viable.

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ABSTRACT

This paper investigates the effect of OPEC production decisions (increase, cut, maintain) on both WTI and Brent crude oil prices between Q1 1991 and Q1 2015 by employing the event study methodology and by using two indices as benchmarks (BCI and S&P GSCI). We employ an EGARCH model to take into account the high volatility of oil prices and some stylized facts characterizing this volatility. We find that the impact of OPEC's announcements on oil prices (i)evolves over time and among decisions, (ii) is more significant for production cut and maintain, (iii) is different for WTI and Brent prices, and (iv) is sensitive to the benchmark index. Moreover, OPEC's decisions depend on the exploration and extraction cost of more expensive/unconventional oil resources.

1. Introduction

The 1973 oil crisis and the major economic and geopolitical events (see, for instance, Salameh (2014)) since then shed light on the economic vital importance (see Bollino (2007)) of oil prices and their high level of volatility, as well as the role played by the Organization of Petroleum Exporting Countries (OPEC) in oil markets. Indeed, its members produce 40% of the world's crude oil and their exports represent about 60% of the traded oil internationally (see Matsumoto et al. (2012)). The impact of OPEC decisions about the production level (increase, cut or maintain) on oil prices is a controversial issue among policy makers, regulators, and academics in particular. For some, this impact is weak or has been declining over time, especially lately as more and more non-OPEC producing countries increase their market share. For others, the impact is strong as prices deviate from their competitive level when members modify their oil production. Finally, there are some who support the viewpoint that OPEC's impact changes over time as a result of prevailing market conditions.

The role of OPEC may also be scrutinized through the lens of the recent evolution of oil prices and the exploration of new oil resources. Indeed, we have seen oil prices not only breaking the $40 bbl long-run level but staying for a long time at $80 bbl, which is the level that makes the exploration and extraction of more expensive/unconventional oil resources economically viable (for

* Corresponding author.
E-mail addresses: aloutia@gmail.com (A. Loutia), constantin.mellios@univ-paris1.fr (C. Mellios), kandriosopoulos@escpeurope.eu (K. Andriosopoulos).

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instance, US shale oil, Canada's tar sands, Brazil's deep-sea offshore oil, Venezuela's heavy oil, and Arctic offshore oil, among others). Moreover, it is estimated that these resources represent about 50% of the global oil and gas proven reserves, thus increasing the importance of other non-OPEC producing countries still more on the global energy scene and reducing the influence on global oil prices of OPEC announcements. In this paper, we investigate the informational role of OPEC and its (potential) contribution to oil price formation. Our aim is to examine, by using the event study methodology (see, for instance, MacKinlay (1997)), how OPEC announcements can affect oil prices, which are characterized by a time-varying volatility.

The consequences of OPEC power on oil prices have been analyzed, through the market structure, in the literature (Bina and Vo, 2007; Fattouh and Mahadeva, 2013). Models often consider OPEC as a cartel, whose members can collude, manipulating prices through production quotas, resulting in monopolistic profits (see, among others, Ezzati (1976), Pindyck (1978), Adelman (1980,1982), Salant (1982), Aperjis (1982), Griffin (1985) and Smith (2005)). An alternative view is based on market competition, suggesting that the oil market is competitive and therefore OPEC has little influence on oil prices by operating as a cartel (Crémer and Salehi-Isfahani, 1980, 1989; MacAvoy, 1982; Teece, 1982). Empirical evidence for these two explanations of OPEC behavior has yielded conflicting results (see, for instance, Loderer (1985), Griffin (1985), Gulen (1996), Alhajji and Huettner (2000), Kaufmann et al. (2004) and Smith (2005)). Geroski et al. (1987), Griffin and Neilson (1994), Brémond et al. (2012) and Fattouh and Mahadeva (2013) argue that OPEC's behavior varies over time depending on economic, market, and geopolitical conditions and cannot be represented by a single model. The 2000s, characterized by the financialization of commodity markets, brought the role of information in price formation to the fore. Thus, instead of directly modeling OPEC's behavior, another strand in the literature empirically studies the effect of OPEC's announcements of production changes on oil prices.

Few papers deal with the OPEC announcements and even fewer employ the event study methodology[1]. The first attempt to examine this topic was made by Draper (1984), who, by means of an event study on heating oil futures prices returns between fall 1978 (when NYMEX first introduced these futures contracts) and 1980, concluded that investors anticipated OPEC's announcements. However, the period is very short and the contract under scrutiny does not represent the OPEC basket of crude oil contracts. Deaves and Krinsky (1992) analyzed crude oil as well as heating oil futures returns over a longer period, distinguishing favorable and unfavorable news for investors who take long positions. They found that traders earn economically and statistically significant abnormal returns after an OPEC conference conveying "good news." They conclude that their results do not support the market efficiency hypothesis.

More recent studies have been conducted by several authors. Guidi et al. (2006) separated the whole period, 1986–2004, into conflict and non-conflict sub-periods. However, not only are the sub-periods short but also the authors are mainly interested in the impact of OPEC conferences on stock markets. Although their results seem to validate market efficiency, they detected an asymmetric reaction to OPEC's decision during periods of conflict between United States and United Kingdom stock markets. Hyndman (2008) studied how crude oil spot and two-month futures prices, as well as prices of oil-related company stocks, reacted to OPEC's announcements during 1986–2002. His results indicate that abnormal returns are statistically significant. However, he did not specify the model that allowed him to calculate abnormal returns. Lin and Tamvakis (2010) enriched the analysis over a long period, 1982–2008, by examining the impact of OPEC's announcements on OPEC and non-OPEC crude oil, and for different oil qualities. Their empirical evidence suggests that the effect of OPEC's decision depends on the production quotas (increase, cut, or status quo) and on the price trend. In contrast, they did not find a significant difference between OPEC and non-OPEC crudes or between oil qualities. The computation of abnormal returns is not based on any model, but rather on the average daily return of the estimation period. By examining both OPEC's and US Strategic Petroleum Reserve (SPR) announcements over the period 1983–2008 on spot and futures prices, Demirer and Kutan (2010) found positive significant cumulative abnormal return (CAR) differences for OPEC production decreases during the post-event period, whereas SPR announcements did not affect these differences. Although the authors used three different models to assess abnormal returns (the market model, the autoregressive conditional heteroscedasticity (ARCH) model, and the three-factor Fama–French model), they did not indicate how the Fama–French model might be applied to spot and future oil prices. Moreover, by performing a statistical test on the difference between the CARs of the last and the first day of the post-announcement period, the authors examined a form of a static persistence. Finally, instead of studying OPEC's announcements, (Brunetti et al., 2010) analyzed the effect of OPEC members' "fair price" statements on nearby futures crude oil prices from 2000 to 2009. They found that these statements have a limited influence on crude oil prices.

