Going Downstream – An Economical Option for Oil and Gas Exporting Countries?

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Abstract

This paper surveys normative and positive reasons why oil and gas exporting countries chose to enter into downstream industries. Several explanations are surveyed from a normative and a positive aspect and then tested against observations, including: price differentiation (export taxes) from industrial organizations (about vertical integration and property rights), and arguments based on fostering development, on a comparative advantage, on hedging and a few others (e.g., opportunities due to climate mitigation). Few normative justifications meet the test of explaining what is going on. Local refining can serve as a partial hedge against the vagaries of oil price. Refining for domestic and regional markets can be economical and even local subsidies can be justified to some extent. However, all of those justifications seem to be mismanaged politically by granting the national oil companies a monopoly and by very large subsidies on refined products. Instead, current downstream activities serve rather political and managerial than economic objectives.

Keywords: downstream activities, subsidies, export taxes, oil exporting countries, political economy, hedging

1. Introduction

From the perspective of a resource exporting country, it seems very tempting to export final products instead of raw materials. This topic is high on the political agenda of many resource exporting countries, particularly in the Middle East and North African (MENA) countries on which this paper focuses. The refining and processing sectors have the potential to generate profit, stimulate employment, and promote human capital development. That's why this topic is high on the political agenda.

The objective of this paper is to discuss the reasons why resource exporting countries should and do go downstream and to test these explanations against empirical facts. The potential justifications of pursuing this strategy of going down the value chain accounts for normative as well as positive arguments. Normative justifications (for details see Section 3) are:

(i) To offer the resource to the local population at preferential terms for consumption and as an input for local production. Most of the oil and gas exporting countries, and especially MENA countries, hand out large subsidies on refined products.

(ii) From an industrial organization (IO) perspective, going downstream amounts to vertical integration that is able to capture economies of scope, increase market power, and eliminate double marginalization. Indeed, when the Seven Sisters ran the oil business, they were (almost) completely vertically integrated from extraction to end-use including shipping, refining and selling at the pump.

(iii) From a trade perspective, the resource exporting country may have a comparative advantage in upgrading the resource.

(iv) Downstream activities require more complex tasks. They have the potential to provide economy wide spillovers, thereby fostering overall economic development.

(v) Downstream activities (e.g., refining, petrochemicals) can provide a hedge against the price volatility that often characterises resource markets.

The positive and politico-economic arguments (some borrowed from Public Choice, see Section 4), include:

(vi) Security of supply (not unimportant for sanction-prone countries like Iran and Russia).

(vii) Subsidies to local industries as a result of lobbying.

(viii) Consolidation of power by elites.

(ix) Building empires to meet the preferences of those in power.

A summary of the status quo (Section 2) is followed by sketching and reviewing the different theoretical explanations (Sections 3 normative and 4 positive), which is then followed by checking the above theoretical arguments against empirical facts (Section 5). The major conclusion of our analysis is that only a few of the normative arguments apply and, even less so, if the actual implementation is taken into account. In contrast, positive theories explain what is going on much better.

