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To what extent geopolitical tensions in major oil-producer countries and unexpected news related to the Organisation of the Petroleum Exporting Countries (OPEC) affect oil price? What are the effects of non-market externalities in oil price? Are oil price forecasters aware or affected by such externalities when making their predictions? In this article, I analyse the influence of these events on oil price by means of Granger causality, using an unique measure accounting for these events (2001-12). I found evidence favouring OPEC countries'-related news as an oil price driver, influencing short-term forecasts, and reducing the consensus when unanticipated news are available.
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1. A complex market

There is a wide range of research analysing the oil market beyond the boundaries of Economics. Perhaps, oil uniqueness for the energy matrix of industrialised economies and their *remotely* located producers, attracts the attention of as many fields with different viewpoints to analyse.

From an economic perspective, the understanding of any market relies hugely on the effect of agent's behaviour on the equilibrium dynamics. Some specific cases, such as the oil market, would include issues concerning industrial organisation, natural resources sustainability, externalities, and other complexities affecting its evolution. In particular, the oil market is characterised as a market with big global players–in the supply and demand side–whose behaviour more than often threaten the world's production chain and even political and financial stability. Moreover, big players from the supply side carry the unpleased label of a worldwide recognised cartel (see Griffin and Xiong, 1997; Gülen, 1997; Jones, 1990; and Kaufmann *et al.*, 2004 for details).

Big oil producers, *i.e.* oil exporter countries, have taken a step further on their industrial organisation by creating the Organisation of the Petroleum Exporting Countries (OPEC). Established in Baghdad, Iraq, and effective since January 1961, the main aim of OPEC is "*to coordinate and unify the petroleum policies of its Member Countries and ensure the stabilisation of oil markets in order to secure an efficient, economic and regular supply of petroleum to consumers, a steady income to producers and a fair return on capital for those investing in the petroleum industry.*" (OPEC, 2012). The organisation includes, as for 2014, twelve countries primarily located in the Middle East and Africa, plus two Latin American members. As an organisation under statutes, each member has to continuously fulfil several requirements concerning production and operations data reporting; a full commitment towards OPEC policy mandates. This obviously leads to think that OPEC acts coordinate into setting quotas, prices, or any other market distortion.

OPEC's effective power has been analysed thoroughly from an economic point of view by researches and policy makers.[2] Many and diverse events have occurred since OPEC establishment–mainly wars and political instability–, there is no current consensus about the role of OPEC as price setter. Most remarkably, Almoguera *et al.* (2011) suggest

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[2] It is worth mentioning that abstracting from all non-economic issues, there are two notable researchers that has moving forward the *econometrics of oil price*: Professor Lutz Kilian (University of Michigan, US) and Professor James Hamilton (University of California, San Diego, US).

that the ability of OPEC to set prices since its creation is rather episodic. They find that during the period from 1974 until 2004, OPEC acts as Cournot competition when sharing global market with non-OPEC oil producers. Their empirical results, as the authors argue, are in favour of specific but non time-robust price rises due to OPEC compared to the competition price level.

From the demand side it is unlikely that big consumers were trying to confront deliberately the suggested OPEC behaviour. According to energy statistics from CIA World Factbook (2014), the ten major oil consumer countries are: United States, China, Japan, India, Russia, Brazil, Germany, Saudi Arabia, Canada, and South Korea. As the evidence on OPEC's behaviour is inconclusive, neither of this diverse list of countries has been associated specifically against OPEC in a regular basis, despite the United Nations World Trade Organisation (UN-WTO) surveillance for fair trade.[3]

In terms of what extent OPEC sets prices and whether the effects of non-market externalities in oil spot price are adverse are questionable as well as oil price forecasters being aware of externalities when making their predictions. All these questions are certainly important for a broad group of policymakers, from global-based organisations to specific central bankers fighting imported inflation.

In this article, I provide some answers to these questions by means of econometric data analysis. However, despite all the machinery that has been used in regard to OPEC behaviour, I proceed considering one of the most striking time-series econometrics tools: Granger causality (Granger, 1969).