The dramatic fluctuations in oil prices have led some authors to investigate the relation between OPEC's announcements and the volatility of oil prices. Taking the period from 1989 through 2001 and employing an event study period, (Horan et al., 2004) explored how and whether the implied volatility of crude oil option prices react to OPEC's announcements. Their results suggest that implied volatility increases before announcements and decreases the first day following OPEC's meetings. Other authors have opted for a study of realized volatility of oil price returns. Using intraday returns of crude oil and natural gas futures contracts over a five year period (1995–1999), Wang et al. (2008) found strong evidence of a positive impact of a production increase announcement on weekly volatility, but no evidence of impact on daily volatility. Bina and Vo (2007) tried to detect the effect of OPEC production decisions on spot and futures oil prices as well as in the OPEC production quota changes following oil price fluctuations (1983–2005). They argued that OPEC decisions cannot reduce oil price volatility and that production adjusts to spot and futures oil price fluctuations in an expected manner. Schmidbauer and Rösch (2012), for the period 1986–2009 and for daily data, concluded that the impact of OPEC's decisions on volatility is anticipated by investors, as there is a positive effect before the announcements and an asymmetric effect on expected returns after the announcements.

The purpose of this paper is to investigate the influence on oil prices of OPEC's announcements in a framework of event studies. Our dataset covers the period from March 1991 to February 2015, including, unlike existing papers, the sharp fluctuations in oil prices of 2008 (a sharp increase followed by an important decrease before another pronounced increase), characterized by a high level of volatility. We divide the period into two sub-periods (1991–2004 and 2005–2015): during the first sub-period, prices uniformly increased, while the second sub-period was much more turbulent and prices were much higher. This allows us both to examine if oil prices reacted distinctly to OPEC's announcements during these two periods and to assess the robustness of our results. We consider daily returns of West Texas Intermediate (WTI) and Brent returns and OPEC's announcements of drop, status quo,

[1] See also Kaufmann et al. (2004), Wirl and Kujundzic (2004) and Mensi et al. (2014), who use other econometric methods to examine the same topic.

or increase oil production. To compute abnormal returns, we use the market model,with the residuals modeled by an Exponential GARCH (EGARCH) process, developed by Nelson (1990), in order to capture the random volatility of oil prices. To the best of our knowledge, in the event studies setting applied to OPEC's announcements, Bina and Vo (2007) have been the only ones to date to use GARCH residuals. However, two stylized facts characterize the volatility behavior of asset prices and oil prices in particular: first, the existence of an asymmetric response of volatility to positive and negative past returns and, second, the persistence of shocks for the estimates of volatility (see Narayan and Narayan (2007), Ewing and Malik (2010) and Wei et al. (2010)). The EGARCH model is able to represent these observed properties. For the empirical tests, as a proxy for the market portfolio, we use two different popular commodity indices, the Goldman Sachs-Standard and Poors Commodity Index (S&P GSCI) and the Bloomberg Commodity Index (BCI),as well as their energy counterparts. Thus we are able to assess the sensitivity of our results to different indices and to complement the existing literature.

Empirical evidence shows that the second sub-period is at variance with the first sub-period, depending on the OPEC decision. OPEC behavior seems to change during distinct periods, and its role is perceived differently by market participants. With regard to the nature of OPEC's decisions, our findings globally confirm those obtained by the aforementioned studies. In particular, the reaction of oil prices to these decisions is asymmetric, in the sense that the effect of production cut and maintain decisions is more significant. However, the impact of OPEC's announcement on oil prices differs when considering WTI prices or Brent prices. Similarly, the choice of the index may lead to contrasting results, reflecting the weight of oil in each index, as well as the specific weight of WTI or Brent in each index.

The remainder of the paper is organized as follows. The data and methodology are described in Section 2. Section 3 presents and discusses our empirical findings. Finally, Section 4 offers some concluding remarks and the policy implications of our findings.

2. Data and methodology

In this section, we first focus on describing the data used and briefly present the event study methodology applied.

2.1. Data description

The data consist of all daily spot prices obtained from Thomson Reuters Datastream and the Energy Information Administration (EIA) from March 1991 to February 2015 for WTI and Brent crude oil. Fig. 1 shows that WTI and Brent prices steadily but slowly increased from 1991 to 2004, radically changing in their pace of growth and attaining very high values in July 2008. Then prices sharply decreased, before increasing again in mid-2009. Moreover, these two periods are characterized by different levels of volatility. Consequently, we consider three different panel data: panel A for the whole period (6291 daily observations), panel B from March 1991 to December 2004 (3652 daily observations), and panel C from January 2005 to February 2015 (2639 daily observations).

In regards to the two benchmark indexes used, at first, the BCI is a broadly diversified index and is currently composed of 22 commodities traded on US exchanges, with the exception of aluminum, nickel, and zinc, which trade on the London Metal Exchange (LME).On the other hand, S&P GSCI is a world production index that is well diversified, both across commodity sub-sectors and within each sub-sector. Currently, it contains 24 commodities from all sectors. The energy counterparts of these two indexes contain oil and its derivatives and gas, namely WTI crude oil, Brent crude oil, heating oil, gasoil, RBOB gasoline and natural gas.

Table 1 displays some descriptive statistics for our sample oil prices. The mean of spot prices is around $45, while the volatility is around 30% to 35%. The skewness is positive, while kurtosis is close to 3. Finally, the Jarque–Bera test indicates, as expected, that neither oil price is normally distributed.

OPEC decisions on oil production are made during OPEC conferences, which take place at least twice a year. In addition to these regular meetings, if market conditions require, extraordinary meetings can be held during the year. The decisions may take the form of quota reductions, increases, or maintenance of the status quo. A formal announcement is made at the end of each conference with the cartel's decision. In our methodology, these

Table 1
Descriptive statistics for WTI and BRENT.

	WTI	BRENT
Mean	44.030	44.700
Median	27.660	26.200
Maximum	145.310	144.070
Minimum	10.820	9.220
Std. Dev.	31.220	34.844
Skewness	0.910	0.989
Kurtosis	2.450	2.523
Jarque–Bera	1090.785***	1247.880****
Observations	7237	7237

Note:
*Indicates the *t*-statistic is significant at 10% level.
**Indicates the *t*-statistic is significant at 5% level.
*** Indicates the *t*-statistic is significant at 1% level.

