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GEOPOLITICAL TENSIONS, OPEC NEWS, AND OIL PRICE: A GRANGER CAUSALITY ANALYSIS[*]

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Abstract

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 a unique measure of geopolitical tensions accounting for supply disruptions for the 2001-12 period. I found evidence favouring OPEC countries'-related news as an oil price driver *jointly* with supply disruptions as well as reducing the consensus when unanticipated news are available. When considering separately OPEC news, the evidence--rather episodic--suggest some influence on the oil price expectations consensus plus a feedback dynamics between OPEC news and the level of oil price expectations.

Resumen

¿En qué medida las tensiones geopolíticas en los principales países productores de petróleo y noticias inesperadas relacionadas con la Organización de Países Exportadores de Petróleo (OPEP) afectan el precio del petróleo? ¿Cuáles son los efectos de externalidades fuera de mercado en el precio del petróleo? ¿Están los predictores del precio del petróleo conscientes de tales externalidades al momento de realizar sus predicciones? Este artículo analiza la influencia de estos eventos en el precio del petróleo mediante causalidad de Granger, utilizando una medida única de las tensiones geopolíticas que explican las disrupciones del suministro para el período 2001-12. Se encuentra evidencia que indica que las noticias relacionadas con los países de la OPEP influyen sobre el precio del petróleo *conjuntamente* con las disrupciones del suministro, así como también en la reducción del consenso en las proyecciones frente al arribo de noticias inesperadas. Al considerar por separado las noticias de la OPEP, la evidencia--bastante episódica--sugiere cierta influencia en el consenso de las proyecciones, además de una retroalimentación entre las noticias de la OPEP y las propias proyecciones del precio del petróleo.

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1 Introduction

In this article, I analyse the influence of geopolitical tensions and news related to the Organisation of the Petroleum Exporting Countries (OPEC) events on Brent oil price for the (monthly) period ranging between 2001.1 and 2012.3 using a unique *ad-hoc* variable–labelled $GT\&N$–specially built for these purposes. 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 (henceforth, Gc; Granger, 1969; 1980; 2003).[1] Note that as emphasised by Barrett and Barnett (2013), Gc is a tool designed to measure if an independent variable affects another dependent instead of testing for a specific mechanism.[2]

Three hypotheses are examined. The first one analyses if the $GT\&N$ variable Gc oil price, and the opposite should not hold if $GT\&N$ already measures (exogenous) unexpected oil-production-related events. The second hypothesis analyses if $GT\&N$ Gc the oil-price forecasts released in the *Consensus Forecasts* (CF) monthly report; again, expecting that the opposite should not hold. A third hypothesis investigates if $GT\&N$ Gc the dispersion of mentioned expectations, as evidence of geopolitical tensions affecting the uncertainty surrounding future observations of oil-price realisations.

There are also proposed some robustness exercises. The first one underpins a baseline concept in regard to the use of forecasting CF outcomes (labelled as "auxiliary hypothesis"). This is, actual observations of oil price Gc its own expectations, but the opposite should be rejected. Hence, this result could be interpreted as evidence of CF survey as an efficient forecasting procedure in terms of the information used for making predictions.

Two natural extensions are also reported. The same set of hypotheses with the two components of $GT\&N$ series: (i) considering just OPEC-related news, and (ii) the baseline measure but excluding the events associated to OPEC. It is also included a recursive estimation of the validity of these hypotheses across time.

The results are in favour of OPEC-related news as an oil-price driver *jointly* with supply disruptions. These results are obtained when considering all kinds of events in $GT\&N$ measure. When considering just OPEC-related news, the results show bidirectional Gc between $GT\&N$ and expectations dispersion. Finally, when considering the $GT\&N$ measure excluding the OPEC-related events, the results plainly indicates an influence of these events on oil price. Hence, the finding of OPEC as an oil-price driver while statistically significant in the baseline specification could not be considered as a robust one. Some similar qualitative results are found in Smith (2005), Alhajji and Huettner (2000) for the 1973-94 period for OPEC behaviour, and Almoguera *et al.* (2011).

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 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

[1] This approach has been also used for similar purposes in, for example, Gülen (1996) and Kaufmann *et al.* (2004). Another approach found in the literature is the *event study* as used, for example, by Demirer and Kutan (2010) and Lin and Tamvakis (2010).

[2] This distinction is important since a huge literature focus on OPEC's behaviour under several assumptions to indeed test a *mechanism*. This article goes one step beyond OPEC behaviour while still circumscribing to oil market. However, in order to proceed, I consider OPEC simply as one of many news generator devices without imposing any structure.

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 threatens 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 Gülen, 1996; Griffin and Xiong, 1997; Jones, 1990; Kaufmann *et al.*, 2004, and Brémond *et al.*, 2012, for details).

Big oil producers, *i.e.* oil exporter countries, have taken a step further on their industrial organisation by creating the 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 2015, 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 of OPEC as a convenor into setting quotas, prices, or any other market distortion (Kaufmann *et al.* 2004).

A lot of attention has been attracted to a particular OPEC conference scheduled twice a year–in regular times–which outcome consists basically in a market quota setting for participant countries. There is a lot of speculation in the days surrounding these conferences as, in principle, could be the main price setting mechanism managed by OPEC. A long-standing research in this matter possibly begins with Griffin and Teece (1982), MacAvoy (1982), and Draper (1984), when analyse the effect of meeting outcome–decoded as an increase, no change, or decrease in quota–on oil-market based securities. A similar aim is extended in Deaves and Krinsky (1992), Wirl and Kujundzic (2004), Guidi *et al.* (2006), and Hyndman (2008) among others, plus some other OPEC issues such as reserves (Taylor and van Doren, 2005, and Considine, 2006). The results achieve certain consensus when quotas are reduced, and that the effect on price has been declined since mid-1980s. Strong evidence is found of OPEC as an oil price driver during the 1970s.

Besides the impact on the level, comprehensive literature also analyse the impact of OPEC news into oil price volatility. Some examples are Deaves and Krinsky (1992), Horan *et al.* (2004), Fattouh (2005), Lin and Tamvakis (2010), Aguiar-Conraria and Wen (2012), Cairns and Calfucura (2012), Brémond *et al.* (2012), López and Muñoz (2012), Schmidbauer and Rösch (2012), and Mensi *et al.* (2014) among others.

OPEC's effective power has been analysed thoroughly from an economic point of view by researches and policy makers (Pindyck, 1978; Salant, 1976; Teece, 1982; Moran, 1982; Hochman and Zilberman, 2015). Many diverse events have occurred since OPEC's establishment–mainly wars and political instability–and there is no current consensus about the role of OPEC as price setter (Loderer, 1985; Smith, 2005; Fattouh, 2005). Most remarkably, Almoguera *et al.* (2011) suggest that the ability of OPEC to set prices since its creation is rather episodic. The authors find that during the period from 1974 until 2004, OPEC acts similar to a Cournot competition when sharing the 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's comparison to the competition price level.[3]

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,

[3] The OPEC behaviour analysed plainly as a cartel is also a long-standing issue in the literature. See, for instance, Adelman (1982), Aperjis (1982), Teece (1982), Dahl and Yücel (1989), Gülen (1996), Alhajji and Huettner (2000), Adelman (2002), and Fattough (2007) among others. As above mentioned, the results are episodic and dependant on several assumptions previously made regarding OPEC's held power.

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 on a regular basis (obviously excluding Saudi Arabia, one of the major OPEC oil producer), despite the United Nations World Trade Organisation (UN-WTO) surveillance for fair trade.