[3]A tasty ingredient has been recently added to this never-ending course. In 11 September 2014, US Secretary of State John Kerry meets Saudi King Abdullah in Jeddah, Saudi Arabia, in which is argued to be a coordination against oil price rises due to Middle East tensions. Moreover, this rise could help Russia to finance few economic sanctions imposed by the US and EU. See The DailyMirror, 31 October, 2014: *Oil Politics: The Secret US-Saudi Deal* for a review.

2. Does Sir Clive Granger cause all this?

The notion of Granger causality is as simple as useful–and different to "ordinary" causality. It states that if lagged values of a variable x_t predict current values of another variable y_t, and that forecast includes lags of x_t as well as y_t, then x_t Granger cause y_t ($x_t \rightarrow y_t$). Formally, this corresponds to test if all the lags of x_t are jointly statistically significant in the following regression:

$$y_t = \mu + \sum_{i=1}^{p_y} \phi_i y_{t-i} + \sum_{j=1}^{p_x} \theta_j x_{t-j} + \varepsilon_t, \quad (1)$$

where lags of y_t controls for autocorrelation, $\{\mu; \boldsymbol{\phi}; \boldsymbol{\theta}; \sigma_\varepsilon^2\}$ are parameters to be estimated (with, say, ordinary least squares), and ε_t is a white noise. The autoregressive orders (p_y, p_x) can be chosen according to an appropriate model selection criterion such as measures based in the Kullback-Leibler information criterion (*i.e.* Akaike and Schwarz) or the *General-to-Specific* (GETS) methodology. Statistical inference is carried out by testing the joint null hypothesis $H_0 : \theta_1 = ... = \theta_{p_x} = 0$ (x_t do not Granger cause y_t). The vector that contains the restrictions is F-distributed with $(p_x, T - (p_y + p_x + 1))$ degrees of freedom (T is the sample size). For a simple, and rather humorous example on the mechanics of Granger causality, see Thurman and Fisher (1988).[4]

3. Gettin' jiggy wit' it

By means of Granger causality I provide evidence on the following hypothesis: $(NH1)$ Do geopolitical tensions and announcements ("news") concerning OPEC countries (labelled $GT\&N$) affect the oil spot price (P^{Oil})?, $(NH2)$ Do these tensions affect oil price forecasts ($\mathbb{E}[P^{Oil}]$)?, and $(NH3)$ Do these tensions affect the consensus (ΔP^{Oil}) of market analysts forecasts of oil price?.

It is expected that $NH1 : GT\&N \rightarrow P^{Oil}$ and $NH2 : GT\&N \rightarrow \mathbb{E}[P^{Oil}]$. But, in order to conclude about its reliability, the inverse

[4]Nevertheless, probably this finding does not cause Sir Clive Granger's fun, as in regard of Granger causality in his Nobel Lecture of 2003 states: "*Of course, many ridiculous papers appeared.*" (Granger, 2003, p. 366).

should not be true for both assumptions. The inverse negative $NH1$, $P^{Oil} \nrightarrow GT\&N$, supposes that the current oil price does not drive disturbances in OPEC countries. Also, if the expectations measure do not concern OPEC members, it should be follow that $\mathbb{E}[P^{Oil}] \nrightarrow GT\&N$. But, it is allowed for forecasters to consider actual values of oil price as an indicator of future values. Hence, the following auxiliary hypothesis emerges, $ANH : P^{Oil} \rightarrow \mathbb{E}[P^{Oil}]$. Finally, associated with greater tensions is the uncertainty about future values of oil price. For that reason, it is expected that $GT\&N \rightarrow \Delta P^{Oil}$, but the inverse should not hold.

Basically, these hypotheses are posed to test if OPEC countries affects oil price, its forecasts, and the consensus surrounding those forecasts. The analysis requires a reliable (and simple) quantitative measure of geopolitical tensions and news measuring unexpected shocks about OPEC countries. Note that I bring forecasters into analysis for a matter of robustness.

In order to isolate the pure OPEC announcement effect, I use two measures of the $GT\&N$ variable, one containing *all* what happened with OPEC countries, including political instabilities plus purely OPEC announcements; and a second one excluding the specific OPEC behaviour.