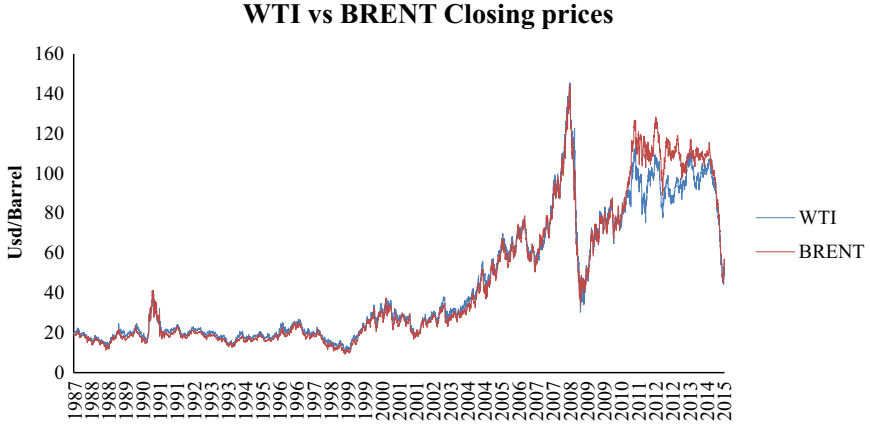

Fig.1. WTI and Brent closing prices from 1987 to 2015. (Sources: Datastream and EIA).

Table 2.1
CARs around OPEC Increase quotas (whole period).

Event day	WTI				BRENT			
	SPG	SPGE	BCI	BCIE	SPG	SPGE	BCI	BCIE
−5	−0.913	−0.992	−0.949	−0.407	0.956	1.110	0.484	1.009
−4	−1.37	−1.334	−1.420	−0.930	−0.878	−0.601	−0.870	−0.504
−3	−0.365	0.040	−0.888	−0.214	0.911	1.448	0.556	1.220
−2	−0.719	−0.927	−0.231	−0.652	−0.733	−0.453	0.2676	−0.207
−1	1.041	0.420	−0.111	0.004	0.840	0.791	0.497	0.435
0	1.604	−0.366	0.776	−0.031	0.932	0.343	0.912	0.354
1	0.631	−1.772*	−0.404	−1.678	−0.938	−1.710	−0.768	−1.881*
2	2.102*	−0.537	0.999	−0.078	0.395	−0.467	0.584	−0.514
3	−0.225	−2.637**	−1.299	−3.444***	−0.197	−1.136	−0.282	−1.594
4	−0.406	−1.621	−0.367	−2.872**	0.732	0.286	0.945	−0.397
5	−1.959*	−3.852***	−0.765	−3.730***	−1.366	−2.261**	−0.254	−2.160**

Note:
The following acronyms are used. WTI: West Texas Intermediate, SPG: Standard and Poors Commodity Index, BCI: Bloomberg Commodity Index, SPGE and BCIE are their energy counterparts.

* Indicates the *t*-statistic is significant at 10% level.
** Indicates the *t*-statistic is significant at 5% level.
*** Indicates the *t*-statistic is significant at 1% level.

Table 2.2
CARs around OPEC Increase quotas (1991 Q1–2004 Q3).

Event day	WTI				BRENT			
	SPG	SPGE	BCI	BCIE	SPG	SPGE	BCI	BCIE
−5	−0.719	−0.913	−0.741	−0.204	0.474	0.513	0.222	0.690
−4	−1.271	−1.165	−1.495	−0.673	−0.543	−0.305	−0.806	−0.276
−3	−0.292	0.283	−1.237	0.281	1.055	1.586	0.191	1.36
−2	−0.995	−0.360	−1.039	0.009	0.814	1.349	0.647	1.264
−1	1.459	1.020	0.092	1.227	1.864*	1.481	0.956	1.337
0	1.847*	0.166	0.707	0.881	1.344	0.306	0.870	0.527
1	0.936	−1.216	−0.698	−0.525	−0.555	−1.694	−1.130	−1.760
2	2.464**	−0.331	0.976	0.800	0.604	−0.994	0.181	−0.930
3	0.028	−2.532**	−0.927	−2.241**	0.827	−0.873	0.147	−1.198
4	−1.527	−1.960*	−0.117	−1.732	0.874	0.142*	1.547	−0.166
5	−1.024	−1.720	0.751	−0.589	0.640	−0.364	1.789*	−0.095

Note:
The following acronyms are used. WTI: West Texas Intermediate, SPG: Standard and Poors Commodity Index, BCI: Bloomberg Commodity Index, SPGE and BCIE are their energy counterparts.
*Indicates the *t*-statistic is significant at 10% level.
**Indicates the *t*-statistic is significant at 5% level.
***Indicates the *t*-statistic is significant at 1% level.

Table 2.3
CARs around OPEC Increase quotas (2005 Q1–2015 Q1).

Event day	WTI				BRENT			
	SPG	SPGE	BCI	BCIE	SPG	SPGE	BCI	BCIE
−5	0.080	−0.095	0.304	−0.05	−0.13	−0.169	0.056	−0.091
−4	0.180	−0.180	0.261	−0.338	−0.400	−0.481	−0.207	−0.472
−3	0.792	−0.063	0.879	−0.603	−0.012	−0.271	0.314	−0.375
−2	0.562	−0.374	0.872	−0.600	−0.553	−0.78	−0.104	−0.729
−1	0.451	−0.804	0.432	−1.239	−0.948	−1.217	−0.655	−1.340
0	0.462	−0.69	0.530	−1.008	−1.447	−1.647	−1.030	−1.628
1	0.134	−1.425	0.258	−1.616	−1.24	−1.495	−0.837	−1.564
2	−0.146	−1.310	−0.316	−1.366	−1.328	−1.425	−1.050	−1.382
3	−0.926	−2.097	−2.197	−2.913*	−2.044	−2.049	−2.397*	−2.542*
4	−0.183	−1.703	−2.349	−3.532**	−2.947*	−3.070*	−3.565**	−3.906**
5	0.127	−1.498	−1.341	−3.145*	−4.373**	−4.464**	−4.422**	−4.881**

Note:
The following acronyms are used. WTI: West Texas Intermediate, SPG: Standard and Poors Commodity Index, BCI: Bloomberg Commodity Index, SPGE and BCIE are their energy counterparts.
*Indicates the *t*-statistic is significant at 10% level.
**Indicates the *t*-statistic is significant at 5% level.
***Indicates the *t*-statistic is significant at 1% level.

announcements are considered as the event day. During the whole sample period, as shown in Table 2.1, Table 2.2, Table 2.3, there were 83 announcements; of which 47 refer to a production status quo, 19 to a production cut, and 17 to a production increase.

