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Diversification Strategy Under Deep Uncertainty for MENA Oil Exporting Countries

Abstract

MENA oil exporting countries have been hit by a double shock: Covid-19 and the oil price collapse. Their short-term strategy to offset the impact of these shocks will focus simultaneously on fiscal adjustment and coordinating on oil supply cuts with other producers to support oil prices and revenues. While the degree of fiscal adjustment is constrained by its social, political and macroeconomic implications, effective output cut faces several challenges including coordination among producers and the scale of the global oil demand shock. Achieving a meaningful and sustained price increase through collusive supply response is contingent about some key uncertain factors such as the extent of the supply reductions in response to lower oil prices and the extent and duration of global oil demand contractions and the speed and shape of global oil demand recovery. MENA oil exporting countries also face long-term challenges and Covid-19 shock gives new urgency to adjusting their long-term strategy to reduce risks and improve their resilience. These countries face two major long-term issues. First, there is no single successful strategy to shield against the long-term risks of oil price crash. Diversification works only when it offers risk reduction by the pooling of uncorrelated income streams. If these countries diversify only into sectors where inputs rely on hydrocarbon infrastructures and where both tangible and intangible relationships exist across fossil and non-fossil fuel businesses, they may not achieve sufficient risk reduction. On the other hand, if they diversify into substantively different areas that have little in common with their current primary industry, which constitute the core of their comparative advantage, they run the risk of not being competitive. Second, irrespective of the strategy taken, in the face of disruptive forces, there is a fundamental trade-off between expected return and the variance of return, i.e. the cost of reducing the long-term risks and increasing resilience is to accept lower expected return on existing assets, for instance, by investing in measures that align their hydrocarbon sector with low carbon scenarios. This lowers the overall return but reduces the risk of disruption in the long run.

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1. Introduction

The novel coronavirus has been a clear reminder that we are living in a complex and interdependent world, where unexpected shocks can cascade instantly across borders, markets, and industries, with impacts that can be both severe and hard to predict. Under these conditions, risk becomes an even more important dimension of all decisions, as the decision maker could adopt strategies that lead to suboptimal outcomes resulting in a high opportunity cost.

Risks can be categorised as preventable risks, strategic risks and non-controllable risks. Preventable risks, as the name suggest, are internal risks that are controllable and can be avoided. Strategic risks are related to executing a particular strategy such as the decision to implement an oil output cut or expand market share by adopting a high-volume supply strategy. Non-controllable risks are external risks which are beyond the control of the decision maker such as the risk of Covid-19 and its implications for energy sector and economy, as a whole.

MENA oil exporting countries have been hit by two shocks: Covid-19 and the oil price collapse. These countries cannot influence the likelihood of external risk events but might be able to mitigate the short run and long run impacts of such events. The key challenge is that both short term and long-term strategies must be adopted in an environment of very high uncertainty. For example, there is wide uncertainty on the extent of the global oil demand contraction, its duration, the shape of and the pace of demand recovery, and oil demand growth once the virus is contained. Also, it remains unclear how Covid-19 will impact the pace of energy transition or what its implication for the existing economic and institutional reforms in oil revenue-dependent exporting countries are. Risk-informed strategy is based on accounting for uncertainty in the outcomes.[1]

In this Energy Insight, we analyse the short and long-term strategies available to MENA oil exporting countries in response to Covid-19 and the sharp fall in the oil price and revenues. We show how uncertainties affect the choice of long-term optimum strategy and highlight the key challenges and the trade-offs these countries face under each strategy.

In the short run, MENA oil exporters' main focus would be on fiscal adjustment to cut the budget deficit and to coordinate their oil production policies with other producers to boost oil revenues. With few exceptions, years of procyclical and imprudent fiscal policy as well as political instability has resulted in these countries' fiscal balance and current account balance deteriorating despite the relatively high oil price environment in the last couple of years. The breakeven oil price for a zero fiscal balance are much higher than the current oil prices. Meeting this gap entirely through budget cuts is very challenging as it requires a massive reduction of government spending in some critical areas such as public sector wages, military and health. On the other hand, relying on external and domestic borrowing can expose these countries to exchange rate and credit risks and deprive the private sector from access to credit as they compete with the government for access to funds. While some of these countries hold foreign exchange reserves, their financial buffers are limited compared to the size of their imports and in any case, these have been eroding since the 2014-2016 oil price cycle.

Along with cutting current and capital expenditure, MENA oil exporting countries could pursue oil output strategies to boost their revenues, but this involves important trade-offs. On the one hand, adopting a high volume or market share strategy risks a fall in oil revenues as the higher revenue due to higher volumes may not compensate for the loss in revenues due to the lower oil price. This is especially true in the short-term as low oil prices may not result in the immediate shut in of production in high cost producers, but the uncertainty also pertains to long-term revenues if other producers turn out to be more resilient to a low oil price environment and/or if demand does not strongly recover. On the other hand, cutting output to support prices may result in loss of market share and may not result in large increases

[1] Risk and uncertainty are often used interchangeably but they are different concepts in risk and decision theory literature. Uncertainty is lack of information both on outcome and probability distribution whereas in the case of risk, the outcome is unknown but the probability distribution governing that outcome is known.

in revenues if the cuts are replaced by increases in output from non-participating producers. Also, depending on the size of the demand shock, the output cut may not be big enough to raise prices for a sustained period. Finally, as recent events have shown, negotiating a sustained output cut among large number of producers is becoming increasingly difficult given the diverse nature of players and their different interests.

Oil exporters' long-term strategy also poses key challenges. These countries can adopt three possible strategies to manage their long-term risks whether it is from sustained low oil prices due to persistence of shocks or as a result of structural changes due to the energy transition: the conservative bet-hedging (always play it safe),the diversified bet-hedging strategy (don't put all your eggs in one basket) and a combination of these two. Over the last few decades, all the focus has been on diversification, though it is becoming increasingly clear that this strategy is associated with risks as such a strategy requires deep structural reforms that are difficult to implement. If these countries diversify into sectors where inputs are shared or used jointly by hydrocarbon infrastructures and where both tangible and intangible relationships exist across fossil and non-fossil fuel businesses, they may not achieve sufficient risk reduction. On the other hand, if they diversify into substantively different areas that have little in common with their primary industry, they run the risk of failing to establish viable non-resource export sectors. Finally, no matter what long term strategy MENA oil exporters take, it always involves a trade-off between expected return and its variance: reducing long-term risk comes at the cost of reducing the expected return, as extreme outcomes need to be avoided if the long-term risk is to be reduced.

