Energy Economics 63 (2017) 213–226

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneeco

The relationship between oil prices and rig counts: The importance of lags

Ahmed Khalifa [a,*], Massimiliano Caporin [b], Shawkat Hammoudeh [c,d]

[a] College of Business and Economics, Qatar University, 2713 Doha, Qatar
[b] Department of Statistical Sciences, University of Padova, Via C. Battisti, 241, 35121 Padova, Italy
[c] Lebow College of Business, Drexel University, Philadelphia, PA, United States
[d] Energy and Sustainable Development, Montpellier Business School, Montpellier, France

ARTICLE INFO

Article history:
Received 20 February 2016
Received in revised form 16 January 2017
Accepted 20 January 2017
Available online 6 February 2017

JEL classification:
C22
C58
G11
G15
Q31
Q41

Keywords:
Rig counts
Oil price
Lags
Quantile regression
Quantile-on-quantile

ABSTRACT

This study deals with a timely and relevant issue in the oil market in the wake of the recent drastic drop in oil prices, which is the relationship between changes in oil prices and changes in rig counts, while accounting for other determinants of this relationship. This relationship is of strong interest to analysts, investors and policymakers in the United States and other countries. We empirically verify the impact of changes in oil prices on rig counts, which has lags up to one quarter. This evidence is stable across time and over different linear and non-linear models. The analysis also suggests that the relationship is non-linear, which is verified by both the quantile regression and quantile-on-quantile models. We find evidence of non-linearity that has softened in the most recent years where the relationship between the variables has stabilized.

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1. Introduction

Oil is the most volatile commodity in the world's commodity markets and its price movements have repercussions reverberating throughout the global oil industry and the world economy. Oil prices spiked from a low of about $3.6/barrels in 1972 to a peak of more than $145/barrels in 2008. They then collapsed to reach a nadir of $32 in early 2009, in the heart of the 2007–2009 global financial crisis, but later recovered to exceed $100/barrels by the middle of 2014. More recently, they again plunged by about 70% due to the boom in shale oil and the share-maximization policy by Saudi Arabia, which flooded the oil market with additional production. The fluctuations in oil prices have a strong impact on rig counts, drilling activity, and well productivity. For example, the recent plunge in oil prices has been accompanied with a drastic drop in the drilling activities, which plummeted from the peak of 2460 active rigs on August 30, 2008 to 541 rigs on February 12, 2016 (a 71% fall).[1] The current study investigates the relationship between changes in oil prices and changes in rig counts, while taking into account the flux of other pertinent factors and the significance and relevance of time lags. This relationship is of significant interest for analysts, investors and policymakers, whether they are oil companies, commercial banks or investment banks.

A rig is a machine that rotates the drill pipe from surface in order to drill a new well (or sidetracking an existing one) to explore for, develop and produce oil.[2] Both economic theory and a large body of the existing literature on this topic highlight that a higher price will stimulate

* Corresponding author at: College of Business and Economics, Qatar University, Doha, Qatar.
E-mail addresses: aliabdelkh@qu.edu.qa (A. Khalifa), massimiliano.caporin@unipd.it (M. Caporin), shawkat.hammoudeh@gmail.com (S. Hammoudeh).

[1] Source; http://www.aogr.com/web-exclusives/us-rig-count/2014.

[2] In general, wells can be one of three types: exploratory, development, or infill. For the details about the three types of wells, see (Kellogg, 2014). The rigs can be directional, horizontal and vertical. In the paper, we use the total rig count because the individual rig type may not have an adequate time series.

http://dx.doi.org/10.1016/j.eneco.2017.01.015
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investment in oil fields and vice versa (Kellogg, 2011, 2014). However, the recent relationship between changes in oil prices and rig counts may not be that obvious and direct because of the presence of the lagged response between these variables (Black and LaFrance, 1998).[3] Rig counts can also go silent, while production is going on, as happened in North Dakota recently. Furthermore, the relationship may not be linear, because the effects of changes in oil well productivity, rig efficiency, drilling costs, commodity inflation, hedging, changes in inventories, etc. (Hunt and Ninomiya, 2003), may have an impact on the rig counts, depending on the rig count behavior. Therefore, to quantify and analyze this relationship would require the use of non-linear models.

We investigate how changes in the oil price affect the rig counts and consequently the oil supply. Within this regard, the literature mentions three dimensions.[4] The first dimension is the change in drilling speed, whether positive or negative, over the business cycles, which has been pioneered and well investigated by Osmundsen et al. (2010), and Osmundsen et al. (2012a,b). It also explains the impact of drilling experience, speed and depletion on drilling productivity at the well level. We can include in this dimension what can be described as cream skimming where in our case the costs of drilling and rigs are high initially but then they go down over time because of learning by doing and oil pricing constraints.

The second dimension is the level of oil output from production wells over the business cycles, as investigated by Fattouh et al. (2016).[5] Consistent with these two dimensions, we show evidence supporting the instability of the relationship between these variables over time, and across quantiles of the change in rig counts and oil prices. This suggests that both the market and economic conditions influence the lagged relationship between rig counts and oil price movements. Notably, we observe that changes in rig counts react faster to oil returns when the change in those counts takes values below the counts' median or is not very strong. This observation is consistent with the previous literature such as Kellogg (2014), which finds that the response of drilling activity to changes in price volatility is commensurate with the predictions of the real options theory.