3.1. Data

The analysis is made considering a time span ranging from 2001.1 until 2012.3 (135 observations); in monthly frequency. The $GT\&N$ is constructed by considering the sum of twelve daily variables, each one a dummy variable in which the value of one is assigned to an unexpected event. The events include: UN Oil for Food Program (1995-2003), US relations with Libya and Iran (1996-2004), Iraq War (2003), Iraq post Iraq War (2003-11), Iran post Iraq War (start in 2005), terrorist attacks, Lebanon War (2006), Arab Spring (2011), use of the US Strategic Petroleum Reserve, non-OPEC countries oil-related news, new announcements on discoveries and site exploration, and purely OPEC announcements (see López and Muñoz, 2012, for details). The sources of these variables are Bloomberg, *The Wall Street Journal*, *Financial Times*, and the US Energy Information Administration. These twelve variables are added to make a monthly variable which contain an integer with the number of events and news. This variable is not transformed to a binary one to preserve intensity.

The oil price (P^{Oil}) corresponds to the annual percentage change of the Brent oil price, measured in USD per barrel (source: *Bloomberg*). The expectations ($\mathbb{E}[P^{Oil}]$) corresponds to the annual percentage change of the 12-months-ahead forecast contained in the monthly *Consensus Forecasts* (CF) report. The point estimator reported in the CF report corresponds to the mean of the answers ranging 65-70 respondents. Each report also shows the maximum and the minimum point value reported by respondents ($\mathbb{E}[p^{High}]$ and $\mathbb{E}[p^{Low}]$, respectively). Hence, the difference $\Delta P^{Oil} = \mathbb{E}_{12}[p^{High} - p^{Low}] - \mathbb{E}_3[p^{High} - p^{Low}]$, where $\mathbb{E}_\circ$ is the forecast at $\circ$ months, measure the degree in which the consensus is achieved; while greater the uncertainty is, smaller the consensus achieved. Hence, it is expected that $GT\&N \rightarrow \Delta P^{Oil}$.

Figure 1 exhibits all the variables considered in the analysis: $GT\&N$ (in bars), oil price P^{Oil}, expectations $\mathbb{E}[P^{Oil}]$, and consensus ΔP^{Oil}. It is adverted a major number of disturbances during 2001 to mid 2005, and during the 2011-2 period.

3.2. Results

The results report the outcome of the F test of *global significance*, comprising only the values θ_i of Equation 1. In concrete, it tests the null hypothesis $H_0 : \theta_1 = ... = \theta_{p_x} = 0$, for each $NH1$-3 and ANH given 1 to 4 lags of the x_t variable. The lag structure of y_t is chosen according to the GETS procedure, allowing skipped terms. The estimations are made with Ordinary Least Squares (OLS).

The results are reported in Table 1. Note that for the first lag, in all cases there is evidence favouring OPEC countries'-related news as an oil price driver, influencing short-term forecasts, and reducing the consensus when unanticipated news are available. The first panel of Table 1 suggests some evidence of OPEC-related disruptions influencing oil prices when 1 and 4 lags of are used, at 10% level of confidence. The unexpectedness of the events comprising the $GT\&N$ variable gives the characteristic of short memory behaviour. Hence, what it is important of this finding is that it is significant with one $GT\&N$ lag. Moreover, the hypothesis that P^{Oil} Granger causes disturbances in OPEC countries is utterly rejected.

The second and third panel are plainly in favour of the OPEC-related behaviour towards expectations and forecast uncertainty. Despite of the results with four lags for $NH3$, there is evidence supporting these results whilst no evidence was found against. The fourth panel is used a matter of robustness. It states that the current oil price acts as an input for the forecasters, as it naturally should be. But also it reveals that the market does not follow a self-fulfilling price scheme; at least with exogenous forecasts as the CF are. It is most likely, in the light of results, that oil price forecasts coming from OPEC producers could have an implication for future prices; topic left for further advances.

What happens when excluding the OPEC behaviour from $GT\&N$ variable? Previous results are spoiled (finding bidirectional Granger causality), favouring the hypothesis of purely OPEC news as a price driver.

4. Wrapping up

To what extent oil producers and political disturbances in oil exporter countries affect global oil price? By means of Granger causality I provide evidence favouring OPEC countries'-related news as an oil price driver, influencing short-term forecasts, and reducing the consensus when unanticipated news are available.