In terms of what extent OPEC sets prices and whether the effects of non-market externalities in oil spot price are questionable. It is also questionable if oil price forecasters being aware or affected by these 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. Moreover, oil price is of special interest since there has been found detrimental effects attached to large unexpected shocks affecting a number of stock indices (Hammoudeh and Eleisa, 2004; Hammoudeh and Li, 2004; Pollet, 2005; Malik and Hammoudeh, 2007; Driesprong *et al.*, 2008; Balcilar *et al.*, 2015), and associated even to recessions (Hamilton, 2003, 2009). Oil price also carry a substantial amount of information to different international prices indices affecting global inflation (see De Gregorio *et al.*, 2007, Neely and Rapach, 2011, and Medel, 2015, for details).

However, it is a less clear cut if there are just OPEC news–as an organisation–the driver of oil price shocks, or if it is necessary to include a more ample spectrum of supply disruptions such as political instability, wars, or any other disruption due to non-market externalities. This is important since certain OPEC countries have been subject of substantial geopolitical risk not necessarily affecting organisation's countries only. For that reason, the particular concern of this article is consider OPEC as one within many oil-market-based news-generator devices.[4]

The remaining of the article proceeds as follow. In Section 2 it is presented the Hsiao (1981) version of the (augmented) Gc method, alongside the application to oil price and dataset. In Section 3 there are presented the results for the baseline alongside the two robustness exercises. Finally, Section 4 concludes.

2 Econometric setup

2.1 Granger causality

The notion of Gc 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 Gc y_t ($x_t \rightarrow y_t$). In this article, however, I make use of the Hsiao (1981) version of Gc. This extension could be straightforwardly described as a joint significance F-test of a whole set of parameters associated to the independent variable (x_t) that supposedly Gc the dependent variable (y_t). However, results derived from this baseline procedure may not be appropriate with x_t-variables with intermediate or short memory. Formally, this corresponds to test if all the lags of x_t are jointly statistically significant in the following regression:

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

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, OLS), and $\varepsilon_t \sim iid\mathcal{N}(0, \sigma_\varepsilon^2)$. The autoregressive orders (p_y, p_x) in Equation (1) can be chosen according to an appropriate model selection criterion such as measures based in the Kullback-Leibler information criterion (*i.e.* Akaike or Schwarz), or the *General-to-Specific* (GETS) methodology.

[4] The analysis of OPEC as an organisation composed by several countries with high war risk is not as large as OPEC's analysis by itself. An exception is Bittlingmayer (2005). This article analyses whether country-level war risk affect both level and volatility of oil price alongside considering OPEC behaviour. The results reveal that these price movements affect stock prices. Hence, it gives a role to another kind of shocks despite those due to OPEC.

Statistical inference is carried out by testing the joint null hypothesis $NH : \theta_1 = ... = \theta_{p_x} = 0$ (x_t do not Gc y_t, $x_t \nrightarrow y_t$). The vector that contains the restrictions is F-distributed with $(p_x, T - (p_y + p_x + 1))$ degrees of freedom (where T is the sample size). For a simple and rather humorous example on the mechanics of Gc, see Thurman and Fisher (1988). A formal treat can be found in Harvey (§8.7, 1990), Hamilton (§11.2, 1994), and Patterson (§8.5, 2000).

2.2 An application to the oil market

By means of Gc I provide evidence on the following hypotheses:

1. $NH1$: Do geopolitical tensions in major oil-producer countries and announcements concerning OPEC countries (the $GT\&N$ variable) affect the Brent oil price (P^{Oil})?
2. $NH2$: Do $GT\&N$ affect oil price forecasts ($\mathbb{E}[P^{Oil}]$)? and
3. $NH3$: Do $GT\&N$ affect the consensus ($\mathbb{D}[P^{Oil}]$) 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 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 oil-producers countries. Also, if the expectations measure are orthogonal to oil producers' information set, it should be follow that $\mathbb{E}[P^{Oil}] \nrightarrow GT\&N$. However, 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 $GT\&N \rightarrow \mathbb{D}[P^{Oil}]$, but the inverse should not hold. Bowles *et al.* (2007) and Atallah *et al.* (2013) proposed a similar series when measuring disagreement in ECB surveys' respondents.

Basically, these hypotheses are posed to test if oil-producer countries' geopolitical tensions and unexpected news affect 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; as the $GT\&N$ variable already is. Some other simple measures specifically for OPEC meetings have been also used especially when using event study methodology, as in Demirer and Kuttan (2010) and Lin and Tamvakis (2010).

Note that the analysis involves forecasters for two reasons. The first one is the truly interest in investigating to which extent they are affected by $GT\&N$ in two typical dimensions: point and dispersion of forecasts. The second reason is to stress the reliability of the newly-proposed $GT\&N$ measure.

Some other robustness exercises comprise the use of the $GT\&N$-O and $GT\&N$-NO variables. The former stands for purely OPEC-related news, while the latter for non-OPEC events. Hence, the base $GT\&N$ variable is composed by adding up these two measures. Note, however, that given the geographical proximity of the majority of big oil-producer countries, and the nature of the businesses involved there (same exploited commodity with a very similar technology in a specific region), it is difficult to fully isolate both measures. Hence, it is not imposed an orthogonality condition between them, preserving the benefit of simplicity and easy-to-read results. This also supports the modelling procedure when incorporating more than one lags to control for autocorrelation. Hence, the first lag–the most important when using $GT\&N$–comes from a bias-reduced estimation.

2.3 Dataset

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 ten daily categorical variables, in which the value of one is assigned to an unexpected event associated to an expansion of supply, minus one to a contraction of supply, and zero otherwise. There are identified 204 events divided into the ten categories of Table 1.

Table 1: *GT&N* Components

No.	No. events	Supply eff.	Classification	Description
1.	[*14*]	(+)	*Non OPEC*	UN Oil for Food Program (1995-2003)
2.	[*6*]	(−)	*Non OPEC*	US relations with Libya and Iran (1996-2004)
3.	[*26*]	(−)	*Non OPEC*	Iraq War and post-war period (2003-2011)
4.	[*10*]	(−)	*Non OPEC*	Iran post Iraq War (start in 2005)
5.	[*22*]	(−)	*Non OPEC*	Terrorist attacks
6.	[*8*]	(−)	*Non OPEC*	Lebanon War (2006)
7.	[*25*]	(−)	*Non OPEC*	Arab Spring (2011)
8.	[*3*]	(+)	*Non OPEC*	Use of the US Strategic Petroleum Reserve
9.	[*17*]	(+)	*Non OPEC*	New announcements on discoveries, and site exploration
10.	[*73*]	(+/−)	*OPEC*	Purely OPEC announcements

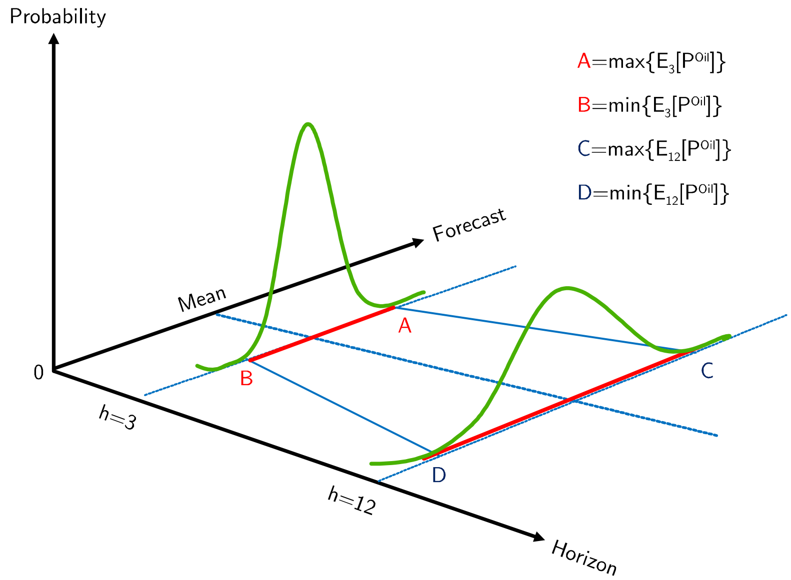
Source: Author's elaboration.