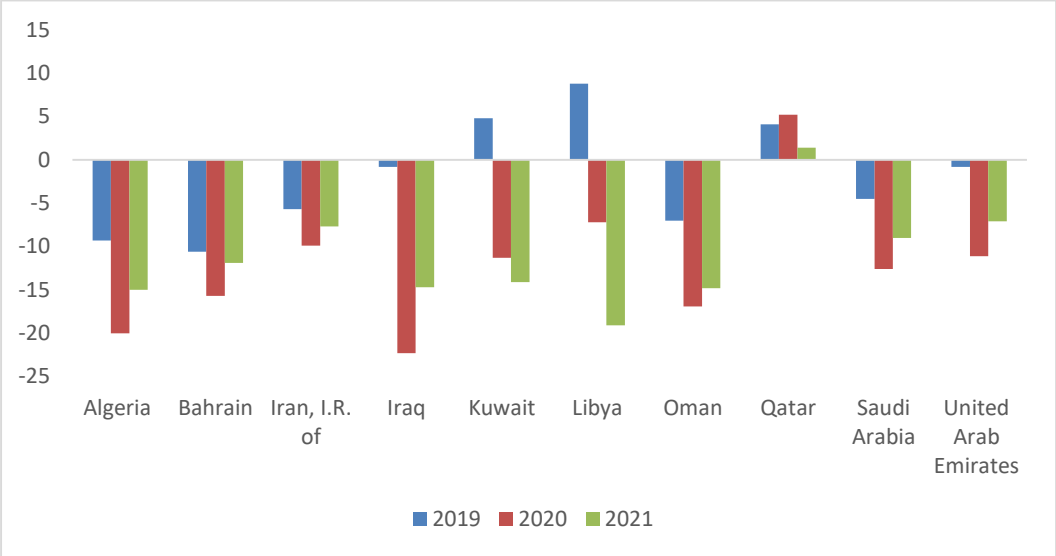
2. Short-term strategy: cost cutting and coordinated output cut

Oil price volatility and the unpredictability of market shocks along with the high share of oil revenue in total government budget have rendered short run fiscal management, budgetary planning and efficient use of public resources very difficult in MENA oil exporting countries. These countries have attempted to smoothen their fiscal expenditure and at least partially decouple it from oil price cycles through a mix of fiscal and monetary policies and by increasing government saving rates and the build-up of foreign assets. However, due to a mixture of factors (such as political and social considerations, regional competitions, corruption and mismanagement), procyclical fiscal policies whereby government spending expands during periods of high oil prices and contracts during downturns have been the key feature of most oil exporting countries' economic policy. The problem is that expansionary fiscal policy during boom times forces oil exporters to adopt painful choices during oil price falls. Also, as a result of imprudent fiscal policy, many of these countries do not have a sufficiently strong fiscal and financial position that provide them with room to manoeuvre during oil price downturns.

In 2019, with an average Brent price of above $64 per barrel, most of the MENA oil exporters were running a budget deficit (see Figure 1). In this current low oil price environment, the budget deficit as a percentage of GDP is expected to rise sharply with all countries projected to run deficits both in 2020 and 2021. Excluding hydrocarbon revenues from the fiscal balance, the budget deficits were significantly higher in 2019 ranging from 7.4 percent of non-oil GDP for Iran to as high as 61 percent of non-oil GDP in Kuwait and with countries like Iraq and Oman's non-oil fiscal deficit standing at around 50% of non-oil GDP (see Figure 2).[2] The government non-oil fiscal balance is expected to rise sharply in all countries in 2020 and 2021 given their high dependence on oil revenues, which are expected to contract sharply while their ability to cut spending is limited.

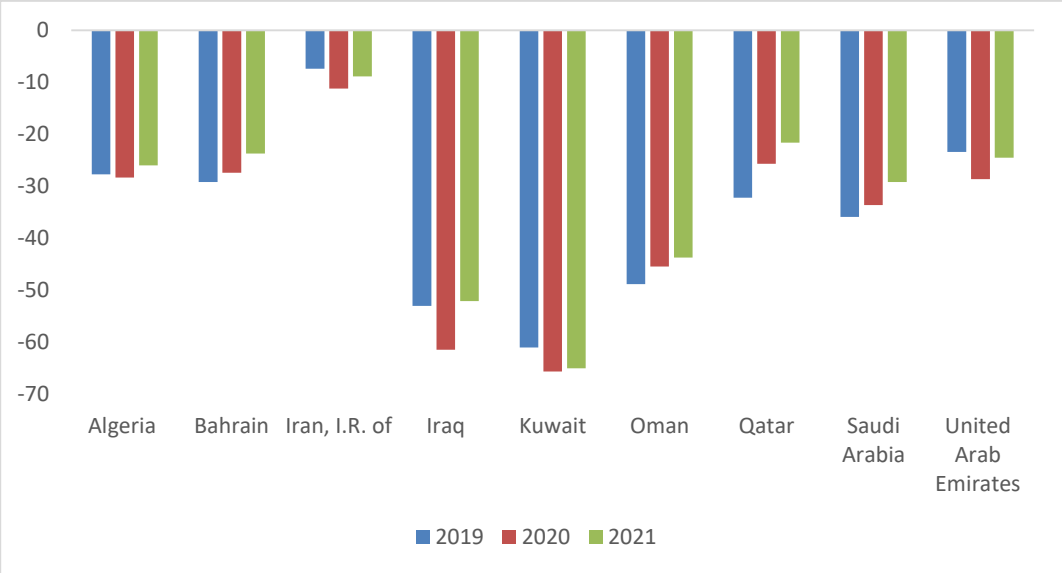
[2] The reason for low figure for Iran is that due to severe sanctions, the government budget has contracted and economy is adjusted to lower hydrocarbon revenue.

Figure 1: General Government Fiscal Balance (% of GDP)



Source: IMF (2020), Regional Economic Outlook: Middle East and Central Asia, April.

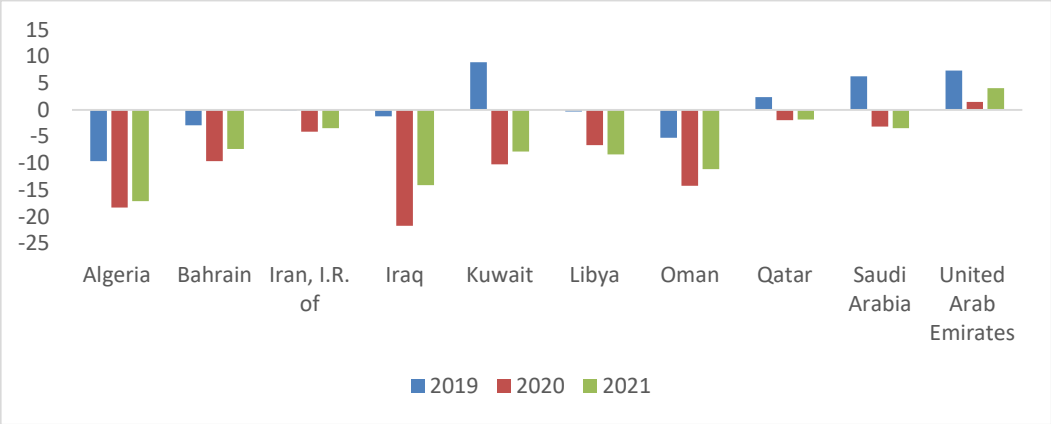
Figure 2: General Government Non-Oil Fiscal Balance (% of non-oil GDP)



Source: IMF (2020), Regional Economic Outlook: Middle East and Central Asia, April.

