Assessment 2a

by Hui Shan Tan

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Case Study Report
Application of Game Theory on Cartel in Oil Industry

By Hui Shan, Tan

Introduction

OPEC is an organization formed by group of multinational oil production countries. It has a market share of around 44% of global crude oil supply. The members will comply with the cartel, to ensure the stabilization of oil supply and price fluctuation in the market. Members are expected to act in mutual interest. The problem arises as there is economic incentive for the members to cheat. This is a simultaneous move and infinitely repeated game with complete information. The complete payoff matrix is available for analysis. The players are choosing their strategy without knowledge of opponent's choice and the game will be repeating when the supply-demand and oil price are fluctuating beyond the favourable range that may crash the oil market.

Discussion

Players:
Firm A and Firm B

Strategic Situation:
Assuming the production restriction of 50 barrels per firm was imposed, the global oil price was USD 50/barrel before the pandemic. Following the outbreak of pandemic Covid-19, most of the countries are locked down, the oil demand declines. There is supply surplus and the storage space tightens, hence the price drops dramatically. OPEC members were committed to cut the production to sustain the market price. The oligopoly oil market is simplified, such that OPEC members are dominating the market and there are only two firms participating in the cartel. They are producing at different fixed costs as shown in Table 1.

Table1: Production Costs.

Firm	A	B
Cost	5	8

The oil price increases as the total production reduced, and vice versa (Table 2).

Table 2: Oil Price.

		Firm B	
		Cheat	**Cooperate**
Firm A	**Cheat**	20	48
	Cooperate	48	65

The production is now restricted to 35 barrels/firm. The production is modelled as in Table 3 with respect to firms' strategies. The profit of each firm is computed in payoff matrix (Table 4), as *profit = production*(price - cost).*

Table 3: Production by Firms for Each Possible Strategy.

		Firm B	
		Cheat	**Cooperate**
Firm A	**Cheat**	(55 , 55)	(55 , 35)
	Cooperate	(35 , 55)	(35 , 35)

Table 4: Payoff Matrix (asymmetric matrix due to difference in production cost)

		Firm B	
		Cheat	**Cooperate**
Firm A	**Cheat**	(825 , 660)	(**2365** , **1400**)
	Cooperate	(**1505** , **2200**)	(2100 , 1995)

Pure Strategy

There is no strategy that is always the best or the worst for a firm regardless of the strategy by another firm. When firm B chooses to cheat, firm A has better payoff by cooperating and worse payoff by cheating. When firm B chooses to cooperate, firm A has better payoff by cheating and worsen by cooperating. Similar scenario observed when we switch the players, but at different payoff values. Therefore, we say that there is dominant or dominated strategy for neither firm.

If both firms cheat, (Cheat, Cheat), the oil price continues to decline and supply increases, they will experience the worse outcome of lower profit. 'Cheat' will not be an ideal strategy for either firm if they expect opponent to cheat. They gain increased profit of (USD 2100, USD 1820) when both cut the production, (Cooperate, Cooperate), but this is not the strategy that maximize the profit attainable by a firm, considering the choice of another firm to cooperate.

The firms are looking for optimal strategy such that they have no incentive to deviate from their initial choice of action when the opponent remains in their strategy, a Nash equilibrium. (Cheat, Cooperate) and (Cooperate, Cheat) are the Nash equilibria for the case.

Observing the payoff matrix, when counterparty is cooperating, the payoff received by the firm to cheat is much higher than that to cooperate. Hence, when a firm cooperates, another firm has incentive to cheat to maximize their profit. As the counterparty is reducing the production, the firm tends to increase production taking up a larger market share and attain a higher profit.

For strategy (Cheat, Cooperate), considering firm A plays a strategy 'Cheat', firm B has no incremental benefit by switching from 'Cooperate' to 'Cheat', due to the lower payoff of USD 660 as compared to USD 1400 in the Nash equilibrium. When firm B is cooperating, there is no incentive for firm A to change its strategy of 'Cheat', as the strategy deviation will not be beneficial to the firm and cause a profit reduction from USD 2365 to USD 2100. The same situation is applicable to the strategy (Cooperate, Cheat), but of different amount for each firm, due to the difference in production cost. Neither of these equilibria is better for both firms than the other, each Nash equilibrium is preferred by different player.

