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Impacts of Global Climate Policies on Middle Eastern Oil Exporters: A Review of Economic Implications and Mitigation Strategies

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Key Points

Climate policies are tightening in an effort to curb carbon dioxide emissions. As a result, global oil demand may peak and gradually decline, causing oil prices to fall. A structural fall in oil prices may have serious implications for Middle Eastern oil exporters. Many studies attempt to estimate the economic implications of climate change response measures for oil exporting countries. However, they have not reached a consensus regarding the magnitude of these implications. This study reviews energy-economy models that estimate the economic implications of climate policies for oil exporting countries. It also assesses the strategies that oil exporting countries may adopt to mitigate the potential economic losses associated with declining oil revenues. Most of the models reviewed support the hypothesis that advanced global climate change mitigation measures will likely create economic losses for oil exporting Middle Eastern countries. Importantly, some estimates suggest that Middle Eastern countries will bear higher costs than other oil exporting countries. Economic diversification is viewed as the best option for developing long-term economic resilience in the Middle East and enabling long-term economic growth.

Introduction

In December 2015, the Paris Agreement (PA) was adopted at the 21st Conference of Parties (COP 21) to the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC aimed to stabilize greenhouse gas (GHG) concentrations at a level that can prevent dangerous anthropogenic interference with the climate system. To achieve this goal, the PA intends to limit the global temperature increase by the end of this century. Its target is "well below 2 degrees Celsius (2°C) above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" (UNFCCC 2015).

The primary tool for achieving the PA's objective is reducing GHG emissions into the atmosphere. In 2018, carbon dioxide emissions from fossil fuel combustion and industrial processes accounted for about 72% of GHG emissions. Oil was responsible for 31% of these carbon dioxide emissions (Olivier and Peters 2019). Thus, the demand and supply of oil will be increasingly affected by the stringent climate policies necessary to reach the emissions reduction objectives (IEA 2021). This raises several challenges for oil exporting economies, but the precise impacts on these economies remain hotly debated in climate negotiations (Barnett 2008; Barnett, Dessai and Webber 2004; Van de Graaf 2017).

Studies continue to attempt to estimate the economic implications of climate policies for oil exporting countries. However, the literature has not reached a consensus regarding the magnitude of the potential losses or gains. One strand of the literature suggests that emissions reduction policies will reduce both oil demand and prices, causing oil rents to shrink (Ansari and Holz 2020; Bauer et al. 2016; IEA 2018; Leimbach et al. 2010; Soummane, Ghersi and Lefèvre 2019; Waisman, Rozenberg and Hourcade 2013). A more limited strand of the literature argues that climate policies can benefit some major oil exporters in the Middle East (Coulomb and Henriet 2018; Johansson et al. 2009; Persson et al. 2007). This outcome depends on the universality of climate policies and assumptions regarding the substitutability of oil uses and the availability of unconventional resources.

This study contributes to the literature by reviewing models' estimates of oil rent outlooks following the implementation of climate policies. It also identifies the elements of these climate policies that will adversely affect oil exporters in the Middle East. Finally, it discusses ways that Middle Eastern countries can respond to climate policies to mitigate their economic impacts.

The remainder of this paper is organized as follows. Section 2 describes the relationship between oil prices and the economic performance of Middle Eastern oil exporters. Section 3 discusses the challenges to these countries' economic development created by global climate policy changes. Section 4 reviews various models' estimates of the economic implications of climate change policies for Middle Eastern oil exporters. Section 5 evaluates the available mitigation strategies for these countries. Finally, section 6 concludes, presenting policy recommendations and avenues for future research.

Oil Prices and Middle Eastern Oil Exporters' Economic Development

In the Middle East, oil exports provide a significant portion of oil exporting countries' incomes. Thus, Middle Eastern oil exporters are vulnerable to changes in oil prices and demand. Table 1 presents oil-related indicators for the five largest Middle Eastern oil producers and exporters.

Oil prices are an important driver of economic performance in Middle Eastern oil exporting countries. For instance, they affect long-run growth in Gulf Cooperation Council (GCC)[1] countries, notably through income transfers and investments. Higher oil prices lead to increased revenue in oil exporting countries through greater export earnings, increasing purchasing power and consumer demand. Empirical studies show that the benefits of oil price increases outweigh the costs of oil price declines.

The magnitudes of the impacts of oil price movements vary across GCC countries. Nusair (2016) shows that higher oil prices offer greater benefits to Kuwait than to Saudi Arabia and the UAE. However, adverse oil price shocks have

Table 1. Oil indicators for selected Middle Eastern oil exporters, 2019.

Indicator	Country				
	Iran	Iraq	Kuwait	Saudi Arabia	United Arab Emirates
Oil reserves (billions of barrels)	155.6	145.0	101.5	297.6	97.8
R/P (years)	120	83	93	69	68
Oil exports (million barrels per day)	1.9	3.9	2.0	7.0	2.4
Oil export revenue ($ billion)	60.5	80.0	52.4	202.4	49.6
Oil rents as a share of gross domestic product (GDP) (%)	20.4%	39.6%	42.1%	24.2%	16.2%
Oil exports as a share of government revenue (%)	90%	92%	90%	64%	41%

Notes: R/P = ratio of reserves to production. We use 2018 data for Iran's oil rents as a share of gross domestic product (GDP).

Sources: BP (2020), Central Bank of Kuwait (2019), International Monetary Fund (IMF) (World Economic Outlook Database), OPEC (Annual Statistical Bulletin), Saudi Arabian Monetary Authority (2019), UAEStat, World Bank (World Development Indicators Database).

long-term impacts only in Kuwait. Studies also find that oil price shocks have short- and medium-term implications for some Middle Eastern oil exporters (i.e., Kuwait, Saudi Arabia, and the UAE). These shocks affect these countries' business cycles by negatively impacting aggregate demand (Ftiti et al. 2016).

The impacts of oil prices differ outside of the GCC as well. Esfahani, Mohaddes and Pesaran (2013) find that oil export revenues are essential to Iran's long-run growth. Thus, in the Iranian economy, the negative impact of an oil price decline is greater than the positive impact of an oil price increase. Mehrara, Maki and Tavakolian (2010) support this finding, arguing that the capital stock has the greatest effect on economic activity when oil revenues are low. However, the capital stock's influence appears to be marginal when oil revenues are high. Owing to rent-seeking behavior, large public investments are likely to be less productive when oil revenues are high. These findings contrast with the results for GCC countries.

Additionally, Fezzani and Nartova (2011) find that Iraq is more dependent on oil revenues as a share of exports than other Middle Eastern exporters. However, oil export revenues have a marginal impact on Iraq's economic growth. Sassoon (2016) notes that corruption prevents Iraq's high oil income from benefitting its broader economy, thereby lowering its resilience during low oil price regimes.