In brackets are shown the number of identified events during the sample span and in parenthesis the expected effect on supply. The last listed category fully comprises the *GT&N-O* variable. When it is used the label "*Non OPEC*" means that not all nor the majority of the events related to that category are plainly associated to OPEC actions. A more detailed description of what kinds of events are included in each category can be found in Appendix A. Daily individual-level identification, however, can be found in Appendix A of López and Muñoz (2012).[5] The sources of these variables are Bloomberg, *The Wall Street Journal*, *Financial Times*, and the US Energy Information Administration. These ten 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; $P^{Oil} = 100\times((oil\, price_t/oil\, price_{t-12})-1)$). The expectations corresponds to the annual percentage change of the 12-months-ahead forecast contained in the monthly CF report, but using the actual value as denominator ($\mathbb{E}[P^{Oil}] = 100\times((oil\, price\, forecast_t/oil\, price_{t-12})-1)$). 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 ($\mathbb{E}_\ell[oil\ price\ forecast^{High}]$ and $\mathbb{E}_\ell[oil\ price\ forecast^{Low}]$, respectively). Hence, the difference $\mathbb{D}[P^{Oil}] = \mathbb{E}_{12}[oil\ price\ forecast^{High} - oil\ price\ forecast^{Low}]$, where $\mathbb{E}_\ell$ is the forecast at ℓ months ($\ell = \{3, 12\}$), measure the degree in which the consensus is achieved; the greater the uncertainty, the smaller the consensus achieved. Hence, it is expected that $GT\&N \to \mathbb{D}[P^{Oil}]$. Figure 1 describes graphically how the variable $\mathbb{D}[P^{Oil}]$ is built and what is measuring; henceforth referred as *dispersion*.

[5] Note that the *GT&N* variable is available from 1999. So, the limiting part of the dataset is CF starting in 2001.

Figure 1: $\mathbb{D}[P^{Oil}]$ variable construction



The consensus variable corresponds to $\mathbb{D}[P^{Oil}] = [C - D]$.
Source: Author's elaboration.

Figure 2 exhibits all the variables considered in the analysis: actual oil price, CF expectations, CF dispersion, and *GT&N* (as *GT&N-O* + *GT&N-NO*, in panel B). It is noticed a major number of disturbances during 2001 (due to 9/11 terrorist attacks), 2003 (Iraq War), mid-2005 (due to Lebanon War), and the 2011-12 period (due to Arab Spring).[6] Note also that exogenous to all of these variables, it is noticed the effect of the financial crisis of 2008-9 initiated after the bankruptcy of Lehmann Brothers investment bank in the US.

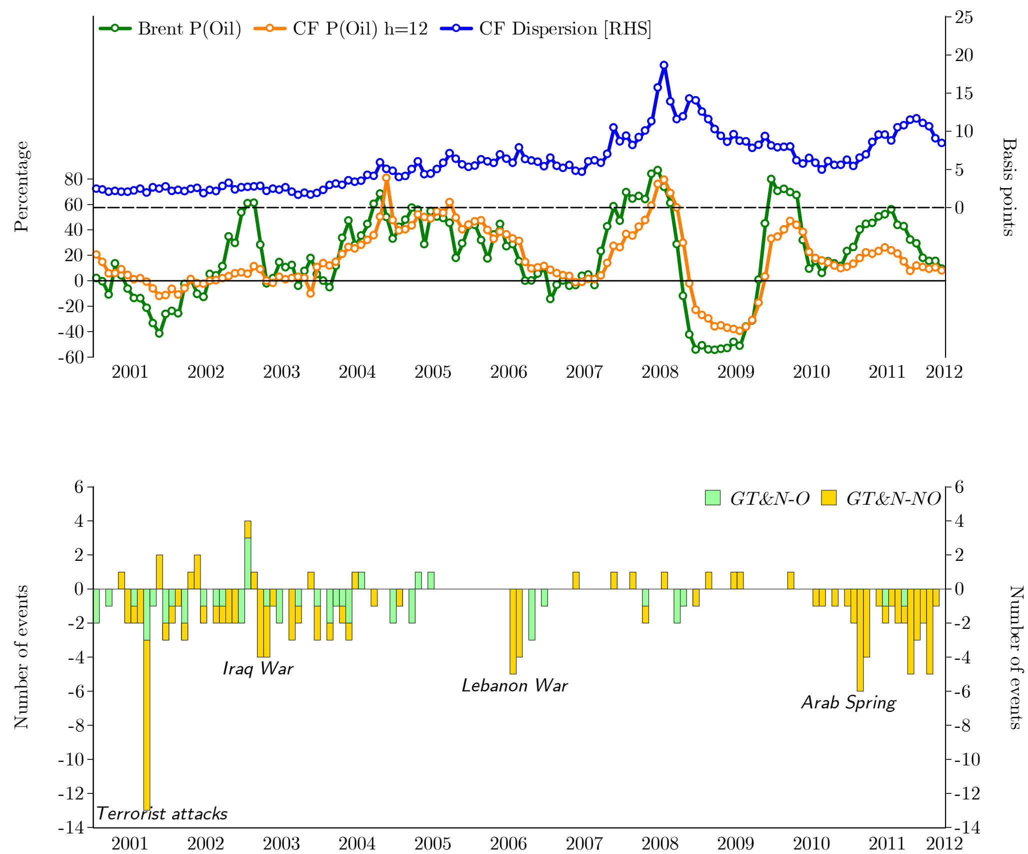
Note also that the use of forecasting variables is made assuming that they are all the time minimising some distance measure to actual values. To assess how reliable these predictions are, in Figure 3 it is presented a birds-eye assessment of accuracy. In panel A, it is presented a scatter plot–in this case, the correspondence–between the actual and forecast values (labelled "Brent P(Oil)" and "CF P(Oil), h=12", respectively). Note that as the majority of observations lie close to the $y = x$ line without outliers, the forecasting accuracy could be considered of a good quality (Root Mean Squared Forecast Error: 8.835; in levels, full sample).

Figure 3, panel B, presents the cross correlation between actual and leads observations of the CF series. The results indicate that in effect, the CF predictions are accurate for the target horizon plus a couple of periods, as a result of oil price persistence.

Table 2 presents some descriptive statistics of the involved series for the analysed sample using the preferred stationary transformation. Note that according to the Augmented Dickey-Fuller test (ADF), the transformations (when applied) deliver stationary series. Also, and in companion with Figure 2, oil price forecasts exhibit a smoother behaviour than actual values, which might contribute to both its accuracy and consensus.

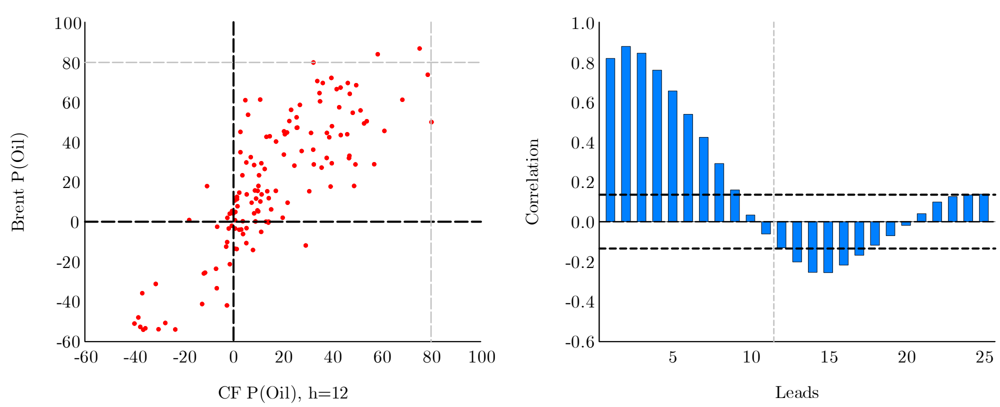
[6]See Appendix A for more details.

