The Geopolitical Dilema: a Game Theory Analysis of OPEC

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In this paper, Laura Finnerty applies classic game theory analysis to OPEC+'s oil supply decisions in the face of threats of US sanctions. She highlights the complexity of the issue as she outlines the optimal strategy for each player given their motivations. This relationship has taken on an interesting dynamic recently as Saudi Arabia is keen to maintain a positive relationship with the U.S following the controversial murder of Jamal Khashoggi, but is unable to withstand current low oil prices. The paper concludes that OPEC+'s supply decisions are much less effective without cooperation with the U.S

INTRODUCTION

Oil prices fell by over 30% in the period from October to December 2018, due to increased global supply (Sheppard and Crooks, 2018). The political dynamics are increasingly complex ahead of OPEC's April meeting, where the cartel will decide whether to further cut oil supplies in a bid to increase global oil prices. President Trump welcomed falling oil prices, hailing them as a "tax cut" for the world (Sheppard, 2018), hence it is assumed that the US' preference for no supply cut is known. Meanwhile, Saudi Arabia, as the world's largest oil exporter requires sustained oil prices to maintain economic growth. Saudi Arabia, OPEC's de facto leader, faces a trade-off between economic and political gains. The murder of Saudi Arabian journalist Jamal Khashoggi, caused fractures in their relationship with the United States, a key Western ally.

Since 2016, Russia along with other non-OPEC oil producers have cooperated with OPEC's supply decisions forming the OPEC+ group. Russia, alongside Saudi Arabia were the biggest benefactors from increasing supply in response to US sanctions on Iranian oil exports. Simultaneously, a boom in US shale produc-

tion has led to further supply in the market, surpassing the decrease in output from Iran and Venezuela. According to the law of supply, as quantity supplied increases the price of a good will decrease, assuming demand is held constant, resulting in falling oil prices. OPEC+ faces a strategic decision; to stabilise global oil prices through a supply cut or give in to political pressure from the US and maintain current output levels. In this paper, game theory is used to model strategic interactions between the US and OPEC+, analysing the optimal strategy for each.

OUTLINE

The model represents an Extensive form Bayesian game with imperfect information. There are two players who move sequentially; OPEC+ and the US. The US only has one type, OPEC+ can be one of two types; Political or Economic. In order to model this random variable Nature moves first and determines OPEC+'s type. After Nature's signal, only OPEC+ is aware of its type and the US never has complete information. OPEC+ must decide between imposing a supply cut or leaving supply at current levels. If OPEC+ does not reduce supply then the game ends and downward pressure on oil prices remain. If OPEC+, decides to impose a supply cut, the US must choose whether or not to retaliate. If the US chooses not to retaliate then the game ends and the supply cut remains in place, increasing global oil prices.

In response to a possible supply cut, the US has several possible forms of retaliation; increased shale production or to reduce Iranian sanctions - both increasing oil supply. Politically, the US could impose sanctions on Saudi Arabia over Jamal Khashoggi's murder. If the US retaliates, OPEC+ may choose to keep the supply cut or to drop it.

ASSUMPTIONS

The first assumption underlying the model is that all OPEC+ members will move together, which requires the cooperation of non-OPEC members, including Russia. Excluding the potential of divergence among OPEC+ members is a simplification of the game. Although it is likely not too restrictive as the Russian Energy minister has confirmed intent for continued cooperation (Devitt, 2018).

Secondly, the model assumes that the United States has the ability to retaliate. A lack of pipeline infrastructure in the Permian basin has limited output, however, three major projects will open next year (Crowley, 2018) creating capacity to increase supply in excess of any OPEC+ cut. In November, the United States gave six-month waivers to eight countries to allow them to continue to buy

Iranian crude oil (Manson, Peel and Bozorgmehr, 2018). The US could retaliate to a supply cut by extending waivers duration or by increasing the number of countries granted exemption.

Finally, there are assumptions over the preferences of the US and OPEC+. Breakeven costs for US shale producers have fallen dramatically (see Figure 4) and hence it is assumed that while US shale producers would benefit from higher oil prices, they can withstand current levels. President Trump, a proponent of fossil fuels, has welcomed falling oil prices as a "tax cut" passed on to regular Americans at gasoline pumps. With an election in 2020, it is in the US President's political interest to suppress crude prices. The US is now the largest oil producer in the world (see Figure 2), and although damaging international relations through retaliation is undesirable, they have strong political leverage over the group's de facto leader.

