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OPEC and the international oil market: Can a cartel fuel the engine of economic development?

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Abstract

The OPEC cartel was formed to promote two economic goals, one microeconomic — low oil market volatility — the other macroeconomic — promotes economic development of its members. These goals create a tension since the cartel's single tool is output quotas. Using this dual micro/macro perspective we analyze oil exporting countries' behavior. We find that the effects of the cartel's choices will be reflected in oil market stability, long-term macroeconomic development, and international oil market structure. If an oil producing country cares about both oil industry profits and macroeconomic stability, the goal of output stability may be inconsistent with cartel membership.

JEL classification: F4; L1; O1; Q4

Keywords: Oil market volatility; Oil market structure; Economic development

OPEC is an international Organization of eleven developing countries which are heavily reliant on oil revenues as their main source of income. Membership is open to any country which is a substantial net exporter of oil and which shares the ideals of the Organization.

Since oil revenues are so vital for the economic development of these nations, they aim to bring stability and harmony to the oil market by adjusting their oil output to help ensure a balance between supply and demand.

OPEC

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The OPEC cartel was formed to promote two economic goals, one microeconomic — the minimization of the volatility of oil markets — the other macroeconomic — the promotion of the economic development of its member countries. These two goals create a tension since the cartel has only a single tool, output quotas, with which to achieve these goals. Thus, it is forced to weight them. The effects of its choices will be reflected in the stability of the oil market, in long-term macroeconomic development, and in the states' decisions to join or withdraw from the cartel, that is, in international oil market structure. Using this dual micro/macro perspective we analyze OPEC's sometimes perplexing (see Griffin, 1985; Griffin and Xiong, 1997; Loderer, 1985) behavior.

Specifically, in this paper we ask a straightforward question — is it possible for OPEC to achieve its stated goals? That is, can an international resource cartel using the standard microeconomic pricing and enforcement mechanisms provide a macroeconomic environment conducive to development and growth? Since the oil sector represents an important share of national income for oil exporting, developing countries, instability in the oil market also can lead to instability in output, and through the Phillips curve, instability in other macroeconomic indicators like inflation; in other words, it can lead to macroeconomic instability. Thus, has OPEC been a useful tool explicitly to achieve oil market, and, implicitly, macroeconomic stability? If the answer to both these questions is no, what is the rationale for OPEC to continue to exist? That is, can oil exporting developing countries improve their development prospects by joining an oil cartel? If so, since all substantial oil exporters can choose to join, why do some important exporting countries like Mexico, Oman, Angola and, perhaps, Russia, whose production and development levels are similar to other countries in OPEC, choose to stay in the fringe? What induces countries like Ecuador to enter and then exit shortly thereafter? Why do Mexico, Russia, Egypt and Kazakhstan find membership inconsistent with their domestic macroeconomic policies if membership is, indeed, intended to promote economic development?

There are two important features of the international oil market worthy of mention. First, the OPEC cartel meets twice a year and in extraordinary sessions whenever necessary. In these meetings, the cartel analyzes the state of the international oil market, and sets quotas for its member states (see www.opec.com). Thus, OPEC tries to move (preempt) the market rather than be moved by it. OPEC's production represents about 40% of total world oil production. Among non-OPEC producers, Russia's production is 12% of world production, and no other country produces even 5% of the total. This means that the international oil market operates as a Stackleberg oligopoly where the OPEC cartel plays the role of the leader. A final important feature that distinguishes the oil cartel from most (if not all) other cartels is that governments, not firms, make the decision about joining the cartel, and it is government ministers who set production quotas.

Taking these features as assumptions, we answer the above questions in the context of a simple model in which oil producing countries choose either to join OPEC or remain part of the fringe. Equilibrium is stable and thus cartel members have no temptation to cheat. OPEC acts as a Stackleberg leader, and reacts to market shocks by setting output quotas for its members. We find that if oil producing country governments care predominately about high oil sector profits, the standard microeconomic assumption, then joining the cartel is the optimal strategy. But countries in the cartel will have more volatile oil production than those in the fringe and, thus, via the link between the oil sector and the macroeconomy, higher macroeconomic instability. Therefore, if these same governments care about macroeconomic stability as well as oil sector profits, then the choice to join the cartel will depend on the intensity of this preference: the more a government cares about macroeconomic stability, the less inclined it is, in general, to be a cartel member.

Thus, if an oil producing country cares about both oil industry profits and macroeconomic stability, the goal of output stability may be inconsistent with cartel membership. Thus, OPEC's membership will be lower than standard analysis would suggest. OPEC's dilemma is that it cannot obtain both its expressed goals with the single tool, setting output quotas, it has at its disposal. And, should it weight the microeconomic goal more heavily, OPEC economies will stagnate.