The third dimension is the change in the number of rigs due to the changes in oil prices, with an emphasis on the vital role of lags, which is the main topic of the current paper. There are several reasons that explain the presence and relevance of lags in rig drilling. During periods of lower oil prices, oil companies initially revisit their resources that they reckon un-economic. There are also rig contracts and rigs rented for a number of years, which stand in the way of suddenly terminating drilling activity. The lags are also present during higher oil periods as it takes more time to acquire new leases/concessions, carry out seismic surveys, recruit workers, etc. (Ghoury and Aneesuddin, 2015).

The objectives of this paper are four-fold. The first objective is to explore the relationship between oil returns[6] and changes in rig counts, while accounting for relevant economic and financial variables. The second objective is to shed some light on the variable that is the initiator or the leader of this relationship. If the relationship is not contemporaneous, then the third objective is to determine the exact timing, the potential non-linearity, the time variation and the structural changes in this relationship. The fourth objective is to analyze in which market or under which economic conditions this relationship is stronger or weaker, given the fact that oil prices go through boom, normal and bust periods. Realizing all these objectives is important for decision makers and analysts, alike. For the former, bullishness in the oil market will have an impact on the exploration and production of oil companies, which seek loans from banks by offering their oil reverses as collateral. For the latter, the finding should pave the way for more research when oil prices and rig counts make a major return to higher oil prices and greater rig counts. Given the importance of lags in the oil price–rig count relationship, increases in rig counts should also serve as a precursor of higher oil prices.

This paper contributes to the scant literature in several ways. First, it uses a flux of oil, economic and financial variables that help characterize the lagged relationship between rig counts and oil prices and production and rig counts. Second, methodologically, it uses quantile regression analyses to measure the oil rig count–oil price relationship under normal and extreme conditions, which fits the erratic behavior of oil prices.

Our results show that there is a directional relationship between changes in oil prices and rig counts but with some lags. This is consistent with the practitioners' heuristic literature, which estimated the lag to be between 2 and 3 months, and is coherent with other preliminary analyses, which highlight symptoms of such a lagged relationship. Further, we note that the relevance of the price–rig relationship changes over time but has become stronger and more stable from 2005 onward, even with controlling for the potential impact coming from other economic and financial variables. Further, the non-linear models show that the impact of oil returns on changes in rig counts becomes positive and stronger when changes in rig counts take large negative values, thus focusing on the lower quantiles. On the contrary, on the upper quantiles the relation is weaker and not statistically significant on the extreme quantiles. Notably, these results emerge in a more clear way when we account for lags up to three months, a quarter. Furthermore, when we do the analysis at a finer detail or a nuance of the dual relationship, that is, by conditioning both on the quantiles of the changes in the rig count and oil returns, we show that the impact of oil returns on changes in rig counts is much higher when the oil returns take on very negative values. Therefore, the downside movements in oil prices lead to larger decreases in rig counts, meaning that the oil impact is stronger during bearish oil markets. Again, we observe this evidence within a model accounting for three months lags of oil and is focused on the extreme quantiles of both variables (change in the rig counts and the oil returns). Moreover, by contrasting this result over two different sub-samples, we find that the large impact of the large negative oil returns on rig counts decreases in the most recent years. These findings have implications for the future oil rig counts in the light of the recent 70% in oil prices and for the duration of the prevailing oil glut since the rig counts affect oil production.

The paper proceeds as follows. Section 2 discusses the related literature. Section 3 describes the data and provides a preliminary analysis of oil returns and rig counts. Section 4 introduces the research methodology. Section 5 presents the empirical results and Section 6 concludes.

2. Related literature

There are three strands of the literature that deal with drilling activities. The first strand focuses on drilling productivity and oil prices. Osmundsen et al. (2012a, 2012b), as indicated earlier, pioneered this strand. This strand examines the impact of drilling experience on drilling productivity at the well levels and finds that congestion externalities and depletion effects counteract learning effects. These effects may not be detected at the aggregate level because of averaging out.

The second strand deals with drilling activities under different economic conditions, Fattouh et al. (2016), Baffes et al. (2015), and Dahl and Duggan (1998) explore the impact of uncertainty on the investment decision regarding drilling activities. These authors show that under

[3] In the pre-oil crash period, oil peaked at $145 a barrel in the week that ended July 11, 2008. On the other hand, the rig count kept moving up and until the week that ended November 7, 2008, or 119 days later the crash, despite the fact that oil had plunged 50% from its highs by then. Once the price of oil bottomed out at $34/barrel in December of 2008, the oil rig count continued dropping until the week that ended May 22, 2009, 154 days later. Recently, the price of oil peaked in June 2014, while the rig count peaked 112 days or approximately four months later, that is during the week of October 10, 2014 approached 1604 rigs. Similarly, the price of oil bottomed around March 13, 2015, while the rig count bottomed around June 26, 2015, or 105 days later, when it approached 629 rigs. See Majeure (2015).

[4] The three dimensions are covered in the literature review section.

[5] We have tried to include this dimension implicitly in our estimation process through considering oil and economic variables, oil inventory levels and industrial production associated with the business cycle that affects the demand for oil. We take the U.S. industrial production index (seasonally adjusted from Bloomberg) and the U.S. oil inventory level as proxies for the world industrial production and global oil inventory level, respectively.

[6] "Oil return" is a common concept in the energy finance literature and it is computed as $\log(\frac{p_t}{p_{t-1}})$ where p is the oil price.

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