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A financial option perspective on OPEC strategy

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Abstract. The article examines the use of discretionary production by key OPEC members to protect the long-term value of their reserves. Although interpretations vary on its behaviour and market power, the organisation sees its role as promoting the security of supply through stabilising markets while protecting market share and ensuring a fair return to capital. Given the new and perennial challenges facing its members, there are diverse views on how these policy objectives may be promoted. Using option theory, we argue that the market stabilisation policy of OPEC in effect, provides free risk management to the global market and conflicts fundamentally with its long-term objective of protecting market share through discouraging high-cost marginal producers. Abandoning this policy, the returns to marginal producers, adjusted for risk, would be reduced. As implications of our research, rather than creating a social good through mitigating price risk, OPEC should allow markets to be volatile and even consider using its discretionary buffer in a *pro-cyclic* manner, to protect the long-term value of its reserves.

Keywords. OPEC, Risk Management, Shale Petroleum.
JEL. Q02, Q43, Q48, Q58.

1. Introduction

The objectives and strategies of the petroleum exporting nations comprising the Organisation of Petroleum Exporting Countries (OPEC) has long been a subject of research and inquiry. Even before it was founded in 1960, there were concerns in the United States that the organisation's future members would use bountiful reserves and low production costs to compete "unfairly" with domestic producers who clamoured for tariff protection from "cheap foreign crude" (Yergin, 1990). Measuring its market power and how it may be used has been a topic of on-going debate. In the 1970s, scenarios involving concerted effort to reduce or with-hold production by OPEC members, extracting economic rents from Western consumers, figured in planning exercises (Jefferson, 2012). Meanwhile, other researchers notably Professor Morris Adelman (1979) saw OPEC as an ineffectual cartel and unlikely to survive. In the 1980s it was believed that OPEC would fall apart through internal dissension (Goldstein, 1983). Others have highlighted the challenges faced by the organisation in pursuing oligopolistic pricing behaviour (MacFadyen, 1993). During the late 1990s and early 2000s, when it was believed that conventional oil supplies were approaching exhaustion or

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"peaking", we saw renewed fears of OPEC with-holding production alongside worries over security of supply and price stability (Campbell & Laherrère, 1998). Today, concerns continue over the role of the Organisation and its effect on non-OPEC producers (Cairns & Calfucura, 2012). Since the new Millennium, the combination of slow growth in global oil consumption, output from new producing regions and the global decarbonisation agenda have become profound threats to the Organisation. Views vary widely on how it should respond or what strategy to pursue (Barnett & Dessai, 2004). But, running through discussions of OPEC strategies and their efficacy, is the supposition that the pursuit of *market stability* is crucial to ensuring markets for their approximately 30 mmbd of production while maximising the value of future production.

Although the objectives of OPEC are often portrayed as being at odds with the economic interests of energy importing countries, from the perspective of the Organisation itself its mission "…is to coordinate and unify the petroleum policies of its Member Countries and ensure the stabilization of oil markets in order to secure an efficient, economic and regular supply of petroleum to consumers, a steady income to producers and a fair return on capital for those investing in the petroleum industry (OPEC, 2012). "Despite occasional dissent from some of its members, from inception OPEC has been a reliable supplier of both crude oil and products to the global market. Through maintaining a key position in supply, providing price guidance to non-members and adjusting discretionary output to stabilise markets, the Organisation has sought, officially, to balance the needs of consumers with those of producers (Horn, 2004). Indeed, rather than abusing its market power pro-actively, according to some researchers, the organisation tends towards re-activity, responding to markets, often with delays (Kisswani, 2016; Mellios & Andriosopoulos, 2016).