Figure 2: Time series plot of involved variables



Source: Author's elaboration using data from Bloomberg, CF, and López and Muñoz (2012).

Figure 3: Graphical forecast accuracy assessment



Source: Author's elaboration using data from CF.

Table 2: Descriptive statistics of the series (*)

	P^{Oil}	$\mathbb{E}[P^{Oil}]$	$\mathbb{D}[P^{Oil}]$	*GT&N*	*GT&N-O*	*GT&N-NO*
Transform.	*Ann. perc.*	*Ann. perc.*	*Basis points*	*No. events*	*No. events*	*No. events*
Mean	18.84	-4.95	27.65	-0.69	-0.27	-0.43
Median	17.28	-8.26	26.00	0	0	0
Maximum	86.55	44.82	80.16	4	3	2
Minimum	-54.65	-23.53	-1.40	-13	-3	-10
Std. deviation	33.66	12.87	17.05	1.81	0.87	1.54
Sign. lags (p_y)	{1}	{5}	{1}	{1}	{3}	{1}
ADF Statistic	-3.44	-3.55	-3.50	-9.08	-4.35	-7.91
p-value	0.011	0.008	0.043	0.000	0.001	0.000

(*) Sample: 2001.1–2012.3 (135 obs.). Source: Author's elaboration using data from Bloomberg, CF, and López and Muñoz (2012).

3 Results

The results report the outcome of the F-test of *global significance*, comprising only the values θ_i of Equation 1. In concrete terms, it tests the joint null hypothesis $H_0 : \theta_1 = ... = \theta_{p_x} = 0$, for each $NH1$-3 and ANH given one to six lags of the x_t variable. The lag structure of y_t is chosen according to the GETS procedure, allowing skipped terms. These results are reported in "Significant lags (p_y)" row of Table 2. The estimations are made with OLS using Newey and West (1987) HAC standard deviations.

There are also presented another type of results for robustness purposes. It could be raised as common knowledge that OPEC finding on influencing oil prices is episodic. For that reason, and circumscribing to the econometric methodology used in this article, it is also reported the F-test p-value of the six lags of the *NH1* and *NH1 Inverse* in a recursive sampling scheme. The first estimation window sample comprises the first 60 observations (2001.1-2005.12) whereas the last includes the full sample (2001.1-2012.3; 135 obs.) and coincides with the figures reported in corresponding tables. Note that despite the valuable information that this exercise provides in terms of stability, it is always preferred for a finite-sample nonparametric-estimation the use of a greater number of observations.

3.1 Baseline results

The results are reported in Table 3. The first panel ($NH1$) shows that the third, fifth, and sixth lag of *GT&N* Gc oil price are significant at 10%, whereas the first and fourth at 15%. Note, however, that while the first lag could be the most important for a variable measuring a shock, the dynamic effect analysed later reveals a regime covering from 2006 to 2010 where p_x=1 is statistically significant at 10% level of confidence. Jointly with this result ($GT\&N \rightarrow P^{Oil}$) it is found that $P^{Oil} \nrightarrow GT\&N$ for any analysed lag.

The second panel rejects the hypothesis that $GT\&N \rightarrow \mathbb{E}[P^{Oil}]$, say, geopolitical tensions affects oil-price expectations. The opposite hypothesis $\mathbb{E}[P^{Oil}] \rightarrow GT\&N$ result as non significant–except with three lags at 15% level of confidence–, suggesting that the considered oil-producers-related news are already exogenous to forecasters' information set.

Table 3: 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: $GT\&N \to P^{Oil}$					NH1 Inverse: $P^{Oil} \to GT\&N$				
Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.	Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	1.942	*0.166*	0.822	$\nrightarrow$	1	0.013	*0.909*	0.051	$\nrightarrow$
2	1.031	*0.360*	0.820	$\nrightarrow$	2	0.660	*0.518*	0.051	$\nrightarrow$
3	2.149	**0.097**	0.821	$\rightarrow$	3	0.557	*0.644*	0.045	$\nrightarrow$
4	1.662	*0.163*	0.820	$\nrightarrow$	4	0.474	*0.755*	0.038	$\nrightarrow$
5	2.234	**0.055**	0.822	$\rightarrow$	5	0.435	*0.824*	0.032	$\nrightarrow$
6	2.240	**0.044**	0.820	$\rightarrow$	6	0.434	*0.855*	0.028	$\nrightarrow$

NH2: $GT\&N \to \mathbb{E}[P^{Oil}]$					NH2 Inverse: $\mathbb{E}[P^{Oil}] \to GT\&N$				
Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.	Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	0.725	*0.396*	0.098	$\nrightarrow$	1	0.832	*0.363*	0.066	$\nrightarrow$
2	0.436	*0.648*	0.098	$\nrightarrow$	2	0.934	*0.396*	0.064	$\nrightarrow$
3	0.320	*0.811*	0.092	$\nrightarrow$	3	1.824	**0.146**	0.065	$\rightarrow$
4	0.238	*0.916*	0.086	$\nrightarrow$	4	1.488	*0.209*	0.058	$\nrightarrow$
5	0.309	*0.907*	0.083	$\nrightarrow$	5	1.642	*0.153*	0.059	$\nrightarrow$
6	0.519	*0.793*	0.081	$\nrightarrow$	6	1.573	*0.160*	0.057	$\nrightarrow$

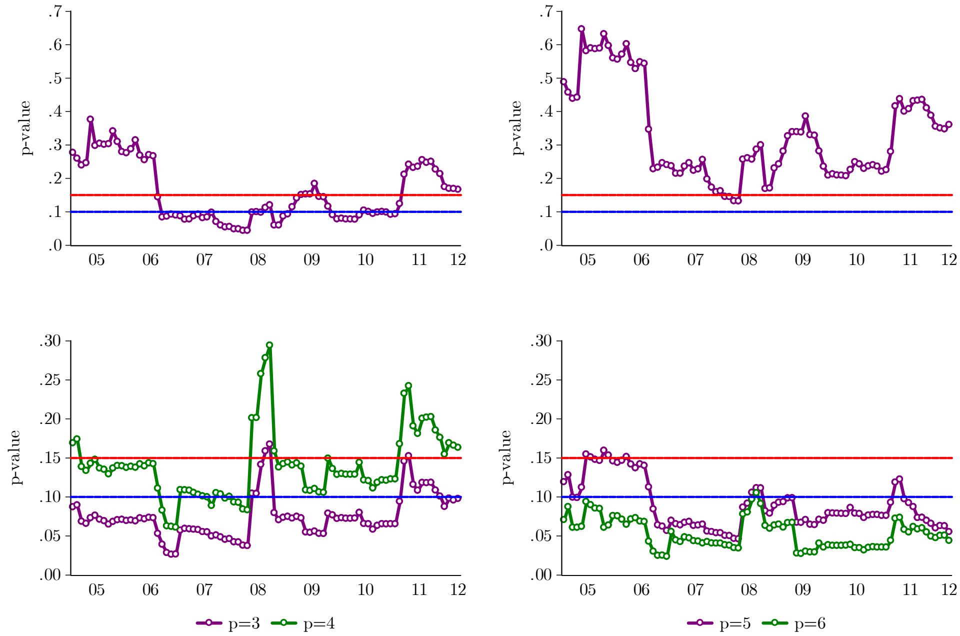
NH3: $GT\&N \to \mathbb{D}[P^{Oil}]$					NH3 Inverse: $\mathbb{D}[P^{Oil}] \to GT\&N$				
Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.	Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	2.259	**0.135**	0.837	$\rightarrow$	1	0.108	*0.743*	0.064	$\nrightarrow$
2	1.473	*0.233*	0.835	$\nrightarrow$	2	0.679	*0.509*	0.061	$\nrightarrow$
3	0.996	*0.397*	0.833	$\nrightarrow$	3	1.471	*0.225*	0.067	$\nrightarrow$
4	2.154	**0.077**	0.839	$\rightarrow$	4	1.202	*0.313*	0.061	$\nrightarrow$
5	1.670	**0.146**	0.837	$\rightarrow$	5	0.990	*0.426*	0.055	$\nrightarrow$
6	1.388	*0.224*	0.835	$\nrightarrow$	6	1.871	**0.090**	0.054	$\rightarrow$