Conclusion

The situation is similar as the coordination game, 'The battle of Sexes'. None of the pure strategy Nash equilibrium is mutual best response for both players. Different player prefers different equilibrium. The situation discussed described part of the reason in real-world case where there is news reporting on the OPEC members cheat for higher return. The payoff received by each firm depends on their decision, as well as the opponent's choice, both of their decisions bring impact to the total supply and hence the oil price. Nevertheless, the real-world cases are much more complicated and cover a wider range of influencing factors. Since there are non-member oil production countries contribute more than half of global supply, a more in-depth study needs to be conducted on the strategic decision by the OPEC members, considering the influences those non-member firms, including the elasticity of supply and the on-going negotiation or price war between members and non-member countries.

Reference

1. Pressbooks. 2020. 10.2 Oligopoly – Principles of Economics. [ONLINE] Available at: https://opentextbc.ca/principlesofeconomics/chapter/10-2-oligopoly/. [Accessed 16 July 2020].
2. Heather Long. 2020. Remember: OPEC almost always cheats on oil output. [ONLINE] Available at: https://money.cnn.com/2016/12/12/investing/opec-oil-output/index.html. [Accessed 16 July 2020].
3. OPEC+ may force extra cuts on cheaters as supplies increase in August. 2020. OPEC+ may force extra cuts on cheaters as supplies increase in August. [ONLINE] Available at: https://www.worldoil.com/news/2020/7/15/opecplus-may-force-extra-cuts-on-cheaters-as-supplies-increase-in-august. [Accessed 16 July 2020].
4. Gina Heeb. 2020. Game theory perfectly explains why OPEC members are going to cheat. [ONLINE] Available at: https://markets.businessinsider.com/commodities/news/oil-price-opec-game-theory-expains-why-members-will-cheat-2018-3-1019171956#. [Accessed 16 July 2020].

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ORIGINALITY REPORT

13%	7%	0%	9%
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PRIMARY SOURCES

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5	Submitted to The Robert Gordon University Student Paper	1%

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GRADEMARK REPORT

FINAL GRADE

80/100

GENERAL COMMENTS

Instructor

Very interesting and timely application! A more intuitive explanation for how the cost asymmetry drives the set of NE would have made it clearer. Also, watch the length limit!

G 50%

E 10%

C 20%

PAGE 1

PAGE 2

PAGE 3

RUBRIC: A2_RUBRIC_FINAL

ANALYSIS

(20) \nIdentify the appropriate game theoretic model to describe the strategic situation

HIGH DISTINCTION (HD) 85-	Accurately identifies/selects (and explains where necessary) all key relevant disciplinary or interdisciplinary knowledge, indicating a breadth of understanding.
DISTINCTION (DN) 75-84 MA	
CREDIT (CR) 65-74 MARKS	Identifies/selects (and explains where necessary) some key relevant disciplinary or interdisciplinary knowledge.
PASS (PS) 50-64 MARKS	
FAIL (FL) >50 MARKS	Does not correctly identify or select relevant disciplinary or interdisciplinary knowledge.

ANALYSIS

(30) \nApply the appropriate solution to correctly solve the game.

HIGH DISTINCTION (HD) 85-	Insightfully and accurately applies relevant disciplinary or interdisciplinary knowledge, demonstrating a depth of understanding. Demonstrates a sophisticated understanding of how particular local/global contexts impact upon the application of knowledge.
DISTINCTION (DN) 75-84 MA	
CREDIT (CR) 65-74 MARKS	Applies relevant disciplinary or interdisciplinary knowledge appropriately but may include minor errors or omissions. Demonstrates a general understanding of local/global contexts in applying knowledge.
PASS (PS) 50-64 MARKS	
FAIL (FL) >50 MARKS	Does not apply relevant disciplinary or interdisciplinary knowledge accurately. Does not demonstrate an understanding of the local/global context in applying knowledge.