Views differ on how OPEC should maximise the value of its massive reserves and low production costs. Should its members keep prices moderate to discourage alternatives and hold market share (Cairns & Calfucura, 2012)? Or, should it try to preserve revenue at higher prices though it may lead to the erosion of market share and encourage production from new sources, conservation and new technologies? Formally, should short-term sacrifices in revenue be made as a form of *protective investment* in exchange for potential benefits accruing over time in conformity with Samuelson's discounted utility model (Samuelson, 1937). Or, should OPEC's pursue a myopic or even time insensitive approach (Kunreuther, Onculer & Slovic, 1998)? Although probable reserves have been increased, other estimates of proven reserves lend weight to adopting a short-term perspective in order to maximise remaining value (Simmons, 2005). But how should "cheating", or non-adherence to allocated production quotas by members, be handled? What role should Saudi Arabia and the Emirate States, acting as "swing" or discretionary producers, assume? What strategy would supportthe latest plans of Saudi

Arabia to broaden and diversify the country's economic base (Vision 2030, [Retrieved from])? Wouldcontinuing its role as swing producer, promoting market discipline among members, while absorbing natural market shocks, be compatible with the ambitions for the Gulf States of creating sufficient reserves to transition their economies away from petroleum dependence (Korybko, 2017)? In sum, for OPEC as whole and its individual members, what strategy would support maximising the value of its reserves, remains open to discussion.

In addition to the perennial concerns of OPEC, important secular trends and events have created further complications. The rise of new production from non-member countries and the de-carbonisation agenda represent unsettling challenges to strategy and aspirations. Such developments were difficult to anticipate. While the exploitation of the Canadian tar sands, the Artic seas and deep off-shore Brazil had long development times, the modern exploitation of petroleum from "tight formations ", shale oil from the Permian, Marcellus and Bakken basins in the United States, was a surprise [Retrieved from]. Moreover, the coincidence of the "Arab Spring", reducing output from key OPEC members thereby *making a place* for new sources of production, could not have been not predicted. The emergence of the United States as the world's largest producer of petroleum, greater than both Saudi Arabia and Russia, has been a matter of consternation (FT, 20-3-18). Reflecting the set rends and events, in the last decade, Brent crude prices have been as high as $144 per barrel and as low as $26.00 per barrel, averaging $82 for the period. Squeezed between these trends and new domestic economic pressures to diversify their economies and reduce resource dependence (FT, 20-3-18, the upsurge in output by non-OPEC members has sharpened the dilemma facing the Organisation: higher prices are needed to protect revenue but may lead to a loss of market share, as marginal producers are encouraged. Attempting to establish higher prices through some members such as Saudi Arabia reducing output and foregoing revenues, might help in the short term but, over time it, may encourage marginal production from higher cost producers.

Recognising these new challenges, in 2015, the Kingdom of Saudi Arabia adopted a fresh tactic and ramped up production to nearly 10.5 mmb/d with the hope of forcing marginal producers to exit the market (Ansari, 2017). To paraphrase the comments of the Saudi Oil Minister, Khalid al-Falih, rather than adjusting supply to support prices, it would aim to protect market share using low-cost production to drive-out marginal producers (Bloomberg, 2016). The consequent fall in the price of crude oil was designed to defend market share, test the resilience of shale oil production and the competitiveness of alternative technologies (Oil Price, 2015). On the whole, the strategy was not successful and shale production from the United States has continued to increase, having more than doubled since 2010 while its cost of production has steadily declined. For the core members of OPEC, Saudi Arabia and the Emirates, the challenge of preserving market share while protecting revenues has never been greater.

Faced with these challenges, what strategy should the Organisation pursue, especially its largest producers, Saudi Arabia and the Gulf States, the members with the greatest scope for adjusting production and exports?

Confronting these circumstances, various researchers have investigated alternative strategies for OPEC. Before the current threat from shale production, it was argued that to protect profits, OPEC must expand output and maintain its share of global markets (Gately, 2007). More recently, however the focus has turned to defensive positions and preserving solidarity among members but recommendations vary on how best to respond to new production and stagnant growth in demand. OPEC's leading producer, Saudi Arabia has repeatedly attempted to coordinate export reductions with both OPEC members and the National Oil Companies from non-member countries like Russia (Bloomberg, 2016; Financial Times 27-3-18). But according to researchers, the scope for OPEC to act in an anti-competitive manner and support prices, is limited (Alhajjia and Huettnerb, 2000).Other researchers have argued that OPEC should adopt a defensive strategy to protect market share (Alkhathlan, Gately & Javid 2016). And further, that the wisdom of ceding market share to new entrants to stabilise markets, is self-defeating, undermining the scope for market leadership (Alkhathlan, Gately & Javid, 2016).