2.2. The methodology

To investigate the effects of OPEC announcements on crude oil prices, we use an event study methodology. It has widely been applied to many fields in financial economics but less frequently to oil prices and OPEC decisions. Event studies examine the behavior of abnormal returns of a security around a relevant event. In our case, events are announcements made by OPEC about its oil production output. The incorporation of the information, following an event, in asset prices may be immediate or may spread out over time. The choice of the event window is not based on formal rules and can differ among different studies. We opt for an event window of five days before and after the announcement (see also Horan et al. (2004), Bina and Vo (2007)).This choice is based on several concerns: to capture information leakages before the OPEC announcement, to take into account the reaction of oil prices after the announcement, to prevent overlapping among OPEC meetings (in the case of extraordinary meetings), and to avoid contamination from other events.

The assessment of the event's impact on asset prices can be measured by the abnormal return (AR_t), which is defined as follows:

$$AR_t = R_t - E(R_t)$$

where R_t is the daily log return on crude oil at date t and $E(R_t)$ is the normal return, which is the expected log return at date t over a period other than the event window. This expectation is not conditional on the information related to the event.

Abnormal returns are used to compute cumulative abnormal returns (CARs) as the sum of the daily abnormal returns over the event window:

$$CAR_t = \sum_{t=-5}^{+5} AR_t$$

The normal returns can be estimated (see also MacKinlay, 1997) by the market model or factor models (Draper, 1984; Demirer and Kutan, 2010), by autoregressive models (Bina and Vo, 2007), or by the constant mean return model (Guidi et al., 2006; Lin and Tamvakis, 2010).[2] The strong assumption of homoscedasticity in oil price time-series is relaxed in some papers in which the variance of residuals follows an ARCH process (Deaves and Krinsky, 1992; Demirer and Kutan, 2010) or a GARCH process (Bina and Vo, 2007). Indeed, high price volatility is a feature of oil markets, and there is strong evidence supporting heteroscedasticity in oil prices (see, among others, Morana (2001), Narayan and Narayan (2007) and Mohammadi and Su (2010)). In this paper, the normal returns are measured by two equations: the market model with homoscedastic residuals (Eq. (1)) and the market model with EGARCH residuals to capture asymmetric variance effects (Eq. (2)).

$$R_t = \alpha + \beta R_{mt} + \varepsilon_t \tag{1}$$

$$E(\varepsilon_t) = 0 \text{ and } Var(\varepsilon_t) = h_t^2 \tag{2}$$

$$\log(h_t) = \omega + \sum_{i=1}^{p} a_i \log(h_{t-i}) + \sum_{j=1}^{q} b_j \left(\frac{\varepsilon_{t-j}}{\sqrt{h_{t-j}}} - \sqrt{\frac{2}{\pi}} \right) + \gamma_j \frac{\varepsilon_{t-j}}{\sqrt{h_{t-j}}} \tag{3}$$

where R_t and R_{mt} are the returns at date $t$on crude oil and the market portfolio, respectively, and ε_t is the disturbance term. α and β are the parameters of the market model, and are constants. h_t is the volatility term, ω is the constant, where a_i and b_i are the weights of the lagged log volatilities and the corrective terms of the models, respectively.

The EGARCH model has some advantages compared to the GARCH model and incorporates some features in oil price volatility. First, unlike the GARCH model, it does not require the imposition of nonnegative constraints on the parameters α, β, and γ, since the variance is automatically constrained to be positive, as the conditional variance is specified in the logarithmic form. Second, it accounts for an asymmetric reaction of volatility to a shock observed in many financial series, which is captured by the parameter γ. A positive parameter implies that a positive shock results in a higher future conditional volatility than a negative shock of the same magnitude and vice versa[3]. Third, the EGARCH model is stationary if $|a| < 1$. The persistence of a shock can be assessed through the estimate of the latter parameter (see Narayan and Narayan (2007)).For the market portfolio, as a market-wide index, we use two different commodity indices, BCI and S&PGSCI, and their energy counterparts, all widely accepted by investors. Using these two indices allows us to test the dependence of the results on the choice of the index.

Once the abnormal returns have been obtained, we perform significance tests on the effect of OPEC's three decisions on oil prices. The null hypothesis indicates that these decisions have no impact on oil prices. In other words, we test whether AR_t and CAR_t are significantly different from zero for each day within the event window. We make use of the cross-sectional parametric test suggested by Corrado (2011), Bina and Vo (2007), and Savickas (2003), which addresses both the conditionally heteroscedastic behavior of volatility and the event-induced variance changes. The t-statistic is formulated as follows:

$$Test = \frac{SCAR_{it}}{\sigma_{SE}}$$

where $SCAR_{it} = \sum_{-5}^{+5} \frac{AR_{it}}{\sqrt{\hat{h}_{it}}}$

After the choice of the normal model, the final step is to determine the estimation period. Although there is no procedure for the definition of this period, usually a pre-event window period is used to avoid the impact of the event on the estimation of the parameters of the normal model. In this paper, the estimation period is obtained by removing the event windows from the initial samples and aggregating the obtained series. This procedure allows us to capture more events.

3. Empirical results and discussion

In this section, we present the results for both WTI and Brent crude oil, for each index, for the three types of OPEC's decisions, as well as for the three sub-periods. Table 2.1, Table 2.2, Table 2.3 and Fig. 2 show CARs and their paths respectively for an increase in quotas announcements. According to other existing studies (Guidi et al., 2006; Bina and Vo, 2007; Lin and Tamvakis, 2010, Demirer and Kutan, 2010; Schmidbauer and Rösch, 2012; Mensi et al.,

[2] MacKinlay (1997) suggested that the market model should behave better, in terms of variance reduction of the abnormal return, than the constant mean return model.

[3] This effect has been observed in several commodity prices' volatility levels (see Bowden and Payne (2008)). When γ is negative, the effect is called the leverage effect, which characterizes many financial assets.