This review of empirical studies confirms that Middle Eastern oil exporters are negatively impacted by low oil prices and require sustained oil rents. Indeed, oil rents not only support growth but also the social welfare system linking oil exporting countries' governments to their populations (Fattouh and Sen 2021). This welfare system consists mainly of public sector employment, low taxation, and other social transfers (Hertog 2017). Welfare schemes are common in all resource-exporting countries, but they are particularly robust in oil exporting countries (Ross 2015). This redistribution of oil rents results in economic inefficiencies. Nevertheless, high oil revenues allow the GCC countries to achieve strong macroeconomic, fiscal and political stability (Elbadawi and Makdisi 2020). In turn, declining rents may create acute political instability in these countries. Bjorvatn and Naghavi (2011) show that significant declines in oil rents may significantly increase the possibility of internal conflict. Rent seeking is more likely to affect these countries when rents are less abundant.

Advanced global climate policies are expected to create risks like those associated with declining oil prices for oil exporting countries. These potential risks were first acknowledged in 1992 in Article 4.8 of the treaty that established the UNFCCC (U.N. 1992). The Intergovernmental Panel on Climate Change (IPCC 2014) reaffirmed that climate mitigation policies may create revenue losses for fossil fuel exporters by devaluing fossil fuel assets. Middle Eastern oil exporters are therefore viewed as opposing advances in climate negotiations (Depledge 2008). However, the global consensus regarding the need for urgent measures to reduce emissions is growing. Thus, some nations, including major oil exporters, have recently shifted from opposing climate policies to becoming more receptive to them (Al-Sarihi and Mason 2020; Ramady and Mahdi 2015).

Challenges for Middle Eastern Oil Exporters from Climate Policies

Global climate policies to reduce overall carbon dioxide emissions and meet the PA's objectives pose a threat to Middle Eastern oil exporters. These policies will significantly alter the outlook for oil demand and prices, putting more stress on oil exporters' state budgets. Researchers have developed different oil demand outlooks that are in line with the PA's objectives. Ansari, Holz and Al-Kuhlani (2019) and Dagnachew et al. (2019) provide comparative analyses of these various energy outlooks. A widely referenced demand outlook that is consistent with the PA is the Sustainable Development Scenario (SDS) created by the International Energy Agency (IEA) (2019). In this scenario, global oil demand is 35.6 million barrels per day (MMb/d) in 2040, or 32.6% lower than its level in the reference scenario. Mitigating the use of fossil fuels will significantly curtail oil demand in major importers of Middle Eastern oil (Table 2).

Table 2. Oil demand and outlook in major oil-importing countries (in MMb/d).

Trading partner	Oil consumption, 2019	Oil imports in 2019 (share of country's total consumption)	Oil imports from the Middle East in 2019 (share of country's total imports)	Oil consumption in 2040		Difference between STEPS and SDS in 2040
				STEPS	SDS	
China	13.2	10.2 (77%)	4.5 (44%)	14.1	8.9	-36%
European Union	10.0	10.5 (105%)	2.1 (20%)	5.6	3.0	-47%
India	5.0	4.5 (91%)	2.7 (60%)	8.7	5.8	-34%
Japan	3.5	2.9 (84%)	2.6 (90%)	2.1	1.3	-39%
South Korea	2.8	2.9 (104%)	2.0 (69%)	2.0[(1)]	0.9[(2)]	-55%
United States	18.5	6.8 (37%)	0.9 (13%)	15.2	8.5	-44%

Notes: Oil consumption in 2019 and 2040 is derived from IEA (2020a). STEPS and SDS refer to the IEA's (2020a) Stated Policies Scenario and the SDS, respectively. Oil imports are derived from BP (2020). The Middle East includes Iraq, Kuwait, Saudi Arabia, the UAE, and other Middle East in BP (2020) data.

[(1)] The STEPS scenario for South Korea is the Baseline scenario provided by the Institute of Energy Economics, Japan (2017).
[(2)] The SDS for South Korea is based on the difference in oil demand between the Business-as-usual and Advanced Technology scenarios provided by Hong et al. (2019).

Sources: BP (2020); IEA (2020a).

Most of the gap between the SDS and the reference scenario comes from the transport sector. This sector's oil demand is 27.0 MMb/d lower in the SDS than in the reference scenario. The difference stems from a combination of fuel efficiency improvements and electric mobility penetration (IEA 2019). Many countries have pledged to ban cars with internal combustion engines in the coming years and have provided incentives to increase electric vehicle use (Burch and Gilchrist 2018). These policies are expected to increase the electric vehicle stock to almost 900 million units by 2040, displacing 9.2 MMb/d of oil demand (IEA 2017).

The potential economic consequences of the data in Table 2 remain uncertain. Even in scenarios in line with the PA, such as the SDS of the IEA (2020a), the decline in oil demand is not steep. Notably, demand in developing countries, such as China and India, will decline more slowly. In the SDS, oil consumption by non-OECD countries decreases by 0.6% per year on average between 2019 and 2040. Consumption will be only 5.5 MMb/d less than current consumption at this horizon (i.e., 46.8 MMb/d vs. 41.3 MMb/d) (IEA 2020a). Thus, demand in developing countries will remain well above OPEC's current production level of about 35 MMb/d (BP 2020).[2] Climate policy will play a critical role in shaping importing countries' demand. However, Middle Eastern exports will also depend on resource availability, competitiveness, and policies in other oil exporting regions (Finley 2012).

If global efforts to mitigate carbon dioxide emissions significantly impact oil demand, oil prices may fall. In the SDS, oil prices stabilize at $53/b (in 2019 dollars) by 2040, 43% less than in the IEA's (2020a) reference scenario. Even if oil prices decline to this level, all Middle Eastern countries can continue to derive substantial rents from oil exports. Their production costs are a fraction of even the lowest projected oil prices.[3] However, this market-based logic provides only a partial picture of the possible outcomes (Dale and Fattouh 2018). The simple break-even oil price (i.e., the price at which selling oil generates a profit) is distinct from the fiscal break-even oil price. The latter price is that required to achieve the planned spending in the state budget.

The fiscal break-even price is more relevant for many Middle Eastern oil exporters because oil is their predominant source of public income. Thus, it is the appropriate metric for analyzing the economic implications of potential oil price declines in Middle Eastern countries. For the five largest Middle Eastern oil exporters in OPEC,[4] the average physical extraction cost is reported to be about $10/b (Dale and Fattouh 2018). However, the fiscal break-even prices for these countries are higher and have remained well above international oil prices in recent years (Table 3).

Some Middle Eastern oil exporters have significantly reduced their fiscal break-even prices. However, these reductions did not result from broad structural reforms (Arezki et al. 2018). They were instead mainly driven by cyclical measures, such as reducing public spending and utilizing financial reserves accumulated when oil prices were high. Moreover, unlike many commodity exporters, Middle Eastern oil exporters anchor their currencies to the United States dollar (or to baskets of currencies, as do Kuwait and Iran). These currency pegs limit policymakers' ability to use independent monetary policy to stabilize shocks, leaving only fiscal actions as possible stabilization tools (Wills and van der Ploeg 2014).