It has been argued that Saudi Arabia should use its own considerable storage capacity estimated at 12 million barrels to maintain cohesion or accommodate deficits from other producers (Cairns & Calfucura, 2012). Emphasising the importance of market stability, researchers have investigated the role of surplus production capacity in stabilising the price for petroleum (Pierru, Smith & Zamrik, 2017). Looking at the role of four OPEC members, Saudi Arabia, Kuwait, Qatar and the UAE, these authors examined the role of the discretionary output buffer of approximately 2 mmbd used to absorb secular perturbations to supply and demand. The authors argue that maintaining this buffer supports the mission of the Organisation to stabilise markets and demonstrate its trustworthiness as a supplier. Notwithstanding the efforts of the Gulf States, other researchers have argued that the actions of other OPEC members, such as trying to gain effective market share through discounting, has undermined long-term prospects (Brown & Huntington, 2017). From a global perspective, the same authors argue that oil security would be enhanced through diversification and reducing upon OPEC production. But might there be a different strategy for OPEC to both retain market share and maximise the value of reserves?

According to OPEC itself, their strategy continues to be one of coordinating and unifying petroleum policies among member countries to ensure an efficient and reliable supply of petroleum to consuming countries while ensuring a fair return to the petroleum industry (OPEC, 2017). As expressed in their official Long-Term Strategy document, OPEC remains committed to market stability and security of supply (ibid). Furthermore, the Organization plans to continue investment and expansion

of production capacity to meet both expected growth in demand while maintaining an adequate level of spare capacity to absorb market shocks although how such capacity may be used to discourage new entrants and marginal producers, remains uncertain. Whether such plans are compatible with efforts to diversify their economic bases and reduce dependence upon petroleum, is also unclear. Altogether, for Saudi Arabia and the Gulf States, faced with fiscal pressures and challenging demographics, the time-worn strategies do not look auspicious: protecting market share through cutting prices while sacrificing revenue; or reducing output to support prices and ultimately revenues, ushering in new competition (IMF, 2017). To address these alternatives, we analyse OPEC strategy taking fresh methodological perspective. Using this perspective, we consider the scope for the swing producers of OPEC to pursue *an alternative strategy*. Might there be a better way for OPEC to protect both its market share *and* prices while discouraging marginal, high-cost production? In this research, we combine financial option theory with some recent insights from the industrial organisation literature on the importance of analysing competitor behaviour, on risk-adjusted basis (Leautier & Rochet, 2014).

2. OPEC behaviour in retrospect

As described above, over the years, OPEC has adjusted output to protect prices, absorb shocks and protect market. As regularly reported, through using approximately 2 mmb/d of lifting capacity in a discretionary manner (Petroleum Economist, 2005, 2012, 2016, 2018), the core members of OPEC, Saudi Arabia and the Gulf Emirates States, have pursued the goal of stable markets. Although losing granularity with annual data, we see how OPEC production as a percentage of total production has varied over time. Like other cartels through history, a discretionary production buffer has been used to support prices, withdrawing supply when prices were too low and increasing production when prices became too high (Reynolds & Pippenger, 2010). Like other cartels it has tried to enforce pricing discipline using quota allocations among members while trying to influence producers who are non-members. Notwithstanding such efforts however, a key problem for OPEC is that its total output is only about a third of total global requirements; its role is important but not pivotal (Alhajji & Huettner, 2000).