These results are important since oil has been long-standing one of the most important commodities worldwide for an incommensurable number of reasons. Large fluctuations of its price are associated with detrimental welfare effects for both producers and consumers.

This article suggests that in order to keep track of price dynamics it is recommended to get to follow geopolitical tensions and the coordinated actions of the associated major producers. This task is easier said than done, since it relies on non-market signals and other externalities that are not necessarily based on a purely economics-based logic.

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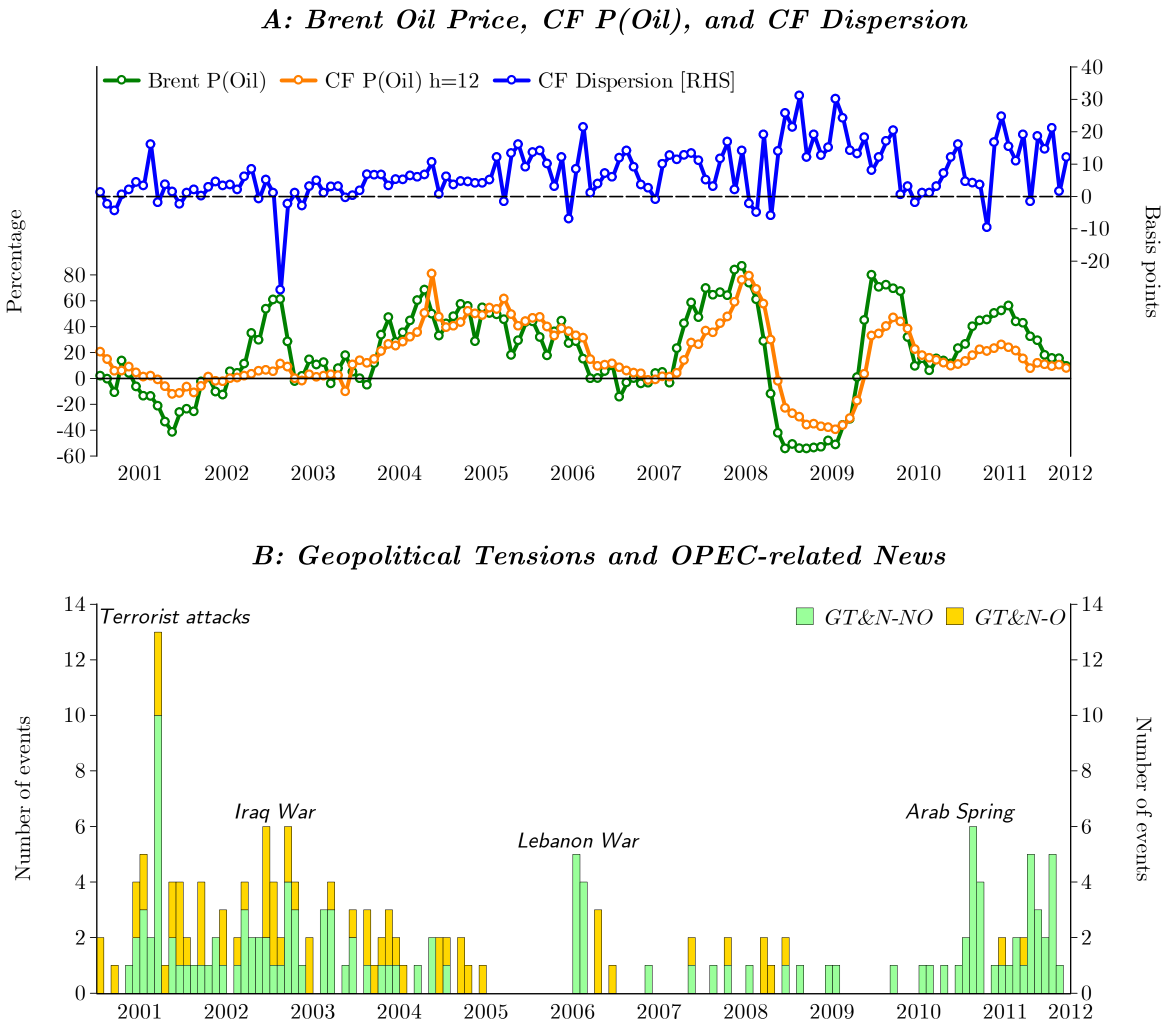
Figure 1: Time series plot of the variables (*)



(*) The $GT\&N$ variable is defined as $GT\&N = GT\&N\text{-}NO + GT\&N\text{-}O$. Source: Author's elaboration using data from Bloomberg, CF, and López and Muñoz (2012).

