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

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# Introduction

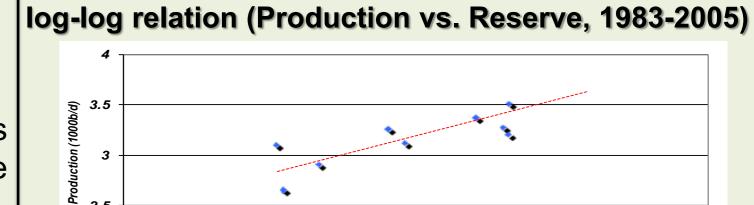
The strategic importance of oil as a primary energy source and the complex dynamics of The data are collection of ten OPEC countries the world oil market provide considerable interest in studying the behaviour of oil (excluding Iraq) for which there are the same economic variables-such as real price of oil, producing countries such as OPEC's and its role in the international oil market. individual crude oil production, production capacity 4.5 Reserves (1000b/d) and proven—collected annually for 24 years from 3.5 5.5 Despite the large number of studies, being conducted to examine the structure of the 1983 in which quota system was implemented to log-log relationship approximates a straight line with a world oil market and analyze the behavior of the OPEC countries, still the nature of OPEC 2005. The data obtained from the OPEC Annual slope less than one which indicates that production Statistical Bulletin. rises when reserves increase, but the share of and its power to influence the oil markets remain inconclusive. reserves produced falls. We believe that OPEC countries can act as a cartel The conflicting interpretations of OPEC and its influence on the world oil market were when they are able to respond to market swings (up Log-log relation (Production vs. Capacity, 1983-2005) built from various hypotheses such as competitive and collusive behavior. Models based and downward changes in demand). Therefore production capacity, reflecting the ability of members on collusive behavior can be used to throw some lights on how and in what aspects the to quickly increase their production and proven OPEC behavior deviates from a completely effective cartel. But, from an empirical reserves, known as deposits that could have been tapped to expand capacity are added to the model. standpoint, it is generally difficult to distinguish these hypotheses by means of the observed price and production data. In order to have a better analysis of country specific Production Capacity(1000 b/ behavior the current study benefits from using It approximates a straight line with a slope equal to individual spot prices of each member at real term one which indicates that production rises as installed **Model Specification** rather than official prices. capacity increases (with almost the same proportion). Goal of this study Model I, is a production based model which assumes market shares could vary with price (official price), this is **Estimation Results** The main goal of this study is to make a estimated via panel data model. contribution in the econometric models used to  $\ln Q_{it} = \alpha + \gamma \ln P_{t} + \beta \ln Q_{it}^{OO} + \varepsilon_{it}$ Estimation results suggest that : analyze the OPEC's behavior.

### **Data Description**

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But rather than aiming to distinguish cartel hypothesis from competitive or to identify which one of the alternatives hypothesizes can better explain the observed behavior, we focus only on collusive behavior with a perfect cartel behavior as a comparison basis. Hence, we aim to answer :

Model II, similar to previous model but based on individual price element and a dynamic trade patterns of OPEC member in order to depreciate the prices.

 $\ln Q_{it} = \alpha_{i} + \gamma_{i} \ln SP_{it} + \beta_{i} \ln Q_{it}^{00} + \varepsilon_{it}$ 

Evidence against an effective cartel among member is stronger than cooperative behavior (comparing) estimated market share coefficients show that some sort of cooperative action might exist among members but statistical evidence to show that to what extent OPEC members cooperate are weak and remain in question).

>Even the typical OPEC member behaves differently from a perfect cartel dose not follow any of the market sharing variants.

>How and in what aspects the OPEC behavior deviates from an effective cartel model.

>How the individual rate of oil production is affected by different variables such as individual spot prices instead of official prices, production capacity and proven reserves.

# Main Novelty of this Study

The adopted models are based on a modified version of Griffin's (1985) approach, focusing on the Collusive behavior. But this study differs from Griffin's study from many aspects as following:

> Using empirical analysis to investigate how the rate of crude oil production by individual **OPEC** states is affected by different variables (such as production capacity and proven reserves)

Using individual spot prices of each member at real term rather than official prices.

Sample period (includes both phases of rising) and falling prices)

 $Q_t$  is total quantity of crude oil produced by member i

- is the real price of crude oil (official price) at time t
- *P<sub>it</sub>* is the real price of crude oil (Spot price) at time t
- $Q_t^{oo}$  is the total OPEC production rather than country i
- Model III, production capacity and proven reserves have been added to the model.