Oil exporting countries are also major importers and their current account balances fare no better (see Figure 3). In 2019, even with the relatively high oil price environment, the majority of MENA oil exporters ran current account deficits. In the current crisis, there are opposing effects on the current account: the reduction in oil revenue will widen the current account deficit while the likely reduction in consumer spending and consequently lower imports and the reduction in the number of expatriates and the associated decline in remittances flows due to the coronavirus induced recession will narrow it. But over all, the reduction in oil revenues is likely to dominate, and in 2020 and 2021, MENA oil exporters are projected to run large current account deficits particularly in Iraq, Algeria, and Oman (Figure 3).

Figure 3: Current account balance (% of GDP)

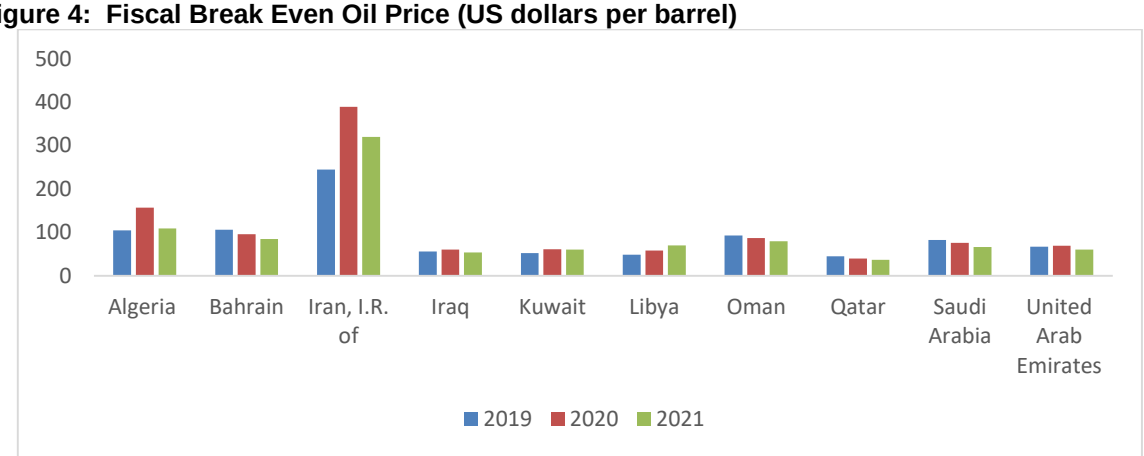


Source: IMF (2020), Regional Economic Outlook: Middle East and Central Asia, April.

If these countries were to address the fiscal and current account deficit by hydrocarbon export revenues, the oil price must be higher. As can be seen from Figure 4, in 2019, the breakeven price for fiscal balance ranges from around $45 per barrel for Qatar to around $245 per barrel for Iran.[3] The breakeven price for a zero current account balance ranges from ranges from $31 per barrel for UAE to $96 per barrel for Algeria (see Figure 5). Regardless of the limitations with the breakeven indicators, the key point is that current oil prices are much lower than these breakeven prices and budgets deficits are not sustainable in a low-price environment.

Reducing this gap entirely through budget cuts is very challenging, as it requires a massive reduction of government spending in some critical areas such health and social development, education and military. Despite these challenges, governments can reduce the budget deficit, to some extent, through for example reducing public wages and subsidies or delaying capital projects (measures that have already been taken in a number of countries), or in severe cases depreciate their currency, but to the extent that these measures reduce the welfare of citizens and impact negatively the private sector, they will face public and private sector backlash.

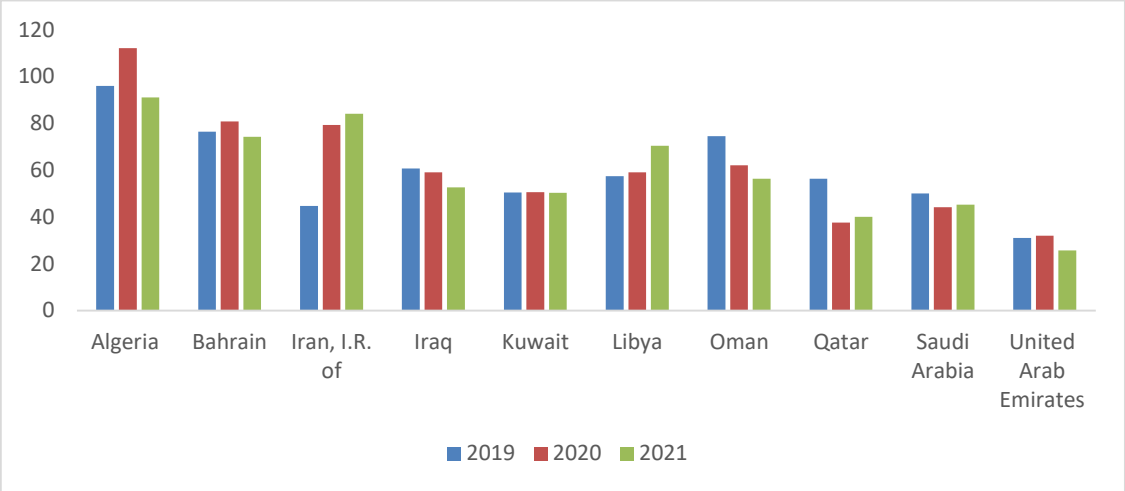
Figure 4: Fiscal Break Even Oil Price (US dollars per barrel)



Source: IMF (2020), Regional Economic Outlook: Middle East and Central Asia, April.

[3] The high breakeven price for Iran is due to sharp decline in oil exports following US sanctions which means higher prices is needed to generate a given level of revenue.

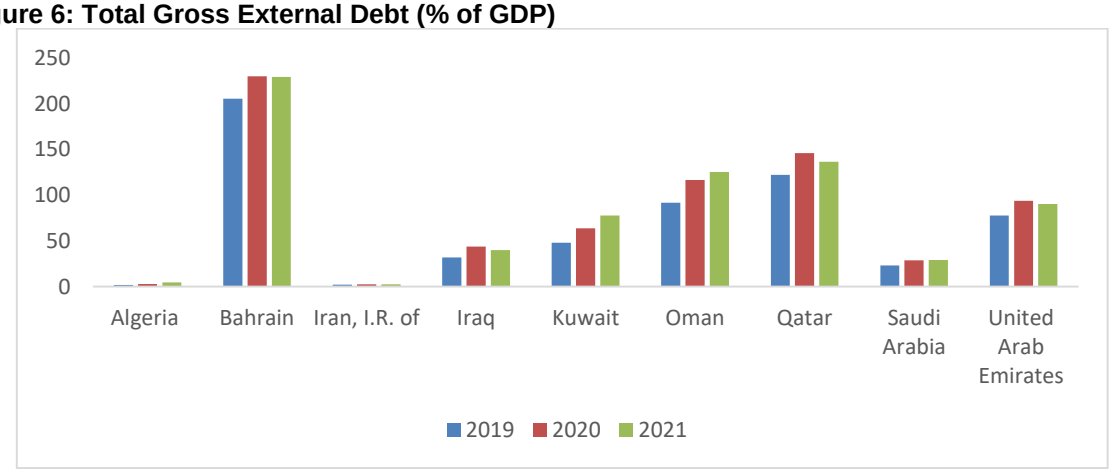
Figure 5: External Break Even Oil Price (US dollars per barrel)



Source: IMF (2020), Regional Economic Outlook: Middle East and Central Asia, April.

