Market behavior of OPEC countries: An Application of Panel data Models

Massimo Filippini, Mozhgan Alaeifar, Mehdi Farsi.
Centre for Energy Policy and Economics
Department of Management, Technology and Economics, ETH Zurich
Zurichbergstr. 18, CH-8032 Zurich, Switzerland
Tel. +41-44-632 7561, Fax. +41-44-632 10 50
and
Department of Economics, University of Lugano
mfilippini@ethz.ch,malaeifar@etzh.ch, mfarsi@ethz.ch

Overview

Given the strategic importance of oil as a primary energy source and the complex dynamics of the world oil market, it is important to analyze the behavior of oil producing countries especially Organization of the Petroleum Exporting Countries. Since the 1973 oil shock, OPEC has been at the center of attention and considered as the main responsible for the following excessive increases in oil prices. There has been a long debate within the economic literature about the nature of OPEC and its power to influence the oil markets, whether it acts as a cartel or as a trade organization of competing producers. Although many empirical studies have been conducted, there is no conclusive and clear evidence on the behavior of OPEC and its members. This literature is characterized by a variety of approaches and conflicting interpretations. However, most studies have focused on time-series approaches using high-frequency observations with separate analyses for individual countries. The panel aspects of the data and their use in accounting for unobserved differences among countries have been hardly investigated.

The main goal of this study is to make a contribution in the econometric models used to analyze the OPEC's behavior. The adopted models are based on a modified version of Griffin's (1985) approach, mainly focusing on the Collusive and Competitive behavior among OPEC countries. The empirical analysis is also used to investigate how the rate of crude oil production by individual OPEC states is affected by different variables.

Several previous studies (*e.g.* Jones, 1990; Carol Dah1 and Mine Yucel, 1991; Ramcharran, 2002 and Kaufmann et al., 2004) have analyzed the collusive, competitive and monopolistic behavior of OPEC and its power to influence the market. For example, Griffin (1985) claims that "OPEC appears to be a real cartel with at least partially effective output coordination" while Gulen (1996) suggests that "OPEC did not act as a cartel in the 1980's in order to maintain prices, while it took the advantage of market condition in 1970's and did not have to restrain output." On the other hand, Kaufman et al.

(2005) reject the long standing belief that OPEC members pay little or no attention to their quota while Alhajji and Huettner (2000b) state "even after 1983, members did not follow their quota". Despite a plethora of interpretations of these studies the empirical evidence about OPEC behavior remains inconclusive. This discrepancy among the findings in the literature could be explained by the fact that individual countries have different behaviors depending on a wide variety of unobserved factors related to their various economic and political structures. Moreover, because of the lack of precision of the available data on demand and costs, it is difficult to distinguish collusive from competitive behavior for oil producers.

The main novelty of this paper is in using panel data models and econometric specifications that can better handle the unobserved heterogeneity in the production behavior of oil producing countries. A better ability to investigate the robustness of the results is also another important benefit of using panel data models. To our knowledge none of the previous studies in this field has used the panel data models to account for heterogeneity among countries. Moreover, in comparison with previous studies this paper uses a sample period that includes both phases of rising and falling prices. Therefore, the results should provide better estimates of production under price fluctuations. Including new variable such as "production capacity" allows us to explore whether a country would potentially increase production in response to higher prices, should it have the required extra capacity. Because in fact, only the countries that operate sufficiently below their full capacity can increase production in response to higher prices. In addition, including quota levels allows us to assess the extent to which the members' cooperation determines the production.

Specification and Methods

This study analyzes market behavior for OPEC countries, based on the model proposed by Griffin (1985) for an individual country *i*'s production. Our modification to Griffin model in addition to use of panel data models which have been mentioned earlier, starts from adding new variables such as quota (in line with Kaufman et al., 2004) and production capacity. The adopted model can be written as follows:

$$\ln Q_{it} = \alpha_i + \gamma_i \ln P_t + \beta_i \ln Q_{it}^{OO} + \lambda_i \ln Quota_{it} + \delta_i \ln PRC_{it} + \varepsilon_{it} \quad (1)$$

where subscripts i and t respectively represent the country and year, P is the real price of crude oil and Q_{it}^{OO} is the total quantity of crude oil produced by all OPEC members except country i. $Quota_{it}$ is official quota set by OPEC, and PRC_{it} represents the country's production capacity. Using a data set for ten OPEC nations (excluding Iraq) over a 24-year period, this paper applies a panel data model, e.g. GLS model to analyze the production behavior of OPEC countries. In order to validate the conclusions and to better identify the characteristics of OPEC behavior, we also analyze the data for individual countries and compare the results with those obtained from panel data models.

Results

Estimation results from the random coefficient model provide negative and significant relationship between price and production for three countries: Saudi Arabia, United Arab Emirates (UAE) and Indonesia. These results show a certain contrast with previous studies. For instance, Griffin (1985) found negative relationship between price and production for Kuwait, Qatar, Libya and Venezuela (quarterly data, 1971: I to 1983: III), Jones (1990) reports this negative relationship only for United Arab Emirates and Kuwait (quarterly data, 1982: IV to 1988: IV) and Ramcharran (2002), find this for seven states with annual data (1973 – 1997). These differences can be partly explained by the additional variables in this study.

The negative elasticity of supply represents backward bending supply curve suggesting the presence of target revenue to cover investment needs for some members. The differences between the magnitudes of price elasticity might be related to capacity utilization, defined as the ratio of production to maximum production capacity (Kaufmann et al., 2004). Market sharing behavior for OPEC can be seen from the changes in a country's production resulting from the production changes in the rest of OPEC countries. According to Griffin (1985), elasticity equal to one indicates constant market sharing behavior and a value greater than zero represents partial market sharing behavior. The estimation results indicate that most of OPEC countries have elasticity greater than zero implying that they respond to changes in production by other OPEC members. The effect of quotas on production reflects output coordination behavior among members. Elasticity equal to one indicates entire output coordination while a value equal to zero denotes absence of output coordination among members. The results indicate all members respond to their quotas but do not strictly adhere to their assigned levels.

Conclusion

Using a panel dataset from oil producing countries, OPEC, this paper has studied market behavior of these countries over 24 years. A random-coefficient model has been applied to explore the effect of unobserved heterogeneity across different countries. Compared to time series data which have been widely used in this area, panel data models provide a better statistical efficiency through pooling the data across countries and a better control for "omitted variables bias" (Swamy and Tavlas, 1995) and heterogeneity bias in the coefficients' estimates.

From the results some important issues with respect to market behavior can be pointed out. First, OPEC's production behavior can be best explained by a partial market sharing behavior. The results of this study suggest that cartel behavior has not been achieved during the sample period. This can be explained by the absence of a monitoring system and a punishment mechanism for cheaters. Second, the results support the hypothesis of output coordination (but in an imperfect way) among all members.

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