OPEC and cheap fuel policies*

Gal Hochman† and David Zilberman‡

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Abstract

OPEC is an intergovernmental organization of large oil-exporting countries. While OPEC collectively determines production quotas, individual OPEC countries determine domestic fuel prices; that is, individual OPEC countries determine the allocation of the crude-oil production among domestic consumption and exports. Using cooperative game-theory, we show that the OPEC decision to relegate consumption choices to the individual OPEC countries reduces the political cost of cartalization and helps maintain OPEC as a cohesive cartel in the world oil markets. It makes possible for a group of heterogeneous countries to cooperate in international crude-oil markets for over 50 years.

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†Corresponding author: Rutgers, The State University of New Jersey — New-Brunswick — NJ — Phone: 510.289.0907 — email:gal.hochman@rutgers.edu.

‡University of California Berkeley — Berkeley — CA — email:zilber11@berkeley.edu.

1 Introduction

The political-economy literature argues that economics alone cannot fully explain economic outcomes and policy choices. The political-economy models begin with the assertion that policy choices are not made by social planners. But policy is the result of political struggle within an institutional structure and that researcher and the policy advisers have to be well aware of how politics influences policymaking. For example, the literature assessing U.S. policy is influenced by the Political Action Committees, and assumes organized interest-groups advance outcomes of political issues or legislation (Helpman and Grossman, 2002, and references therein). Studies belonging to this strand of the literature suggest that policy is established within a political economic context where different groups have different weights (Grossman and Helpman, 1994 and 1995; Karp and Perloff, 2002; Gawande and Krishna, 2003).

However, other political-economy institutions exist that affect policy. Citizens are unorganized but responsive to policy design, and policymakers are aware of the citizens response when making policy decisions. Bill Clinton used the term "it's the economy, stupid" and exploited bad economic times to affect voters preferences during the 1992 U.S. presidential race. "It's the economy, stupid" was a phrase introduced by Bill Clinton's campaign strategist James Carville, to suggest that Bill Clinton emphasizes economic issues and that Clinton cares about "pocketbook issues." In 1992 the U.S. economy was coming out of recession, and during bad economic times people care about financial resource issues.

Citizens may also resort to violent means of influencing the political-economy of policy design. In January 2011 food prices were identified as a trigger for Tunisia's unrest as well as for riots across much of northern Africa, including Egypt, a country that depends heavily on Russian grain.[1] Other examples include the French Revolution, which was a result of high food prices. In July, 1788, a hailstorm destroyed crops leading France to its worst harvest in forty years, and the winter of 1788-89 was severe and not making things better. This led to hunger and people to riots, thus leading to the French Revolution.[2] Fuel protests in the United Kingdom in 2000 resulted in widespread disruption to the supply of petroleum products, leading to protests calling for a reduction in the fuel duty rate. After the protests subsided, the government froze the fuel duties.[3] History taught us that food shortages and in modern times, fuel shortages, can result in riots. Many have emphasized it, including Dominique Strauss-Kahn, the managing director of the International Monetary Fund, who warned of mass starvation and other atrocious consequences if food prices were allowed to rise too high.

Well-targeted redistribution wealth policies require adequate institutional and administrative capacities, which we assume OPEC countries lack.[4] Therefore, an individual OPEC country may respond to domestic political struggle by introducing energy subsidies to redistribute wealth–a practice that is common in developing countries (IEA, OPEC, OECD, and World Bank, 2011). If, in addition, we assume OPEC countries are non-democratic regimes that need to bribe the population into complacency, then those countries will employ wealth redistribution policies on an ongoing bases and

[1] See http://www.foreignaffairs.com/articles/67338/evan-fraser-and-andrew-rimas/the-psychology-of-food-riots and http://www.survivingeconomiccollapse.net/2011/03/food-riots-oil-shocks-the-middle-east-and-us/.

[2] See http://www.fsmitha.com/h3/h33-fr.html.

[3] See http://www.guardian.co.uk/politics/2000/nov/09/uk.oil.

[4] Although developed countries have generally relied on regulatory instruments and taxes or tax preferences, supplemented by support for capital formation in the sector, R&D and raw materials, developing countries often used interventions that reduce the price of energy to consumers (IEA, OPEC, OECD, and World Bank, 2011).

face a constant trade-off between redistributing oil-revenues and employing domestic (fuel) subsidies. Although these regimes may use oil-revenues to subsidize public goods or invest in military and/or security forces, lack of capacity and institutional constraints force them to subsidize fuel consumption.

When modeling the political-economy framework, we assume policymakers in OPEC countries are aware of the population behavior, which is unorganized but responsive to policy. We also incorporate into the model the stylized fact that while OPEC determines the production quotas collectively[5] each individual OPEC country determines the domestic fuel consumption prices unilaterally (Gupta et al., 2002; Reiche, 2009; Ragab, 2010; among others). The political-economy framework developed for both the OPEC-wide and the country-specific decisions, is akin to cheap food policies where governments subsidize domestic food consumption to achieve political stability (Lewis, 1955; Schultz, 1968; Johnson, 1975; among others).