Auxiliary NH: $P^{Oil} \to \mathbb{E}[P^{Oil}]$					Auxiliary NH Inverse: $\mathbb{E}[P^{Oil}] \to P^{Oil}$				
Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.	Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	5.380	**0.022**	0.277	$\rightarrow$	1	0.834	*0.363*	0.823	$\nrightarrow$
2	3.235	**0.043**	0.329	$\rightarrow$	2	0.743	*0.478*	0.823	$\nrightarrow$
3	3.298	**0.023**	0.342	$\rightarrow$	3	1.518	*0.213*	0.823	$\nrightarrow$
4	2.303	**0.062**	0.350	$\rightarrow$	4	1.195	*0.316*	0.823	$\nrightarrow$
5	2.012	**0.082**	0.366	$\rightarrow$	5	0.951	*0.451*	0.821	$\nrightarrow$
6	1.871	**0.091**	0.364	$\rightarrow$	6	1.514	*0.179*	0.824	$\nrightarrow$

(*) OLS estimations with Newey-West HAC standard errors. Sample: 2001.1–2012.3 (135 obs.).
p-value: **bold**<15%; *italics*>15%. Source: Author's elaboration.

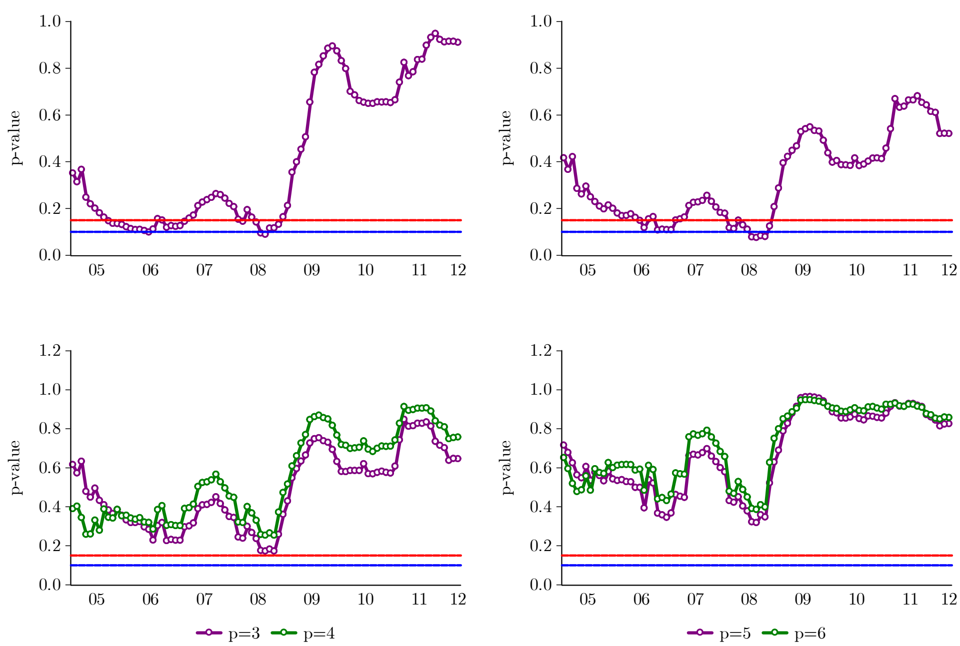
The third panel states that for lags one, four, and five there is evidence suggesting that $GT\&N \to \mathbb{D}[P^{Oil}]$, implying an uncertainty effect into oil-price forecasts. Note that for the opposite hypothesis it is found Gc with six lags only; a result that should be read carefully. As the last significant lag of $GT\&N$ which Gc the dispersion is the fifth, and since six lags of dispersion Gc $GT\&N$ the effect can be understood as the time required for forecasters (5 months) rejoining consensus in their forecasts after gathering news information in a 5-months period. Hence, the first round effect can still be associated to $GT\&N$ affecting $\mathbb{D}[P^{Oil}]$.

Figure 4: Recursive estimation of NH1 p-value: all events (*)



(*) Horizontal lines: p-value=10% (blue); 15% (red). Source: Author's elaboration.

Figure 5: Recursive estimation of NH1 Inverse p-value: all events (*)



(*) Horizontal lines: p-value=10% (blue); 15% (red). Source: Author's elaboration.

The fourth panel exhibits the result for the auxiliary hypothesis $P^{Oil} \rightarrow \mathbb{E}[P^{Oil}]$ and $\mathbb{E}[P^{Oil}] \nrightarrow P^{Oil}$. As expected, and in conjunction with Figure 3, CF survey forecasts "behaved well" in terms of accuracy and expectations formation. Note that these are robust results, with full lags significance in one direction and full rejection in the opposite.

The recursive p-value estimation for p_x=3, 5, and 6 in panels C and D of Figure 4 reveals that these estimations are robust. Note that especially in this case (and following the original Granger, 1969, sense), the first lag (p_x=1) represent the most relevant case because $GT\&N$ measure has the property–by construction–of being a news shock variable. Remarkably, panel A of Figure 4 show evidence supporting the $NH1$ especially for the period between 2006 and 2010. Particularly for this period, the first lag result as significant while being the most tranquil period of the sample, with more supply contraction events associated to OPEC.

Nevertheless, Figure 5 for *NH1 Inverse* is bolder about to not reject the underlying hypothesis of non-significant parameters, especially since 2008 for p_x={1,2}; in some sense playing in favour of *NH1*.

3.2 Robustness results

3.2.1 Purely OPEC news

The results using the purely-OPEC version of the $GT\&N$ variable–$GT\&N$-O–are presented in Table 4. The first panel show that there is no Gc from $GT\&N$-O to P^{Oil} at conventional levels of confidence. Nevertheless, there is some evidence for p_x={2,3,6} that P^{Oil} actually Gc $GT\&N$-O. This inverse causality must be read jointly with the results of the second panel, which exhibit a feedback dynamics between $GT\&N$-O and $\mathbb{E}[P^{Oil}]$ for all lags, except p_x=1 for *NH2 Inverse*. These results give a more delicate role to OPEC news, since they appear affected by the oil price and its expectation, which in turn act as an input for forecasters.

The third panel, however, indicate bidirectional Gc between $GT\&N$-O and $\mathbb{D}[P^{Oil}]$ for all considered lags at conventional levels of confidence. This result supports the claim–at least, do not reject it–that $GT\&N$-O already measure unexpected news of OPEC oil production. These news Gc forecasters' dispersion as well as uncertainty in future oil prices lead to significant disruptions in OPEC's countries' oil production.

Note that, following the description of the $GT\&N$ variable in Appendix A, the events purely related to OPEC are particularly related to oil production in contrast to the remaining dummies accounting for political instability and other externalities. The fact that results are robust to the whole set of hypothesis using the combined measure, indicates that the *joint* interaction of these unexpected events shape the forces that utterly influence oil price.

The recursive p-value estimations are presented in Figure 6 for *NH1*. In this case, it is found a plain non-rejection of the *NH1* across the sample and lags (panels A-D). Same result is basically found with *NH1 Inverse* in Figure 7 (especially since 2008). Hence, the results using the purely OPEC measure, in conjunction with results of Figures 4 and 5, lead to think that it is a mixture of geopolitical tensions plus OPEC news that jointly influence oil price, instead of an isolated OPEC behaviour.