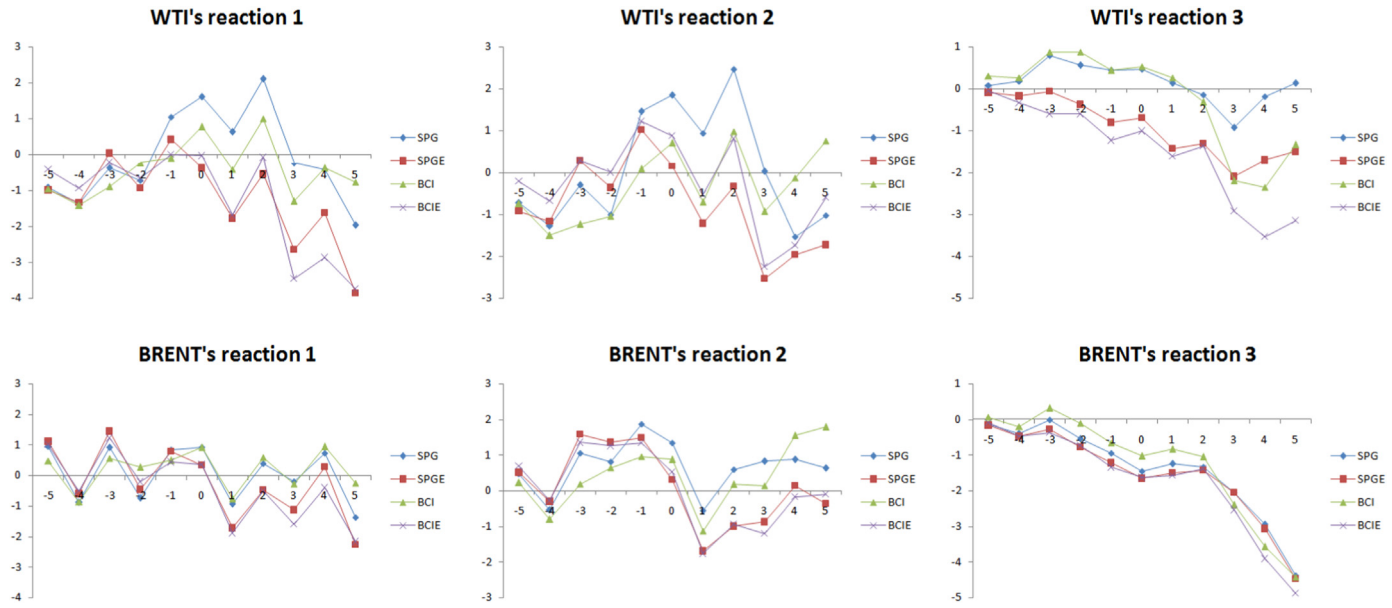

Fig.2. CAR paths for increase quota announcements for all periods.

2014), whatever the commodity index and the oil price chosen, the results are generally not statistically significant. These results can be explained by OPEC's so-called "cheating" behavior—showing no respect for the quotas allocated to OPEC's members—with the tendency to increase their production above the agreed quotas (Kaufmann et al., 2004; Lin and Tamvakis, 2010; Colgan et al., 2012). For example, Colgan et al. (2012) has reported a 10% excess in production over OPEC members' quota from 1982 to 2009. OPEC may thus anticipate "cheating" by its members and adapt quotas accordingly. More generally, OPEC may endorse unilateral decisions made previously by its members. Another argument is put forward by Hyndman (2008). He explains the low significance of results by the fact that it is easier for OPEC's members to agree on a quota increase, a behavior that can be readily anticipated by the market. Market participants do not react to an increase in production, as they seem to expect such decisions. However, the significance improves for the energy counterpart of the indices, as oil is a major constituent (except for WTI during the first sub-period, relative to BCI). For the vast majority, there is a significant impact on CARs after the announcement day. The market does not anticipate, and thus does not incorporate the information of an increase in production, but rather adjusts during the post-announcement period.

As expected, the CARs are negative in most cases. Indeed, an increase in oil production will drive prices down. Nevertheless, Fig. 2 reveals that CARs may be positive, although more often insignificant. This result is more pronounced during the first sub-period and for Brent oil prices. A possible explanation could be as follows. On the one hand, OPEC often acts as a marginal producer (see, for example, Kaufmann (2004)) in order to offset, at least partially, the difference between oil demand and non-OPEC supply, using its spare production capacity.[4] Between 1991 and 2004, we observe two phenomena. First, the consumption of crude oil constantly increased, as did the production by both OPEC and non-OPEC producers. Second, the level of OPEC's spare capacity dramatically plummeted between 1981 (around 14 million barrels (mb) per day) and 1990 (less than 2 mb per day), whereas it fluctuated during the first sub-period between about 2 mb per day and 8 mb per day. On the other hand, non-OPEC oil producers are generally considered as price takers, meaning that they do not adjust their production to influence oil prices. Consequently, non-OPEC producers operate at or near full capacity and so have little spare capacity. Taking all these considerations together, it can be argued that an increase in OPEC's production may be interpreted by market participants as a sign of tensions in the oil market, signaling a greater intervention of OPEC and thus resulting in higher future oil prices. The greater is the OPEC intervention, the greater is its impact on oil prices. However, OPEC's diminishing spare capacity limits its ability to manipulate oil prices.

When a reduction in oil production is announced, the results, consistently with other papers mentioned above, are more significant than in the previous case (see Table 3.1, Table 3.2, Table 3.3 and Fig. 3). In general, WTI prices react more than Brent prices to OPEC's cut announcements, whatever the index. Moreover, except for the second sub-period, the results seem more sensitive to S&P GSCI than to BCI. This can be explained by the weights of the WTI crude oil and Brent crude oil in these indices. Indeed, the weight of WTI crude oil is higher than that of Brent crude oil in the two indices, even if, in recent years (notably since 2011), the proportion of WTI decreases in favor of Brent, though the latter has not overtaken the former yet. For example, the weight of WTI (Brent) in the S&P GSCI in 2011 and 2013 was 32.6% (15.9%) and 24.7% (22.1%), respectively. For BCI, the corresponding figures were 14.7% (0%) in 2011 and 9.2% (5.8%) in 2013. Moreover, the cumulated weights of WTI crude oil and of Brent crude oil in the S&P GSCI are much more important than those in the BCI. Similar to an increase in production quotas decisions, in most cases, the cut decisions have a significant effect after the announcement day. However, for the whole period and especially for the first sub-period, WTI returns responded significantly to those decisions before the announcement day (up to three days). It follows that when WTI prices fluctuate in a relatively narrow band, the market anticipates OPEC's cut decisions. The significance is more pronounced for the first sub-period when prices are lower.

Following a cut in production, oil prices should increase and consequently CARs should be positive. This is indeed the case for the whole period and the first sub-period for both WTI and Brent crude oils. However, during the second sub-period, significant CARs are negative and high for the two crude oil prices (see also

[4] The US Energy Information Administration (EIA) defines spare production capacity as the additional volume of production that can be brought on within 30 days and sustained for at least 90 days.

Table 3.1
CARs around OPEC Cut quota (whole period).