Separating policy decisions, where the OPEC wide decision allocates production quotas among OPEC countries but the country-specific decision determines domestic fuel prices, introduces flexibility into the OPEC organization. It allows individual OPEC countries to adjust wealth-redistribution mechanisms to address domestic political-economy concerns, while maintaining cooperation among OPEC countries in international oil markets and leading to the OPEC success of maintaining a cohesive cartel for more than 50 years. Pindyck (1978) work suggested that the gains to OPEC producers from cartelization in the world oil markets are large and this is one reason for the formation of OPEC and its success in maintaining itself as a cohesive cartel. Pindyck points to "significant costs associated with cartelization–political costs, cost of coordination of output and price,..." This work shows that the political-economy institution of OPEC makes possible for individual countries to address various domestic political-economy concerns while cooperating over the allocation of production quotas. This work also shows that relegating decisions of oil-wealth redistribution to individual countries facilitates cooperation among this heterogeneous group of countries.

In the next section (Section 2), we present the model. Section 3 presents the decision process while using cooperative game theory. The outcome of the game is derived in Section 4, while discussion and concluding remarks are offered in Section 5.

2 The OPEC bargaining model

Assume two types of countries, Home (h) and Foreign (f), where country f's variables are denoted with an asterisk (*) (Bagwell and Staiger, 2002). For tractability and without loss of generality, and given that this paper aims to explain OPEC success of maintaining an active cartel, the number of countries of type "Foreign but not Home" is normalized to 1 and denote the country of type Foreign by F.

Country $h \in \{1, ..., H\}$ and country F are endowed, respectively, with L_h and L^* units of the numeraire good 0, where $L = \sum_h L_h$. Assume country h produces q_h units of oil, with x_h units sold domestically and m_h units sold abroad (i.e., $q_h = x_h + m_h$), and we let $X = \sum_h x_h$, $M = \sum_h m_h$, and $Q = \sum_h q_h$. However, country F exports the numeraire good 0. For simplicity and without loss

[5] See http://www.opec.org/.

of generality, we assume that country F does not produce fuel.[6] We also assume balanced trade and that markets clear.

The population in each country is normalized to 1. Following the literature on the political economy of international trade (e.g., Grossman and Helpman, 1994 and 1995), preferences for a consumer in country h are captured by the following quasilinear utility:

$$U_h = c_{0h} + u_h\left(c_{1h}\right) - b_h, \tag{1}$$

where c_{0h} denotes the numeraire good, c_{1h} denotes fuel, and where $\partial u_h/\partial c_{1h} > 0$ and $\partial^2 u_h/\partial c_{1h}^2 < 0$. Let b_h denote the cost to the consumers from exercising political clout and affecting policymaker decisions. We assume consumers are price-takers and when making consumption choices take income as given. Consumers also take income as given when determining their response to prices they perceive as too high. We also assumed that because of organizational set-up costs and consumers' inclination to "free ride" (Olson, 1965), consumers are unable to achieve an organizational form that, assuming cooperation, influences decisions designed and implemented by policymakers. However, although consumers fail to solve the collective choice problem, consumers do actively respond to policymaker choices. The response whose cost is b_h–e.g., riot in reaction to increased energy prices–is assumed to be predictable behavior.

We normalize the price of the numeraire good 0 to 1. Now, let p_{1h} denote the consumer price of fuel in country h, and let p_1^* denote the price in country F. The consumer's total expenditure (income) in country h is I_h. With these preferences and assumptions, country h's per-capita inverse demand equals $\partial u_h/\partial c_{1h}$. The consumer in country h devotes the remainder of total expenditure to the numeraire good, i.e., $c_{0h} = I_h - p_{1h} \cdot c_{1h}$, thereby attaining a utility level of

$$V_h = I_h + cs_h - b_h,$$

where $cs_h = u_h\left(c_{1h}\left(p_{1h}\right)\right) - p_{1h} \cdot c_{1h}$ is the consumer surplus from fuel consumption. That is, given income, the net benefit to fuel consumers from fuel consumption is

$$u_{fh} = cs_h - b_h,$$

where b_h represents the cost to fuel consumers of exercising political power. In equilibrium, supply equals demand, i.e., $c_{1h} = x_h$ and $c_1^* = M$. We similarly define preferences in F; namely, country F's per capita inverse demand equals $\partial u^*/\partial c_1^*$ and $V^* = I^* + cs^*$.

Country $h's$ cost function is $tc_h\left(q_h\right)$. Its derivative, $mc_h = \partial tc_h/\partial q_h > 0$, is the marginal cost function of country h, which is increasing in q_h, i.e., $\partial^2 tc_h/\partial q_h^2 > 0$. While, for simplicity, our analysis does not explicitly model the dynamics of oil, the marginal cost can be interpreted broadly to include the marginal extraction costs as well as the user costs (which represent the dynamic shadow price of depleting the stock of the non-renewable resource).

A key stylized fact guiding the analysis is that the domestic consumer prices in OPEC countries, p_{1h} for $h \in H$, are lower than the price paid by consumers in the oil-importing countries, p_1^*, and

[6] In principle, the model may allow country F to produce and import oil. Then, if the oil-importing country behaves competitively, country h's decision should simply incorporate into the calculation the residual import demand of oil *net* of production in country F.

that domestic fuel prices vary among OPEC countries. This wedge, which equals $p_1^* - p_{1h}$, is the domestic fuel consumption subsidy in country h and can be decomposed into two elements: an OPEC differential subsidy, $\varphi_h = p_1^* - mc_h$, and a country-specific differential subsidy, $s_{1h} = mc_h - p_{1h}$. In other words, $sub_{1h} = \varphi_h + s_{1h}$.