Table 3. Fiscal break-even prices for the five largest Middle Eastern oil exporters in OPEC, 2014–2020.

Year	Variable	Iran	Iraq	Kuwait	Saudi Arabia	UAE
2014	Oil price	96.3	96.3	96.3	96.3	96.3
	Fiscal breakeven	100.0	101.4	54.5	105.7	91.0
	Surplus/shortfall	-3.7	-5.1	41.8	-9.5	5.3
2015	Oil price	49.5	49.5	49.5	49.5	49.5
	Fiscal breakeven	44.1	58.5	47.2	94.0	64.7
	Surplus/shortfall	5.3	-9.0	2.3	-44.5	-15.2
2016	Oil price	43.3	43.3	43.3	43.3	43.3
	Fiscal breakeven	58.4	46.3	43.4	96.4	51.1
	Surplus/shortfall	-15.1	-3.0	-0.1	-53.1	-7.8
2017	Oil price	50.8	50.8	50.8	50.8	50.8
	Fiscal breakeven	64.8	42.3	45.7	83.7	62.0
	Surplus/shortfall	-14.0	8.5	5.1	-32.9	-11.2
2018	Oil price	65.2	65.2	65.2	65.2	65.2
	Fiscal breakeven	67.8	45.4	53.6	88.6	64.1
	Surplus/shortfall	-2.6	19.9	11.7	-23.3	1.2
2019	Oil price	57.0	57.0	57.0	57.0	57.0
	Fiscal breakeven	279.5	52.3	53.0	82.6	67.1
	Surplus/shortfall	-222.5	4.7	4.0	-25.6	-10.1
2020	Oil price	41.1	41.1	41.1	41.1	41.1
	Fiscal breakeven	521.2	63.6	64.5	78.2	75.9
	Surplus/shortfall	-479.5	-21.9	-22.8	-36.5	-34.2

Notes: The fiscal break-even prices for 2020 are estimates. Surplus/shortfall is the difference between the oil price and the fiscal break-even price. A surplus occurs when the oil price is higher than the fiscal break-even price, and a shortfall occurs in the inverse situation.

Sources: International Monetary Fund (IMF) and U.S. Energy Information Administration (EIA) databases.

These cyclical measures have not brought fiscal break-even prices below or even close to international oil prices. Thus, Middle Eastern oil exporters' fiscal indicators have deteriorated. In 2014, the average government fiscal balance for the five oil exporters listed in Table 3 was a surplus of 2.8% of gross domestic product (GDP). By 2016, they had an average deficit of 7.2% of GDP. Although their fiscal balances improved by 2019, with deficits amounting to 0.9% of GDP on average, these countries' overall public debt rose significantly. Whereas debt represented only 12.4% of GDP on average across the five countries in 2014, it reached 31.6% of GDP on average in 2019. These debt levels are moderate by international standards. However, this rapid deterioration linked with declining oil price raises questions about their future sustainability. Ultimately, the development outlooks for oil exporting countries are uncertain owing to increasingly stringent climate policies.

Potential Economic Costs of Global Climate Action for Middle Eastern Oil Exporters

Assessing the economic implications of advanced global climate policies for oil exporting countries is a major focus of policymakers, particularly in the Middle East (Barnett 2008; Ramady and Mahdi 2015). These implications are among the most debated topics in climate negotiations. Various modeling tools are used to determine whether climate policies will create economic losses or benefits for oil exporters and the magnitudes of these impacts. The models' results depend on a wide range of modeling characteristics, including the regional breakdown, the scope of emissions, and the time horizon. Various assumptions that cannot be determined with certainty may also alter the models' outcomes. For instance, models use different assumptions about the coverage of international policy regimes. The ability to substitute between various energy sources and the costs of doing so vary across models. Models assume different rates of technological innovation and future energy supply availability as well (Ansari, Holz and Al-Kuhlani 2019; Dagnachew et al. 2019; Nikas, Doukas and Papandreou 2019).

Barnett, Dessai and Webber (2004) review six different estimates of the expected implications of the Kyoto Protocol for oil exporting countries published in 1999 and 2000. The Kyoto Protocol aimed to reduce the emissions of 37 industrialized countries. All six models indicate that oil exporting countries will suffer losses if climate policies are implemented in industrialized countries. The specific estimates of these losses differ across the six models owing to their different approaches and assumptions. However, the expected losses from the Kyoto Protocol's implementation compared to a business-as-usual scenario are generally estimated to be about 10% of oil revenues. Table 4 provides an updated literature review, presenting estimates from models of climate policy impacts published since 2003.

Seven of the nine studies referenced in Table 4 find that climate policies mainly result in losses for oil exporting countries. Moreover, these seven studies suggest that Middle Eastern countries bear the highest mitigation costs if climate policies are implemented. These costs may be measured as shares of oil export revenues or as shares of GDP. The high mitigation costs arise because the Middle East is highly dependent on oil revenues. The models typically find that the revenue losses for Middle Eastern oil exporters result from oil price declines rather than from export volume reductions. Indeed, the region has abundant and cost-competitive conventional oil reserves, meaning that its exports are unlikely to drastically decline. Middle Eastern countries can leverage this cost advantage to increase oil exports now, under the threat of an accelerated energy transition. However, doing so may flood the market and drive oil prices even lower, thereby aggravating oil rent losses (Waisman, Rozenberg and Hourcade 2013).[5]

These seven models find significant costs for other oil exporting countries as well. For instance, Leimbach et al. (2010) estimate that Russia will suffer losses ranging from 5% to 10% of

Table 4. Models' estimates of climate policies' impacts on Middle Eastern oil exporting countries.