Governments may also rely on external and domestic borrowing. External debt to GDP ratio in most countries is relatively low with the exception of Bahrain, Qatar and Oman but in the view of the crisis debt rules may be relaxed (see Figure 6). But the downside is that external debt exposes the country to exchange rate and credit risks whereas financing the budget deficit by domestic borrowing can deprive the private sector from much needed credit dragging down further private sector activity.

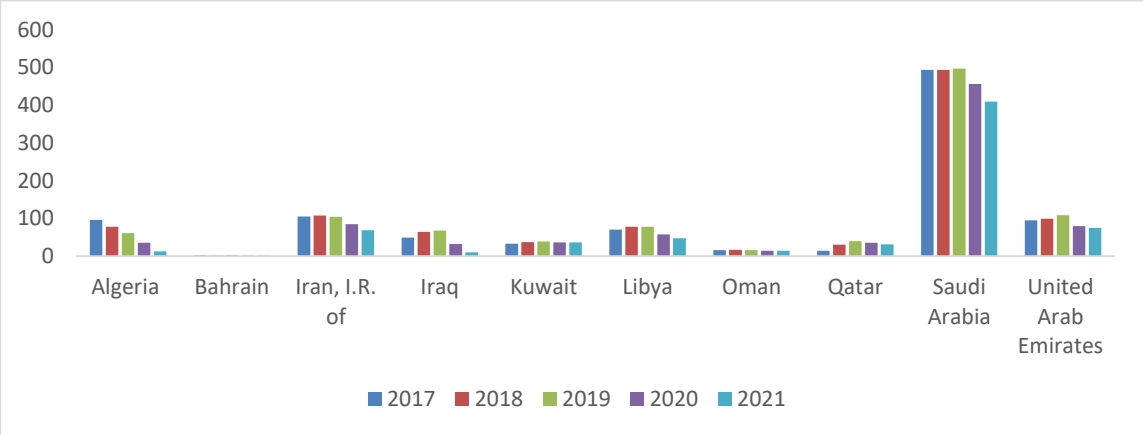
Figure 6: Total Gross External Debt (% of GDP)



Source: IMF (2020), Regional Economic Outlook: Middle East and Central Asia, April.

Those countries with large enough buffer in the form of sovereign wealth fund or foreign currency reserves (FX) are in a better position to withstand a period of low oil prices. Given the wide uncertainty that oil-exporting countries face, one would expect a cautionary fiscal policy, but this seems not to be the case for some of these countries. Countries such as Bahrain and Oman seem to be very vulnerable to oil price shocks as their foreign reserves is just equivalent of 1.1 and 6 months of imports in 2020. On paper, Iran can support its imports for around 15 months but most of its reserves are not accessible due to US sanctions and therefore these foreign reserves are of limited use. Countries like Saudi Arabia and Algeria have accumulated large FX reserves. However, a deeper look into these countries reveals that these have been falling. Just before the previous oil price collapse in 2014, Saudi Arabia foreign reserves reached all time high of USD 731.2 billion but declined almost continuously over the last few years and as of February 2020 these stood at USD 486.1 billion, a fall of 33%. In Algeria, FX reserves reached USD 194 billion in the first quarter of 2014 but at the end of the first quarter of 2020 these stood at USD 60 billion. At these rate of decline, reserves will be exhausted in 2022 (MEES, 2020).

Figure 7: Gross Official Reserves (Billion of US Dollars)



Notes: Excludes overseas assets of sovereign wealth funds (SWFs). Source: IMF (2020), Regional Economic Outlook: Middle East and Central Asia, April.

Alongside adjusting spending, MENA oil-exporting countries can coordinate their oil production policies with other producers and collectively cut output to raise oil prices and boost oil revenues. However, a sustained price response is much trickier in the current context given the scale of the demand shock and the wide uncertainty engulfing the oil market both in terms of the size of the demand contraction and its duration. Furthermore, there is large uncertainty about the shape of the recovery and whether long-term oil demand will permanently be impacted due to structural shifts in the real economy and in consumers' behaviour for instance as a result of new working and travel patterns.

In addition to these uncertainties, concluding output cut agreements has become increasingly more challenging. As the size of the cut needed to balance the market gets large, more diverse and heterogenous producers need to join the agreement. No individual country would be willing to shoulder the bulk of the adjustment and let others free ride. There are studies that show that costs of negotiating a collusive outcome is large when there is asymmetry between parties as there is no focal point for them to select an equilibrium (Thomadsen and Ki-Eun, 2007). Also maintaining an extended collusion is major challenge. The incentive for each individual country to comply with collusive agreement results from comparing the short run gain from deviating (which is the difference between deviation profit and collusive profit) and the long run losses resulting from collapse of agreement and consequently further decline of oil prices. With the increase in the number of participants in the collusive agreement, monitoring becomes increasingly more difficult and the incentive to deviate for some players increases. Thus, there is always the risk that no agreement can be reached, or an agreement can be reached with less than optimum number of participants and with unequal sharing in the burden of adjustment.

Given the costs involved in reaching collusive agreements and the uncertainty regarding the gains from such a strategy, some countries such as Saudi Arabia, UAE, Iraq and Kuwait to lesser extent can consider adopting a high volume-low price or market share strategy. However, this strategy risks a fall in oil revenues as the higher revenue due to the increase in market share does not compensate for the loss in revenues due to the lower oil price. This is especially true in the short-term as low oil prices may not result in the immediate shut-in of oil production in high cost producers and/or strong recovery in oil demand. But the uncertainty also pertains to long-term revenues if other producers turn out to be more resilient to a low oil price environment. Also, for a market share strategy to work, it requires that prices stay lower for longer enough to impact expectations and alter the behaviour of high cost producers and their financial backers. But as discussed above, given oil exporters' heavy reliance on oil revenues and their weak financial buffers, it is doubtful that many of them will be in a position to sustain such a policy for a long period of time.

In sum, while the degree of fiscal adjustment is constrained by its social, political and macroeconomic implications, effective output cut faces several challenges related to coordination problems and the uncertainty in revenue gains associated with this strategy, especially given the scale of the demand shock. The alternative strategy of high output low price strategy may also not achieve higher revenues, especially in the short term.

3. Long-term strategies: diversified bet hedging, conservative bet hedging or combination of both?

MENA oil exporting countries are also exposed to long-term challenges. Gradual changes in the energy system along with occurrence of low probability high impact events that impact oil demand can result in revenue disruption and loss of market share of well-adapted players. This is not unprecedented; the history of energy transition contains examples of industries and energy sources that have been replaced by cheaper and more efficient alternatives as a result of accidents, market disruptions, government policies or changes in consumers' preference (see Fattouh et al., 2019).