The paper proceeds as follows. We first provide a brief discussion of the economic performance of the OPEC member states, and examine OPEC's ability to influence the oil market. We then examine how OPEC's objectives — as specified in its mission statement — could be operationalized, write down a model of the cartel, and analyze its behavior. Finally, we summarize and interpret our results.

1. The OPEC economies

OPEC was established in 1960 to take sovereign control over oil resources, and to ensure that the interests of oil producing countries would be well represented in world markets. The founding members of OPEC felt that their economies were at the mercy of the oil companies, and that they were not being adequately compensated for the oil the companies were extracting, exporting, and refining. By design, OPEC was to establish orderly oil markets with stable prices and to promote the economic development of its member states. OPEC's mission differentiates it from a narrowly defined cartel under which joint profits are maximized. That OPEC does not behave strictly like a narrowly defined cartel has been found by Griffin (1985), Griffin and Xiong (1997), and Loderer (1985), among others. Their results could be explained, in part, by OPEC's broader goals.

In comparison with other developing economies, the immensely oil rich economies have underperformed. Their economies are characterized by very high population growth rates and high rates of oil dependence both in terms of personal income and public finance. High extraction rates have led to falling oil reserves. In many OPEC member countries, investment, even in the oil sector, is low. Cordesman (1999) argues that many oil states do not even have the resources to develop their own oil and gas reserves. Yet because of the high level of oil dependence, the oil sector must perform well both to maintain current and ensure future living standards (Morrison, 2004). But, oil sector and overall economic productivity in the OPEC economies has declined, and today less rather than more is being produced with the same resources.

This economic decline has been interpreted by some as evidence that the OPEC economies have been victims of the resource curse (Auty, 2001; Eastwood and Venables, 1982; Gylfason, 2001; Rodriguez and Sachs, 1999; Sachs and Warner, 2001; Stevens, 2003), the apparently anomalous empirical finding that many resource rich countries underperform their resource poor peers. The reasons given for the curse are many: decline in the terms of trade, revenue volatility, the Dutch disease, crowding out, government mismanagement, rent seeking, corruption, etc. But, the end result is the same — relative poverty in the midst of plenty.

We suggest, in contrast, that some of the blame for the economic decline may lie in the cartel rather than in the resources it allocates. While OPEC, at least in principle, can adjust supply to maintain targeted (nominal) oil prices to maximize oil firm profits, it has not been able to control the market adequately to ensure a steady stream of oil derived revenues, that is, national income and so macroeconomic stability. For example, Venezuela's public sector oil revenues were 27% of GDP in 1996 but only 12.5% in 1998 (Barnett and Ossowski, 2003). The orderly market, the supposed empirical manifestation of a profit oriented pricing policy, is claimed to be a reality (Jalali-Naini and Asali, 2004), but the implied macroeconomic benefits to OPEC members are

more like a fiction. When OPEC was founded in the early 1960s, the oil market was quite stable and the cartel strategy appeared to work. Yet, with the high oil market volatility from the 1970s on, the dual OPEC goals of long-term growth and development may not be achievable via the unitary profit-oriented pricing policy.

2. Market equilibrium when stability does not matter

2.1. Assumptions

There is a continuum[1] of petroleum producing countries distributed along the interval (1,N). These oil industries are controlled by their governments.

There is a cartel of oil producers which governments can freely choose to join. Assume n_c countries belong to the cartel while $n_f=N-n_c$ do not and remain in the fringe. Since oil output in each country is determined by the number of wells drilled and the amount of oil underground, it is reasonable to assume that each country's petroleum industry exhibits constant returns to scale technology and has the same cost function, $C=C(x_{ti})$, where x_{ti} is country i's petroleum production at period t. This means that oil production has constant marginal costs. Oil prices are set according to the demand function $P_t=f(Q_t)+\varepsilon_t$, where $f'<0$ and $f''<0$, Q_t denotes the world oil production and ε_t is a random term whose expected value is zero and variance is equal to σ_ε^2. The profit function for the petroleum industry at time t in country i is $\pi_{ti}=P_t x_{ti}-C(x_{ti})$, $i\in(1,N)$. Suppose, initially, that profits are the only concern; thus, the country's maximization problem is

$$\text{Max}\sum_{t=0}^{\infty}\frac{1}{(1+r)^t}\pi_{ti}. \tag{1}$$

Assume that shocks are known before oil producers make output decisions, however, future shocks are unknown.