Model	Impact of climate policies on oil exporters	References
KLEM-KSA	Shifting from an oil price under a less stringent climate policy to one under a more stringent climate policy will cause losses for Saudi Arabia. For example, shifting from the IEA's (2017) New Policies Scenario to the SDS reduces GDP by 1.4% in 2030. This shift also reduces total trade revenues from 2017 to 2030 by $504 billion.	Soummane, Ghersi and Lefèvre (2019)
REMIND	In a 450 ppm scenario, global oil rents fall by $5.7 trillion between 2010 and 2100. MENA countries will incur the largest losses. However, carbon rents of $31.9 trillion are sufficient to compensate for the fossil fuel rent loss, even for MENA countries.	Bauer et al. (2016)
IMACLIM-R	Losses for Middle Eastern countries range from $6 trillion to $10.7 trillion in the period from 2010 to 2050. These losses correspond to reductions of 16% to 26% of total oil revenues compared with the baseline scenario.	Waisman, Rozenberg and Hourcade (2013)
MS-MRT	Saudi Arabia's estimated losses between 2000 and 2030 from importing countries implementing the Kyoto Protocol range from $100 billion to $200 billion. The corresponding losses for the rest of OPEC are $150 billion to $310 billion. Saudi welfare is estimated to drop by 4% because of the Kyoto Protocol's implementation. Welfare in other OPEC countries is expected to drop by 1%.	Kingdom of Saudi Arabia (2011)
REMIND-R	MENA countries bear the highest costs in three simulated scenarios representing alternative climate policy regimes. The mitigation costs for MENA countries amount to at least 9% of the region's consumption by 2100 relative to the baseline scenario.	Leimbach et al. (2010)
OligOPEC	OPEC's oil rents under a climate policy increase by 4.1% ($442 billion) between 2010 and 2100 compared to the baseline scenario. Higher carbon prices resulting from stringent climate policies affect unconventional resources rather than conventional reserves with low extraction costs.	Johansson et al. (2009)
GET-RE	OPEC's oil rents are higher for stabilization levels of 400 ppm to 550 ppm. Cumulative oil rents from 2010 to 2100 are 4.4% and 3.0% higher in the 400 ppm and 450 ppm scenarios, respectively. However, a stringent climate policy scenario (i.e., 350 ppm) can reduce OPEC's cumulative oil rents by 10%.	Persson et al. (2007)
MESSAGE/ MACRO	Losses for MENA countries range from 1.5% to 5.4% of GDP in 2050 in the 450 ppm and 400 ppm stabilization scenarios, respectively.	Graßl et al. (2003)
FAIR/TIMER	A 550 ppm scenario is expected to reduce oil revenues by 35% relative to the baseline scenario for Middle Eastern countries in 2050. The region's costs are estimated to range from 3% to 4% of GDP.	Van Vuuren et al. (2003)

Notes: MENA= Middle East and North Africa. ppm= particles per million, which is used to describe GHG concentrations expressed in carbon dioxide equivalent units. The 450 ppm scenario was previously used to represent a 50% chance of limiting global warming to 2 degrees Celsius above pre-industrial levels (IEA 2016). Baseline scenarios assume that no climate policies are enacted.

Source: See the column labeled "References."

consumption relative to a baseline scenario by 2100. Moreover, the generated carbon rents (i.e., the revenue derived from emissions allowances under climate policy scenarios) cannot compensate for Russia's oil rent losses. This result contrasts with those for the Middle East (Bauer et al. 2016).

Two of the nine studies reviewed in Table 4 find that climate change policies may ultimately increase OPEC's revenues. Persson et al. (2007) and Johansson et al. (2009) estimate that OPEC may benefit from climate policy implementation. Specifically, OPEC may achieve gains of 3% to 4.4% of oil rents by 2100 (Table 4). Both studies' results depend on the universality of the climate regime and the absence of policies protecting synthetic fuel production from carbon pricing. Moreover, their results are sensitive to OPEC's market power, although OPEC members' rents increase regardless of whether OPEC is a price maker.

Potential Responses of Middle Eastern Oil Exporters to the Economic Impacts of Climate Mitigation Measures

The implementation of stringent climate policies may place downward pressure on global oil prices, resulting in economic losses for Middle Eastern oil exporters. These countries may need to develop responses to increase their economic resilience. This section reviews the literature on strategies that oil exporting countries can adopt to mitigate the impacts of oil revenue declines on their economies. It also discusses ways to implement these strategies and the possible outcomes of their implementation.

Specifically, the literature identifies six strategies that Middle Eastern oil exporters can adopt to mitigate the economic impacts of climate policies. These strategies are bilateral exchanges of experiences, unilateral actions, quota agreements, price wars, financial compensation, and economic diversification (Table 5). In this section, we discuss the applicability of four of these mitigation strategies. Aside from their contributions to economic diversification, we show that they may prove difficult to implement, and their effects may be transitory at best.

The studies described in Table 5 suggest that any action plan must differentiate between short-run and long-run strategies. Long-run strategies can generate sustained revenue flows independent of oil price fluctuations. Moreover, the relevance and feasibility of mitigation strategies differ by country, and assessments of these strategies must consider country-specific characteristics. The economic impacts of oil price changes and mitigation strategies will not be uniform across oil exporters (IPCC 2014).

We now discuss the feasibility of the four strategies that we view as the most relevant for Middle Eastern oil exporters. These strategies are quota agreements, price wars, financial compensation, and economic diversification. Quota agreements are relevant for Middle Eastern exporters because they are OPEC members. Price wars are relevant because some Middle Eastern countries have historically attempted to preserve their market shares through price wars when facing market shocks. Financial compensation is relevant because Middle Eastern exporters have requested compensation to offset losses from industrialized countries' climate policy mitigation measures within previous climate negotiations. Finally, economic diversification is relevant because all Middle Eastern countries have initiated strategic plans for resilient economic growth independent of the oil sector.

Middle Eastern oil exporters often deploy the collaborative approach of quota agreements to stabilize the oil market. With new climate policies looming, this strategy may serve to maintain prices when the demand for oil declines. However, although quota agreements may achieve success in the short term, they are challenging to impose across countries and to maintain over sustained periods. Colgan (2014) and Ghoddusi, Nili and Rastad (2017) find that OPEC members largely and almost systematically violate their production quotas. Moreover, some argue that attempting to resist the oil price declines resulting from oil-importing countries' climate policies will reduce OPEC's overall rents. It may even worsen the revenue outlook for OPEC members that reduce

Table 5. Potential strategies for Middle Eastern oil exporters to mitigate the economic impacts of climate policies.

Strategy	Actions	Expected outcomes	Justification	Challenges
Bilateral exchanges of experiences	Invest oil revenue surpluses in diversified portfolios based on successful international experiences.	Shield the economy against the effects of climate policies or resource depletion and ensure intergenerational equity.	Successful examples, including Norway (Gelb and Grasmann 2010) and Kuwait (Shehabi 2021), suggest that diversified portfolios can generate revenue.	This strategy is only relevant for countries with high rents per capita (El-Katiri 2016).
Unilateral actions	Reform domestic energy prices by removing fossil fuel incentives.	Achieve fiscal gains and reduce domestic carbon dioxide emissions.	Many reforms have been implemented in the Middle East since the 2015 oil price decline (Krane and Hung 2016).	This strategy is politically delicate in the Middle East (Fattouh and El-Katiri 2013).
Quota agreements	Negotiate output levels using collaborative actions among exporting countries.	Sustain oil prices in the long term at levels that can ensure significant rents and avoid switching to alternative sources.	Quotas can reduce price volatility and stabilize the oil market, notably through spare capacity (Pierru, Smith and Zamrik 2018).	OPEC members have largely violated their production quotas in the past (Colgan 2014; Ghoddusi, Nili and Rastad 2017).
Price wars	Extract and market available oil resources.	Drive high marginal cost producers out of the market.	Price wars can defend market share against penetration by more elastic suppliers (Behar and Ritz 2017).	A price war from OPEC may drive prices below those that would prevail in a perfectly competitive oil market (Ansari 2017).
Financial compensation	Negotiate within the UNFCCC for financial transfers to oil exporters.	Offset expected oil rent losses from declines in exports.	Compensation addresses the adverse impacts of response measures, ultimately fostering progress in climate negotiations (Barnett and Dessai 2002).	Estimates suggest that such monetary compensation cannot offset revenue losses for Middle Eastern countries (Waisman, Rozenberg and Hourcade. 2013).
Economic diversification	Foster the contributions of domestic non-oil industries in the private sector.	Improve the economy's resilience to oil price variations and expected rent declines under stringent climate policies.	Economic diversification in services and manufacturing results in higher growth, lower unemployment and lower public debt than concentration in energy-related industries does (Soummane, Ghersi and Lecocq 2022).	Decades may pass before tangible results start to materialize (Callen et al. 2014).