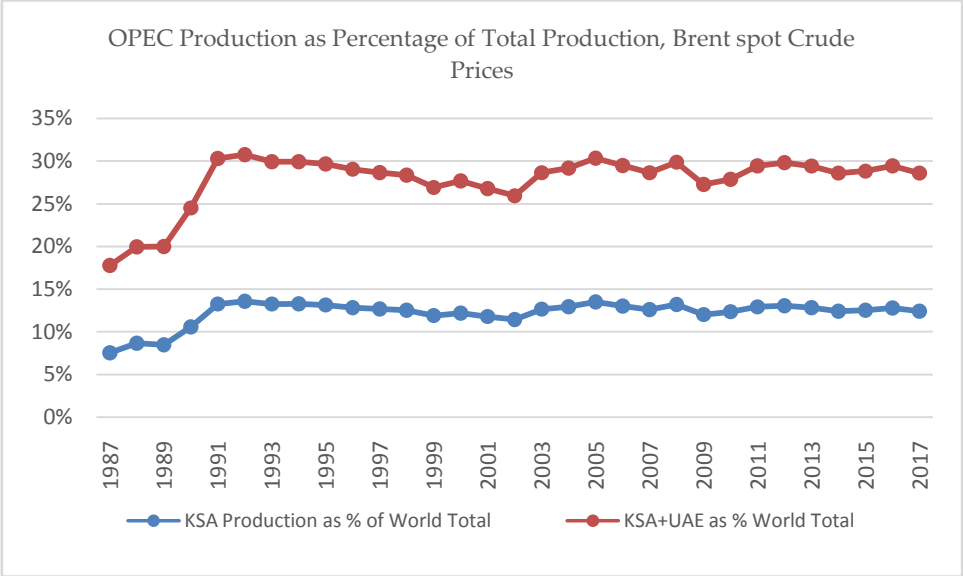

Figure 1. *OPEC Production as Percentage of Total Production, Brent spot Crude Prices*
Source: US DOE-EIA. [Retrieved from].

At a macro-economic level, it has been argued that the stabilising role of swing producers of OPEC provides global benefits of approximately USD 20 billion per annum in the short term in avoided costs, depending upon elasticity assumptions, may be (Pierru, Smith & Zamrik, 2017). These results are consistent with the work from Oxford Economics [Retrieved from]. But this is a measure of the economic benefits of the avoided supply short-fall. It does not measure the benefits of market stability or reduction in price volatility. Although OPEC has a committed itself to stable markets emphasising the benefits to global consumers, we ask whether stabilising markets and reducing price volatility through adjusting output helps the Organisation itself? Apart from the benefits to consumers from stable prices, we ask whether pursuing stable marketshas not also been indirectly beneficial to marginal, high-cost produces?

We argue that by varying output through the use of discretionary buffer, reducing price volatility through stabilising markets, OPEC has created a public good to the global economy in addition to the macro-benefits of avoided supply disruption. Data on price volatility in of itself is not conclusive and as we see in Figure 2 and Table 1 below, price volatility has varied considerably over time:

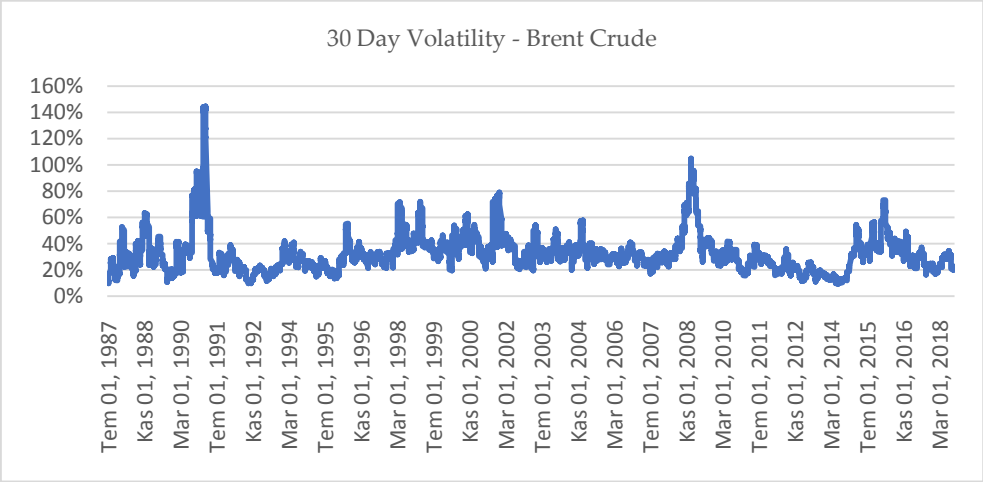

Figure 2. *30 Day Volatility - Brent Crude*
Source: US DOE-EIA. [Retrieved from].