2.2. The fringe

Firm f in the fringe takes the output of all other petroleum producers as given and maximizes Eq. (1) to determine its own output. The first order condition for a country in the fringe is

$$f(Q_t^*)+\varepsilon_t+f'(Q_t^*)x_{if}^*-C'(x_{if}^*)=0, \tag{2}$$

where the superscript "$*$" denotes the optimum choice. The second-order condition is:

$$2f'(Q_t^*)+f''(Q_t^*)x_{if}^*-C''(x_{if}^*)<0 \quad \text{(to be maximum)}. \tag{3}$$

Solving Eq. (2), we obtain the follower's reaction function (country f) to the cartel's move:

$$x_{if}^*=\phi^{f(K_t^*,\varepsilon_t)}, \tag{4}$$

[1] We assume the continuum modeling for analytical ease. This formulation enables us to avoid concentrating attention on corner solutions that have no economic interest.

where $K_t^* = \sum_{c=1}^{n_c} x_{tc}^*$ is the cartel's oil production in period t. Using Eq. (2), we obtain the partial derivative of x_{tf} with respect to K_t and denote it by ϕ_K^f, that is,

$$\phi_K^f = \frac{\partial \phi^f}{\partial K_t} = -\frac{f'(Q_t^*) + x_{tf}^* f''(Q_t^*)}{2f'(Q_t^*) + x_{tf}^* f''(Q_t^*) - C''(x_{tf}^*)}. \tag{5}$$

From Eq. (3), the denominator is negative, thus

$$\phi_K^f < 0 \quad \text{if and only if} \quad f'(Q_t^*) + x_f^* f''(Q_t^*) < 0.$$

When reaction functions are upward sloping, $\phi_K^f > 0$, there is a situation in which followers copy or undercut the leader like, for example, entrants undercutting the price of the incumbent in the contestable market literature (Baumol, 1982) or followers in the development stage that invest more than the leader and are thus more likely to collect a patent in a research and development game (Reinganum, 1985). On the other hand, when reaction functions are downward sloping, $\phi_K^f < 0$, the leader makes a preemptive move, like an incumbent firm that invests in excess supply (Spence, 1979; Dixit, 1980). OPEC's operating procedure, semiannual plus extraordinary meetings, is to preempt the market.

2.3. The cartel

For the sake of simplicity, assume that countries on the interval $(1,n_c]$ are in the cartel and countries on the interval $(n_c,N]$ are in the fringe. The leader takes into account the follower's reaction function (4), so it chooses x_{ti} for each cartel member to maximize

$$V_i = E_t \sum_{s=t}^{\infty} \beta_i^s \left[f(Q_s)K_s + \varepsilon_s K_s - \int_{c=1}^{n} C(x_{sc}) \right].$$

Since $Q_s = K_s + n_f \phi_K^f$, the first order condition for every country c in the cartel is:

$$f(Q_t^*) + \varepsilon_t + K_t^*(1 + n_f \phi_K^f) f'(Q_t^*) - C'(x_{tc}^*) = 0. \tag{6}$$

Since all countries are equal except for their membership in the cartel, we may consider symmetric equilibria, so x_{tc} is the same for every cartel member and x_{tf} is the same for every country in the fringe.

Theorem 1. *Suppose that the slope of the reaction function ϕ_K^f is continuous, monotonic and well-defined for $1 < n_c \leq N$; then there is a Nash equilibrium with cartel size equal to n_c^* and the number of countries in the fringe equal to $n_f^* = N - n_c^*$ such that $\phi_K^f = \frac{1-n_c^*}{n_c^*(N-n_c^*)}$. In that Nash equilibrium, each country in the cartel produces the same amount of oil and obtains the same profit as a country in the fringe, $x^* = x_c^* = x_f^*$. That is, $x_c \geq x_f$ if and only if $\pi_c \geq \pi_f$.*[2]

To illustrate the theorem, consider Fig. 1, where for the sake of simplicity, we have assumed that ϕ_K^f is constant. Although the assumption made in Theorem 1 about ϕ_K^f is more general, it is noteworthy that ϕ_K^f is constant if the demand function is linear and oil exploitation technology is constant returns to scale. Define $B(n_c) = \frac{1-n_c}{n_c(N-n_c)}$ and n_c^* as the size of the cartel such that $B(n_c^*) = \phi_K^f$.

[2] All proofs are available from the authors upon request.