Sources: Strategies adapted from Pershing (2000) and Van de Graaf and Verbruggen (2015).

their production in accordance with the agreements (Babiker and Jacoby 1999).

If a collaborative approach is difficult to organize, oil exporters may seek a non-collaborative short-term option. Middle Eastern oil exporters may or may not openly declare a price war. Either way, they can attempt to use prices to preserve market share in an increasingly competitive market with expected declines in demand and prices. Nevertheless, the 2015 oil price slump, following the expansion in shale oil production, proved that such a strategy may not have the desired results. Many highly uncertain parameters influenced the outcomes of the 2015 price environment. For instance, unconventional oil producers demonstrated surprising abilities to adjust their costs in response to low international oil prices (OPEC 2017). Thus, OPEC's strategy to drive high marginal cost producers from the market caused prices to fall below the expected prices under perfect competition (Ansari 2017).

Another strategy for Middle Eastern oil exporters is to seek financial compensation within the climate negotiations framework. However, this strategy has proved to be politically unrealistic and practically difficult (Barnett and Dessai 2002; Barnett, Dessai and Webber 2004). Indeed, negotiations with an oil exporter to abandon a share of its underground oil reserves have only been attempted once, in the case of Ecuador. The deal failed in 2013 owing to a lack of financial pledges (Van de Graaf and Verbruggen 2015).[6] Financial compensation schemes are complex because defining the extent of the lost revenue that requires compensation is impossible. As a result, few oil exporters have considered this strategy (Barnett and Dessai 2002). Saudi Arabia explicitly states in its national commitments to the UNFCCC that its climate pledges are not contingent upon international financial support (Kingdom of Saudi Arabia 2015). Furthermore, even if compensation schemes are implemented, the amount of compensation is unlikely to offset Middle Eastern countries' entire revenue losses (Waisman, Rozenberg and Hourcade 2013).

Finally, Middle Eastern oil exporters can mitigate the impacts of climate policies through economic diversification. This strategy is often cited as the only viable long-term strategy to ensure income stability and sustainability (Hvidt 2013; Van de Graaf and Verbruggen 2015). Recent studies show that diversification can effectively counter the effects of the low oil prices that may arise from climate policy implementation. Soummane, Ghersi and Lecocq (2022) estimate the impacts of diversifying into services and manufacturing for Saudi Arabia. They find that this strategy can increase growth and reduce unemployment and public debt by 2030 relative to a strategy of developing energy-intensive industries. However, this outcome depends on further domestic energy price reforms fostering energy efficiency gains and tax adjustments being used for additional investments. Shehabi (2020) analyzes the case of Kuwait to show that reforming domestic energy prices can foster economic diversification in a low oil price environment. However, other past experiences show that economic diversification must be accompanied by effective institutions and governance to eliminate dependence on hydrocarbon revenues. Moreover, diversification must be pursued as a long-term strategy, and results may not materialize for decades (Callen et al. 2014).

Conclusions and Policy Implications

Increasingly, global climate change mitigation efforts are aiming to cut carbon dioxide emissions by reducing fossil fuel use. These efforts are expected to significantly alter the outlooks for global oil demand and prices. Oil exporters in the Middle East are mostly dependent on oil export revenues, and economic diversification has made little progress in these countries. Thus, future declines in oil demand and prices resulting from stringent climate policies may create considerable development challenges.

This study reviewed models estimating the extent of the expected losses or gains for oil exporting countries resulting from advanced global climate actions. The impacts of these actions on oil demand and prices are difficult to assess with certainty. Most studies suggest that advanced global climate mitigation policies are likely to reduce oil rents for Middle Eastern oil exporters. These studies' estimates suggest that oil exporting countries in the Middle East will bear higher costs than other oil exporting countries. However, a few studies argue that some oil exporters may benefit from climate policy implementation. This outcome may arise under certain conditions related to the universality of climate policy, substitutability and resource availability.

This study also reviewed and assessed six strategies that Middle Eastern oil exporters may adopt to mitigate advanced global climate policies' impacts on oil rents. These strategies are bilateral exchanges of experiences, unilateral actions, quota agreements, price wars, financial compensation and economic diversification. Some of them, such as investments in diversified portfolios and financial compensation, may not offset the potential declines in oil revenues. Others, such as quota agreements on production levels, may be difficult to implement. Scholars widely agree that economic diversification is the optimal strategy from global and national perspectives because it can generate sustainable growth independently from oil rents.

This study reviewed models published between 2003 and 2019. Its conclusions were drawn around the time of unprecedented lockdown measures implemented in 2020 to mitigate the spread of COVID-19. The resulting closures of many businesses and economies led to a major global decline in oil demand and a historic collapse in oil prices. The economic recovery from the COVID-19 pandemic is also expected to alter the prospects for oil demand and prices discussed in this study. Governments worldwide are increasingly pledging to incorporate climate actions and sustainability in their economic recovery packages. Thus, Middle Eastern oil exporters may incur oil rent losses sooner than the scenarios described in this review anticipated. We recommend that future research investigate whether the pandemic and its subsequent policies may have long-lasting effects on oil producers. We also recommend researching the extent of short-term losses, as it may take time for the global economy to fully recover.

Declaration

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Endnotes

[1] The GCC countries are Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE). The GCC countries listed in Table 1 (i.e., Kuwait, Saudi Arabia and the UAE) provided 81% of the GCC's GDP in 2018.

[2] As of January 1, 2020, OPEC's members are Algeria, Angola, Congo, Equatorial Guinea, Gabon, Iran, Iraq, Kuwait, Libya, Nigeria, Saudi Arabia, the UAE and Venezuela. This tradeoff conceptually applies to other non-power systems, such as transportation, healthcare, etc.

[3] The literature provides no exact estimates of extraction costs in the Middle East. However, the general consensus is that the region is first in the cost curve. Smith (2009, 9) reports that extraction costs range from "probably no higher than $5/b for Saudi Arabia and $10 elsewhere in the Middle East." A more recent report states that the extraction cost of Saudi oil is $7/b (Saudi Aramco 2020).

[4] This group comprises Saudi Arabia, Iraq, the UAE, Iran and Kuwait. According to the Joint Organisations Data Initiative, these countries are the first, third, fifth, sixth and seventh largest crude exporters worldwide, respectively.