Subsidizing domestic fuel results in lower prices and more consumption domestically but less oil exports. When politicians in country h subsidize fuel and support the domestic price, p_{1h}, they create a wedge between the international and the domestic price of fuel, i.e., $p_1^* - p_{1h} > 0$. Let r_{1h} denote the forgone revenues from selling fuel domestically and not exporting it. That is, the fuel subsidy generates an opportunity cost of

$$r_h = sub_{1h} \cdot p_1^* \cdot c_{1h} \tag{2}$$

to country h.

The aggregate social welfare of the economy, W_h, is a function of the endowment (i.e., L_h), the profits (i.e., π_h), the forgone revenues (i.e., r_h), and the net monetary benefits from consuming fuel:

$$W_h = L_h + \pi_h - r_h + cs_h - b_h.$$

We similarly define welfare in country F:

$$W^* = L^* + \pi^* - r^* + cs^*.$$

3 Modeling the OPEC decision process

The model is based on the following assumptions. First, oil-importing countries are price takers, while OPEC is exercising its monopolistic power in the international oil-markets.[7] This assumption follows the line of argument set forth in the literature on international trade, which assumes that countries that have market power establish policies that maximize their social welfare, taking the behavior of the rest of the world as a given. The optimal-tariff literature is one branch of this literature; the literature on optimal export tax is another (see Bhagwati, Panagariya, and Srinivasan, 1998, and references therein). Second, assume that OPEC, as a whole, sets the allocation of production quotas among OPEC countries but that individual OPEC countries set domestic fuel prices. In the 1980s, OPEC introduced a group-production ceiling (i.e., production quotas), which is divided among OPEC member countries (see http://www.opec.org/), and numerous works on OPEC that followed employed the idea that OPEC allocates production quotas among OPEC countries (Griffin 1985; Kaufmann et al., 2008; among many others). At the same time, several studies argued that subsidizing gasoline consumption is part of wealth sharing from oil-generated revenues in Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE (Reiche, 2009) and, more generally, in Arab countries (Gupta et al., 2002; Ragab, 2010). Third, assume decisions are made sequentially; namely, assume a sequential decision process, whereby, at the first stage, countries determine the domestic fuel consumption subsidies and, at the second stage, OPEC countries cooperate and set production quotas. Normally, OPEC meets

[7] Oil-importing countries do not exercise their monopsonstic power because the demand for oil demand is concentrated in the transportation sector [International Energy Agency (IEA), 2005] and the demand for oil in the light-duty vehicle sector is very inelastic (Hughes, Knittel, and Sperling, 2008).

eight times a year (see http://www.opec.org/) while decisions regarding domestic policies are made less frequently (Ragab, 2010).[8] These assumptions are integrate to approximate OPEC's pricing behavior.

Cheap fuel policies, similar to cheap food policies where governments subsidize domestic food consumption to achieve political stability (Lewis, 1955; Schultz, 1968; Johnson, 1975; among others), aim to bribe the domestic population into complacency. Politicians understand that although fuel consumers are not organized, fuel consumers respond to policy. Furthermore, politicians are aware of the political cost of high fuel prices, which can lead to riots and support for opposition groups. We, therefore, use cooperative game theory to model the political process leading to domestic fuel prices and assume fuel consumers can penalize policymakers for high fuel prices.

On the other hand, the OPEC-wide decision is made during the OPEC ministerial meetings. In those meetings, analysis of important market drivers is surveyed and then OPEC countries decide collectively if, and by how much, should current production levels change. Countries present their preferences and views and then decisions are made while employing a unanimous rule: Each Full Member Country shall have one vote. All decisions of the Conference, other than on procedural matters, shall require the unanimous agreement of all Full Members [Article 11.B, Chapter III, OPEC Statute]. Formally, we model the political process leading to the allocation of production quotas among OPEC countries, while using cooperative game theory, and explain the negotiation outcome.

Although we employ similar techniques to model the country-specific and the OPEC-wide policy decisions, the two are inherently different. When determining the country-specific fuel prices politicians do not explicitly negotiate with fuel consumers, but they do recognize the political cost of setting fuel prices too high; a cost that is a product of the consumers response to policy and which we assumed is predictable. Whereas no explicit negotiation occurs at the individual country level, during the ministerial meetings when determining the allocation of production among OPEC countries the countries explicitly negotiate the final outcome. Formally, we model the decision process using cooperative game theory and employing the n-person cooperative game, which was defined and characterized in Harsanyi (1963 and 1977).[9] We use this theory to explain both the country-specific decision and the OPEC wide decision.

Building on these assumptions, a model that consists of a country-specific decision and an OPEC wide decision is developed. The OPEC decision is on the production quotas and the implied OPEC differential subsidy while the country-specific decision is on the deviation from the OPEC differential subsidy, i.e., it is about the domestic fuel prices. We assumed that first countries set domestic fuel prices, and then countries meet and allocate production quotas among the OPEC countries (Fig I).

3.1 The first stage: The country-specific differential subsidies

The political straggle leading to domestic fuel prices is modeled below, while assuming politicians are aware of the domestic population response to high fuel prices–reflecting the importance of cheap fuel

[8] See also the IEA website (i.e., http://www.iea.org/).

[9] Zusman (1976) and Rausser and Zusman (2011) employed the n-person cooperative game to formalized the formation of quantitative policy (Tinbergen, 1956) assuming additive preferences.