Event day	WTI				BRENT			
	SPG	SPGE	BCI	BCIE	SPG	SPGE	BCI	BCIE
−5	1.065	2.198**	0.538	1.642	−0.672	−0.178	−0.646	−0.066
−4	−0.077	1.149	−1.084	0.100	−1.108	−0.475	−1.357	−0.537
−3	1.052	2.510**	−1.421	0.428	−0.992	−0.577	−1.832*	−0.800
−2	4.959***	6.188***	1.623	3.694***	−0.552	−0.309	−1.436	−0.726
−1	4.360***	5.506***	1.462	3.632***	−2.093*	−1.689	−2.393**	−1.761*
0	5.130***	6.790***	1.162	4.716***	−1.639	−0.816	−2.704**	−1.346
1	3.327***	6.808***	−1.636	3.725***	−0.668	1.326	−3.149***	0.008
2	5.000***	7.742***	0.750	4.771***	0.900	2.314**	−0.909	1.092
3	5.243***	6.935***	1.776*	4.519***	−0.352	0.591	−1.442	−0.614
4	8.942***	11.097***	3.482***	6.828***	2.513**	3.776***	0.3182	1.694
5	10.401***	11.149***	4.622***	7.844***	3.322***	3.581***	1.203	2.322**

Note:
The following acronyms are used. WTI: West Texas Intermediate, SPG: Standard and Poors Commodity Index, BCI: Bloomberg Commodity Index, SPGE and BCIE are their energy counterparts

* Indicates the *t*-statistic is significant at 10% level.
** Indicates the *t*-statistic is significant at 5% level.
*** Indicates the *t*-statistic is significant at 1% level.

Table 3.2
CARs around OPEC Cut quota (1991 Q1–2004 Q3).

Event day	WTI				BRENT			
	SPG	SPGE	BCI	BCIE	SPG	SPGE	BCI	BCIE
−5	1.169	2.340**	1.023	2.344**	−1.047	−0.293	−0.591	0.035
−4	0.294	1.283	−0.125	0.748	−0.896	−0.201	−0.637	−0.064
−3	1.435	2.828**	0.121	1.097	−1.241	−0.712	−1.287	−0.936
−2	6.265***	7.391***	4.226***	5.390***	−0.675	−0.570	−0.732	−0.972
−1	5.474***	6.876***	3.954***	5.430***	−1.810*	−1.403	−1.142	−1.549
0	6.089***	8.077***	2.818**	6.339***	−1.492	−0.678	−2.371**	−1.317
1	4.156***	6.716***	−0.203	4.553***	0.796	2.440**	−1.953*	0.793
2	5.079***	7.343***	1.969*	5.220***	1.646	2.837**	−0.189	1.132
3	5.862***	7.817***	3.142***	5.522***	0.613	1.279	−0.697	−0.585
4	8.206***	10.345***	4.090***	6.837***	3.658***	4.418***	0.893	1.479
5	8.988***	9.637***	5.189***	7.120***	4.616***	4.066***	2.102*	1.904*

Note:
The following acronyms are used. WTI: West Texas Intermediate, SPG: Standard and Poors Commodity Index, BCI: Bloomberg Commodity Index, SPGE and BCIE are their energy counterparts.

* Indicates the *t*-statistic is significant at 10% level.
** Indicates the *t*-statistic is significant at 5% level.
*** Indicates the *t*-statistic is significant at 1% level.

Table 3.3
CARs around OPEC Increase quota (2005 Q1–2015 Q1).

Event day	WTI				BRENT			
	SPG	SPGE	BCI	BCIE	SPG	SPGE	BCI	BCIE
−5	−0.024	0.142	−0.451	−0.735	−0.023	0.069	−0.289	−0.266
−4	−1.000	−1.028	−1.017	−1.480	−0.590	−0.387	−0.674	−0.568
−3	−0.805	−1.960	−2.091	−2.087	0.012	0.073	−0.651	−0.316
−2	−1.947	−3.050*	−2.525*	−3.120*	−0.164	0.012	−0.801	−0.601
−1	−2.249	−4.089**	−2.340	−3.917**	−1.611	−1.469	−1.985	−1.89
0	−2.627*	−4.562**	−2.718*	−4.405**	−1.292	−1.139	−1.760	−1.677
1	−1.475	−3.214**	−2.109	−3.452**	−2.317	−2.065	−2.711*	−2.409*
2	−0.743	−2.361*	−1.910	−2.961*	−1.336	−1.104	−1.850	−1.547
3	−1.067	−3.086*	−1.267	−3.170*	−1.636	−1.498	−1.701	−1.670
4	1.986	−0.075	0.104	−1.395	−0.414	−0.254	−0.854	−0.622
5	2.346	0.408	−0.086	−1.193	−1.170	−0.909	−1.761	−1.221

Note:
***Indicates the *t*-statistic is significant at 1% level respectively. The following acronyms are used. WTI: West Texas Intermediate, SPG: Standard and Poors Commodity Index, BCI: Bloomberg Commodity Index, SPGE and BCIE are their energy counterparts.

* Indicates the *t*-statistic is significant at 10% level.
** Indicates the *t*-statistic is significant at 5% level.

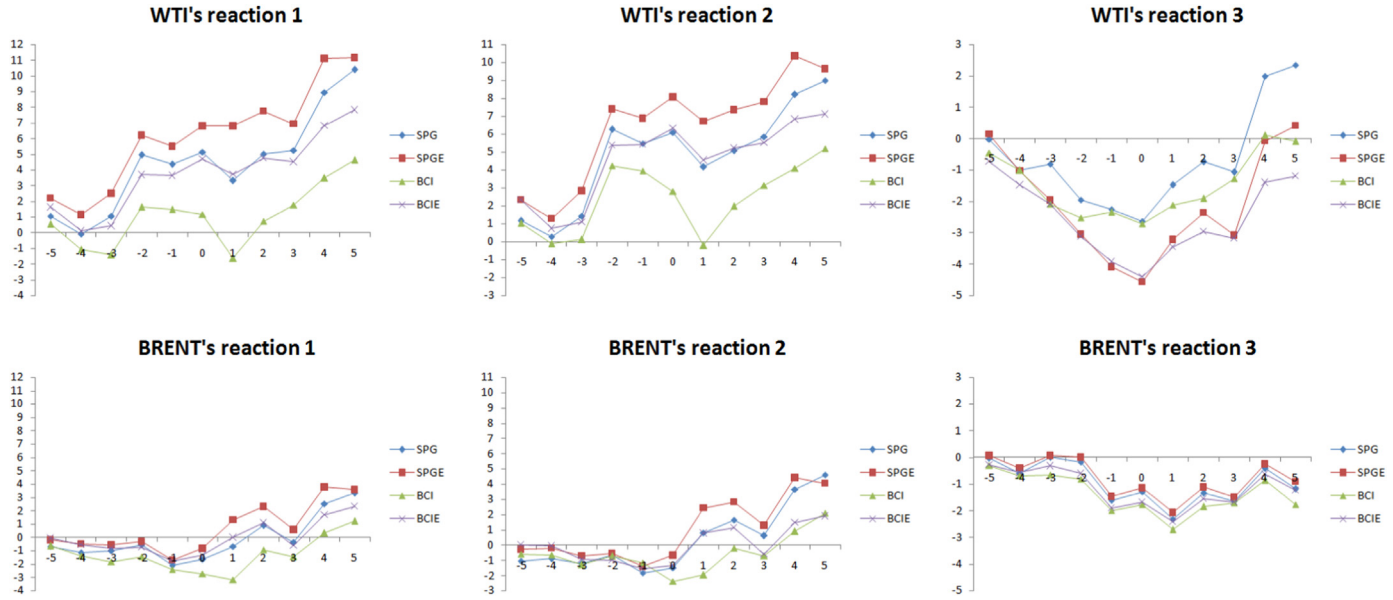

Fig.3. CAR paths for Cut quota announcements for all periods.