[5] Saudi Arabia and OPEC engaged in a price war in 2014 and 2015 to preserve market share during the rise of shale oil. Ansari (2017) shows that after this price war, oil prices dropped below the levels that would have prevailed in a perfectly competitive market.

[6] The United States withdrew from the PA owing to disagreements on financing climate mitigation efforts in developing countries (see https://trumpwhitehouse.archives.gov/briefings-statements/statement-president-trump-paris-climate-accord/).

References

Al-Sarihi, Aisha, and Michael Mason. 2020. "Challenges and Opportunities for Climate Policy Integration in Oil-producing Countries: The Case of the UAE and Oman." *Climate Policy* 20(10):1226–41. https://doi.org/10.1080/14693062.2020.1781036

Ansari, Dawud. 2017. "OPEC, Saudi Arabia, and the Shale Revolution: Insights from Equilibrium Modelling and Oil Politics." *Energy Policy* 111:166–78. https://doi.org/10.1016/j.enpol.2017.09.010

Ansari, Dawud, and Franziska Holz. 2020 "Between Stranded Assets and Green Transformation: Fossil-fuel-producing Developing Countries Towards 2055." *World Development* 130:104947. https://doi.org/10.1016/j.worlddev.2020.104947

Ansari, Dawud, Franziska Holz, and Hashem Al-Kuhlani. 2019. "Energy Outlooks Compared: Global and Regional Insights." *Economics of Energy and Environmental Policy* 9(1):21–42. https://doi.org/10.5547/2160-5890.9.1.dans

Arezki, Rabah, Raouf Boucekkine, Jeffrey Frankel, Mohammed Laksaci, and Rick van der Ploeg. 2018. "Rethinking the Macroeconomics of Resource-rich Countries." Center for Economic Policy Research. https://www.researchgate.net/publication/326080177_Rethinking_the_macroeconomics_of_resource-rich_countries

Babiker, Mustafa H. M., and Henry D. Jacoby. 1999. "Developing Country Effects of Kyoto-type Emissions Restrictions." MIT Joint Program on the Science and Policy of Global Change, Report 53, Cambridge, MA. https://globalchange.mit.edu/publication/13852

Barnett, Jon. 2008. "The Worst of Friends: OPEC and G-77 in the Climate Regime." *Global Environmental Politics* 8(4):1–8. https://doi.org/10.1162/glep.2008.8.4.1

Barnett, Jon, and Suraje Dessai. 2002. "Articles 4.8 and 4.9 of the UNFCCC: Adverse Effects and the Impacts of Response Measures." *Climate Policy* 2(2-3):231–9. https://doi.org/10.1016/s1469-3062(02)00023-2

Barnett, Jon, Suraje Dessai, and Michael Webber. 2004. "Will OPEC Lose from the Kyoto Protocol?" *Energy Policy* 32(18):2077–88. https://doi.org/10.1016/s0301-4215(03)00183-6

Bauer, Nico, Ioanna Mouratiadou, Gunnar Luderer, Lavinia Baumstark, Robert J. Brecha, Ottmar Edenhofer, and Elmar Kriegler. 2016. "Global Fossil Energy Markets and Climate Change Mitigation – An Analysis with REMIND." *Climatic Change* 136(1):69–82. https://doi.org/10.1007/s10584-013-0901-6

Behar, Alberto, and Robert A. Ritz. 2017. "OPEC vs. U.S. Shale: Analyzing the Shift to a Market-share Strategy." *Energy Economics* 63:185–98. https://doi.org/10.1016/j.eneco.2016.12.021

Bjorvatn, Kjetil, and Alireza Naghavi. 2011. "Rent Seeking and Regime Stability in Rentier States." *European Journal of Political Economy* 27(4):740–8. https://doi.org/10.1016/j.ejpoleco.2011.05.007

BP. 2020. "BP Statistical Review of World Energy June 2020." https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook-2019.pdf

Burch, Isabella, and Jock Gilchrist. 2018. "Survey of Global Activity to Phase out Internal Combustion Engine Vehicles." Center for Climate Protection. https://theclimatecenter.org/wp-content/uploads/2018/09/Survey-on-Global-Activities-to-Phase-Out-ICE-Vehicles-FINAL.pdf

Callen, Tim, Reda Cherif, Fuad Hasanov, Amgad Hegazy, and Padamja Khandelwal. 2014. "Economic Diversification in the GCC: Past, Present, and Future." International Monetary Fund. https://doi.org/10.5089/9781498303231.006

Central Bank of Kuwait. 2019. "The 48th Economic Report For The Year 2019." https://www.cbk.gov.kw/en/statistics-and-publication/publications/economic-reports

Colgan, Jeff D. 2014. "The Emperor Has No Clothes: The Limits of OPEC in the Global Oil Market." *International Organization* 68(3):599–632. https://doi.org/10.1017/s0020818313000489

Coulomb, Renaud, and Fanny Henriet. 2018. "The Grey Paradox: How Fossil-fuel Owners Can Benefit from Carbon Taxation." *Journal of Environmental Economics and Management* 87:206–23. https://doi.org/10.1016/j.jeem.2017.07.001

Dagnachew, Anteneh G., Andries F. Hof, Paul L. Lucas, and Detlef P. van Vuuren. 2019. "Insight into Energy Scenarios: A Comparison of Key Transition Indicators of 2° C Scenarios." PBL Netherlands Environmental Assessment Agency. https://www.pbl.nl/sites/default/files/downloads/pbl-2019-insight-into-energy-scenarios_3686.pdf

Dale, Spencer, and Bassam Fattouh. 2018. "Peak Oil Demand and Long-run Oil Prices." Energy Insight 25, Oxford Institute for Energy Studies. https://www.oxfordenergy.org/publications/peak-oil-demand-long-run-oil-prices/

Depledge, Joanna. 2008. "Striving for No: The KSA in the Climate Change Regime." *Global Environmental Politics* 8(4):9–35. https://doi.org/10.1162/glep.2008.8.4.9

El-Katiri, Laura. 2016. "Vulnerability, Resilience, and Reform: The GCC and the Oil Price Crisis 2014-2016." Columbia Center on Global Energy Policy. https://www.energypolicy.columbia.edu/sites/default/files/Vulnerability%2C%20Resilience%20and%20Reform%3A%20The%20GCC%20and%20the%20Oil%20Price%20Crisis.pdf

Elbadawi, Ibrahim A., and Samir Makdisi. 2020. "The Sustainability of GCC Development Under the New Global Oil Order." Economic Research Forum Working Papers. https://doi.org/10.1007/978-981-15-5728-6_13

Esfahani, Hadi Salehi, Kamiar Mohaddes, and M. Hashem Pesaran. 2013. "Oil Exports and the Iranian Economy." *The Quarterly Review of Economics and Finance* 53(3):221–37. https://doi.org/10.1016/j.qref.2012.07.001

Fattouh, Bassam, and Laura El-Katiri. 2013. "Energy Subsidies in the Middle East and North Africa." *Energy Strategy Reviews* 2(1):108–15. https://doi.org/10.1016/j.esr.2012.11.004