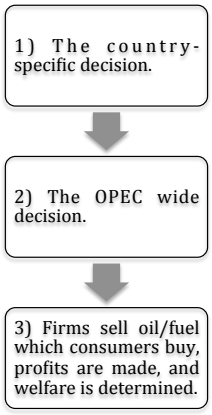

Figure I: The timing of the game

policies. We show that by relegating choice of domestic fuel prices to individual countries, OPEC reduces the political-economy cost of cartalization and makes long-run sustainability possible.

We assume policymakers in OPEC countries are aware of citizens' response to fuel prices, and that this behavior is predictable. We model policymakers behavior as a process that accommodates conflicting interests, and model domestic policy decision process employing the n-person cooperative game (Harsanyi, 1977). Fuel consumers share common interest but organizational set-up costs and individual proclivities to "free ride" (Olson, 1965) prevent them from achieving an active organizational form. However, fuel consumers respond to fuel prices perceived as high with demonstrations and riots and we assume this behavior is predictable.

Formally, domestic fuel prices are set by the individual OPEC countries during the first stage of the game, and this decision process is assumed a two step process (Fig II):

1. First, the response of fuel consumers to high prices is determined. We assume this behavior is predictable and that policymakers are aware of consumers response.
2. Then, given the predictable relation between high fuel prices and riots and demonstrations, policymakers set domestic fuel prices, which optimize tradeoff between oil-revenues and political stability.

That is, first fuel consumers optimal response to high fuel prices and policymakers optimal response to political instability is set, namely, the optimal threat strategies $\left\{\widetilde{p}_{1h}, \widetilde{b}_h\right\}$ and thus disagreement payoffs, i.e., $\left\{G_h\left(\widetilde{p}_{1h}, \widetilde{b}_h\right), u_{fh}\left(\widetilde{p}_{1h}, \widetilde{b}_h\right)\right\}$, are set (recall that fuel consumers take income as given when determining their response to policy). Then, and given the disagreement payoffs, we assume policymakers set policy **as if** they were explicitly negotiating with the consumers; that is, a cooperative game between fuel consumers and policymakers is played. The outcome of the cooperative game is the outcome of the simple Nash bargaining game (Nash, 1953).

The economic frontier models the scarcity, cost, and efficiency of resource allocation; it is the efficient combination of resources attainable under the constraints imposed by the economic structure.

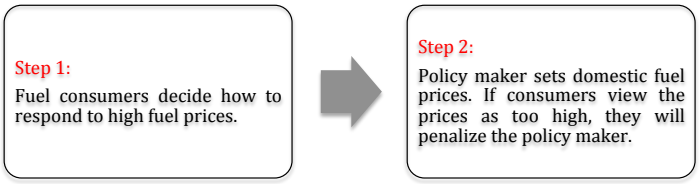

Figure II: The domestic fuel prices (stage 1)

However, political feasibility, i.e., political penalties as well as administrative capacity and institutional constraints, are not considered. On the other hand, the political-economy frontier models the efficient combinations of resources attainable under the political-economy structure. The political-economy frontier is obtained from the economic frontier by introducing administrative constraints and institutions, as well as allowing domestic population to impose penalties on the policymakers. The political-economy frontier includes the political constraints, which affects the politicians policy decisions. These political constraints include lack of administrative capacity and institutions, whose introduction causes the frontier to shift down and to the left.

Define country $h's$ political-economy frontier as the upper-right boundary of feasible payoffs to policy makers and fuel consumers:

$$H_h\left(W_h, u_{fh}\right) = 0.$$

Policymakers maximize an additive objective function, which is the weighted sum of the economic surplus and the penalty imposed by fuel consumers, i.e., β_h:

$$G_h = W_h - \beta_h.$$

β_h is the consumers strength and influence over policy makers; it is the penalty imposed by the fuel consumers when fuel prices are set too high. We assume a penalizing policy β_h such that $\frac{\partial \beta_h}{\partial b_h} > 0$.

Harsanyi (1977) showed that the solution to this bargaining problem is

$$G_h\left(\widehat{p}_{1h}, \widehat{b}_h\right) + \frac{\partial H_h}{\partial u_{fh}} u_{fh}\left(\widehat{p}_{1h}, \widehat{b}_h\right) = \max_{s_h, b_h}\left[G_h\left(p_{1h}, b_h\right) + \frac{\partial H_h}{\partial u_{fh}} u_{fh}\left(p_{1h}, b_h\right)\right],$$

where hat ($\widehat{}$) denotes the equilibrium actions, and where at the optimal solution

$$\frac{\partial H_h}{\partial u_{fh}} = -\frac{\partial \beta_h}{\partial b_h}.$$

Furthermore, when solving the second step, $\frac{\partial H_h}{\partial u_{fh}}$ is held constant (Harsanyi, 1977). That is, during the second step policymakers maximize a weighted sum of the economic surplus and consumers surplus from fuel consumption.