Guidi et al. (2006) and Lin and Tamvakis (2010)). Despite the OPEC cut announcement, oil prices have continued to decrease. OPEC's cut decisions occurred in 2006, when oil prices fell significantly, and before the sharp increases in 2007 and 2008 (when prices peaked in July 2008). This apparently counterintuitive result may reflect considerations of market participants with regard to world current and future supply and demand for oil and their skepticism concerning the cohesion of OPEC as a group, as well as the actual reduction in production. Indeed, from 2005 to 2008, economic growth and oil demand were strong, whereas the oil supply and the spare capacity were low, putting upward pressure on oil prices.

However, oil prices depend also on expectations of future supply and demand, which turn out to be very difficult to predict when market conditions are uncertain. For instance, a slight discrepancy between EIA's oil demand forecasts and anticipations for 2007 impacted oil prices more heavily than OPEC's announcement. In 2008, market participants attached more importance to the world economic recession and the resulting decrease in oil demand than to the insufficient OPEC production cut. Economic considerations may be amplified by OPEC members' behavior vis-à-vis quotas. OPEC is a group of countries with divergent political and economic interests. Its members may disagree on the decision and on the level of quota cuts, in particular during periods when prices are falling. In this case, it is difficult to achieve discipline on the part of OPEC members, who may not comply with the quotas assigned (as experienced in 2015 by the actions of a key member, Saudi Arabia).

Table 4.1, Table 4.2, Table 4.3 and Fig. 4 present the results when production quotas remain unchanged. The most significant results are obtained for this decision type. There are more significant CARs for WTI than for Brent (see also Mensi et al. (2014)) and relative to BCI. In almost all cases, the sign of the CARs is negative. Status quo decisions may have a significant impact on the pre-announcement period, on the event day, and on the post-announcement window. Such announcements are often perceived as non-decisions for different reasons, as already mentioned above. Market fundamentals, economic conditions, or geopolitical events could lead OPEC to reduce its production. Nevertheless, disagreements among OPEC members result in a status quo. The

Table 4.1
CARs around OPEC Maintain quota (whole period).

Event day	WTI				BRENT			
	SPG	SPGE	BCI	BCIE	SPG	SPGE	BCI	BCIE
−5	0.624	0.287	−0.01	1.358	0.896	1.097	0.410	1.193
−4	−0.336	−0.380	−1.273	0.852	−1.243	−0.825	−1.688*	−0.590
−3	−1.756*	−1.478	−4.369***	−0.013	−0.983	−0.169	−2.835***	−0.230
−2	−0.427	−0.775	−3.255***	0.179	−0.528	0.070	−2.035**	−0.281
−1	−0.500	−1.272	−2.501**	0.051	0.114	0.397	−0.802	0.214
0	−2.142**	−3.466***	−3.696***	−2.241**	−2.534**	−2.691***	−2.937***	−2.862***
1	−2.194**	−2.998***	−3.210***	−0.899	−0.665	−0.743	−1.052	−0.858
2	−2.141**	−3.123***	−3.424***	−1.361	−1.580	−1.929*	−1.851*	−2.247**
3	0.598	0.925	−1.381	2.620**	−0.750	−0.416	−1.211	−0.360
4	2.087**	2.041**	−0.599	3.291***	−1.089	−1.117	−1.315	−0.790
5	1.806*	1.512	−1.024	3.035***	−1.143	−1.221	−1.257	−0.825

Note:
The following acronyms are used. WTI: West Texas Intermediate, SPG: Standard and Poors Commodity Index, BCI: Bloomberg Commodity Index, SPGE and BCIE are their energy counterparts.

* Indicates the *t*-statistic is significant at 10% level.
** Indicates the *t*-statistic is significant at 5% level.
*** Indicates the *t*-statistic is significant at 1% level.

Table 4.2
CARs around OPEC Maintain quota (1991 Q1–2004 Q3).

Event day	WTI				BRENT			
	SPG	SPGE	BCI	BCIE	SPG	SPGE	BCI	BCIE
−5	1.881*	1.567	1.413	1.884*	1.355	1.169	0.979	1.07
−4	1.00	0.764	1.056	1.495	−0.195	−0.220	−0.130	−0.264
−3	−0.604	−0.839	−2.115**	0.038	−0.823	−0.511	−2.345**	−0.896
−2	−0.502	−0.611	−1.876*	−0.223	−0.393	−0.092	−1.872*	−0.932
−1	−0.977	−0.620	−1.907*	−0.338	−0.119	0.390	−1.147	−0.630
0	−2.956***	−3.021***	−3.752***	−2.719**	−1.749*	−1.791*	−2.743**	−3.190***
1	−2.186**	−2.086**	−2.692**	−1.482	−0.349	−0.327	−1.439	−1.894*
2	−0.982	−1.144	−1.444	−0.711	−0.750	−1.355	−1.544	−3.221***
3	2.038*	3.374***	0.898	3.967***	0.105	0.259	−1.254	−1.053
4	2.451**	3.360***	1.058	3.630***	0.033	−0.334	−1.409	−1.783*
5	1.637	2.448**	0.228	2.627**	−0.148	−0.617	−1.763*	−2.108**

Note:
The following acronyms are used. WTI: West Texas Intermediate, SPG: Standard and Poors Commodity Index, BCI: Bloomberg Commodity Index, SPGE and BCIE are their energy counterparts.

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*** Indicates the *t*-statistic is significant at 1% level.

market interprets such decisions as a signal that there is a sufficient level of supply. Thus oil prices fall and CARs are negative. Moreover, it recognizes a greater influence of these decisions and tries to anticipate them. A maintain of production also has an influence on returns with a post-announcement delay of several days, notably in the second sub-period and for WTI prices.

These results may be put in perspective by introducing non-conventional oil resources into the reasoning. The exploration of such resources is relatively costly and is economically efficient only under high oil price conditions. For instance, the US produced more than 3 mb a day in 2014 from shale formations. If prices remain high, non-OPEC countries can raise their production and challenge OPEC's role in oil price formation. However, OPEC members' exports and revenues depend heavily on oil prices. Thus, OPEC faces a dilemma: maintain production quotas at levels that would keep prices elevated or at levels that would contribute to lower prices, forcing out some of the high-cost producers. The potential increase in non-conventional oil resources and natural gas production, which can significantly affect global energy markets, may arise as a key factor in OPEC's decision-making.