Although Middle Eastern producers have lower breakeven costs (see Figure 5), according to the IMF, countries such as Saudi Arabia need oil prices sustained in the $85-$87 range to finance state spending (Hiller, 2018). A supply cut is in the economic interest of OPEC+, however, the question remains whether Saudi Arabia can withstand US retaliation. Saudi Crown Prince Mohammed bin Salman wants to avoid conflict with the US President after he stood by him following the murder of Jamal Khashoggi, ignoring calls from Washington to impose sanctions for the killing. Saudi Arabia cannot afford to lose the US as a Western ally but simultaneously cannot withstand $50 a barrel oil prices without serious economic ramifications.

The outcomes for the US are ranked as follows:

U(No Cut)>U(Cut, Retaliate, Drop)>U(Cut, Not Retaliate)>U(Cut, Retaliate, Keep)

For the United States the best outcome is that no supply cut is imposed and oil prices remain low. In response to a supply cut, the US would rather retaliate if they believe OPEC+ will drop the cut than not retaliate at all. However, the worst outcome is if the US retaliates and the supply cut is maintained, damaging international relations and suffering higher oil prices.

If OPEC+'s type is economic:

U(Cut, Not Retaliate)>U(Cut, Retaliate, Keep)> U(No Cut)>U(Cut, Retaliate, Drop)

If OPEC+'s type is economic it is assumed that the benefits from higher

oil prices outweigh some damages to international relations. The best outcome is that OPEC+ impose a supply cut and the US does not retaliate resulting in higher oil prices but limited tension between the groups. However, OPEC+ acting in its economic interest, would prefer to cut supply and maintain the cut in response to US retaliation rather than not cutting supply at all. The worst outcome is to cut supply and then back down to US retaliation resulting in damaged international relations and no economic benefit from a supply cut.

If OPEC+'s type is political:

U(Cut, Not Retaliate)>U(No Cut)>U(Cut, Retaliate, Drop)>U(Cut, Retaliate, Keep)

If OPEC+'s type is political it is assumed that while the economic gains from a supply cut is beneficial, avoiding further strain to international relations is more important. The best outcome is that OPEC+ cuts supply and the US chooses not to retaliate. However, if the political OPEC+ believes the US will retaliate to a supply cut then they would rather not cut supply. The worst outcome for the political OPEC+ is the same as the US where following retaliation, the supply cut remains in place and international relations are severely damaged.

EQUILIBRIA

Starting at the end of the game it is clear that the Economic type of OPEC+ will choose to Keep a supply cut and the Political type will choose to Drop a supply cut, hence those are the relevant payoffs to consider. The Economic type has a pure strategy. An Economic OPEC+ will always prefer to play Cut regardless what the US chooses later in the game. A Political OPEC+ will randomise at its first information set where it will choose between Cut and No Cut.

- α: Pr(OPEC+ is Economic)

- k: Pr(Cut | OPEC+ is Political)

- b: Pr(US chooses to Retaliate)

- p: Pr(OPEC+ is Economic | Cut)

Model 1: α = 2/3

The first model we look at assumes that OPEC+ is Economic with probability 2/3 and Political with probability 1/3, hence it is twice as likely that OPEC+ is Economic than it is to be Political. The model results in a unique pooling equilibrium.

Pooling PBE (Perfect Bayesian Equilibrium):

- OPEC+ strategy:

    o Economic OPEC+: (Cut, Keep)

    o Political OPEC+: (Cut, Drop)

US strategy: (Not to Retaliate)

- US beliefs:

    o OPEC+ is Economic with probability 2/3 and Political with probability 1/3. The US' beliefs are consistent. Their posterior beliefs are equal to their prior beliefs as the actions of OPEC+ do not reveal any information about their type. The US' strategy is optimal because the expected utility from not retaliating is higher when $p > 1/3$, and in this case $p = 2/3$. OPEC+ strategy is also optimal. Since the US will always choose Not to Retaliate, both the Economic and Political types of OPEC+ will choose to cut earning their highest payoffs of 10.