Table 4: Granger causality testing results: OPEC events (*)

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

Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	0.020	*0.887*	0.820	$\nrightarrow$
2	0.154	*0.858*	0.820	$\nrightarrow$
3	0.104	*0.958*	0.818	$\nrightarrow$
4	0.088	*0.986*	0.817	$\nrightarrow$
5	0.121	*0.988*	0.815	$\nrightarrow$
6	0.199	*0.977*	0.814	$\nrightarrow$

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

Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	1.904	*0.170*	0.125	$\nrightarrow$
2	2.141	**0.122**	0.145	$\rightarrow$
3	2.086	**0.105**	0.139	$\rightarrow$
4	1.514	*0.202*	0.144	$\nrightarrow$
5	1.281	*0.277*	0.136	$\nrightarrow$
6	1.879	**0.090**	0.149	$\rightarrow$

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

Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	7.959	**0.005**	0.152	$\rightarrow$
2	4.329	**0.015**	0.186	$\rightarrow$
3	3.156	**0.027**	0.190	$\rightarrow$
4	2.923	**0.023**	0.184	$\rightarrow$
5	2.718	**0.023**	0.184	$\rightarrow$
6	2.525	**0.024**	0.178	$\rightarrow$

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

Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	1.239	*0.268*	0.113	$\nrightarrow$
2	2.941	**0.056**	0.157	$\rightarrow$
3	2.887	**0.038**	0.161	$\rightarrow$
4	2.527	**0.044**	0.162	$\rightarrow$
5	2.323	**0.046**	0.164	$\rightarrow$
6	1.951	**0.077**	0.148	$\rightarrow$

NH3: $GT\&N\text{-}O \rightarrow \mathbb{D}[P^{Oil}]$

Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	0.000	*0.990*	0.836	$\nrightarrow$
2	0.078	*0.925*	0.834	$\nrightarrow$
3	0.054	*0.984*	0.832	$\nrightarrow$
4	3.087	**0.018**	0.837	$\rightarrow$
5	2.298	**0.049**	0.835	$\rightarrow$
6	1.956	**0.076**	0.834	$\rightarrow$

NH3 Inverse: $\mathbb{D}[P^{Oil}] \rightarrow GT\&N\text{-}O$

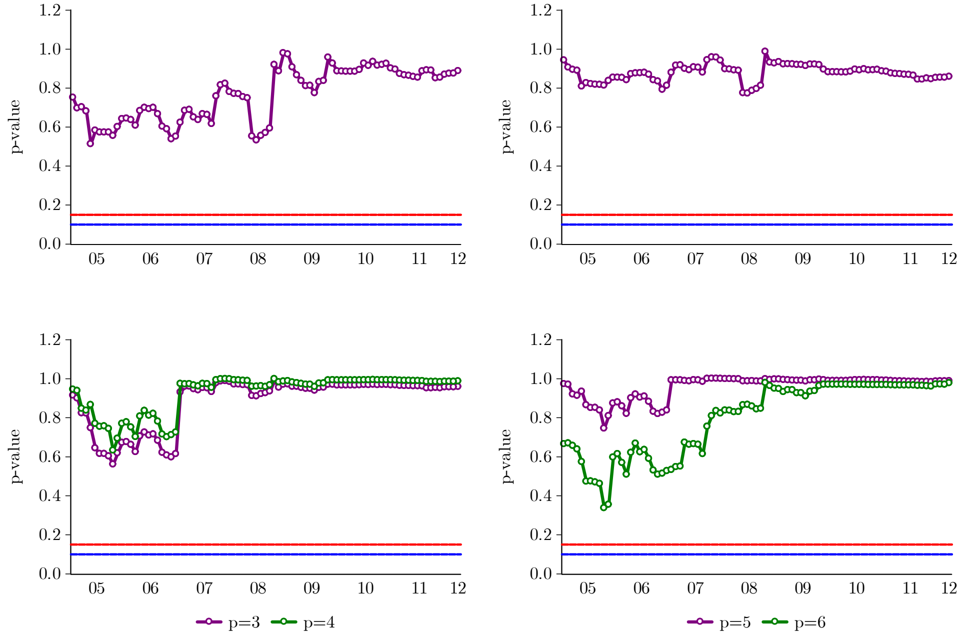
Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	1.212	*0.273*	0.11	$\nrightarrow$
2	2.327	**0.101**	0.121	$\rightarrow$
3	1.587	*0.195*	0.123	$\nrightarrow$
4	1.830	**0.127**	0.122	$\rightarrow$
5	1.489	*0.198*	0.120	$\nrightarrow$
6	1.478	*0.191*	0.119	$\nrightarrow$

(*) OLS estimations with Newey-West HAC standard errors. Sample: 2001.1–2012.3 (135 obs.).
p-value: **bold**<15%; *italics*>15%. Source: Author's elaboration.

3.2.2 Non OPEC news

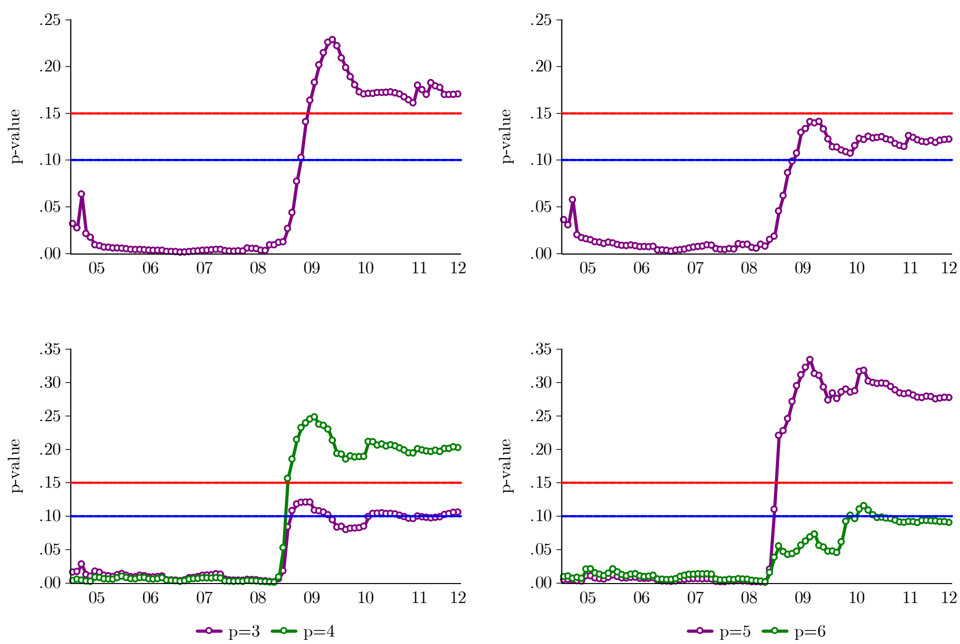
The results using the non OPEC version of the $GT\&N$ variable—$GT\&N\text{-}NO$—are presented in Table 5. Except for one isolated case (*NH1*: p_x=2) there is found that $GT\&N\text{-}NO$ Gc oil price at conventional significance levels. This finding reinforces the hypothesis that OPEC by itself does not directly affect oil price but rather its forecast level and dispersion. Moreover, the second panel show that the $GT\&N\text{-}NO$ Gc oil price expectations, which is the second part of the results found with $GT\&N\text{-}O$. This result imply that future turbulences in oil price are indeed associated to not only in OPEC countries, but geopolitical tensions and disturbances in general, and forecasters consider OPEC news as an input when making their forecasts.

Figure 6: Recursive estimation of NH1 p-value: OPEC events (*)



(*) Horizontal lines: p-value=10% (blue); 15% (red). Source: Author's elaboration.