Table 1. *Brent Crude Oil Volatility (Source: Authors' calculations)*

KEY STATISTICS BRENT CRUDE OIL VOLATILITY 7-1987 to 4-2018	
Average	33%
Minimum	9%
Maximum	145%
Standard. Deviation	15%

It is not possible to say from the data by how much the actions of the Gulf States through adjusting their buffer, have reduced volatility. As we see in Figure 2, after rising from mid-2014 up to 2016, price volatility for crude oil has followed a downward trend. What volatility might have been without intervention by the Gulf States is naturally counterfactual. Notwithstanding, we can observe that if high-cost producers sought to protect their revenues and hedge a portion of their production, it would have had a cost. Further, even if marginal producers were not engaged in a hedging program, by making their returns riskier, their cost of capital would have been greater. Using option theory, we can quantify benefits of risk reduction. The plot of Figure 3 below shows that for every 1% reduction in volatility, for example from 50% to 49%, the price of single option to hedge the position falls by approximately $0.23.[2] By dampening price volatility through the operation of a buffer, OPEC has reduced the costs of hedging and/or lowered the cost of capital for exploration and production activities. In sum, the organisation has provided the benefits of risk management to the worlds' consumers and producers the value of which may be quantified using financial option theory.

[2] Using DerivaGem software the Vega, ∂Price/∂ Volatility=0.23. For every 1% change in volatility, the price of the option changes by approximately $0.23. We assume a risk-free rate of 3%, strike price = market price of $60 USD per barrel, expiry one year.

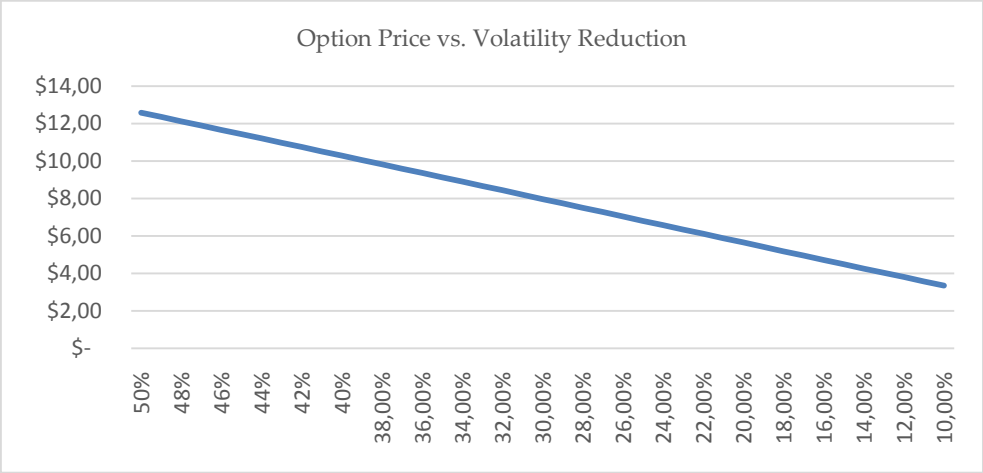

Figure 3. *Option price against Volatility. Assuming a risk-free rate of 3%, strike price = market price of $60 USD per barrel, expiry one year. Authors' calculation using DerivaGem© Software*

On a volume of 2 mmbd, the amount used by the Gulf States as a buffer stock, we calculate the costs of a long straddle position, consisting of a long call and a long put as would be used to hedge price volatility (Hull, 2012). We use the latest 30 -day volatility for Brent Spot Crude Oil of 30% from the International Commodity Exchange to compute hedging costs.[3]Rather than adjusting a buffer of 2 mmbd in capacity, we suppose the same amount were hedged, to stabilise markets. Although market price volatility is not eliminated through the operation of a buffer stock, it is reduced. Of course, an individual firm reducing its exposure to price volatility through hedging is *not* the same as making the overall market less volatile through operating a buffer but we propose that option theory may be used to value the benefit in risk reduction. Assuming a one-year hedging program, we find, as shown in Figure 2 below, that eliminating volatility on one-million barrels would have a cost of slightly more than USD 1 billion annually while hedging 2 million barrels annually would have a cost of nearly USD 2 billion annually. In reducing market price volatility, these results capture how markets value improved price stability. So, in addition to the $20 billion of benefits quantified by previous researchers, there is a positive risk management externality in OPEC's behaviour.