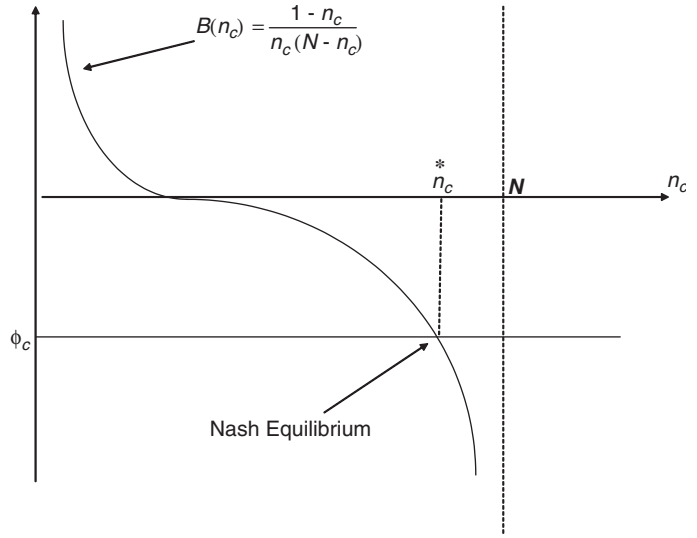

Fig. 1. The size of the cartel when stability does not matter.

If the cartel size is greater than n_c^*, the cartel's market power is strong but each cartel member produces $x_c^* < x_f^*$. Once the cartel sets the quotas to target some price level, it is optimal for cartel members to cheat, that is, to imitate producers in the fringe and thus increase their production. The cartel's market power weakens and cheating countries do not benefit from those belonging to the cartel. If cartel members are subject to some cost, like bargaining costs or moral punishments, they are better off if they quit. On the other hand, if the cartel size is less than n_c^*, then $x_c^* > x_f^*$ and profits are higher for cartel members. Producers in the fringe will find it optimal to join the cartel to gain from its market power. A Nash equilibrium is reached once the cartel has reached its optimal size n_c^* where cartel members have no incentive to cheat since equilibrium output and profit is the same for countries both in the cartel and the fringe. Therefore, the cartel solution is stable.

3. Market equilibrium when stability matters

In the previous section's analysis, we assume that decision makers only care about the oil firm profits, and find a cartel size which constitutes a Nash equilibrium where there is no temptation to cheat. In practice, however, governments make the decision about joining the oil cartel. Thus, if membership in the cartel means more unstable production, a developing oil-exporting country's government that cares about the oil production stability, and hence output stability, a standard measure of macroeconomic stability, may decide to quit the cartel. Yet, why may a government give weight to oil output stability in their objective function? There are several reasons.

First, the OPEC charter states that the cartel countries care not only about profits from the oil industry, but also about creating an appropriate environment for investment and growth. Therefore, since oil output volatility in oil exporting developing countries leads to volatility in national income, and then through the Phillips curve in other macroeconomic variables, oil output stability must be an issue.

Second, when access to international capital markets is imperfect, countries face a trade-off between higher oil profits and stable output. To illustrate this, let $W = \sum_{i=0}^{\infty} U(C_{t+i})$ be the inter-temporal utility function of country i's representative agent, which is subject to a budget constraint like $C_t + B_t = Y_t + (1+r)B_{t-1}$, where B_t is bonds, Y_t is output and r is the real interest rate.

Under reasonable functional assumptions, welfare is optimized along the consumption smoothing path $C_t = C_{t-1} = C$. In this situation, individuals borrow when the oil market is down and vice versa. Yet, if the country has no access to international capital markets, its local financial institutions are weak, and/or it suffers from strong political business cycle problems, which is the usual case in emerging markets (Jeanne, 2003; Litan et al., 2003; Sy, 2003), the consumption smoothing path may not be feasible, and the solution to the maximization problem becomes $C_t = Y_t$, that is, consumption follows the cycle. Therefore, although joining the cartel may provide a higher average income to the typical oil exporting developing country, it may also generate more output volatility, which diminishes welfare. Therefore, the government faces a trade-off between having higher income and greater oil output stability.

Third, for the typical oil-exporting developing country, if the government cares about developing other industries, stability in the number of barrels produced also provides more stability to the oil industry's local suppliers making investment in those related sectors less risky, and thus helping the development of areas in which the country should have natural comparative advantages. Finally, every time the oil industry adjusts output, lays off workers, and generates a multiplier effect causing still more jobs to be lost. Thus, a government that cares about employment stability should worry about stabilizing the number of barrels of oil it produces. [3]

Therefore, since the cartel implicitly determines the output level at which profits and thus income are maximized by setting the number of barrels extracted, it is reasonable to define the following objective function for a government that cares about both firms' profit and oil output stability:

$$V_{it} = E_t \sum_{s=t}^{\infty} \beta_i^s [\pi_{is} - \delta_i (x_{i,s-1} - \bar{x}_i)^2].$$