Assuming $G_h\left(\widetilde{p}_{1h}, \widetilde{b}_h\right)$ and $u_{fh}\left(\widetilde{p}_{1h}, \widetilde{b}_h\right)$ are down and left of point C in Fig. III, fuel consumers optimal strategy is $\widehat{b}_h = 0$ and the fuel prices p_{1h} maximize

$$G_h\left(p_{1h}, b_h = 0\right) + \frac{\partial H_h}{\partial u_{fh}} u_{fh}\left(p_{1h}, b_h = 0\right)$$

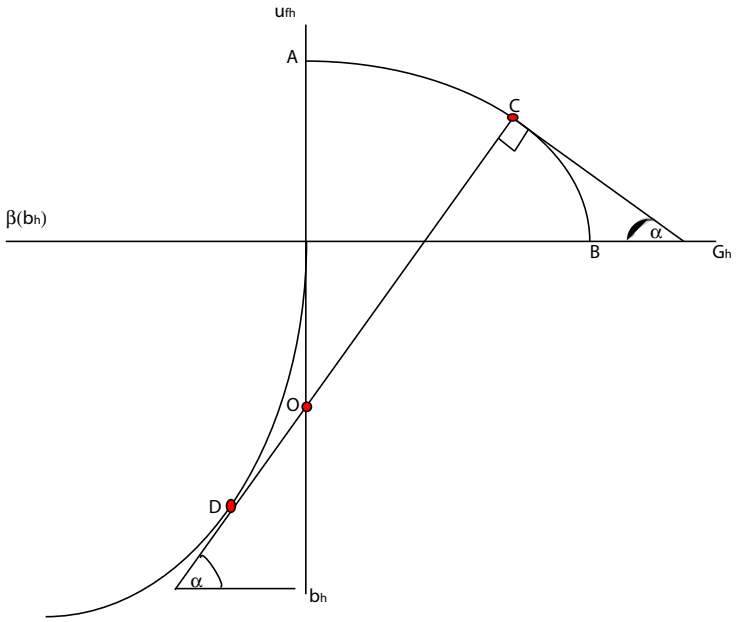

Figure III: The bargaining among fuel consumers and policymakers

where

$$-\frac{\partial W_h}{\partial u_{fh}} = \frac{u_{fh}\left(\widehat{p}_{1h}, \widehat{b}_h\right) - u_{fh}\left(\widetilde{p}_{1h}, \widetilde{b}_h\right)}{G_h\left(\widehat{p}_{1h}, \widehat{b}_h\right) - G_h\left(\widetilde{p}_{1h}, \widetilde{b}_h\right)} = \frac{1}{\frac{\partial H_h}{\partial u_{fh}}}$$

is held constant. At equilibrium, the line joining the disagreement point with the cooperative outcome of the bargaining game is positively sloped and this slop equals the absolute value of the political-economy frontier.

The solution is depicted in Fig. III, where the segment AB depicts the political-economy frontier, and where b_h increases as we move down and $\beta(b_h)$ increases as we move left. The disagreement strategies chosen result in the best bargaining outcome. Graphically, the slop of the penalty function $\beta_h(b_h)$ equals the slope of the line DOC, namely, $\frac{\partial \beta_h}{\partial b_h}(=\alpha)$. This also equals the absolute value of the slope of the political-economy frontier at the equilibrium outcome. The equilibrium outcome is the intersection of DOC with the political-economy frontier $H(.)$, i.e., point C in Fig. III.

The outcome of the first stage of the game maximizes

$$\underset{\{p_{1h}\}}{Max}\ G_h = W_h + \gamma_h \cdot cs_h, \tag{3}$$

where

$$\gamma_h = \frac{\partial \beta_h}{\partial b_h} \text{ and } u_{fh} = cs_h.$$

Politicians in country h maximize G_h by choosing the domestic fuel price p_{1h}. They choose p_{1h} given the domestic fuel prices set by other OPEC countries, $\{p_{1j}\}_{j\neq h}$. This political-economy process

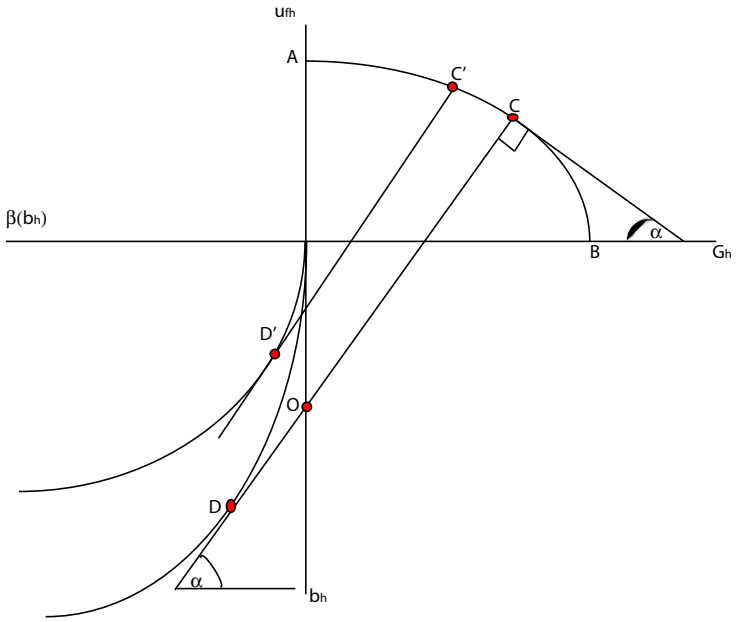

Figure IV: The bargaining outcome and the penalty function

suggests that a more concave penalty function results in a better outcome for fuel consumers. Where a more concave penalty function suggests that, given b_h, fuel consumers can cause more damage to policymakers.