By operating a buffer to stabilise price shocks, Saudi Arabia and the core members of OPEC are in effect providing the benefits of risk management services to the global petroleum market using their discretionary production: Increasing output as prices rise and cutting output when prices fall according to its stated mission. Had marginal producers undertaken their own hedging programs, it would have been at a significant cost. Or, if not undertaken, it would have increased their cost of capital given risk tolerance of private investors. Through using its discretionary capacity as a buffer to dampen market volatility, OPECs'

[3] Annualised Volatility is computed from the thirty-day average of standard deviations in percentage changes in daily prices, multiplied by √252, trading days per year (Hull, 2012).

swing producers generate social benefits in price volatility reduction to marginal producers and the global economy. Given the low-cost nature of OPECs output, moreover, it is almost surprising that a price stabilisation strategy, was pursued (Reynolds, 1999). In other extractive industries, managing price risk has been shown to be important for high-cost producers, not low-cost ones (Tufano, 1996). We further note, holding volume in storage as a buffer, has an opportunity cost in financial terms.

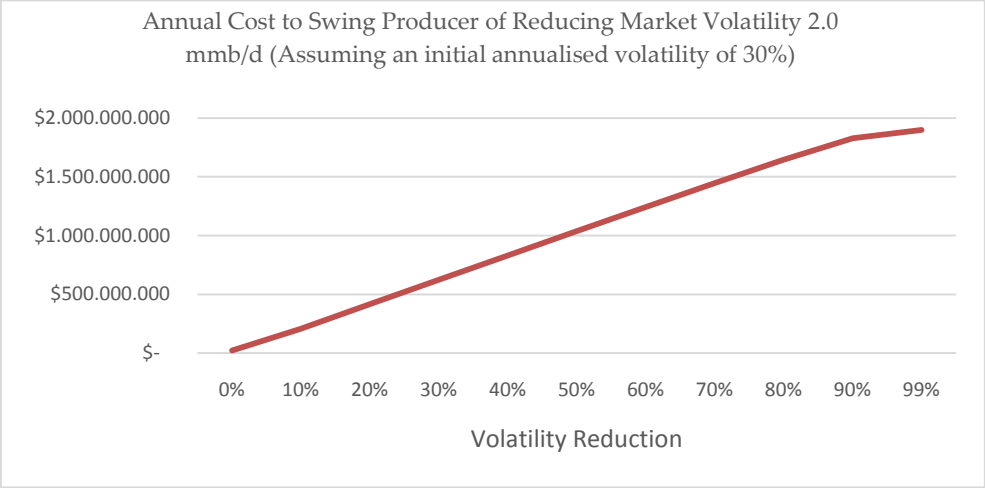

Figure 4. *Annual Cost to Swing Producer of Reducing Market Volatility 2.0 mmb/d (Assuming an initial annualised volatility of 30%)*
Source: Authors' calculations using DerivGem© Software.

To illustrate the benefit to global consumers and producers of OPEC providing price risk management, we can explore the impact at a firm level. Using data for the largest shale oil producers in North Americawe compute the following results, shown in Table 1.

Table 2. *Financial Impact of Hedging (Source: Authors' calculations using SEC Filed Annual Reports, 2017)*

MAJOR NORTH AMERICAN SHALE OIL PRODUCERS	RETURN ON EQUITY (2017)	PROFIT MARGIN (2017	THEORETICAL ANNUAL HEDGING COST	ANNUAL REVENUE (2017)	ANNUAL REVENUE NET OF HEDGING COST	PERCENT REDUCTION IN REVENUE WITH HEDGING	ADJUSTED PROFIT MARGIN WITH HEDGING	ADJUSTED ROE WITH HEDGING
Apache Corporation	18.25%	22.51%	$ 167,877,025	$ 5,890,000,000	$ 5,722,122,975	3%	21.87%	17.73%
Cabot Oil & Gas	3.94%	5.73%	$ 285,164,398	$ 1,740,000,000	$ 1,454,835,602	16%	4.79%	3.29%
Devon Energy	8.04%	6.53%	$ 1,432,257,388	$ 13,730,000,000	$ 12,297,742,612	10%	5.85%	7.20%
EOG Resources	17.07%	22.80%	$ 585,563,794	$ 11,290,000,000	$ 10,704,436,206	5%	21.62%	16.18%
New Field Exploration	36.40%	24.17%	$ 144,280,809	$ 1,770,000,000	$ 1,625,719,191	8%	22.20%	33.43%
Pioneer Energy	7.68%	15.74%	$ 1,884,014,580	$ 5,290,000,000	$ 3,405,985,420	36%	10.13%	4.94%

