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DETERMINANTS OF GLOBAL OIL PRODUCTION – EMPIRICAL EVIDENCE FOR MORE THAN SHORT RUN CARTEL RENT MAXIMIZATION

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OVERVIEW

We analyze empirically how past oil price realizations affect oil production based on a rich dataset on crude oil production, prices, real economic activity and institutional quality, mostly at monthly frequency. Following a descriptive analysis we derive two main hypotheses: First, we test if a large part of oil price changes is reflected in oil production changes only with a certain lag. Second, we suppose that the reaction of oil production to oil price changes is heterogeneous across different countries, as well as across the main country groups OPEC, OECD and non-OECD/non-OPEC. The evidence supports both hypotheses. Both propositions have important implications for the academic and policy debates on issues such as climate policy, the functioning of cartels and long run oil supply dynamics.

METHOD

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, oil prices and a number of additional control variables. We control for real global activity by means of the Baltic Dry Index (BDI), deflated by U.S. CPI [1]. The BDI is significantly correlated with global real economic activity [1]. We use the oil rig count as a proxy for investment in oil production capacity. Finally, we control for institutional quality using the six country-level governance indicators provided by the World Bank's Worldwide Governance Indicators (WGI) Project [2].

Much of the existing literature on the response of oil output to price changes [3-6] uses logarithms of prices and quantities. However, especially the price and quantity variables are clearly non-stationary over the sample period we consider [7], thus providing spurious results in OLS regressions. We trade off information content in the data in favor of analytical clarity by first taking logs and then applying the *Hodrick-Prescott-Filter* (HP) to achieve stationarity.

Our identification strategy for the effect of prices on crude oil production is based on a two-step approach. Before estimating our main regression model we isolate the effects of oil prices on oil investment and real activity by only including the portion of these two variables that cannot be explained by a number of lagged price changes. This approach removes the possibility for oil prices to work through our proxies for investment and real activity as well as through the price variable itself, thus facilitating more precise identification of the effect of prices on quantities. We first regress the BDI and the rig count (RIG) on a number of lags of oil prices, as follows:

$$RIG_{t,i} = \alpha_i + \sum_{s=0}^{S} \beta_{s,i} WTI_{t-s} + \varepsilon_{t,i} \quad (1)$$

$$BDI_t = \varphi + \sum_{s=0}^{S} \gamma_s WTI_{t-s} + \mu_t \quad (2)$$

where BDI_t and RIG_{it} are the HP filtered logarithm of the BDI and rig count, respectively. WTI_t is the HP filtered log of the real WTI price. S denotes the lag order for both auxiliary regressions. We choose $S = 7$, i.e. we include a total of eight time periods, in this case quarterly averages, of the WTI price. The residuals from these OLS regressions, $\overline{REAL_t}$ and $\overline{I_{it}}$, are proxies for real economic activity and investment into oil production capacity, respectively, that have been purged of the influence of prices.

We then include $\overline{REAL_t}$ and $\overline{I_{it}}$ into our main regression model, as follows:

$$Q_{t,i} = \omega_i + \sum_{k=1}^{K} \delta_{k,i} WTI_{t-k} + \sum_{l=1}^{L} \theta_{l,i} \overline{I}_{t-k,i} + \sum_{m=1}^{M} \tau_{m,i} \overline{REAL_{t-m}} + \Psi_i INST_{t,i} + \eta_{t,i} \quad (3)$$

where $Q_{t,i}$ is the HP filtered crude oil output by group or country, respectively, WTI_t the log of the real oil price, $\overline{I}_{t,i}$ the residuals from (1) and $\overline{REAL_t}$ the residuals from (2). $INST_{t,i}$ is a matrix containing the six governance indicators. We include ten years of lags for both the crude oil price and BDI residuals and five years of lagged investment residuals, due to data constraints. Thus, we analyze short-term, medium-term and longer term responses of crude oil production.

RESULTS

We conduct the analysis for three main groups of countries, OPEC, OECD and non-OECD/non-OPEC, as well as for selected countries from each of the three groups representing the majority of each group's oil output. In the case of OPEC crude oil production responds to prices pro-cyclically in the short term and counter-cyclically in the medium to longer term. OECD production responds counter-cyclically across the entire lag spectrum, which is consistent with a target revenue approach. Non-OECD/non-OPEC responds positively in the short term and is thus consistent with competitive behavior. However, heterogeneity regarding the price response of output exists not only on the group level but also on the individual country level.

The results for the remaining explanatory variables also conform to our two hypotheses. Output responds positively to investment in the cases of OPEC and non-OECD/non-OPEC, while exhibiting a significant negative effect for the group of OECD countries. Real economic activity has a strong and sustained positive effect on crude oil output in OECD countries across the range of time lags, while production in non-OECD/non-OPEC countries also reacts positively to real economic activity, although mainly in the medium to longer term. OPEC production reacts to real economic activity in a counter-cyclical manner. Institutional quality indicators exhibit the least heterogeneous output effects of all our explanatory variables on the group level, while also being heterogeneous at the country level.

CONCLUSIONS

We find that oil output reacts to the entire lag spectrum of our explanatory variables, thus confirming our first hypothesis. Furthermore, substantial heterogeneity exists in the response of oil output to our control variables in most cases, thus confirming our second hypothesis.

Overall, through our dynamic analysis we find additional support for some results in the existing literature regarding the price response of oil output, while also uncovering new evidence. In particular, there appears to be significant income smoothing for the group of OECD countries by adjusting output to prices counter-cyclically, once we account for the remaining control variables. Furthermore, we conclude that the behavior of some countries appears to be more similar to countries that are part of the other groups than they resemble members of their own groups.

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