Here β_i is the time-preference parameter for country i, π_{is} is the oil firms' profit, the term $(x_{i,s-1} - \bar{x}_i)^2$ accounts for the loss due to the instability in the oil production (a proxy for the variance of the GDP gap), and δ_i weights the government's dislike of oil output instability in the objective function, that is, δ_i is the instability aversion parameter. With this objective function, Eqs. (2) and (6) become:

$$f(Q_t^*) + \varepsilon_t + f'(Q_t^*)x_{if}^* - C'(x_{if}^*) = 2\beta_f \delta_f (x_{if}^* - \bar{x}_f) \text{ and} \tag{7a}$$

$$f(Q_t^*) + \varepsilon_t + K_t^*(1 + n_f \phi_K^f) f'(Q_t^*) - C'(x_{tc}^*) = 2\beta_c \delta_c (x_{tc}^* - \bar{x}_c^*), \tag{7b}$$

where $\bar{x}_i$ and $\bar{\pi}_i$ denote country i's optimal oil production and the profits of the oil industry in steady state equilibrium, respectively.

Theorem 2. *When the government values oil sector stability, then:*

i) the following three statements are equivalent: (a) $\bar{x}_c \geq \bar{x}_f$, (b) ($\bar{\pi}_c \geq \bar{\pi}_f$), and (c) $\phi_K^f \leq \frac{1-n_c}{n_c(N-n_c)}$;
ii) given n_c^*, then $\bar{x}_c$ and $\bar{x}_f$, and thus $\bar{\pi}_c$ and $\bar{\pi}_f$ are independent of β and δ.

Theorem 3. *i) Oil output is positively correlated across countries.*
ii) The oil output variance is a decreasing function of the time preference parameter (β) and the instability aversion parameter (δ).

[3] Even though every country has an important non-traded sector, the arguments above apply even if oil were the only good that the economy produced.

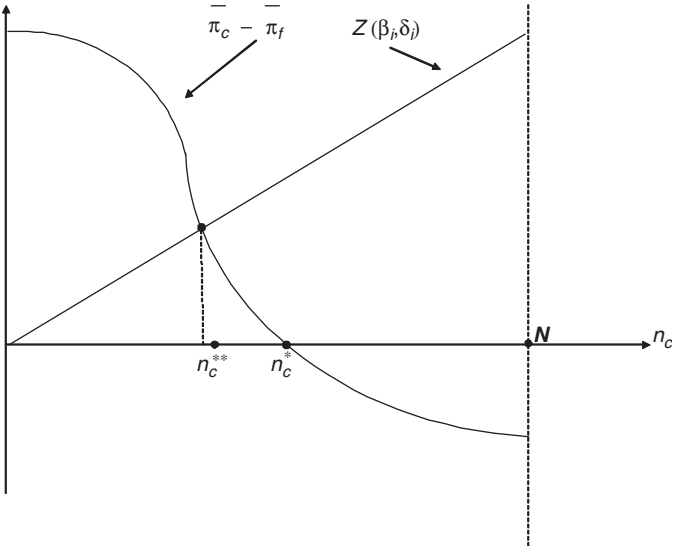

Fig. 2. Equilibrium cartel size.

This means that, ceteris paribus, cartel and fringe producers respond to a positive demand shock by increasing output. It also means that volatility in oil production decreases the higher the time preference parameter (higher β), and the stronger the government's instability aversion (higher δ). Thus, care for output stability reduces a countries' willingness to accept a highly variable production quota. These facts may induce governments to change their decision about joining the cartel.

Theorem 4. *Assume that oil production exhibits constant returns to scale, that the reaction functions are negatively sloped, and that $\delta > 0$. Consider two identical producers except that one belongs to the cartel and the other is in the fringe, then:*

i) the oil output variance is higher for a producer in the cartel than the identical producer in the fringe $\sigma_c^2 - \sigma_f^2 > 0$;
ii) the difference $\sigma_c^2 - \sigma_f^2$ is a decreasing function of β and δ; and
iii) the difference between the average profit for the producer in the cartel and the producer in the fringe, $\bar{\pi}_c - \bar{\pi}_f$, decreases as the cartel size increases.

The intuition behind this result is that the cartel uses its higher market power to obtain a higher profit as it faces a demand shock. When gain is lower the more a country cares for output stability.