Proposition 1 *The more damage fuel consumers can cause policymakers, the higher is the consumers' final payoff; in other words, given that* $\beta_h^{'}(b_h = 0) = \beta_h(b_h = 0)$*, if* $\frac{\partial^2 \beta_h^{'}}{\partial b_h^2} < \frac{\partial^2 \beta_h}{\partial b_h^2} < 0$ *for all* b_h*, then* $u'_{fh} > u_{fh}$ *and* $G'_h < G_h$*.*

The greater the damage fuel consumers cause policymaker under disagreement, the higher the final payoff to fuel consumers. Graphically, the more damage fuel consumers can inflict on policymakers, the smaller is the slope of the DOC line segment in equilibrium. We depict two scenarios in Fig. IV, where $\frac{\partial^2 \beta_h^{'}}{\partial b_h^2} < \frac{\partial^2 \beta_h}{\partial b_h^2}$ for all b_h and the slope of $D'OC'$ is smaller than that of DOC. To prove the result hold the slope of DOC constant and increase the concavity of β. But then we get a contradiction to the optimality conditions, because the slope of the political-economy frontier at the intersection of the frontier with the DOC line now is smaller. Thus, the DOC line segment should be made flatter. The more severe is the response of consumers to high prices the lower are the equilibrium prices. The solution is based on the idea of mutually optimal threat strategies; that is, the best possible outcome of trying to maximize the damage to someone else under a disagreement situation and of trying to minimize the cost of the disagreement to oneself (Harsanyi, 1977).

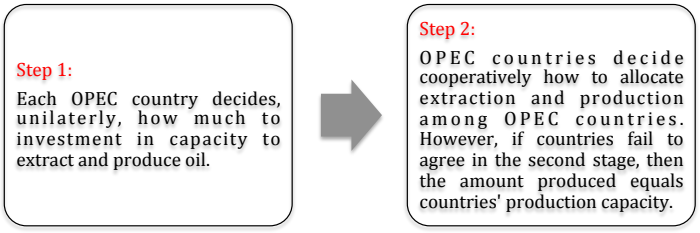

Figure V: The allocation of production quotas among OPEC countries (stage 2)

3.2 The second stage: Allocating production quotas

We assumed the second stage of the game is composed of two steps (Fig V). First, countries announce their conflict strategies, which will be employed should countries fail to agree. Each country decides unilaterally how much to investment in capacity used to extract and produce crude oil. When modeling the OPEC wide decision we assumed that OPEC countries make investment decisions and build capacity. The capacity in an OPEC country defines the maximum amount a country can produce. Following Harsanyi (1963), we assumed that the disagreement payoffs are not given by the rules of the game but are variable and depend on the actual retaliatory strategies countries would use against each other in case they could not agree on the final payoffs. Then, countries allocate production among OPEC countries.

Define the political-economy efficiency frontier as the upper-right boundary of the feasible payoffs space:

$$H\left(G_1, G_2, ..., G_H\right) = 0.$$

The equilibrium threat strategies are solved such that every coalition's threat strategies are optimal against all other coalitions' threat strategies. We defer the formal derivation of the conditions resulting in optimal threat strategies to Harsanyi (1977) chapter 12. It can, however, be shown that at the optimal solution production capacity is chosen such that the marginal damage inflicted by country j on other OPEC countries equals the absolute value of the slope of the political-economy frontier with respect to G_H; i.e., $-\frac{\partial H}{\partial G_h}$.

The political-economy frontier is used to define the outcome of the negotiation of the OPEC ministerial meetings; that is, the solution of the second stage maximizes

$$G_{OPEC} = \sum_h \delta_h G_h,$$

where δ_h equals the absolute value of the slope of the political economic frontier with respect to G_h, i.e., $\delta_h = -\frac{\partial H}{\partial G_h}$ (see also Rausser and Zusman, 2011). This structure suggests that when modeling the OPEC wide decision, politicians, when allocating production decisions among OPEC countries, place different weights on different countries.

The OPEC ministerial meetings maximize

$$G_{OPEC} = \sum_h \delta_h \left(W_h + \gamma_h \cdot cs_h\right) \tag{4}$$

by choosing cooperatively the allocation of production $\{q_h\}_{h=1}^H$ among OPEC countries. OPEC chooses $\{q_h\}_{h=1}^H$ given the domestic prices in the OPEC countries.

Fuel consumers affect the OPEC-wide decision and the magnitude of their impact on the allocation of production is determined by γ_h. However, allowing individual OPEC countries to respond to domestic fuel consumers mitigates the effect of these consumers on the OPEC wide decision. The more damaging are the consumers (assuming this is measured by the concavity of the damage function), all else equal, the smaller is γ_h in equilibrium. The OPEC organization structure allows individual countries to reduce domestic political pressure by reducing domestic fuel prices. OPEC relegates consumption decisions to individual countries and this helps keep the domestic political struggle at bay during the OPEC ministerial meetings (see Proposition 1 and the discussion that follows it).

Proposition 2 *The countries with the spare production capacity are the countries with the bargaining power.*

Proposition 2 explains why, although the OPEC Statute allocates one vote to one country, Saudi Arabia is considered by many the kingpin of the OPEC organization (e.g., Alhajji and Huettner, 2000a and 2000b). The bargaining game is a two step model. The outcome of the game solves Eq. (4), and is affected by the non-cooperative capacity decisions done at the first step and which determines $\delta_h = -\frac{\partial H}{\partial G_h}$. Spare capacity is not and has never been evenly distributed throughout OPEC. At times, more than 90% of OPEC's spare capacity resided within Saudi Arabia. While toward mid-2010 many OPEC countries operated at capacity, some argued that Saudi Arabia's spare capacity reached more than 4 million barrels a day.[10] Even today, Saudi Arabia is responsible for 2/3 of the spare capacity of OPEC.