The probability that a particular industry or energy source survives depend not only on the range of uncertainties it faces (such as the speed and the magnitude of the change in its environment) but also on the degree of its preparedness to face risk. A rational risk averse player will invest in measures that reduce the risk of a substantial loss. The Covid-19 shock will give a new urgency for oil exporting countries to adjust their long-term strategy.

A useful concept to analyse how agents respond to a highly unpredictable environment is ***bet hedging*** which is originally developed by Physicist Daniel Bernoulli in 1738 (Stearns, 2000). Simply put, bet hedging is defined as *a strategy that decreases the fitness of a player to its environment in their typical conditions in exchange for increased fitness in stressful conditions* (Olofsson et al., 2009).

Over the last few years, there has been considerable discussion about adaptation strategies for oil exporting countries which are exposed to adverse effect of disruptive trends in the energy sector. Whereas most of these discussions focus solely on diversification and the ways which barriers to diversification can be removed, we argue that long-term fitness and adaptability in an uncertain environment can be improved through two pure risk reduction strategies and their combination: ***conservative bet hedging*** and ***diversifying bet hedging***.

The essence of a conservative bet hedging strategy is reflected in the old saying that 'a bird in the hand is worth two in the bush'. To understand this, let's assume that an investor who has been making a return of 11 in its typical years is now faced with an uncertainty: she is exposed both to good and bad years which affect the performance of her assets, each occurring with equal probability. Let's assume that there are two strategies available to this investor to hedge against this uncertainty. Strategy A gives the investor the return of 11 in good years and 1 in bad years. Strategy B produces the return of 6 in good years and 3 in bad years (see Table 2). The question is: which strategy should a risk averse investor choose?

Table 2: conservative bet hedging

	Strategy	
Year type	**A**	**B**
Good year	11	6
Bad year	1	3
Arithmetic mean	6	4.5
Geometric mean	3.31	4.24

Obviously, strategy A has a higher expected return (6) compared with strategy B (4.5). However, strategy B is a better choice for long-term survivability because although it has a lower expected return, it has a considerably lower variance compared with strategy B (2.25 as opposed to 25). Daniel Bernoulli was the first to show that the criteria for long run fitness under uncertainty is geometric mean and not the arithmetic mean. Strategy B has a geometric mean of 4.24 which is significantly higher than 3.31 in the case of strategy A. The geometric mean gives greater weight to low values than does the arithmetic mean and it penalizes variance. Strategy B's best performance is worse than the strategy A's best

performance, but Strategy B's worst performance is much better than that of Strategy A, and this is the key to its success. In other words, under conservative bet hedging, the decision marker lowers his best performance under favourable conditions in order to improve his worst performance under unfavourable conditions.

How can this be translated in the context of oil exporting countries? The core sector of oil exporting countries is the extraction and exportation of crude oil, natural gas, natural gas liquids (NGL) and condensates. This is a high return, but also a high-risk business given the volatility in the oil price and the potential change in demand patterns. Adopting a conservative bet hedging strategy to shield against the risks of revenue disruption involves taking a two set of key measures:

- Improving the cost efficiency of the oil and gas sector;
- Decarbonise the production process of oil and gas and the final petroleum products.

For cost efficiency oil exporters can, for example, focus on investments which are low on the cost curve, running them efficiently and where feasible restricting extracting reserves at the lower end of the conventional range and take measures that optimise operations and capture operational synergies across various elements of the value chain.

For decarbonisation, these countries can reduce the carbon intensity of oil/gas production process and de-carbonise the end products through a combination of change in the operational procedure and investment in new technologies. For example, investment in carbon capture, storage and utilisation (CCUS) enables these countries to decarbonise their final products and thus strengthen the economics and sustainability of their oil/gas industry. There is also a growing non-combusted use of oil/gas as feedstocks for petrochemicals and lubricants which these countries can benefit from.

The key part of a conservative bet hedging strategy, in this context, is to replace oil exports, as oil demand declines, with new energy carriers which are clean and can be produced using existing oil and gas infrastructures. In the energy sector, some products are close to each other in the product space in the sense that the ability to export one product opens the possibility of producing and exporting the other. For example, future energy carriers such as ammonia or hydrogen can be produced from hydrocarbons. Hydrogen, as one of the main elements of Ammonia, is mainly produced through a process called steam reforming using methane which is the cheapest albeit not a clean method of producing hydrogen. Hydrogen can also be produced from electricity through electrolysis process which depending on the source of electricity can be cheap or expensive, clean or polluting. Investment in CCUS enables decarbonised production of hydrogen either through steam reforming or electrolysis. This strategy requires continuous improvement of technologies, companies, products and human capital, engineering and design, patenting laws, and expertise in trade laws.

The cost is a major consideration of decarbonising final products of oil exporting countries and therefore is key to the conservative bet hedging. For instance, the average price of ammonia in 4Q 2019 was around USD 226 per tonne. The added costs resulting from the use of CCUS are estimated to vary between USD 23.8 to 25.4 per tonne (Global CCS Institute, 2017). Marginal cost of production of oil and gas in MENA countries is very low in the range of $2 to $5 per barrel[4]. Average cost is higher but for most these countries are very likely to be below $10 per barrel which is among the cheapest in the world. The availability of cheap to extract oil/gas enables these countries to absorb the added cost of CCUS as a form of an internal carbon tax. The advantage of this strategy is that it does not require a shift of focus away from hydrocarbon business; instead it allows these countries to prolong the life of oil/gas industry by producing clean products.

The return on a conservative bet hedging strategy, as described above, is undoubtedly lower than the current default strategy of oil and gas exports given the costs involved and the lower margins, but its risk profile is also lower. First, improving the cost efficiency of oil and gas industry increases the

[4] graphics.wsj.com/oil-barrel-breakdown/

resilience of the sector. Second the production of hydrogen and ammonia is a very established process. CCUS is not new but it is currently very costly. This means there is significant room for cost efficiency gain and R&D in this area that these countries can exploit. Third, during the transition era these countries can still export oil/gas and benefit from the generated rents, while at the same time, improve the return on decarbonised products (be it ammonia, hydrogen or alternative low carbon fuels).

A detailed analysis of measures under a conservative bet hedging is out of scope of this short paper but the message is that oil-exporting countries can reduce the long-term risk of revenue disruption by focusing on creating a well-functioning and efficient energy sector that brings a wider range of resources and technologies into play.

This strategy is less complex to implement given its close relationship with the existing hydrocarbon business in these countries, but it suffers from two main drawbacks. First, there is some degree of correlation between prices of all energy products when there is for example a global decline in energy demand. Second, with the growth of decentralised technologies, future energy systems will be characterised by a high level of competition and the absence of energy superpowers. This means it becomes increasingly difficult to extract rent beyond marginal costs. It might also not deliver other government objectives such as job creation for local workforce as energy industry is very capital intensive.