Figure 7: Recursive estimation of NH1 Inverse p-value: OPEC events (*)



(*) Horizontal lines: p-value=10% (blue); 15% (red). Source: Author's elaboration.

Table 5: Granger causality test results: non-OPEC events (*)

NH1: $GT\&N\text{-}NO \rightarrow P^{Oil}$					NH1 Inverse: $P^{Oil} \rightarrow GT\&N\text{-}NO$				
Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.	Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	2.238	**0.137**	0.822	$\rightarrow$	1	0.164	*0.201*	0.147	$\nrightarrow$
2	1.794	*0.170*	0.821	$\nrightarrow$	2	0.835	*0.436*	0.140	$\nrightarrow$
3	2.944	**0.035**	0.822	$\rightarrow$	3	0.598	*0.618*	0.133	$\nrightarrow$
4	2.611	**0.039**	0.822	$\rightarrow$	4	0.473	*0.756*	0.126	$\nrightarrow$
5	2.027	**0.079**	0.823	$\rightarrow$	5	0.825	*0.534*	0.121	$\nrightarrow$
6	2.913	**0.011**	0.821	$\rightarrow$	6	0.594	*0.735*	0.107	$\nrightarrow$
NH2: $GT\&N\text{-}NO \rightarrow \mathbb{E}[P^{Oil}]$					NH2 Inverse: $\mathbb{E}[P^{Oil}] \rightarrow GT\&N\text{-}NO$				
Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.	Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	0.162	*0.688*	0.093	$\nrightarrow$	1	5.288	**0.023**	0.159	$\rightarrow$
2	0.186	*0.830*	0.087	$\nrightarrow$	2	2.731	**0.069**	0.154	$\rightarrow$
3	0.225	*0.879*	0.081	$\nrightarrow$	3	1.904	**0.132**	0.156	$\rightarrow$
4	0.171	*0.953*	0.075	$\nrightarrow$	4	1.471	*0.215*	0.152	$\nrightarrow$
5	0.175	*0.971*	0.069	$\nrightarrow$	5	1.547	*0.179*	0.154	$\nrightarrow$
6	0.276	*0.948*	0.062	$\nrightarrow$	6	1.616	**0.148**	0.154	$\rightarrow$
NH3: $GT\&N\text{-}NO \rightarrow \mathbb{D}[P^{Oil}]$					NH3 Inverse: $\mathbb{D}[P^{Oil}] \rightarrow GT\&N\text{-}NO$				
Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.	Lags (p_x)	F-stat.	p-value	$\overline{R}^2$ Reg.	Infrc.
1	2.688	**0.103**	0.838	$\nrightarrow$	1	0.021	*0.885*	0.147	$\nrightarrow$
2	1.638	*0.198*	0.836	$\nrightarrow$	2	0.061	*0.941*	0.140	$\nrightarrow$
3	1.151	*0.331*	0.834	$\nrightarrow$	3	0.757	*0.520*	0.137	$\nrightarrow$
4	1.385	*0.242*	0.838	$\nrightarrow$	4	0.599	*0.664*	0.131	$\nrightarrow$
5	1.074	*0.378*	0.836	$\nrightarrow$	5	0.477	*0.793*	0.124	$\nrightarrow$
6	0.894	*0.502*	0.834	$\nrightarrow$	6	0.464	*0.834*	0.117	$\nrightarrow$

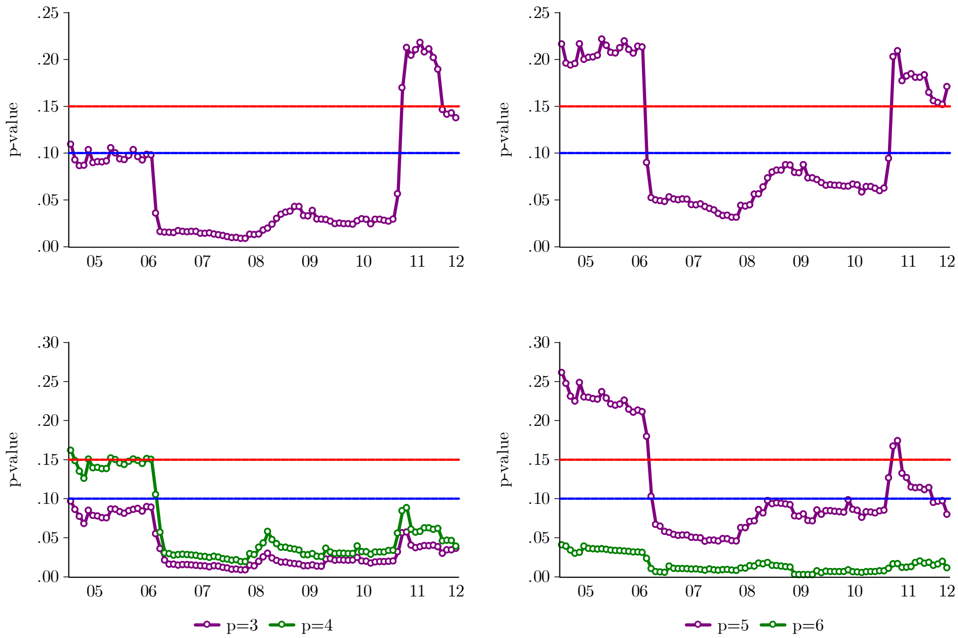
(*) OLS estimations with Newey-West HAC standard errors. Sample: 2001.1–2012.3 (135 obs.).
p-value: **bold**<15%; *italics*>15%. Source: Author's elaboration.

The third panel, except for p_x=1 in *NH3*, show that non OPEC news and the dispersion of forecasts are independent, giving a unique role to OPEC countries influencing forecast disagreement.

The recursive p-value results for *NH1* are presented in Figure 8. It is basically found the same situation across the different lags: significance through mid-2010 to then rise above the 10% confidence level threshold. This finding supports the view that at least between 2006 and 2010 non-OPEC events may play a role into determining oil prices. This situation may be reinforced when analysing the results of Figure 9 especially with lags three to six, clearly showing a no rejection the *NH1 Inverse*.

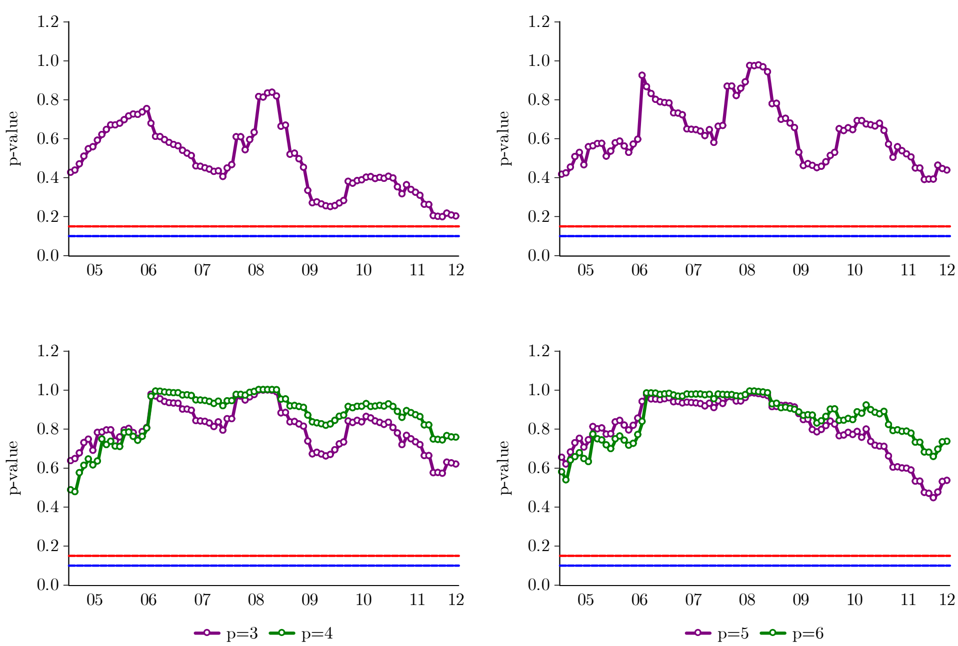
These results are in line with the findings of Bittlingmayer (2005) obtained for a previous sample, when suggesting that war risk is enough to cause price disruptions since traders mark up price to cover expectation of possible scarcity.