Consider a country deciding whether or not to join the cartel from period t on. The expected profit of the oil industry is $\bar{\pi}_c$ if it joins the cartel, or $\bar{\pi}_f$ if it stays in the fringe. Country i's objective function can be written as

$$V_i = \frac{1}{1-\beta_i}[\bar{\pi}_i - \delta_i \sigma_i^2(\beta_i, \delta_i)].$$

Let V_c denote the country's net gain if it joins the cartel and V_f if it stays in the fringe. Country i joins the cartel if $V_c > V_f$, that is, if

$$\bar{\pi}_c - \bar{\pi}_f > Z(\beta, \delta), \tag{8}$$

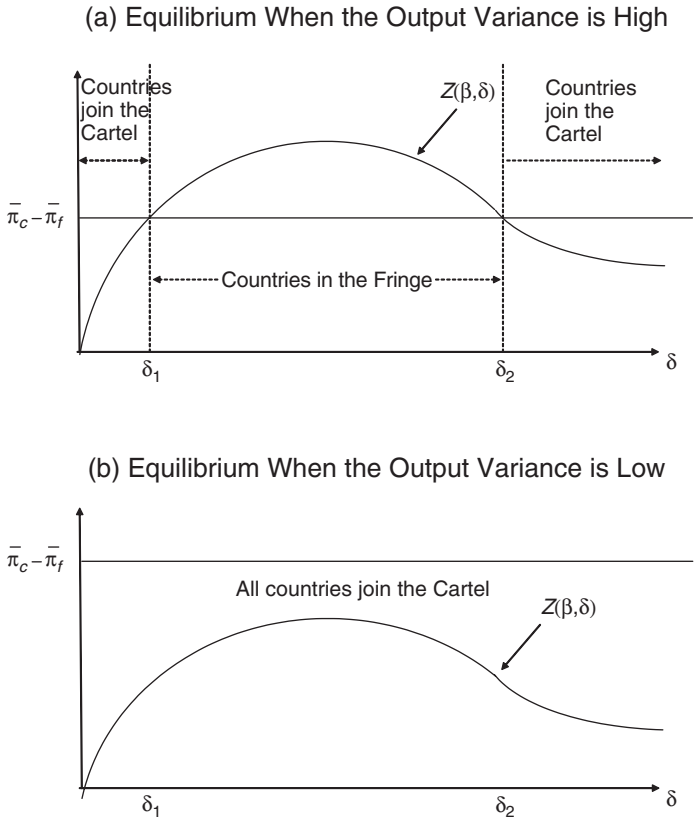

Fig. 3. Equilibrium cartel size. (a) Equilibrium when the output variance is high. (b) Equilibrium when the output variance is low.

where $Z(\beta,\delta)=\delta[\sigma_c^2(\beta,\delta)-\sigma_f^2(\beta,\delta)]$. The term $(\bar{\pi}_c-\bar{\pi}_f)$ measures the gain in expected profits and $Z(\beta,\delta)$ measures the loss due to output instability if the country is in the cartel instead of in the fringe. From Theorem 4, the difference $(\bar{\pi}_c-\bar{\pi}_f)$ is a decreasing function of n_c that cuts the axis at $n_c=n_c^*$, as shown in Fig. 2. The number of countries that join the cartel depends on the countries' distribution across the parameters β and δ.

To get some insights, define the index set for the N countries in such a way that $Z(\beta_i,\delta_i)$ is a continuous increasing function of $i\in(0,N)$. From Fig. 2, we observe that inequality (8) holds for the first n_c^{**} countries; those with $i<n_c^{**}$ join the cartel, and the other $n_f^{**}=N-n_c^{**}$ remain in the fringe. From (ii) of Theorem 4, $Z(\beta,\delta)\geq 0$, and thus there exists an equilibrium in which some producers join the cartel and some others decide to stay in the fringe. If $\delta=0$, then $Z(\beta,\delta)=0$ and equilibrium is reached when the cartel size equals n_c^* as in Theorem 1. Yet, if $\delta>0$, equilibrium is reached for a cartel size equal to n_c^{**} smaller than n_c^*, that is, the cartel size is smaller when some countries prefer output stability.