The essence of ***diversified bet hedging*** is reflected in another old saying: “don’t put all your eggs in one basket”. Like the previous case, a diversified strategy reduces the variance of return in presence of an unpredictable environment. However, the mechanism through which it achieves this result is risk spreading. Again, consider the aforementioned investor under the same uncertainty (i.e., being exposed to good and bad year with equal probability that affect the performance of his assets). As can be shown in Table 3, let’s assume there are three strategies available to the investor:

- Strategy A, which is good-year focused and gives a high return in good years (11) but a low retrun in bad years (1);
- Strategy B which is bad-year focused and provides a high return in bad years (10) but a low retrun in good years (1.1);
- And strategy D which is diversified and is expressed as equal proportion of Strategy A and B.

Table 3: Diversified bet hedging

		Strategy	
Year type	**A**	**B**	**D**
Good year	11	1.1	6.05
Bad year	1	10	5.5
Arithmetic mean	6	5.55	5.775
Geometric mean	3.31	3.31	5.76

If the investor knew that every year will be a good year, then strategy A is optimum. Likewise, if she knew that every year is a bad year strategy B is the optimal choice. However, due to unpredictability of environment and the fact that good and bad year happens randomly with probabilities of 50 per cent each, the role of diversified strategy (D) becomes important. Although strategy D underperforms significantly compared with A in a good year and B in a bad year, overall, it will outperform both strategies in an unpredictable environment (see Table 3). We can think of strategy D as if each year, the investor tosses a fair coin and then executes the strategy of either A or B randomly based on the outcome of coin flipping (with equal probability). The expected return of diversified strategy in a good year or a bad year is the arithmetic mean of the return achieved by the two focused strategies in that year, but its geometric mean is significantly higher which means it has a higher chance of survival.

Initiatives on economic diversification in the national development plans of MENA oil exporting countries have been proposed since 1970s with the aim to provide a safeguard against commodity price fluctuation and to prepare for the era when oil reserves deplete. Since the turn of the new century, however, energy transition changed the discourse from peak oil supply to peak oil demand and stranded asset. This gave a new momentum to diversification efforts in these countries. The key premise is that diversification has risk-reduction effects on these countries' income which are highly reliant on oil revenues through changes in business-specific risk and increase in the number of income sources.

There have been attempts in MENA oil exporters to expand to new sectors such as banking and financial services, tourism, entertainment as well as agriculture but with mixed success. Most have had a special view on energy intensive sectors such as chemicals, fertilizer, iron and steel, nonferrous metals like aluminium and non-metallic minerals such as cement. Energy is an important cost driver in heavy industries and access to cheap hydrocarbon resources provide these countries with a strong competitive advantage in the global market for these commodities. Recently and as part of diversification initiatives in these countries, they have started investment in renewables such as wind and solar. All MENA oil exporting countries have abundant sunshine, and some have good wind resources too. Renewable electricity enables production of green hydrogen and ammonia, as clean commodities for export, if these countries choose not to pursue the path of CCUS and instead diversify away from fossil fuels.

However, these countries face real challenges to realise a meaningful diversification strategy. This is because diversification is only successful if it offers risk reduction by pooling uncorrelated income streams. In other words, if these countries diversify into sectors where inputs rely on hydrocarbon infrastructures and where both tangible and intangible relationships exist across fossil and non-fossil fuel businesses, they may not achieve sufficient risk reduction. For example, all energy intensive industries are susceptible to carbon border tax adjustment if they are produced by cheap unabated hydrocarbons and have a high carbon content. On the other hand, if they diversify into substantively different areas that have little in common with their current primary industry, which constitute their core competitive advantage, they run the risk of failure of establishing viable non-resource export sectors. Furthermore, achieving diversification requires building human capital and improving the education system as well as extensive reforms to improve the business environment, transparency and economic governance. It also needs streamlining procedures, reducing excess monopoly rents in non-tradable sectors and removing barriers to private sector participation. There is uncertainty about whether and how quickly such extensive economic and institutional reforms can be implemented in these countries.

The two types of pure strategies (conservative bet hedging and diversified bet hedging) available to oil exporting countries to manage long term risk differ in their impact on the performance of these countries under various market conditions. Conservative bet hedging reduces the fluctuation in revenue by the generalist strategy of consistently responding moderately well to a range of different market conditions but focusing on core competitive advantage. Diversified bet hedging is based on the idea of risk spreading through specialising in different sectors which are not simultaneously affected by the same market condition. However, these two strategies are neither binary nor mutually exclusive. It is possible to be partially successful on either strategy or to combine some elements of both strategies (***combined bet hedging***), if the degree of risk reduction expected to achieve justifies the costs incurred. Thus, overall, three long-term risk reduction strategies available to oil-revenue-dependent exporting countries: conservative bet hedging, diversifying bet hedging and combined bet hedging. In the next subsection we will show how key uncertainties facing these countries influence the choice of long-term strategy.

Incorporating uncertainties in the long-term strategy

Oil exporting uncertainties are exposed to many uncertainties as far as long term strategy is concerned, but for the sake of simplicity we consider the following sources:

- Uncertainty about the speed of the global energy transition.
- Uncertainty about external factors that accelerate or decelerate energy transition (for example does Covid-19 speed up or slowdown the energy transition?)

- Uncertainty about technology outcomes when transition is completed (for example will CCUS be part of the decarbonised technology mix?)
- Uncertainty about the success of existing economic and institutional reforms in the region to remove barriers to economic and government income diversification.

There are a variety of criteria, in decision theory, that can be applied in order to choose the optimal risk reduction strategy under the environment of uncertainty. These criteria make implicit assumptions about the attitude of the decision-maker and the information available about the choice at the time (see Didier et al., 2009). For example, theory assumes that the decision-maker is aware of the various possible states of nature but has insufficient information to assign any probabilities of occurrence to them. In other words, there are many unknowns and no possibility of knowing what could occur in the future to alter the outcome of a decision.

There are four sources of uncertainties, as mentioned above, and we assume each have two possibilities:

- The speed of the energy transition can be fast or slow;
- Covid-19 can accelerate or decelerate the energy transition;
- Economic/institutional reform can be successful or unsuccessful;
- Decarbonised technology mix can be favourable with CCUS in the mix or unfavourable without CCUS.

This means there will be sixteen possibilities of future outcomes. The policymaker does not know which of these sixteen possibilities will happen in the future thus decision about long term strategy needs to be made under uncertainty.

To see how this works, let us assume that payoffs for each strategy, under each possible outcome of uncertainty can be represented by Table 4. To calculate these payoffs, we have made the following simple assumptions:

- The maximum gain of diversified strategy is 30 and its cost is 5
- The maximum gain of conservative bet hedging is 22 and its costs is 2
- The combined strategy yields a payoff which is the average of diversified and conservative bet hedging

We assume that the outcome of uncertainty does not affect the success of strategies in the same way. For example, we assume that the success of diversification strategy is more affected by economic/institutional reforms and transition speed compared with other uncertainties. Similarly, the success of conservative strategy depends more on technology mix outcome and transition speed than other factors. Following this, we assign the following share to each uncertainty, when it turns favourable, in releasing the full gain under each strategy:

- For a conservative bet hedging: CCUS in the technology mix (40%), slow transition (40%), decelerated by external factors (15%) and successful economic/institutional reforms (5%),
- For diversified bet hedging: Successful economic/institutional reforms (60%), slow transition (20%), decelerated by external factors (15%) and CCUS in the technology mix (5%)
- The share of uncertainties in realising full gain for diversified strategy is the average of the two.