Figure 8: Recursive estimation of NH1 p-value: non-OPEC events (*)



(*) Horizontal lines: p-value=10% (blue); 15% (red). Source: Author's elaboration.

Figure 9: Recursive estimation of NH1 Inverse p-value: non-OPEC events (*)



(*) Horizontal lines: p-value=10% (blue); 15% (red). Source: Author's elaboration.

4 Concluding remarks

To what extent geopolitical tensions in major oil-producer countries and unexpected news related to the OPEC affect global oil price? By means of Gc I provide evidence favouring OPEC countries'-related news as an oil price driver *jointly* with supply disruptions, influencing short-term forecasts, and reducing the consensus when unanticipated news are available.

These results are obtained when considering all kinds of events in $GT\&N$ measure: geopolitical tensions and OPEC-related news. When considering just OPEC-related news, the results show bidirectional causality between $GT\&N$ and expectations level and dispersion. Moreover, when considering the $GT\&N$ measure excluding the OPEC-related events, the result is plainly favouring that geopolitical tensions affect current level of oil price. Hence, the finding of OPEC as an oil-price driver while statistically significant in the baseline specification may not be considered as a robust one. Some similar qualitative results are found in Smith (2005), Alhajji and Huettner (2000) for the 1973-94 period for OPEC behaviour, and Almoguera *et al.* (2011). The fact that results are robust to the whole set of hypothesis using the combined measure and whole sample, indicates that the *joint* interaction of these unexpected events shape the forces that utterly influence oil price.

These results are important since oil has been long-standing important commodity worldwide for an incommensurable number of reasons. Large fluctuations of its price are associated with detrimental welfare effects for both producers and consumers. Further research may consider a forecasting model for the $GT\&N$ variable (and its components) alongside an analysis of a more ample spectrum of news that may indirectly affect oil market. A special candidate series are those related to politic developments surrounding OPEC members, and other oil producers such as Russia and the US.

This article suggests that in order to keep track of price dynamics, it is recommended 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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A *GT&N* variable description

In this appendix, there are provided some extended descriptions of the ten dummy variables used into the construction of the *GT*&*N* couple of variables. It basically constitutes a redefinition and translation of the database description provided in López and Muñoz (2012). A graph of the ten variables is presented in Figure A1.

1. **UN Oil for Food Program (1995-2003)** [+]. Programme developed by UN established in 1995 as a response to Iraqis citizen claims affected by economic sanctions imposed in the aftermath of Gulf War in 1991. The programme allows to Iraq sell petroleum in world markets in exchange of food, medicines, and other humanitarian help, aiming to bind Iraqi military capacity. The programme finishes in 2003. The events referred to this programme are UN resolutions on Iraqi global oil market quotas, similar to the impact of new discoveries.

2. **US relations with Libya and Iran (1996-2004)** [–]**.** Events considered in this category are related to sanctions act imposed to Iran and Libya promulgated in 1996. This act imposes economic sanctions for entrepreneurial-kind relations with Iran and Libya. The programme constitutes a response to the nuclear agenda and support provided to Iran to certain terrorist associations (*Hezbolla*, *Hammas*, and *Jihad*). In 19 December, 2003, Libya announces its intention to leave the nuclear programme as well as massive destruction weapons development and the beginning of a new era of cooperation with the US.

3. **Iraq War and post-war period (2003-2011)** [–]. News related to the US invasion to Iraq in March 2003, and Saddam Hussein capture in December 2003. Also includes events related to the installation of the provisional government in Iraq and reestablishment of Iraq's international affairs.

4. **Iran post Iraq War (start in 2005)** [–]**.** Accounts for events related to justified hearsays of the re-establishment of a nuclear career during the administration of President Mahmoud Ahmadinejad starting in August 2005.

5. **Terrorist attacks** [–]**.** Constitutes events referred to terrorist attacks to productive installations in the Middle East, or terrorist targets. 9/11 attacks are included within this category.

6. **Lebanon War (2006)** [–]**.** Also referred as Israel-Hezbolla War o July War, is a 34-days-long conflict occurred in Lebanon spanning from 12 July to 14 August, 2006; after a ceasefire statement of the UN. The conflict has a *de facto* end in 8 September, 2006 when Israel unblocks maritime restrictions over Lebanon.

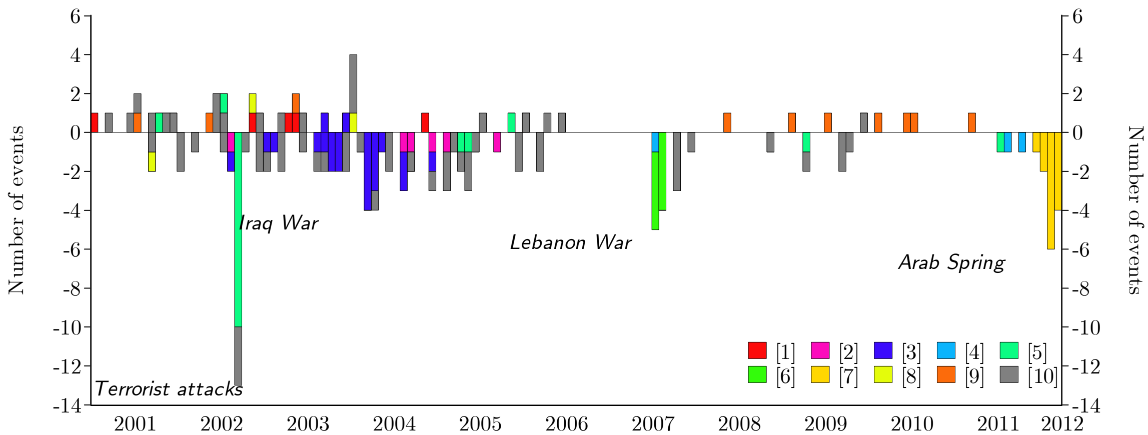
7. **Arab Spring (2011)** [–]**.** Constitute waves of anti-government demonstrations and strikes in Arab countries starting in 18 December, 2010 in Tunisia. Governments of Tunisia, Egypt, Libya, and Yemen were overthrown. Civilian demonstrations were performed in Bahrain and Syria; massive movements strikes in Algeria, Iraq, Jordan, Kuwait, Morocco, and Oman; minor events were adverted also in Lebanon, Mauritania, Saudi Arabia, Sudan, and Western Sahara.

8. **Use of the US Strategic Petroleum Reserve** [+]**.** The Strategic Petroleum Reserve (SPR) is world's greatest for-emergency reserve of oil, which capacity achieves more than 700 millions of barrels. This variable accounts for the US announcements on sales with stabilisation purposes or domestic emergencies. An in-depth and up-to-date analysis in regard of the use of SPR can be found in Demirer and Kutan (2010).

9. **New announcements on discoveries, and site exploration** [+]**.** News related to oilfields discoveries, explorations, and strategic alliances between firms in order to exploit Middle East oilfields.

10. **Purely OPEC announcements [+/−].** Announcements on OPEC's quotas reassignment or major maintenance works. This variable by itself constitutes the *GT&N-O* measure. In contrast, the sum of the previous nine constitutes *GT&N-NO*.

Figure A1: *GT&N* variable composition: all events



Source: Author's elaboration using data from López and Muñoz (2012).

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