[The relationship between oil prices and the rig counts: A one-way street with]

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Overview

The study deals with a timely and relevant issue in the oil market, which is the relationship between changes in oil prices and changes in rig counts. This relationship is of significant interest for analysts, investors and policymakers, whether they are oil companies, commercial banks, investment banks, in the United States and other countries. We verify empirically the existence of a positive impact from lagged oil returns (up to one quarter) to changes in rig counts, while taking into account the influence of other pertinent factors. Moreover, we show that this relationship changes over time and is likely to be more complex than what can be captured by a simple linear model. By observing the results of several models, we find a common denominator where all the methods used show that oil returns positively affect changes in rig counts, as is documented by the practioners' literature, with a lag of up to three months. This implies that changes in oil prices are not immediately reflected in changes in the rig counts. Further, we note that the relevance of the price-rig relationship changes over time but becomes 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 stronger when the oil returns take large negative values. Therefore, the oil impact is stronger during bearish oil markets. This result may have an implication for the recent 70% plunge in the oil prices. It implies that the ensuing fall in oil rig counts and the impact on oil prices will be large, but the result will come with a lag. In turn, this has strong consequences for the prevailing oil glut over time. Since the literature shows that changes in oil rig count affect production, then this result is relevant for the duration of the oil glut as it must be shorter than the market expects, or it may point to a significant drop in U.S. oil production but with a lag.

Methods

We now consider the analysis of the relationship between the changes in rig counts and the oil returns by means of quantile methods, thus underscoring the potential of non-linearity and asymmetry across the quantiles of the variables. Given the discussion and evidences of the previous section, when moving to the analysis of the quantile regression models, we focus only on the specifications where the change in rig counts is the dependent variable. Moreover, as we plan to consider the possible non-linear impact from oil returns on the changes in rig counts, as modelled by means of the quantile regression and the quantile-on-quantile analyses, we allow for two possible lag designs. In the first case, we include among the quantile covariates three monthly lags of oil returns, while in the second we consider the previous quarter oil return lag only. We also include in both cases the last period's lag for the change in oil productivity as a further empirically relevant covariate. We exclude all the additional covariates adopted in the linear model of Eq. (10) as they turned out to be of a limited statistical significance over the full sample.

We thus consider the following models for the conditional quantiles

$$Q_\tau(\Delta Rig_t) = \delta_{0,\tau} + \delta_{1,\tau}\Delta Rig_t + \delta_{2,\tau}R^{Oil}_{t-1} + \delta_{3,\tau}R^{Oil}_{t-2} + \delta_{4,\tau}R^{Oil}_{t-3} + \delta_{5,\tau}\Delta RProd_{t-1} \quad (1)$$

$$Q_\tau(\Delta Rig_t) = \delta_{0,\tau} + \delta_{1,\tau}\Delta Rig_t + \delta_{2,\tau}\left(R^{Oil}_{t-1} + R^{Oil}_{t-2} + R^{Oil}_{t-3}\right) + \delta_{3,\tau}\Delta RProd_{t-1} \quad (2)$$

The use of a single covariate associated with the oil returns also allows for using the specification of a quantile-on-quantile model

$$Q_{\tau,\theta}(\Delta Rig_t) = \alpha_{\tau,\theta} + \delta_{1,\tau,\theta}\Delta Rig_t + \delta_{2,\tau,\theta}\left(R^{Oil}_{t-1} + R^{Oil}_{t-2} + R^{Oil}_{t-3}\right) + \delta_{3,\tau,\theta}\Delta RProd_{t-1} \quad (3)$$

where the first quantile index, τ, refers to the change in rig counts, while the second quantile, θ, points to the quarterly oil return.

We emphasize that the quantile models exclude all the covariates previously analyzed in the linear model with the exception of the rig productivity, which is the most relevant covariate for changes in the rig counts. With too many parameters to estimate (that is with many covariates), the efficiency of the estimators gets lower and we might end up with no significance at all. Further, we do not estimate the previous models on the full sample as even the simple linear specification shows parameter instability. We thus start directly with the rolling evaluation of the quantile regression models in Eqs. (1) and (2).

Results

We emphasize that the quantile models exclude all the covariates previously analyzed in the linear model with the exception of the rig productivity, which is the most relevant covariate for changes in the rig counts. With too many parameters to estimate (that is with many covariates), the efficiency of the estimators gets lower and we might end up with no significance at all. Further, we do not estimate the previous models on the full sample as even the simple linear specification shows parameter instability. We thus start directly with the rolling evaluation of the quantile regression models in Eqs. (1) and (2).

Notably, when estimating the quantile regression models, we recover the coefficients that are quantile-specific. Therefore, despite Eqs. (1) and (2) having a limited number of parameters to estimate, the total number across quantiles and over a rolling scheme is too large to be included in a table. We thus decide to provide a first graphical evaluation monitoring the statistical significance of the estimated coefficients. We fix the quantiles we consider in the range 0.1 to 0.9 with a 0.1 step. Moreover, we fix the estimation window to 120 data points (ten years as we use monthly frequency), and we roll the sample with a 1-month step. Reminding that the full sample has a size of 298 months, we have a sequence of 179 estimates of the models in the previous equations, each is based on a different 120-month window. For each of those 179 estimates of the models, we count across quantiles the fraction of statistically significant coefficients associated with the change in rig counts, oil returns and the change in rig productivity. If a covariate is always statistically significant in causing the change in rig count quantiles (across the 9 quantiles we consider), the plot will reach the 100% level.

Conclusions

The quantile regression outcomes confirm the importance of lagged oil returns in the causation of change in rig count quantiles, with increased statistical significance from 2005 onward. However, the impact seems to be constant across the quantiles, thus suggesting the appropriateness of linear specifications. To better understand the nature of the information flow from oil returns to change in rig counts, we fit a quantile-on-quantile regression, where we condition coefficients on quantiles of both oil returns and the change in rig counts. We find that the relationship between the variables is stronger and less stable in the below the median quantiles of change in rig counts. Moreover, we note that the impact of oil returns on the changes in rig counts becomes higher when the oil returns take on values in the lower quantiles. Therefore, oil impact is stronger during bearish oil markets. This result may have an implication for the recent 70% plunge in the oil prices. It implies that the ensuing fall in oil rig counts will be large, but it will come with a lag. In turn, this has strong consequences for the prevailing oil glut over time. Moreover, since the literature shows that changes in oil rig count affect production, then this serial result is relevant for the duration of the oil glut as it must be shorter than the market expects, or it may point to a significant drop in U.S. oil production but also with a lag.

However, we also note that the impact is stabilizing in the recent years, moving the relationship across variables toward linearity, even if with the presence of lags. A linear relationship, thanks to its simple structure, allows for immediate analyses coming from changes in the covariates, which in this case are the oil returns. Therefore, irrespective of the size of the changes in rig counts or of oil returns, we are able to evaluate the consequent future evolution of changes in rig counts, thanks to the presence of lags. Finally, we stress that in the above median changes in rig count quantiles, the relationship is stable and positive, implying that bullish oil markets increase the rig counts. It is possible the shale oil boom is a confounding factor in the relationship, which shows significant structural breaks.

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