Under each strategy when an unfavourable outcome is realised for an uncertainty, the payoff declines by the corresponding share. The strategy is partially successful if some of the uncertainties happen to be favourable and some unfavourable. The strategy is fully successful if all uncertainty parameters turn out to be favourable and fully unsuccessful if all outcomes are unfavourable.

As an example, if energy transition happens to be fast and accelerated by external factors like Covid-19 but economic reforms are successful and CCUS is in the technology mix, the payoff for each strategy can be calculated as follows:

- *Conservative bet hedging*: 22-0.4*22-0.15*22-2= 7.9 (highlighted in light green in the Table 4)
- *Diversified bet hedging*: 30-0.2*30-0.15*30-5= 14.5 (highlighted in light brown in the Table 4)
- Combined bet hedging: (7.9+14.5)/2= 11.2 (highlighted in light blue in the Table 4)

The rest of the payoffs in Table 4 can be calculated in the same way. In the absence of actutal data, however, it is important to note that these payoffs are just for illustrative purposes and we do not make any interpretation of the numbers. For example, we have assumed that diversification, if fully successful, has a higher gain (30) as well as a higher cost (5) compared with with the conservative strategy which has a gain of 22 and a costs of 2. We do not know whether this assumption is true. But the general process of adopting the optimum long-term risk reduction strategy under uncertainty and the trade-offs the decision maker face remain the same irrespective of the entries in the table of payoffs.

Decision-Making Under Uncertainty

Now that the Table of payoffs is computed decision rules can be applied. If the decision maker is optimistic about outcome of uncertainties (i.e. the energy transition is slow and COVID-19 will not accelerate its pace, economic reforms will be successful and CCS is part of the mix), she can apply a criterion known as Maximax, which means maximisation of the maximum payoff. In this approach, the decision-maker identifies the maximum payoff for each strategy under various possible outcomes. The maximum of these payoffs is identified, and the corresponding strategy is selected.

In order to apply the Maximax criteria, we need to first identify the maximum payoff of each strategy under all possible sets of outcomes. As can be seen from the Table 4, the maximum payoff for conservative bet hedging is 20, for diversified bet hedging is 25 and for a combined strategy is 22.5. This means the diversified bet hedging provides the maximum payoff of all strategies. In other words, if the outcome and payoff are as shown as in Table 4 and decision maker is optimistic, the optimum strategy according to Maximax criterion is diversification.

Table 4: Payoffs under different possibilities of outcome for uncertainties

Energy transition																
	Fast								Slow							
External factors (covid-19)	Accelerate				Decelerate				Accelerate				Decelerate			
Economic reforms successful?	Yes		No		Yes		No		Yes		No		Yes		No	
CCs in the mix?	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Conservative bet hedging	7.9	-0.9	6.8	-2	11.2	2.4	10.1	1.3	16.7	7.9	18.9	6.8	20	11.2	18.9	10.1
Diversified bet hedging	14.5	17	-3.5	-5	19	17.5	1	-0.5	20.5	19	2.5	1	25	23.5	7	5.5
Combined Strategy	11.2	8.05	1.65	-3.5	15.1	9.95	5.55	0.4	18.6	13.45	10.7	3.9	22.5	17.35	12.95	7.8

Now let us consider the case that the decision maker is pessimistic about the future i.e. she thinks that all the uncertainty parameters will turn unfavourable. For example, transition is fast, Covid-19 will accelerate the energy transition, economic reforms are not successful and CCS will not be part of the energy mix. Under this situation another decision criterion can be applied which is known as Maximin which means the maximisation of minimum payoff. The pessimistic decision-maker need to identify the minimum payoff for each possible course of action and select the corresponding strategy which provides the highest minimum payoff.

As can be seen in Table 4, the minimum payoff under conservative strategy is -2, under diversified strategy is -5 and under a combined strategy is -3.5. Thus, according to Maximin criteria, the optimum strategy is conservative bet hedging. In other words, despite assuming faster energy transition which will be accelerated by Covid-19, the fact that decision maker is pessimistic about the success of diversification efforts will render the diversifying bet hedging strategy less optimal because its failure results in a much higher loss compared to failure of the optimum strategy. Put another way, conservative strategy provides the best worst-case scenario.

The decision maker may be neither pessimistic nor optimistic about future outcome of uncertainties and strategies available might be very close to each other. Under this condition, she can apply a decision rule known as 'regret minimisation'. This rule minimizes opportunity costs or minimise the maximum regret. Regret minimisation focuses upon the regret that the decision-maker might have from selecting a particular strategy. Regret, in this context, is defined as the difference between the best payoff the decision maker could have realised, had he known which outcome was going to occur, and the realised payoff under chosen strategy. Using this criterion, we see from Table 5 below that the maximum regret under a conservative bet hedging is 17.9 whereas it is 16.4 under a diversified strategy and 8.95 under a combined bet hedging. This means the optimum choice according to this decision rule is combined bet hedging strategy.

Table 5: Regret minimisation

Regret-CBH	6.6	17.9	0	0	7.8	15.1	0	0	3.8	11.1	0	0	5	12.3	0	0
Regret-DBH	0	0	10.3	3	0	0	9.1	1.8	0	0	16.4	5.8	0	0	11.9	4.6
Regret-Combined BH	3.3	8.95	5.15	1.5	3.9	7.55	4.55	0.9	1.9	5.55	8.2	2.9	2.5	6.15	5.95	2.3

What if the decision maker is partially pessimistic/optimistic about future outcome of uncertainties? If this is the case, then she can use a decision rule called Hurwicz Criterion[5] . If we assume α (between zero and one) is the degree of optimism, then the degree of pessimism will be 1 - α. To identify the optimum strategy under this decision rule the weighted average of the maximum and minimum payoffs of each strategy is computed as shown in Table 6. The strategy with highest average is regarded as optimal.

