Modeling OPEC Production

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Important Questions

What is the nature of OPEC as an organization?
How do prices affect OPEC production?
Are production decisions asymmetric?

Opec Supply Behavior

Competitive Behavior--Positively sloped Demand Curve

Cartel Model--Control output to raise prices

Target Revenue Model--Limited Absorptive Capacity

Property Rights Model--Uncertainty about future ownership

Empirical Analysis

$$\mathrm{Ln}\ Q_{it} = \alpha_i + \gamma_\iota\ \ln P_t + \beta_i\ Q^{OO}_{it} + \varepsilon_{it}$$

$\gamma_\iota > 0$ Competitive behavior

$\gamma_\iota < 0$ Non-competitive behavior

$\beta_i = 1, \gamma_\iota = 0$ Constant market sharing

$\beta_i = 1, \gamma_\iota \neq 0$ Market sharing

$\beta_i > 0, \gamma_\iota \neq 0$ Partial market sharing

Griffin, J.M. 1985, Opec behavior: a test of alternative hypotheses *American Economic Review* 75(5) 954-963

Previous Results

Results

- γ generally is negative
- β generally is non-zero

Implicit Assumptions

- Variables cointegrate
- Price is independent variable, production is dependent variable
- These assumptions are rejected

Methodology: Step 1

Expand Equation

$$\text{Ln } Q_t = \alpha + \gamma \ \text{ln}P_t + \beta \ \text{ln } Q^{OO}_{it} \ \lambda \ \text{Behavior} + \ \varepsilon_{it}$$

Behavioral variables

- Quota
- Installed capacity
- Reserves

Methodology: Step 2

Estimate Cointegrating Relationships

Test for cointegration

Estimation Technique

DOLS (Stock & Watson, 1993)

VECM (Johansen, 1991)

Methodology: Step 3

Estimate Short-Run Dynamics

- Exogenous vs endogenous
  - Is error correction term for DOLS estimate zero?
  - Are error correction terms in VECM equal to zero?

Methodology: Step 4

Test for Asymmetry

Decompose DOLS Residual

$$^{+}\mu_t = (\Delta \text{Variable} > 0) * \mu_t$$

$$^{-}\mu_t = (\Delta \text{Variable} < 0) * \mu_t$$

Estimate error correction model

$$\Delta Q_t = \alpha + {}^{+}\gamma * {}^{+}\mu_{t-1} + {}^{-}\gamma * {}^{-}\mu_{t-1}$$

Test symmetry hypothesis

$$^{+}\gamma = {}^{-}\gamma$$

Results: Is Production Exogenous?

- Both ADF and lambda statistics indicate cointegration
- Error correction term associated with lagged residuals from DOLS estimate are statistically significant
- One or more of the error correction terms in the production equation of the VECM are statistically significant

Results: Do OPEC Nations "Obey" Quotas

	β	β = 1
Indonesia	0.079	1.60
Iran	1.00	1.42
Libya	1.24	2.52
Nigeria	0.656	2.63
Saudi Arabia	0.942	1.66
UAE	0.482	172.7
Venezuela	0.54	3.22

Values in red reject null hypothesis at $p < .05$

Results: How Do Prices Affect OPEC Production?

	β	Utilization Rate
Indonesia	--	0.91 ± 0.04
Iran	--	0.87 ± 0.13
Libya	0.100	0.86 ± 0.13
Nigeria	0.258	0.93 ± 0.09
Saudi Arabia	3.349	0.74 ± 0.11
UAE	2.686	0.82 ± 0.10
Venezuela	0.137	0.86 ± 0.11

Values in red reject the null hypothesis at $p < 0.05$

Methodology Are OPEC Decisions Asymmetric?

	Price	Quota
Indonesia	-0.09 -0.84	--
Iran	-0.85 -0.51	--
Libya	--	-1.28 -0.46
Nigeria	--	--
Saudi Arabia	--	--
UAE	--	--
Venezuela	--	--

Values in yellow are $^{+}\gamma$ Values in red are $^{-}\gamma$

General Finding

- OPEC is an effective cartel that influences production by assigning quotas
- Higher oil prices are an incentive to most OPEC nations to increase production
- There is some evidence that production responses are asymmetric

What Will You Hear At Future LINK Meetings?

- What determines OPEC quotas?
- What determines installed capacity?