Fattouh, Bassam, and Anupama Sen. 2021. "Economic Diversification in Arab Oil-exporting Countries in the Context of Peak Oil and the Energy Transition." In *When Can Oil Economies Be Deemed Sustainable?*, edited by Giacomo Luciani and Tom Moerenhout, 73–97. Singapore: Palgrave Macmillan. https://doi.org/10.1007/978-981-15-5728-6_5

Fezzani, Brahim, and Dilyara Nartova. 2011. "Oil Prices Fluctuation Impact on Iraq's Economy." *European Journal of Social Sciences* 26(4):626–33. https://www.researchgate.net/publication/292495904_Oil_prices_fluctuation_impact_on_Iraq's_economy

References

Finley, Mark. 2012. "The Oil Market to 2030—Implications for Investment and Policy." *Economics of Energy & Environmental Policy* 1(1):25–36. https://doi.org/10.5547/2160-5890.1.1.4

Ftiti, Zied, Khaled Guesmi, Frédéric Teulon, and Slim Chouachi. 2016. "Relationship Between Crude Oil Prices and Economic Growth in Selected OPEC Countries." *Journal of Applied Business Research (JABR)* 32(1):11–22. https://doi.org/10.19030/jabr.v32i1.9483

Gelb, Alan, and Sina Grasmann. 2010. "How Should Oil Exporters Spend Their Rents?" Center for Global Development Working Paper (221). https://www.cgdev.org/publication/how-should-oil-exporters-spend-their-rents-working-paper-221

Ghoddusi, Hamed, Masoud Nili, and Mahdi Rastad. 2017. "On Quota Violations of OPEC Members." *Energy Economics* 68:410–22. https://doi.org/10.1016/j.eneco.2017.10.016

Graßl, Hartmut, Juliane Kokott, Margareta Kulessa, Joachim Luther, Franz Nuscheler, Rainer Sauerborn, Hans-Joachim Schellnhuber, Renate Schubert, and Ernst-Detlef Schulze. 2003. "Climate Protection Strategies for the 21st Century: Kyoto and Beyond." German Advisory Council on Global Change. http://www.gci.org.uk/Documents/wbgu_sn2003_engl.pdf

Hertog, Steffen. 2017. "The Political Economy of Distribution in the Middle East: Is There Scope for a New Social Contract?" In *Combining Economic and Political Development*, edited by Giacomo Luciani, 88–113. Leiden: Brill Nijhoff. https://doi.org/10.1163/9789004336452_006

Hong, Jong Ho, Jitae Kim, Wonik Son, Heeyoung Shin, Nahyun Kim, Woong Ki Lee, and Jintae Kim. 2019. "Long-term Energy Strategy Scenarios for South Korea: Transition to a Sustainable Energy System." *Energy Policy* 127:425–37. https://doi.org/10.1016/j.enpol.2018.11.055

Hvidt, Martin. 2013. "Economic Diversification in GCC Countries: Past Record and Future Trends." Kuwait Programme on Development, Governance and Globalisation in the Gulf States. http://eprints.lse.ac.uk/55252/

Institute of Energy Economics, Japan (IEEJ). 2017. "IEEJ Outlook 2018 - Prospects and Challenges Until 2050." https://eneken.ieej.or.jp/data/7748.pdf

International Energy Agency (IEA). 2016. *World Energy Outlook 2016.* Paris: IEA/OECD. https://www.oecd-ilibrary.org/energy/world-energy-outlook-2016_weo-2016-en

---. 2017. "World Energy Outlook 2017." IEA/OECD. https://www.oecd-ilibrary.org/energy/world-energy-outlook-2017_weo-2017-en

IEA (2018), Outlook for Producer Economies, IEA, Paris https://www.iea.org/reports/outlook-for-producer-economies

IEA (2018), World Energy Outlook 2018, IEA, Paris, https://doi.org/10.1787/weo-2018-en

---. 2019. "World Energy Outlook 2019." Paris: IEA/OECD. https://www.oecd-ilibrary.org/energy/world-energy-outlook-2019_caf32f3b-en

---. 2020a. "World Energy Outlook 2020." IEA/OECD. https://www.oecd-ilibrary.org/energy/world-energy-outlook-2020_557a761b-en

---. 2020b. "The Oil and Gas Industry in Energy Transitions." https://www.iea.org/reports/the-oil-and-gas-industry-in-energy-transitions

---. 2021. “World Energy Outlook 2021.” IEA/OECD. https://www.oecd-ilibrary.org/energy/world-energy-outlook-2021_14fcb638-en

Intergovernmental Panel On Climate Change (IPCC). 2014. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, U.K.: Cambridge University Press. https://doi.org/10.1017/cbo9781107415416

Johansson, Daniel J. A., Christian Azar, Kristian Lindgren, and Tobias A. Persson. 2009. “OPEC Strategies and Oil Rent in a Climate Conscious World.” *The Energy Journal* 30(3):23–50. https://doi.org/10.5547/issn0195-6574-ej-vol30-no3-2

Kingdom of Saudi Arabia. 2011. “Second National Communication of the Kingdom of Saudi Arabia Submitted to the UNFCCC.” http://unfccc.int/resource/docs/natc/saunc2.pdf

---. 2015. “The Intended Nationally Determined Contribution of the Kingdom of Saudi Arabia under the UNFCCC.” https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Saudi%20Arabia%20First/KSA-INDCs%20English.pdf

Krane, Jim, and Shih Yu Hung. 2016. “Energy Subsidy Reform in the Persian Gulf: The End of the Big Oil Giveaway.” Issue Brief, no. 04.28.16. James A. Baker III Institute for Public Policy of Rice University. http://bakerinstitute.org/research/persian-gulf-energy-subsidy-reform/

Leimbach, Marian, Nico Bauer, Lavinia Baumstark, and Ottmar Edenhofer. 2010. “Mitigation Costs in a Globalized World: Climate Policy Analysis with REMIND-R.” *Environmental Modeling & Assessment* 15(3):155–73. https://doi.org/10.1007/s10666-009-9204-8

Mehrara, Mohsen, Majid Maki, and Hossein Tavakolian. 2010. “The Relationship Between Oil Revenues and Economic Growth, Using Threshold Methods (The Case of Iran).” *OPEC Energy Review* 34(1):1–14. https://doi.org/10.1111/j.1753-0237.2010.00172.x

Nikas, Alexandros, Haris Doukas, and Andreas Papandreou. 2019. “A Detailed Overview and Consistent Classification of Climate-economy Models.” In *Understanding Risks and Uncertainties in Energy and Climate Policy*, edited by Haris Doukas, Alexandros Flamos, and Jenny Lieu, 1–54. Cham: Springer. https://doi.org/10.1007/978-3-030-03152-7_1