The dynamics of the cartel in this model can be seen as a repeated game, where players are free to choose the strategy of whether or not to join the cartel; they are free to "cheat" and condition (8) defines equilibrium. Consider a country that joins the cartel, so Eq. (8) holds. If the country

Table 1
Instability in oil exporting countries

Sorted by S.D. of oil output			Sorted by S.D. of consumption/GDP		
Russia	Fringe	2.10	U.K.	Fringe	0.022
Indonesia	OPEC	2.23	Denmark	Fringe	0.025
Syria	Fringe	2.28	Ecuador	Fringe	0.026
Bahrain	Fringe	2.67	Norway	Fringe	0.036
Yemen	Fringe	3.37	Venezuela	OPEC	0.037
Kazakhstan	Fringe	3.50	Cameroon	Fringe	0.040
Gabon	Fringe	4.13	Canada	Fringe	0.044
Canada	Fringe	4.25	Colombia	Fringe	0.044
Norway	Fringe	4.34	Mexico	Fringe	0.047
Mexico	Fringe	4.39	Indonesia	OPEC	0.048
Ecuador	Fringe	4.53	Syria	Fringe	0.053
Nigeria	OPEC	4.71	Malaysia	Fringe	0.057
Congo (Brazzaville)	Fringe	4.85	Algeria	OPEC	0.066
Malaysia	Fringe	4.99	Trinidad and Tobago	Fringe	0.070
Cameroon	Fringe	5.20	Vietnam	Fringe	0.075
Egypt	Fringe	5.76	Egypt	Fringe	0.078
Oman	Fringe	5.97	Gabon	Fringe	0.082
Iran	OPEC	6.10	Kazakhstan	Fringe	0.085
Libya	OPEC	6.20	Libya	OPEC	0.097
Trinidad and Tobago	Fringe	7.22	Yemen	Fringe	0.100
U.K.	Fringe	7.58	Nigeria	OPEC	0.105
Vietnam	Fringe	8.73	Iran	OPEC	0.109
United Arab Emirates	OPEC	9.77	United Arab Emirates	OPEC	0.111
Saudi Arabia	OPEC	9.79	Qatar	OPEC	0.113
Colombia	Fringe	10.05	Oman	Fringe	0.113
Venezuela	OPEC	10.12	Bahrain	Fringe	0.119
Qatar	OPEC	10.27	Saudi Arabia	OPEC	0.119
Kuwait	OPEC	10.36	Russia	Fringe	0.119
Algeria	OPEC	10.45	Congo (Brazzaville)	Fringe	0.152
Denmark	Fringe	12.97	Kuwait	OPEC	0.476

Data source: International Energy Annual Report, Energy Information Administration, US Department of Energy, IFS/IMF, and own computations.

imitates the fringe's behavior, it is not punished, but its loss in terms of profits is too high since it does not maximize Eq. (1) and thus it will be worse off: the cartel is internally stable. Similarly, a country in the fringe will not want to imitate a country in the cartel since the cost in output instability is too high. Therefore, a country joins the cartel if it is committed to keep its quota, and thus the cartel solution defined by Eq. (8) is a stable equilibrium.[4]

What are the features of those countries that join the cartel? Given δ, from (ii) of Theorem 4, $\sigma_c^2-\sigma_f^2$ is a decreasing function of time-preference factor β. Therefore, countries with a low time-preference factor β, which have a strong preference for current consumption and low investment-output ratios, give little importance to future losses due to output instability, and so $Z(\beta,\delta)$ is small. For them, inequality (8) holds. They are likely to join the cartel.

The analysis of the parameter δ requires a more detailed analysis. Given β, since $\sigma_c^2-\sigma_f^2$ is a decreasing function of δ, $Z(\beta,\delta)$ has the shape shown in Fig. 3(a). Thus, countries with either low δ ($<\delta_1$)

[4] Here we follow the definition of a stable cartel as suggested in D'Aspremont et al. (1983), Donsimoni et al. (1986), Jacquemin and Slade (1989) and Marette and Crespi (2003).

Table 2
ML-binary probit

Includes Indonesia			Excludes Indonesia		
Variable	Coefficient	*p*-values	Variable	Coefficient	*p*-values
C	−2.79	0.0052	C	−5.48	0.006
S.D. oil output index	0.19	0.0334	OILVAR	0.39	0.011
S.D. oil consumption/GDP	13.45	0.0868	CYVAR	27.09	0.028
McFadden R-squared: 0.24			McFadden R-squared: 0.44		

or very high δ ($>\delta_2$) join the cartel. If δ is low, the government is relatively unconcerned with output stability, caring more for oil sector profits. On the other hand, countries with a very high δ have much to lose from oil production instability, and will join the cartel only if their quota is insensitive to demand shocks, diminishing the instability effect. The cartel offers the high δ countries production stability, but at the cost of oil sector profits, while offering low δ countries greater production instability but higher oil sector profits. Both types of producers benefit. Middling δ countries do better staying in the fringe.