Many factors affect the capacity choice among OPEC countries: An OPEC country may be limited by the United Nations Atomic Energy Agency, or war can severely hamper a country's production capacity. However, once the amount of spare capacity is determined, it affects the outcome of the negotiations such that more spare capacity translates to more bargaining power.

4 The equilibrium outcome

We solve the game backward while assuming countries' endowments are sufficiently large. That is, we begin with the OPEC wide quota-allocation decisions and then characterize the country-specific decision. When characterizing the equilibrium, the implications to international oil markets is discussed and the mechanism used by OPEC countries to promote cooperation among oil-exporting countries analyzed.

4.1 The allocation of quotas

The solution of the second stage bargaining problem is the solution $\{q_h\}_{h=1}^H$ that maximizes Eq. (4) given δ_h and γ_h for all $h \in H$ (Harsanyi, 1977). This results in the following condition:

$$\underbrace{\sum_{h\in H} \delta_h \frac{\partial tr_h}{\partial q_j} - \delta_j mc_j}_{\text{The producer effect}} + \underbrace{\sum_{h\in H} \delta_h \left[(1+\gamma_h)\cdot \frac{\partial cs_h}{\partial c_h}\frac{\partial c_h}{\partial q_j} - \frac{\partial r_h}{\partial c_h}\frac{\partial c_h}{\partial q_j}\right]}_{\text{The consumer effect}} = 0 \text{ for all } j \in H, \tag{5}$$

[10] See http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aVD11escRHdQ.

where $tr_h = p_1^* \cdot q_h$. Equation (5) can be decomposed into two parts. The first captures the impact on producers from a small increase in production, namely, the production effect. That is,

$$\sum_h \delta_h \frac{\partial tr_h}{\partial q_j} - \delta_j mc_j.$$

The small increase in the amount country j produces affects OPEC countries' revenue from oil extraction and production (i.e., $\sum_h \delta_h \frac{\partial tr_h}{\partial q_j}$) but also increases country j marginal cost (i.e., $-\delta_j mc_j$); it affects the monetary resources available for policymakers that are used to finance public expenses such as food and housing, as well as military and security forces. Allocating more production quotas to country j increases oil revenues to country j, but reduces revenues to other countries because increasing production reduces world crude-oil prices p_1^*.

The second effect captures the impact on consumers, namely, the consumption effect. That is,

$$\sum_h \delta_h \left[(1+\gamma_h) \cdot \frac{\partial cs_h}{\partial c_h} \frac{\partial c_h}{\partial q_j} - \frac{\partial r_h}{\partial c_h} \frac{\partial c_h}{\partial q_j} \right]. \tag{6}$$

The change in consumer surplus is weighted by $(1+\gamma_h)$; it is weighted by consumers' ability to influence policymakers when setting domestic policy. The larger is the marginal effect consumers have on policymakers (i.e., $\gamma_h = \frac{\partial \beta_h}{\partial b_h}$), the larger is the consumption effect. However, the consumption effect is smaller the larger is the impact of quotas on the costs of subsidizing domestic fuel consumption in OPEC countries (i.e., $\sum_h \frac{\partial r_h}{\partial c_h} \frac{\partial c_h}{\partial q_j}$). Although the fuel consumers do not attend the OPEC ministerial meetings, they affects the decision process leading to the allocation of quotas.

The analysis highlights the tension between oil-revenues and subsidizing domestic fuel consumption. Since when a country lacks capacity and institutions to develop efficient ways of redistributing oil-wealth, the consumer effect matters. If revenues collected by the ruling party lead to much less domestic benefits than subsidizing domestic fuel consumption, then to bring the population into complacency policymakers use subsidies. However, lowering domestic fuel prices keeps the domestic political struggle at bay and reduces the effect of domestic politics on the OPEC wide decision.

4.2 The domestic fuel prices

The first stage optimization problem results in the following:

$$\frac{d\left(tr_h - tc_h\right)}{dp_{1h}} + (1+\gamma_h) \cdot \frac{dcs_h}{dp_{1h}} = \frac{dr_h}{dp_{1h}}. \tag{7}$$

Equation (7) suggests that politicians compare the gains from subsidizing domestic fuel consumption with the cost. Whereas reducing domestic fuel prices increases consumer surplus (i.e., $(1+\gamma_h) \cdot \frac{dcs_h}{dp_{1h}} < 0$), it also increases the wedge and the associated cost of domestic fuel subsidization (i.e., $\frac{dr_h^s}{dp_{1h}}$).

The first order condition [i.e., Eq. (7)] is composed of two affects: the revenue effect and the gasoline-consumption effect. The revenue effect, i.e.,

$$\frac{d\left(tr_h - tc_h\right)}{dp_{1h}},$$

measures the marginal impact of an increase in domestic fuel prices on the quota allocation and world oil prices. The gasoline-consumption effect, i.e.,

$$(1+\gamma_h)\cdot\frac{dcs_h}{dp_{1h}}-\frac{dr_h}{dp_{1h}},$$

measures the impact of fuel prices on consumer surplus, i.e., $(1+\gamma_h)\cdot\frac{dcs_h}{dp_{1h}}<0$. The gasoline-consumption effect also measures the cost of subsidizing domestic fuel consumption, i.e., $\frac{dr_h}{dp_{1h}}<0$. The gasoline-consumption effect suggests that policymakers value consumer benefit from gasoline consumption different than the cost of subsidizing consumption. Note that the equilibrium conditions suggest that $\gamma_h>0$.