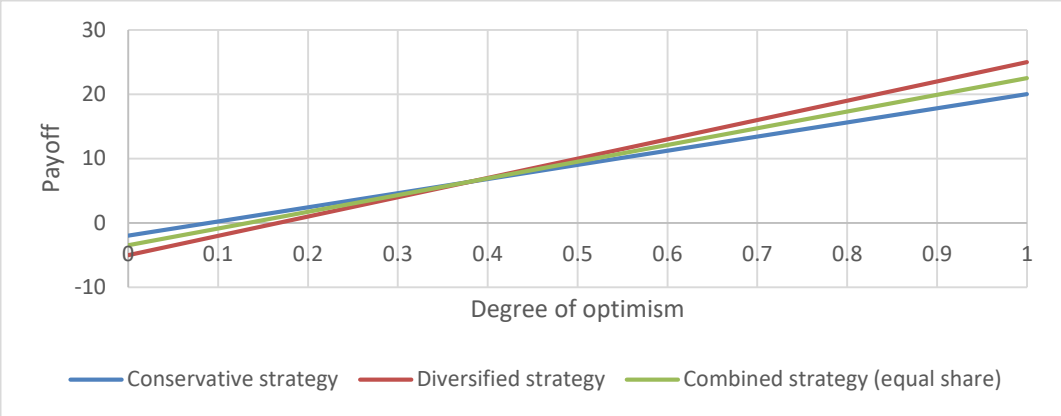
Table 6: Hurwicz Criterion

Strategy	Maximum pay off	Minimum pay off	Weighted Average
Conservative bet hedging	20	-2	$22\alpha - 2$
Diversified bet hedging	25	-5	$30\alpha - 5$
Combined Strategy	22.5	-3.5	$26\alpha - 3.5$

[5] This is a criterion introduced in 1951 by Nobel Prize laureate in Economics Leonid Hurwicz. The original paper in which this method is introduced entitled: "The Generalised Bayes Minimax Principle: A Criterion for Decision Making Under Uncertainty " Cowels Commission Discussion Paper 355, February 8, 1951.

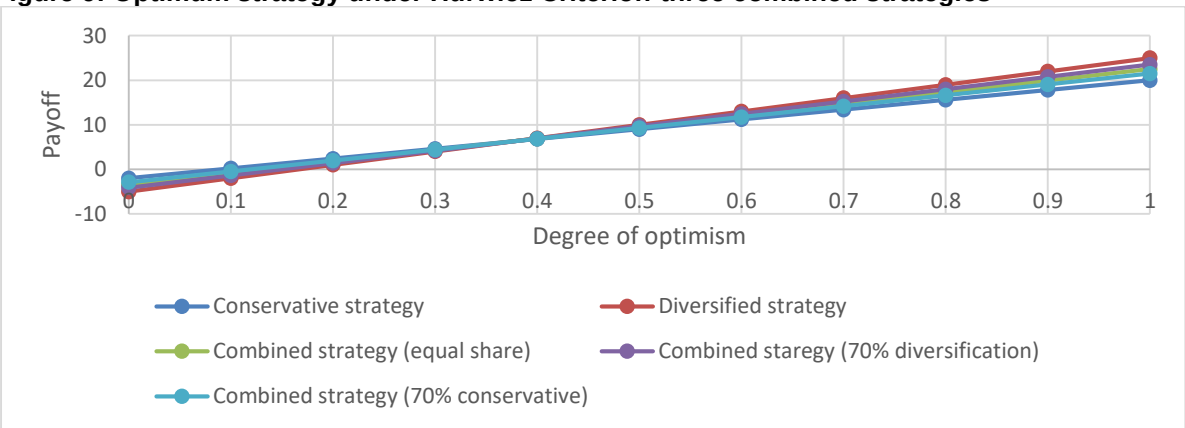
The results are presented in Figure 8. As can be seen from the figure, the optimum strategy is highly affected by the degree of optimism/pessimism about future outcomes. First, the more optimistic is the decision maker, the higher is the payoff for the diversification strategy. On the other hand, the more pessimistic she is about the future, the stronger is the rationale for a conservative strategy. Second, there is a level of optimism (around 40% in this case) at which all three strategies are equivalent. If the decision maker's confidence about the uncertainty of outcomes exceed 40%, diversification will be the optimum strategy otherwise conservative bet hedging is the optimum. This result is independent of how the combined strategy is arranged.

Figure 8: Optimum strategy under Hurwicz Criterion



So far, we have assumed that combined strategy is the average of diversified and conservative bet hedging with equal weight is given to each one. Now we create two further combined strategies: one which gives more weight to diversification elements (70%) and another one which assign a higher share to conservative bet hedging (70%). The result is presented in Figure 9. As can be seen from the figure, and similar to the previous cases, diversification is never an optimum strategy when there is a high degree of pessimism about outcome of uncertainties. Likewise, conservative bet hedging is never the optimal strategy when the decision maker has a high degree of optimism about the future. A combined strategy outperforms the other two if the decision maker is only concerned with loss minimisation. This is because it will result in lowest payoff loss compared to the optimum strategy under the condition of perfect information. This is evident from Figure 9 that shows combined strategies are not optimum except at the point of intersection of lines, but they are always closer to the optimum both on the optimist and pessimist sides. In other words, if the decision maker is optimist but ex-post proved to be wrong, she will benefit more under a combined strategy than a diversified strategy. Conversely, if the decision maker is pessimist but turned out to be wrong, she will have a higher pay off under a combined strategy than a conservative strategy.

Figure 9: Optimum strategy under Hurwicz Criterion-three combined strategies



Over that last two decades many of the oil exporting countries in the region have been trying to hedge their bets through diversification efforts. This reveals that these countries have had some hope and perhaps confidence that uncertainties affecting the outcome of this strategy will likely to be in their favour -for example, their current efforts to remove barriers to diversification will likely succeed. It remains to be seen how Covid-19 will impact their expectations about the future and whether it results in any revision of long-term strategies in these countries.

Furthermore, long term strategy for oil exporting countries is about risk reduction and not just about revenue generation which has been the focus of previous studies. However, a risk reduction strategy always involves a trade-off between expected return and its variance; reducing risk comes at the cost of reducing the return, as extreme values need to be avoided if long term risk is to be reduced. This means the long-term adaptability of oil exporting countries entail accepting lower return on their existing assets- for instance by incurring a cost in making their products and processes in line with the requirements of a low carbon future.

4. Conclusions

MENA oil exporting countries have been hit by a double shock: Covid-19 and the oil price collapse. Their short-term strategy to offset the impact of these shocks will focus simultaneously on fiscal adjustment and coordinating on oil supply cuts with other producers to support oil prices and revenues. While the degree of fiscal adjustment is constrained by its social, political and macroeconomic implications, effective output cut faces several challenges including coordination among producers and the scale of the global oil demand shock. Achieving a meaningful and sustained price increase through collusive supply response is contingent about some key uncertain factors such as the extent of the supply reductions in response to lower oil prices and the extent and duration of global oil demand contractions and the speed and shape of global oil demand recovery. MENA oil exporting countries also face long-term challenges and Covid-19 shock gives new urgency to adjusting their long-term strategy to reduce risks and improve their resilience. These countries face two major long-term issues. First, there is no single successful strategy to shield against the long-term risks of oil price crash. Diversification works only when it offers risk reduction by the pooling of uncorrelated income streams. If these countries diversify only into sectors where inputs rely on hydrocarbon infrastructures and where both tangible and intangible relationships exist across fossil and non-fossil fuel businesses, they may not achieve sufficient risk reduction. On the other hand, if they diversify into substantively different areas that have little in common with their current primary industry, which constitute the core of their comparative advantage, they run the risk of not being competitive. Second, irrespective of the strategy taken, in the face of disruptive forces, there is a fundamental trade-off between expected return and the variance of return, i.e. the cost of reducing the long-term risks and increasing resilience is to accept lower expected return on existing assets for instance by investing in measures that align their hydrocarbon sector with low carbon scenarios. This lowers the overall return but reduces the risk of disruption in the long run.

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