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Centre for Energy Policy and Economics
Swiss Federal Institute of Technology Zurich



3rd International Workshop on Empirical Methods in Energy Economics (EMEE2010)

Surrey Energy Economics Centre (SEEC)

University of Surrey, UK

24th – 25th June 2010

NOTE:

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THE DYNAMIC RESPONSE OF THE CRUDE OIL SUPPLY TO CHANGES IN CRUDE OIL PRICES

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Overview

The stream of literature analyzing the relationship between the supply and prices of crude oil is anchored by the seminal work of Griffin (1985). Subsequently, a number of authors have either updated (Jones, 1990; Ramcharran, 2002) or extended Griffin's work (Dahl and Yücel 1991; Smith 2005; Alhajji and Huettner, 2000; Ringlund et al., 2008; Kaufmann et al., 2008). However, this literature mostly focuses on the concurrent effect of oil prices on the supply of oil. It also mainly addresses the question of whether OPEC countries exhibit production patterns that are significantly different from those of key non-OPEC countries.

We believe that significant gaps remain in this literature, both methodological and in terms of the analytical focus. Thus, we analyze the response of oil supply to both current and past price signals and look at the dynamic response to past price changes in detail. The availability of comprehensive monthly crude oil production data allows us to address this question both for groups of countries and on the level of individual countries.

Furthermore, while the distinction of crude oil producing countries into OPEC and non-OPEC may have been appropriate in the past, we believe that a further subdivision of non-OPEC countries is warranted. Therefore, we distinguish within the group of non-OPEC countries between OECD and non-OPEC/non-OECD countries and organize our analysis around the three major groups OPEC, OECD and non-OPEC/non-OECD.

We address methodological issues in the existing literature through a more comprehensive set of control variables, such as an index of global real economic activity, a proxy for investment expenditures and countries' institutional quality.

Data and Empirical Methodology

Data

We compile a comprehensive dataset at monthly frequency covering the majority of the world's countries and virtually all of global crude oil production. The dataset contains oil production data and oil prices, in addition to a number of important control variables, which are either new to the literature or have been underutilized to date.

In particular, we draw both crude oil production data for the period 1994-2009 and WTI crude oil prices from the EIA. Furthermore, we use country-level rig count data from Baker Hughes as a proxy for investment (Ringlund et al, 2008) in oil exploration and production. Moreover we control for real global activity by computing an index based on the Baltic Dry Index, similar to Kilian (2009). Using this index replaces GDP as a control variable. While allowing us to control for the key aspects of aggregate global demand, the index is available at a much higher frequency than GDP and not subject to the distortions caused by exchange rates. Finally, we control for institutional quality by using an average of the six country-level governance indicators provided by the World Bank's Worldwide Governance Indicators (WGI) Project (World Bank, 2010).

Methodology

Most of the current literature based on Griffin (1985) uses logarithms of prices and quantities in their analysis. However, especially the price variable is clearly non-stationary, thus providing spurious results in unadjusted OLS regressions. Kaufmann et al. (2008) adapt their estimation to the presence of non-stationarity by using two different approaches, dynamic OLS and VEC models. However, Kaufmann et al. (2008) typically find more than one cointegration relationship for each country, leading to multiple sets of estimation results and thus to a loss of analytical clarity.

We address non-stationarity and trend stationarity by differencing the non-stationary series and removing trends in the trend-stationary cases, respectively. This allows us to carry on with the estimation in a simple linear manner, providing clearer results.

Another contribution is to analyze the response of the crude oil supply to multiple lags of prices. We include concurrent prices, as well as lagged monthly prices and, for periods further removed, either quarterly or annual averages. The lagged prices cover a period of up to approximately 10 years, allowing us to capture medium and longer term price effects.

To separate the effects of past investment on current output from pure price effects, we include current and past investment as control variables. However, to avoid collinearity and

facilitate analytical clarity we filter out the effects of prices on investment by only including the portion of investment that cannot be explained by a number of lagged price changes.

(Very) Preliminary Results

We begin our analysis using data aggregated according to the groups OPEC, OECD and non-OPEC/non-OECD. We find significant differences in the response of the oil supply among the three groups. Generally, the crude oil output in OPEC countries tends to react to changes in prices only in the intermediate term, with a lag of at least one year, while the output in non-OECD/non-OPEC countries reacts faster, showing a reaction time of slightly less than one year. OECD production tends to react even faster, exhibiting significant movement within the first year of price changes.

However, while OPEC output reacts more slowly, it reacts more strongly quantitatively than in either OECD or non-OPEC/non-OECD. These results are consistent with the hypothesis that OPEC countries tend to manage their output more deliberately, while the output in non-OPEC/non-OECD countries, and particularly in OECD countries, is more strongly dominated by profit-maximizing private producers reacting to price signals more immediately.

Having production data and the full set of control variables available on a country level we disaggregate the analysis to individual countries of interest, representing each of the three groups. Results for this section still need to be derived

Summary and Conclusion

In conclusion, our analysis is based on a dataset that extends beyond what is generally available in the existing literature in terms of scope. Therefore, we are able to isolate the dynamic effects of prices on quantities more precisely than is possible in the existing literature, given that we can control for the effects of past investment, real global economic activity and country-specific institutional quality.

We show that the distinction into three groups of countries, namely into OPEC, OECD and non-OPEC/non-OECD, as opposed to the customary distinction into OPEC and non-OPEC, is warranted. The pattern of production reacting to prices is distinct by group, with the OECD countries' production reacting most rapidly, non-OPEC/non-OECD showing a somewhat more delayed reaction, and OPEC reacting slowest. However, while the reaction of OPEC's output is delayed it is stronger than that of the other two groups.

Key References

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