The results show at firm level, the gains from eliminating petroleum price volatility. Of course, we do not know with precision the extent to which existing margins and profitability already reflect risk mitigation efforts. Further, it is counter-factual what market volatility might have prevailed, had the swing producers of OPEC not utilised or had been perceived as willing to utilise their buffer capacity to reduce market volatility. But, if for example Cabot Oil & Gas had conducted its own hedging program using a volatility hedge, as described above, it would have cost the firm nearly $300 million per annum or approximately 16% of

revenues. On the whole, these results are consistent with the finding that because revenue functions are concave in output prices, corporate risk management enhances firm value (Mackay & Moeller, 2007).

3. Policy implications and conclusions

Applying option theory to analyse OPEC's pursuit of price stability also suggests an alternative strategy for the OPEC cartel. Although the Organisation appears committed to stabilising markets, whether it is the best strategy to preserve market share while ensuring adequate revenues to its members, may be debatable. OPEC would like to see higher price levels but such prices encourage exploration and production from high-cost producers, like U.S. shale oil producers, Canadian tar-sands and deep off-shore, ultimately leading to lower prices through greater supply. Critically, by operating a buffer to dampen price volatility and stabilise markets, in effect providing risk management, OPEC enhances the *risk adjusted returns* to marginal, high-cost producers, reducing their own need to hedge.[4] According to the consultancy Wood Mackenzie, the *average* break-even well-head costs of oil production in both the Lower 48 states of the United States and the Gulf of Mexico, is just below $50 per barrel at the well-head while that of Canadian tar-sands, is marginally greater at around $52. Critically, production costs by individual basins, the range is greater (Wood Makenzie, 20-3-18). In 2017 the observed standard deviation for the spot price of West Texas Intermediate was approximately $3 per barrel. Thus, from today's price levels, it would not require a large movement in prices, to render a considerable portion of North American production uneconomic, underscoring the importance of price stability to marginal producers. Moreover, the risk-tolerance of high-cost competitors, such as shale producers, is lower than that of OPEC itself.

The research illustrates the importance of using the two parameters of expected prices and their variance to analyse OPEC behaviour. Our main contributions are the following:

a. We show that the market stabilisation activities of OPEC's swing producers represent a form of price risk management which is beneficial to high-cost, marginal producers;

b. We learn that if such producers were to under-take their own hedging programs to safe-guard revenues, it would reduce profitability; and

c. We observe that the financial performance of high-cost oil producers on a risk adjusted basis would be lower in the absence of either OPEC price stabilisation or company level hedging activity.

[4] It is standard practice in capital budgeting to compute returns adjusted for risk. Risk-adjusted return refines an investment's return by measuring how much risk is required to produce a return. Some common risk measures include alpha, beta, R-squared, standard deviation and the Sharpe ratio.

From a policy perspective, we should consider the possible implications if OPEC were to pursue a different approach forgoing its role in market stabilisation. Greater price volatility would most affect the risk adjusted returns of higher-cost exploration and production activity, eventually leading to less investment and output. Given the lower risk-tolerance of shale and other high cost producers and their reliance upon private capital, it may make sense for OPEC to end its commitment to stable markets. As explored in the industrial organisation literature, the burden of managing risk may be a barrier to entry (Leautier & Rochet, 2014). In theory at least, rather than stabilising prices, OPEC could protect its position by using its discretionary buffer in a *pro-cyclic* manner, to increase market volatility, making investment in high-cost exploration and product, on a risk-adjusted basis, *less* attractive. The pursuit of such a strategy would have big implications for global oil markets and make them less secure. Our observations hearken back to the insights of the late Professor Adelman who argued that "sowing confusion" in oil markets might actually be strategically useful (Adelman, 1972).

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