Finally, let us consider the effect of market volatility on the cartel size. It is apparent that $Z(\beta,\delta)$ is a decreasing function of the variance of ε; thus, if the oil market is very unstable, the variance of ε is big, and equilibrium will be as shown in Fig. 3(a), where some countries find it beneficial to join the cartel and others do not. Yet, if market volatility is low and the variance of ε is too small, $Z(\beta,\delta)$ will be as shown in Fig. 3(b), and all countries join the cartel.

4. Some empirical findings

From inequality (8), cartel countries are those who either care the least or the most about instability. If this is so, among oil exporters, OPEC countries should show either the highest or the lowest volatility in oil production. Table 1 shows the standard deviation of either oil output or consumption/GDP ratio of 30 oil exporting countries for which data are available. Standard deviations for oil output and the consumption/GDP ratio are computed for the periods 1999–2003 and 1980–2003, respectively. To avoid distortion due to the different production volume across countries, we compute variance of the oil output index and not the volume.

Observe that most OPEC countries are in the bottom half of the table, that is, they are among the most volatile in the sample. Indonesia is an exception, as it is the second with low oil output volatility. This suggests that Indonesia could be the only country choosing to join the cartel because of its strong dislike of instability.

Formally, we estimate a probit model for whether or not a country is a member of OPEC, see Table 2. The dependent variable "OPEC" is one if the country belongs to the cartel. Since Indonesia seems to be an exception, we compute two regressions, one including and the other excluding Indonesia. Results are as expected. In both cases, *p*-values show that coefficients are significant. However, significance strongly increases as we drop Indonesia from the sample. Coefficients are positive, meaning that higher variance increases the probability of joining the cartel.

5. Conclusions

A distinguishing feature of the international oil market is that the decision about joining the OPEC cartel is not taken by firms, but by governments that take macroeconomic considerations, namely development and stabilization, into account. This essay studies the issue of whether the

cartel has been a useful tool for those purposes in the context of a Stackleberg type model in which oil exporting, developing countries decide whether or not to join the cartel. The model leads to three important conclusions. The first is that countries with a strong preference for current oil revenue, perhaps to fund high levels of current income, join the cartel. The reasons for this preference may vary across countries: in Kuwait, for instance, it may be due to the high population growth rate (4.9% annually during the last 10 years), while in Iraq it may have been due to the need for current income to finance several wars during Saddam's regime. A strong preference for current consumption (low β) is reflected in relatively low investment/output ratios and poor economic performance in terms of long term per capita output growth. This could account for the economic performance in countries like Kuwait, Iraq, Libya, Nigeria, Saudi Arabia or Venezuela, whose investment/output ratios have been less than 20% during the last decade. The decision to join the cartel and the exigencies of cartel, as opposed to macroeconomic, stability has cursed rather than blessed them.

Second, since the oil-output variance is a source of output instability, countries with very large non-oil sectors or that are highly vulnerable to the oil output variance (high δ) are better off enjoying cartel prices and at the same time having low oil-output variances. Therefore, if their quotas exhibit low variances, it would be beneficial for them to join the cartel. This could explain Indonesia's OPEC membership, since their oil production to GDP ratios are small and the correlations between their oil production and the cartel's are rather low. Finally, we conclude that all oil exporting countries would find it beneficial to join the cartel if the volatility of the oil market were low. This could explain why, for example, when OPEC was set up in the early 1960s, all important oil exporters at that time joined the cartel, and why many of these countries enjoyed high growth rates during the 1960s. The case of Venezuela exemplifies this. After enjoying an average growth rate above 5% per year between 1945 and 1973, one of the highest growth rates in the world, its average growth rate from 1978 on, just after the oil market volatility became a serious concern for producing countries, has been close to zero.

What about the countries in the fringe? All producers whose oil exports are less than 600 thousand barrels per day are in the fringe. However, except for Denmark, oil production is still an important share of their GDPs. Thus, they can take advantage of oil industry windfalls generated by the cartel's leadership role without being members of the cartel. But, this is at the recognized cost of letting their non-oil sector suffer the swings of the oil market. This could be also the case for Russia, Mexico and Angola, whose oil output variances are moderately correlated with OPEC.

Is OPEC an appropriate tool to foster economic development? In an oil market with low volatility, like that prevailing before the 1970s, oil exporting countries may enjoy a high flow of financial resources and enough macroeconomic stability to foster investment and development; this could also be the case of countries like Indonesia, whose oil sector enjoys the advantages of cartel prices, but has a low variance quota inside the cartel that benefits its large non-oil sector. Yet, this is not the case in the volatile oil market of today, where the non-oil sectors of OPEC countries are hindered because of OPEC's hunger for current profits and its having only a single tool to meet two disparate goals. For these countries, currently optimal profligacy begets future decline.

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