4. Concluding remarks and policy implications

The aim of this paper is to contribute to the existing literature on the OPEC role as a major player in oil markets through the impact of its production quotas announcements on oil prices during the period March 1991-February 2015. We use the event study methodology and measure abnormal returns and volatility by the market model and the EGARCH model respectively. We opt for this last to capture some well-known stylized facts characterizing volatility, which differentiates our paper from a few other papers utilizing a GARCH model. To enrich the analysis and for robustness purposes, we examine the impact of OPEC decisions on both WTI and Brent daily returns and use two indices as proxies for the market portfolio (BCI and S&P GSCI).

We find that the announcements effect on oil prices varies across periods, production decisions, oil prices and benchmark indices. Our results suggest that OPEC is less influential during periods when oil prices are high the more so as above a certain level price, unconventional oil resources are economically viable. However, although the effect of OPEC decisions is more pronounced when prices are low, OPEC members may face a

Table 4.3
CARs around OPEC Maintain quota (2005 Q1–2015 Q1).

Event day	WTI				BRENT			
	SPG	SPGE	BCI	BCIE	SPG	SPGE	BCI	BCIE
−5	−1.167	−1.727*	−1.553	−0.407	0.112	0.430	−0.28	0.451
−4	−1.656	−2.200**	−2.904***	−0.855	−1.374	−0.827	−1.942*	−0.565
−3	−1.950*	−2.692**	−4.128***	−0.969	−0.385	0.3276	−1.587	0.436
−2	−0.116	−2.042*	−2.747**	−0.642	−0.101	0.298	−1.018	0.501
−1	0.156	−3.163***	−1.824*	−1.147	0.136	0.165	−0.326	0.667
0	−0.048	−4.578***	−1.422	−2.333**	−1.551	−1.746*	−1.389	−0.816
1	−1.064	−5.340***	−1.997*	−2.148**	−0.334	−0.463	0.030	0.789
2	−2.527**	−6.746***	−3.756***	−3.968***	−1.313	−1.210	−1.031	0.052
3	−1.513	−5.455***	−2.960***	−3.220***	−0.703	−0.496	−0.328	0.781
4	0.285	−4.013***	−1.903*	−2.055*	−0.859	−0.746	−0.226	1.052
5	0.621	−3.959***	−1.612	−1.577	−0.592	−0.510	0.201	1.466

Note:
The following acronyms are used. WTI: West Texas Intermediate, SPG: Standard and Poors Commodity Index, BCI: Bloomberg Commodity Index, SPGE and BCIE are their energy counterparts

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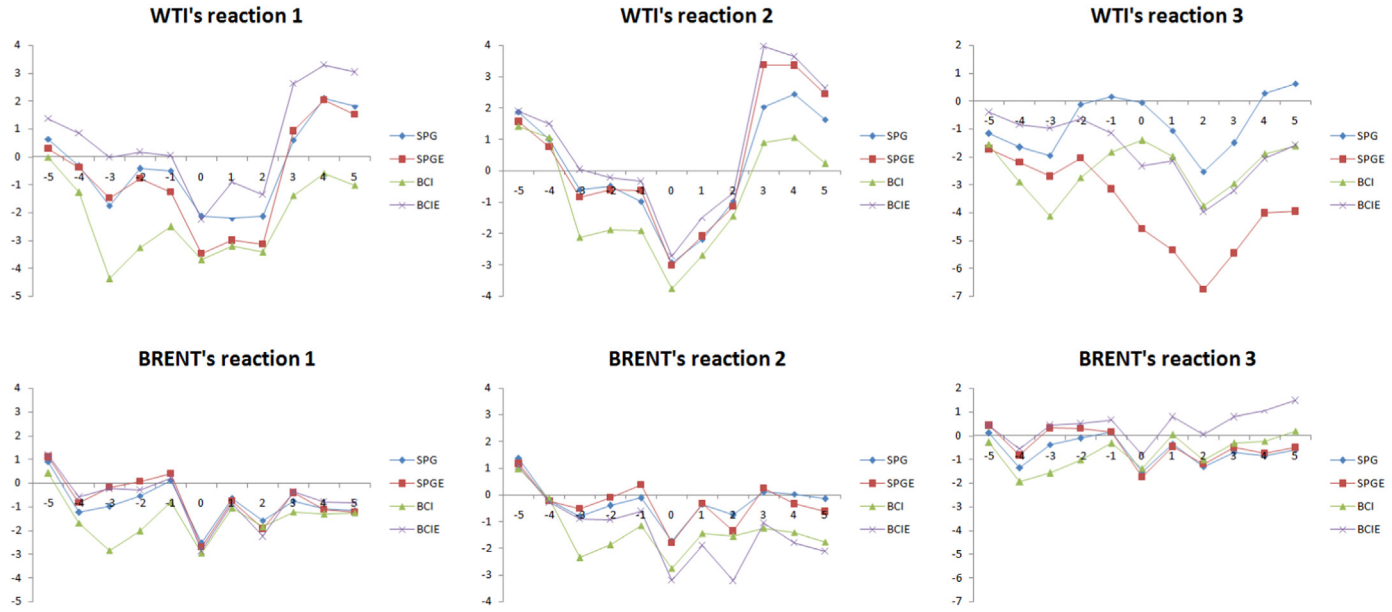

Fig.4. CAR paths for Maintain quota announcements for all periods.

dilemma: keeping prices at low levels could prevent high cost oil producers from entering the market, but, at the same time, could reduce OPEC members' revenues. Oil prices respond differently to quotas changes: a reduction or a status quo in production results in significant cumulative abnormal returns in contrast to an increase in production. These decisions reflect disagreements or a lack of discipline among OPEC's members and the necessity for OPEC to take into account previous unilateral quotas changes. More specifically, a cut decision has a stronger effect and is anticipated by the market when price fluctuations are lower. These reactions may also diverge in significance and magnitude for WTI and Brent crude oil. Similarly, the use of a different index (S&P GSCI or BCI) may alter the results as a consequence of the importance of oil prices in the composition of the index.

The role of unconventional oil is increasing in energy markets. The technological improvements allow for a greater unconventional oil production and unconventional reserves are now estimated to be higher than conventional reserves. It would be interesting to conduct in the future a similar study on the impact of OPEC production decisions, given the role of unconventional oil. Since unconventional oil may change the oil supply, one future research could focus on the factors affecting the supply of the two oil resources. Finally, as unconventional oil may be at the origin of important structural changes, another research could examine the fundamental detrminants of the oil price evolution over time.

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