Nusair, Salah A. 2016. “The Effects of Oil Price Shocks on the Economies of the Gulf Co-operation Council Countries: Nonlinear Analysis.” *Energy Policy* 91:256–67. https://doi.org/10.1016/j.enpol.2016.01.013

Olivier Jos G. J., and Jeroen A. H. W. Peters. 2019. *Trends in Global CO2 and Total Greenhouse Gas Emissions: 2019 Report*. The Hague: PBL Netherlands Environmental Assessment Agency. https://www.pbl.nl/sites/default/files/downloads/pbl-2020-trends-in-global-co2-and-total-greenhouse-gas-emissions-2019-report_4068.pdf

OPEC. 2017. “World Oil Outlook 2040.” https://www.opec.org/opec_web/static_files_project/media/downloads/publications/WOO%20%202017.pdf

Pershing, Jonathan. 2000. “Fossil Fuel Implications of Climate Change Mitigation Responses.” In *Sectoral and Economic Costs and Benefits of GHG Mitigation*, edited by Lenny Bernstein and Jiahua Pan, 85–105. Utrecht, Netherlands: Intergovernmental Panel on Climate Change. https://www.ipcc.ch/site/assets/uploads/2018/05/sectoral-economic-costs-2000.pdf

References

Persson, Tobias A., Christian Azar, Daniel Johansson, and Kristian Lindgren. 2007. "Major Oil Exporters May Profit Rather Than Lose, in a Carbon-constrained World." *Energy Policy* 35(12):6346–53. https://doi.org/10.1016/j.enpol.2007.06.027

Pierru, Axel, James L. Smith, and Tamim Zamrik. 2018. "OPEC's Impact on Oil Price Volatility: The Role of Spare Capacity." *The Energy Journal* 39(2):103–22. https://doi.org/10.5547/01956574.39.2.apie

Ramady, Mohamed, and Wael Mahdi. 2015. *OPEC in a Shale Oil World – Where to Next?* Cham: Springer Books. https://link.springer.com/book/10.1007/978-3-319-22371-1

Ross, Michael L. 2015. "What Have We Learned About the Resource Curse?" *Annual Review of Political Science* 18:239–59. https://doi.org/10.1146/annurev-polisci-052213-040359

Sassoon, Joseph. 2016. "Iraq: Oil Prices and Economic Management." MEEA 15th International Conference, Doha, Qatar. https://www.dohainstitute.edu.qa/MEEA2016/Downloads/Joseph%20Sassoon_Final.pdf

Saudi Arabian Monetary Authority (SAMA). 2019. "Annual Statistics 2019." http://www.sama.gov.sa/en-US/EconomicReports/Pages/YearlyStatistics.aspx

Saudi Aramco. 2020. "FY 2020 Results." https://www.aramco.com/-/media/publications/corporate-reports/saudi-aramco-fy-2020-webcast-presentation-english.pdf

Shehabi, Manal. 2020. "Diversification Effects of Energy Subsidy Reform in Oil Exporters: Illustrations from Kuwait." *Energy Policy* 138:110966. https://doi.org/10.1016/j.enpol.2019.110966

---. 2021. "Redefining Economic Sustainability in Resource-rich States: Comparative Lessons." In *When Can Oil Economies Be Deemed Sustainable?*, edited by Giacomo Luciani and Tom Moerenhout, 153–90. Singapore: Palgrave Macmillan. https://doi.org/10.1007/978-981-15-5728-6_7

Smith, James L. 2009. "World Oil: Market or Mayhem?" *Journal of Economic Perspectives* 23(3):145–64. https://doi.org/10.1257/jep.23.3.145

Soummane, Salaheddine, Frédéric Ghersi, and Franck Lecocq. 2022. "Structural Transformation Options of the Saudi Economy Under Constraint of Depressed World Oil Prices." *The Energy Journal* 43(3):181–200. https://doi.org/10.5547/01956574.43.3.ssou

Soummane, Salaheddine, Frédéric Ghersi, and Julien Lefèvre. 2019. "Macroeconomic Pathways of the Saudi Economy: The Challenge of Global Mitigation Action Versus the Opportunity of National Energy Reforms." *Energy Policy* 130:263–82. https://doi.org/10.1016/j.enpol.2019.03.062

United Nations (U.N.). 1992. "United Nations Framework Convention on Climate Change." https://unfccc.int/resource/docs/convkp/conveng.pdf

United Nations Framework Convention on Climate Change (UNFCCC). 2015. "Paris Agreement." https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

Van de Graaf, Thijs. 2017. "Is OPEC Dead? Oil Exporters, the Paris Agreement and the Transition to a Post-Carbon World." *Energy Research & Social Science* 23:182–88. https://doi.org/10.1007/978-3-030-29089-4_4

Van de Graaf, Thijs, and Aviel Verbruggen. 2015. "The Oil Endgame: Strategies of Oil Exporters in a Carbon-Constrained World." *Environmental Science & Policy* 54:456–62. https://doi.org/10.1016/j.envsci.2015.08.004

Van Vuuren, Detlef P., Michel G. J. den Elzen, Mehmet Emre Berk, Paul L. Lucas, B. Eickhout, Hans Eerens, and Rineke Oostenrijk. 2003. *Regional Costs and Benefits of Alternative Post-Kyoto Climate Regimes: Comparison of Variants of the Multi-stage and Per Capita Convergence Regimes*. Utrecht, Netherlands: RIVM. https://www.researchgate.net/publication/27452110_Regional_costs_and_benefits_of_alternative_post-Kyoto_climate_regimes_Comparison_of_variants_of_the_Multi-stage_and_Per_Capita_Convergence_regimes

Waisman, Henri, Julie Rozenberg, and Jean Charles Hourcade. 2013. "Monetary Compensations in Climate Policy Through the Lens of a General Equilibrium Assessment: The Case of Oil exporting Countries." *Energy Policy* 63:951–61. https://doi.org/10.1016/j.enpol.2013.08.055

Wills, Samuel, and Rick van der Ploeg. 2014. "Why Do So Many Oil Exporters Peg Their Currency? Foreign Reserves as a De-facto Sovereign Wealth Fund." IMF New Perspectives, presented at the joint RES-SPR Conference on Macroeconomic Challenges Facing Low-Income Countries. https://www.imf.org/external/np/seminars/eng/2014/lic/pdf/Ploeg1.pdf

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About the Project

The Climate Change Adaptation and Mitigation Partnership (CAMP) project is very timely and direly important for Saudi Arabia given the mounting risks associated with climate change impacts, the urgency of pushing toward low carbon futures while maintaining economic growth nationally, and the potential economic ramifications of global mitigation efforts on the Saudi energy sector and economy. Against this backdrop, the CAMP project will investigate (1) Saudi Arabia's climate conditions, (2) the role of adaptation measures and their sectoral impacts, and (3) the pathways for the Saudi economy to achieve a low carbon future or climate neutrality by mid-century. (4) The study will also adopt the circular carbon economy (CCE) concept in characterizing the Saudi government's efforts to decarbonize its own economy while meeting its growth aspirations.

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