Table 1: Granger causality testing results: all events (*)

Baseline model: $y_t = \mu + \sum_{i=1}^{p_y} \phi_i y_{t-i} + \sum_{j=1}^{p_x} \theta_j x_{t-j} + \varepsilon_t,\ \varepsilon_t \sim iid\mathcal{N}(0, \sigma_\varepsilon^2)$

NH: $\theta_1 = ... = \theta_{p_x} = 0$ ($x_t \nrightarrow y_t$)

NH1: $GT\&N \rightarrow P^{Oil}$

Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	3.606	**0.060**	0.826	$\rightarrow$
2	1.988	*0.141*	0.826	$\nrightarrow$
3	1.342	*0.263*	0.825	$\nrightarrow$
4	2.027	**0.094**	0.825	$\rightarrow$

NH1 Inverse: $P^{Oil} \rightarrow GT\&N$

Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	0.000	*0.989*	0.117	$\nrightarrow$
2	0.104	*0.901*	0.112	$\nrightarrow$
3	0.073	*0.974*	0.105	$\nrightarrow$
4	0.444	*0.777*	0.103	$\nrightarrow$

NH2: $GT\&N \rightarrow \mathbb{E}[P^{Oil}]$

Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	4.434	**0.037**	0.898	$\rightarrow$
2	4.020	**0.020**	0.899	$\rightarrow$
3	2.704	**0.048**	0.898	$\rightarrow$
4	2.480	**0.047**	0.900	$\rightarrow$
5	1.979	**0.086**	0.899	$\rightarrow$
6	1.639	*0.142*	0.898	$\nrightarrow$

NH2 Inverse: $\mathbb{E}[P^{Oil}] \rightarrow GT\&N$

Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	0.712	*0.400*	0.120	$\nrightarrow$
2	0.395	*0.675*	0.116	$\nrightarrow$
3	1.166	*0.326*	0.119	$\nrightarrow$
4	1.379	*0.245*	0.117	$\nrightarrow$
5	1.145	*0.341*	0.109	$\nrightarrow$
6	1.372	*0.231*	0.119	$\nrightarrow$

NH3: $GT\&N \rightarrow \Delta\mathbb{E}[P^{Oil}]$

Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	3.049	**0.083**	0.160	$\rightarrow$
2	2.451	**0.090**	0.176	$\rightarrow$
3	2.280	**0.082**	0.172	$\rightarrow$
4	1.716	*0.150*	0.167	$\nrightarrow$

NH3 Inverse: $\Delta\mathbb{E}[P^{Oil}] \rightarrow GT\&N$

Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	1.007	*0.317*	0.128	$\nrightarrow$
2	1.657	*0.195*	0.125	$\nrightarrow$
3	1.238	*0.299*	0.119	$\nrightarrow$
4	1.093	*0.363*	0.117	$\nrightarrow$

Auxiliary NH: $P^{Oil} \rightarrow \mathbb{E}[P^{Oil}]$

Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	8.354	**0.004**	0.918	$\rightarrow$
2	16.151	**0.000**	0.933	$\rightarrow$
3	12.219	**0.000**	0.934	$\rightarrow$
4	9.810	**0.000**	0.934	$\rightarrow$

Auxiliary NH Inverse: $\mathbb{E}[P^{Oil}] \rightarrow P^{Oil}$

Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	0.569	*0.452*	0.843	$\nrightarrow$
2	0.932	*0.396*	0.843	$\nrightarrow$
3	0.646	*0.587*	0.841	$\nrightarrow$
4	0.466	*0.760*	0.844	$\nrightarrow$

(*) OLS estimations with Newey-West HAC standard errors. Sample: 2001.1–2012.3 (135 obs.).
p-value: **bold**<10%; *italics*>10%. Source: Author's elaboration.