EXPOSITION

(20) \nDemonstrates proficiency in reading and writing in English

HIGH DISTINCTION (HD) 85-	Excellent word selection, and exemplary grammar and spelling. Excellent structure and organisation. Mainly accurate and adequate referencing. Effectively interprets, translates and paraphrases written texts/spoken language.
DISTINCTION (DN) 75-84 MA	
CREDIT (CR) 65-74	Appropriate word selection, grammar and spelling. Clear structure and organisation.

MARKS	 Mainly accurate and adequate referencing. Effectively interprets, translates and paraphrases written texts/spoken language
PASS (PS) 50-64 MARKS	
FAIL (FL) >50 MARKS	Inappropriate or inaccurate word selection, regular errors in grammar and/or spelling. Poor structure and organisation. Incomplete and/or inaccurate referencing. Inaccurately interprets, translates and paraphrases written texts/spoken language

EXPOSITION

(10) \nCombines information and communication skills to effectively address a specific audience and purpose

HIGH DISTINCTION (HD) 85-	Collects sufficient accurate and relevant information for task. Discovers and interprets information about audience requirements and preferences, and purpose of communication. Applies highly effective search and management strategies to obtain relevant and valid information from digital sources.
DISTINCTION (DN) 75-84 MA	
CREDIT (CR) 65-74 MARKS	Collects some accurate and relevant information for task. Discovers and interprets information about audience requirements and preferences, and purpose of communication. Applies appropriate search and management strategies to obtain relevant and valid information from digital sources
PASS (PS) 50-64 MARKS	
FAIL (FL) >50 MARKS	Does not go beyond provided sources or collects inaccurate or irrelevant information for task. Does not seek or use information about audience requirements and preferences, and purpose of communication. Does not provide evidence of effective search and management strategies for information from digital sources

CREATIVITY

(10) \nIdentifies a creative or complex story about a specific kind of game suitable for critical analysis

HIGH DISTINCTION (HD) 85-	Clearly identifies (and accurately explains where necessary) all relevant, key aspects of a problem or issue, and conveys its complexity. Clearly and accurately outlines purpose of task and method/s of analysis. Formulates insightful questions and/or comprehensive plan to resolve problems, issues
DISTINCTION (DN) 75-84 MA	
CREDIT (CR) 65-74 MARKS	Identifies (and explains where necessary) key elements of a problem or issue, but may not cover all relevant aspects or convey its complexity. Outlines purpose of task and method/s of analysis. Formulates appropriate questions and/or plan to resolve problems, issues.
PASS (PS) 50-64	

MARKS	
FAIL (FL) >50 MARKS	Does not clearly or correctly identify or define/explain an issue or problem. Does not effectively outline purpose of task and method/s of analysis. Does not formulate appropriate questions and/or plan to resolve problems, issues.

CREATIVITY

(10) \nDevelop well-reasoned, appropriate conclusions or solutions

HIGH DISTINCTION (HD) 85-	Presents an insightful / strategic conclusion or solution, well-supported by analysis, evidence, theory and/or research. Clearly explains and justifies assumptions made in investigation. Considers and evaluates differing perspectives and alternative strategies, using appropriate criteria / standards. Acknowledges limitations and constraints of own conclusion / solution
DISTINCTION (DN) 75-84 MA	
CREDIT (CR) 65-74 MARKS	Develops a sound conclusion or solution, but may contain weaknesses or limitations. Discusses and justifies assumptions made in investigation. Considers and assesses differing perspectives and alternative strategies, where appropriate.
PASS (PS) 50-64 MARKS	
FAIL (FL) >50 MARKS	Does not demonstrate understanding of what information / data communicates. Does not present a sound, well-justified conclusion or solution. Does not explain or justify assumptions made in investigation. Does not assess potential solutions against appropriate.