    Model 2: $\alpha = 1/4$

In the second model, we consider new underlying probabilities for OPEC+'s type. This focuses on the political pressure from the United States where international relations between the key nations are already fractured and the group is three times as likely to be a Political type. We assume $\alpha = 1/4$. This yields a unique semi-separating equilibrium whereby the Political OPEC+ is mixing between Cut and No Cut and the US is mixing between Retaliate and Not to Retaliate.

    Semi-separating PBE:

- OPEC+ strategy:

    o Economic OPEC+: (Cut, Keep)

    o Political OPEC+: (Cut with probability 2/3, No Cut with probability 1/3, Drop)

- US strategy: (Retaliate with probability 2/3, Not to Retaliate with probability 1/3)

- US beliefs:

    om OPEC+ is Economic with probability 1/4 and Political with probability 3/4. Using Baye's Rule Pr(OPEC+ is Economic | Cut) = 1/3. OPEC+ Political must play Cut with probability 2/3 for the US to be willing to mix between Retaliate and Not to Retaliate. For this to be optimal for OPEC+

Political, the US must play Retaliate with probability 2/3. If the US observes a supply cut, then it believes OPEC+ is Economic with probability 1/3.

ANALYSIS

By comparing equilibria with different underlying discrete probabilities we see the importance of the probabilities assigned to each type of OPEC+. If it is more probable that OPEC+ will act in its economic interest (Model 1), then the optimal strategy for the US is not to retaliate to a supply cut. However, if it is more probable that OPEC+ is acting in its political interest (Model 2), then the optimal strategy is for the US to mix strategies.

In this paper, co-operation between OPEC+ countries is assumed as a simplification. Although not modelled in this paper, there is a further game theory decision nested within OPEC+; the strategic decision of each OPEC+ country on whether or not to obey a supply cut. This can be thought of as a complex version of the Prisoner's dilemma. The Pareto efficient outcome is for all members to co-operate in cutting supply, however, there is always a monetary incentive to deviate and produce more. In reality, this can be thought of as a repeated game as OPEC will face further supply decisions in the future. Hence, as there is the potential for punishment if members do not cooperate this should lead OPEC+ to the efficient outcome.

An interesting extension to the model would be to include cheap talk signalling, where after the sender (OPEC+) learns their type, they choose a message to send to the receiver (US). In the age of world leaders Tweeting, the addition of a costless signal of intent is realistic. It is in OPEC+'s interest to signal that its type is economic, as then the US's optimal strategy is not to retaliate resulting in the highest possible payoff for OPEC+.

POLICY

OPEC is most efficient when there is cooperation between all members. Increased cooperation between oil producing nations both OPEC and non-OPEC members should lead to greater oil price stability. Hence, there is a policy incentive to create a more formal OPEC+ which would lock in non-member countries such as Russia to cooperate on future supply decisions. As the United States is now the largest oil producer in the world, in order for OPEC's supply decisions to remain effective there is a policy incentive to include the United States in a redefined OPEC group.

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APPENDIX 1

Model 1: $\alpha = Pr(OPEC^+ is Economic) = \frac{2}{3}$

$$EU_{US}[Retaliate|p] = p(1) + (1 - p)(7) = 7 - 6p$$
$$EU_{US}[NotRetaliate|p] = p(5) + (1 - p)(5) = 5$$

US will prefer to Retaliate if:

$$7 - 6p > 5$$
$$-6p > -2$$
$$p < \frac{1}{3}$$

Therefore:

- If p $< \frac{1}{3}$ US will choose Retaliate.
- If p $> \frac{1}{3}$ US will choose Not to Retaliate.
- if p $= \frac{1}{3}$ US will be indifferent between Retaliate and Not to Retaliate.

US beliefs must be consistent with OPEC$^+$'s strategy and Baye's rule:

$p = Pr(OPEC^+ Economic|Cut)$

$= \dfrac{Pr(Cut|OPEC^+ Economic) * Pr(OPEC^+ Economic)}{Pr(C|OPEC^+ Economic) * Pr(OPEC^+ Economic) + Pr(C|OPEC^+ Political) * Pr(OPEC^+ Political)}$

$= \dfrac{(1)(\frac{2}{3})}{(1)(\frac{2}{3}) + (k)(\frac{1}{3})}$

$= \dfrac{2}{2 + k}$