If we assume

$$\frac{dcs_h}{dp_{1h}}<0 \text{ and } \gamma_h>0,$$

then lower domestic prices results in a marginal decline in oil revenues. The decline in oil revenues is larger than the increase in consumer surplus:

$$\frac{\frac{d(tr_h-tc_h)}{dp_{1h}}-\frac{dr_h}{dp_{1h}}}{\frac{dcs_h}{dp_{1h}}}=(1+\gamma_h)>1.$$

That is, an increase of one dollar in oil revenues is worth less than an increase of one dollar in consumer surplus from gasoline consumption. The more damage consumers inflict on policymakers when disagreeing, the larger is the ratio

$$\frac{\frac{d(tr_h-tc_h)}{dp_{1h}}-\frac{dr_h}{dp_{1h}}}{\frac{dcs_h}{dp_{1h}}}.$$

As noted above, γ_h is also impacted by the amount of administrative capacity and institutions that support the use of targeted policy instruments, and which can be used to redistribute wealth. Lack of such resources results in a larger movement away from the economic frontier and policymakers that are more prone to subsidizing fuel.

5 Discussion and concluding remarks

The paper shows that the rules and objectives governing the OPEC organization lead to flexibility and reduces the political cost of cartelization, thus helping OPEC maintain a cohesive cartel for more than 50 years. OPEC determines quota allocation across countries but relegates domestic policy decisions to the countries themselves. This framework allow OPEC countries to respond to political-economy concerns while not violating OPEC decisions.

When the allocation of quotas restricts exports, as opposed to production, it determines revenues from oil exports, which is an important component of government revenues in OPEC countries (IEA, 2005). It restricts the OPEC countries response to domestic political-economy concerns. More generally, and outside the analysis of the paper, it also restricts OPEC response to exogenous fluctuations in world oil prices. That is, demand for more domestic fuel consumption leads to less exports but

a drop in world oil price forces OPEC to export more because of the need to increase government revenues. We plan on expanding this framework into uncertainty and further investigating the OPEC pricing behavior and its implication to the world oil prices.

Lately, we have witnessed a growing interest in dynamic voting models (e.g., Barbera et al. 2001, Carrubba and Volden 2000, Maggi and Morelli 2006, and Messner and Polborn 2004). This literature is motivated partly by the observation that in international organizations there is wide variation in the mode of governance, both across organizations and over time:

- Some organizations, such as the North Atlantic Treaty Organization (NATO), and Mercosur, are governed by unanimity rule.
- Some organizations, such as the rule-making activities of the World Trade Organization (WTO), are governed partly by unanimity rule (with respect to Article IX of the WTO Agreement, Articles I and II of GATT 1994, Article II:1 of GATS, Article 4 of the Agreement on TRIPS) and partly by a qualified majority rule, namely 2/3 or 3/4 (Marrakesh Agreement Establishing the World Trade Organization Articles IX and X).
- Others, such as most United Nations agencies and the WTO dispute settlement system (which is concerned with the enforcement of the agreed upon rules), are governed by simple or qualified majority rules.
- Still others have seen changes of governance mode over time: the European Union (EU) has recently switched from unanimity to qualified majority in several policy areas, and the International Standards Organization (ISO) switched from unanimity to a supermajority rule in the 1970s.

The qualitative difference between the unanimity rule and any non-unanimous rule is that while the unanimity rule requires only coordination, a (simple or qualified) majority rule requires also enforcement. This is because, any time the organization makes a non-unanimous decision, the dissenting members will be tempted to defect, and the organization must keep this temptation in check. OPEC, however, employs a unanimous rule: "Each Full Member Country shall have one vote. All decisions of the Conference, other than on procedural matters, shall require the unanimous agreement of all Full Members" [Article 11.B, Chapter III].

However, coordination among OPEC countries can become a challenge. For example, if, instead of setting production quotas, OPEC would determine export quotas, then OPEC would have further constrained the various countries resulting in higher political-economy cost of cartelization. Oil revenues in most OPEC countries account for more than 80% of total export revenues and more than 40% of the government budget.[11] In 2005 Iran's economy relied heavily on oil export revenues, where revenues represented around 80- 90% of total export earnings and 40-50% of the government budget. On the other hand, the oil sector in Venezuela in 2005 accounted for more than 3/4 of total Venezuelan export revenues, 1/2 of total government revenues, and 1/3 of total GDP. Oil exports is an important source of revenues for OPEC countries. Thus, reducing flexibility and fixing oil-export

[11] See Country Analysis Brief for OPEC countries available at http: www.eia.doe.gov.

revenues restricts OPEC countries ability to coup with political unrest–a topic that lately is affecting some of these countries dearly. Another expansion, which we leave for future research, is why do some OPEC countries cheat while others do-not?

A reason for OPEC's formation and later success in maintaining itself as a cohesive cartel is that the gains from cartelization in the world oil market are so large. The OPEC organization, however, also reduces the costs associated with cartelization: political costs and cost of coordination of output and price. OPEC, aware of these costs, only coordinates production quotas–reducing the political cost of cartelzation, as well as the cost of coordinating domestic policies within the OPEC countries. However, keeping political unrest at bay can also be achieved by subsidizing housing and maintaining low food prices. In future work we plan to expand the framework and discuss the trade-offs among the various tools which can be used to prevent political unrest.

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