#### $\ln Q_{it} = \alpha_{i} + \gamma_{i} \ln P_{t} + \beta_{i} \ln Q_{it}^{00} + \mu_{i} PRS_{it} + \phi PRC_{it} + \delta_{i} war1_{t} + \delta_{i} war2_{t} + \delta_{i} war3_{t} + \varepsilon_{it}$

 $\geq$  production capacity, reflecting the ability of members to quickly increase their production have been tapped to expand capacity are added to

model

warı Persian Gulf war (1986-1989, Low price period) war2 Persian Gulf war (1990-1992, Mild price increase) war3 Persian Gulf war (2000-2005, High price period)

### Hypothesis tests

**Constant Market-Sharing**  $(\gamma = 0, \beta = 1, \mu = 0, \phi = 0)$ 

>Market-Sharing  $(\gamma \neq 0, \beta = 1, 0 < \mu < 1, \phi > 0)$ 

**Partial Market-Sharing**  $(\gamma \neq 0, \beta > 0, 0 < \mu < 1, \phi > 0)$ 

>When individual spot price at real term is considered (Model II) deviation from cartel hypotheses are more obvious than the Model I, because :

*First*, the individual price is based on actual selling price and these prices are set by individual members while official prices are set by the cartel authority.

Second, price depreciation has been done based on the dynamic trade patterns of the OPEC, which includes most trading partners of OPEC countries. Therefore the results by Model II are more reliable than Model I.

>Comparing all estimation results show that results obtained by Model III favors more reality the other models because adding proven reserves and production capacity to the model have led the members to > proven reserve, known as a deposit that could show their actual behavior based on their capacity and total remaining reserves.

> > Estimation results show that after accounting for unobserved heterogeneity, none of the OPEC members appear to follow market sharing variants of cartel model, inconsistent with Griffin (1985')s results. Therefore the use panel data model in this study seem to be promising because:

OPEC members operate in different countries with various production policy, geo-political factors and different extraction cost. Many of these characteristics are not observed or difficult to measure. Such omitted variables could have an important effect on estimation results that can be better accounted for in panel data.

Coefficient	RC Typical country	Algeria	Indonesia	Iran	Kuwait	Libya	Nigeria	Qatar	Saudi Arabia	UAE	Venezuela
price	0	0.08**	0.02	-0.01	-0.02	0.02	0.04	-0.03	-0.01	0.0	-0.06*
production by rest	0.72**	0.55**	0.17**	0.75**	1.37**	0.74**	0.63**	0.62**	1.03**	0.81**	0.56**
Proven Reserves	0.13*	0.09	-0.04	0.1	0.45**	0.17**	-0.01	0.25**	0.23**	0.15**	-0.08
Production Capacity	0.61**	0.74**	0.58**	0.08	1.11**	0.66**	0.43**	0.75**	0.89**	0.40**	0.44**
war1	0.01	0.11**	0.02	-0.06	0.06	0.03	0.07	-0.09	0.08	-0.02	-0.06
war2	0.07*	0.07*	0.04**	0.04	0.01	0.08**	0.08**	0.16**	0.15**	0.02	0.02
war3	-0.05	-0.01	-0.03	-0.04	-0.11**	-0.08**	0.07	-0.28**	-0.11**	-0.03	0.10**
Constant	-5.72**	-4.83**	1.55	-1.03	-19.72**	-6.76**	-2.06	-6.86**	-11.90**	-5.3**	-0.24

Dissimilar to Griffin, this study tests whether the endogeneity problems are important enough to warrant our estimation results.

Using panel data models and econometric specification, such as Random Coefficients models can be considered as the main novelty of this paper.

Panel data models can provide a more accurate estimation while accounting at least partially for the unobserved heterogeneity, depending on crosscountry variation, among member countries.

pooling the information across countries could allow a more accurate estimation of the effect of observed parameter vector: variables especially when typical OPEC country is of interest.



# **Estimation Methods**

Estimation methods are based on Panel data models mainly "Random coefficient model" as follows:

$$y_{it} = \sum_{k=1}^{K} \beta_{ki} x_{kit} + e_{it}$$
$$\beta_i = (\beta_{1i} \dots \beta_{ki})$$

can be seen as the individual deviation from the common mean. In Random coefficient intercept and all explanatory variables vary across countries and each panel-specific is related to an underlying common

$$\beta_i = \beta + u_i$$

	R	Random Coefficient					
Hypothesis	Model I	Model II	Model II				
Constant market sharing	-	-	-				
Market sharing	-	-	-				
Partial market sharing	Algeria, Qatar, Saudi Arabia and UAE	Qatar	-				