2. Stylized Facts

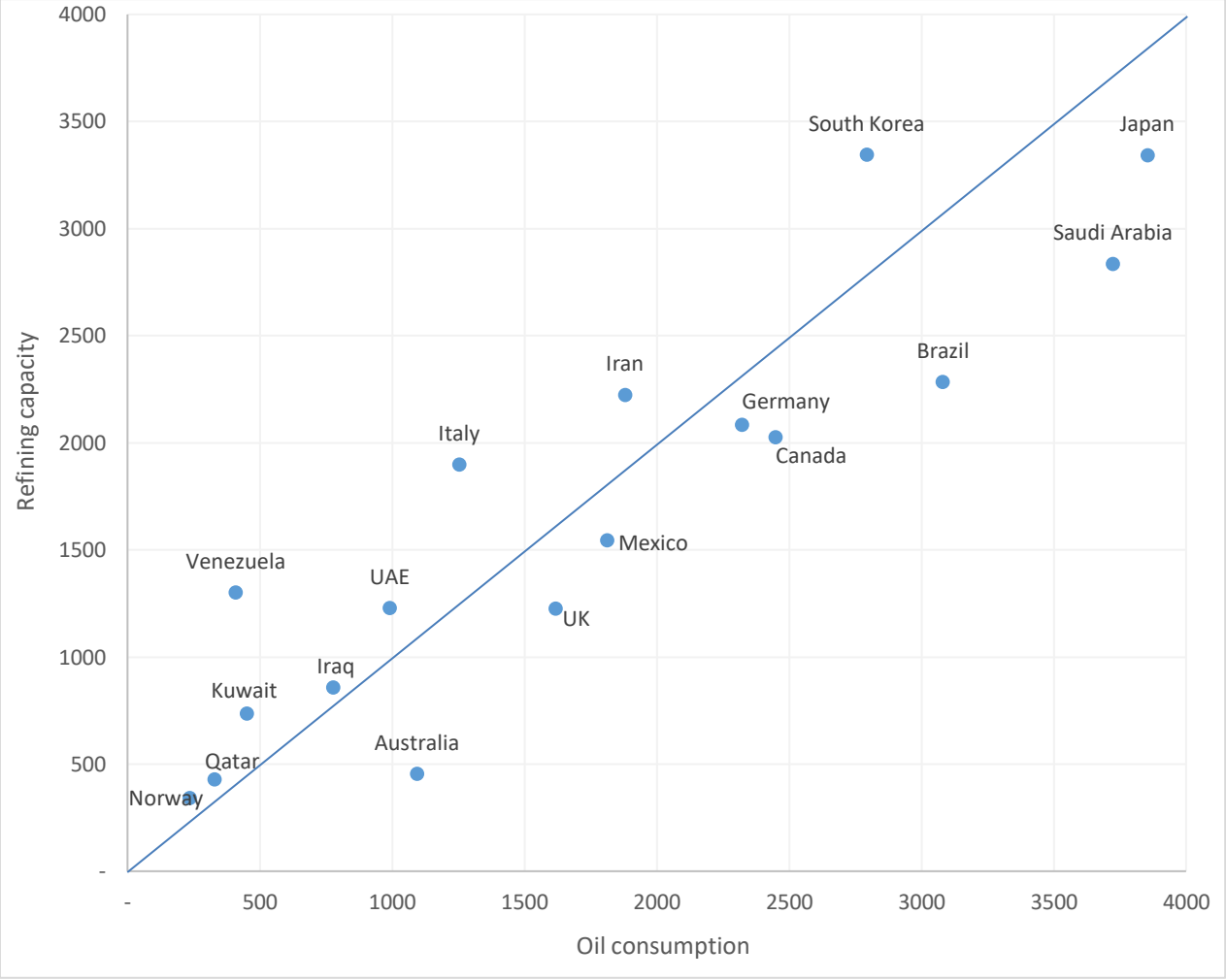
Given the decades-old intentions of MENA countries to develop their downstream industries, the current situation falls short of past promises. The exception is the airline industry in some Persian Gulf countries, which presumably nobody expected a few decades ago when the price of oil started rolling.

The threat of peak oil demand and a shift to refined products is driving refiners to the petrochemical sector. Growing demand for downstream products, like hydrocarbon intermediates and petrochemicals, is offering additional business opportunities for oil and gas exporting countries. However, there is still excess refining capacity globally (see: BP, 2019) and domestic capacities exceed demand in many countries (see Figure 1).

This applies not only to MENA countries but also to Norway. Of course, the relevant comparison between demand and capacity should include the hinterland and this explains to some extent Norway's position given its closeness to Scandinavian and European markets. Surprising is that large oil producers like the United States (refining capacity is around 92% of demand but not shown in Figure 1 because of its large demand) and Canada (an exporter) rely on imports.

The relative position in terms of downstream activities particularly the petrochemical industry is for some oil exporting countries even more pronounced than for refining. For example, SABIC - a Saudi Arabian petrochemical firm- is one of the world's largest after BASF, Sinopec and Dow[1].

Figure 1. Refining Capacity vs. oil consumption in 2018 (Thousand barrels/day)



Source: BP Statistical Review of World Energy 2019

[1] https://www.sciencedirect.com/topics/earth-and-planetary-sciences/petrochemical-industry

The situation is the same for Iran, which has the fourth-largest oil reserves and second-largest natural gas reserves in the world[2]. The current petrochemical production capacity in Iran is around 65 million tons of oil equivalent (Mtoe), consuming approximately 14% of oil demand and 7% of natural gas demand as feedstock. The share of oil and gas consumed as feedstock in Norway amounts to 13% and 10% of total demand, respectively. Norway's main oil company, Equinor (formerly Statoil), is taking part in petrochemical activities abroad. Canada consumes a respective 15% and 3% of total oil and gas demand as feedstock. According to the IEA the petrochemical sector will be the main driver of global oil demand growth, accounting for more than a third of oil demand growth by 2030 (IEA 2018).

Another example of downstream activities is the entry of the Persian Gulf countries into the airline business (Dubai – Emirates, Abu Dhabi – Etihad, Qatar – Qatar Airways, Saudi Arabia - Saudia) that is in contact with the final consumer and that is fairly competitive as can be seen from the number of bankruptcies.

3. Economic Reasons

We first summarize the major reasons for investing in the domestic industry (and maybe into related services) which is based on the output of a resource extracting industry. We focus on hydrocarbons (crude oil and natural gas), and on subsequent activities such as refining, petrochemicals, etc. In this section, all explanations of domestic policy interventions like subsidies to consumers, to a domestic, possibly 'infant', industry are based on economic efficiency arguments. We base our arguments on comparative advantages, and on spillovers as an instrument of economic development. Since all policies that subsidize local consumption must lower the revenues from resource exports, they must be justified by economic efficiency, directly or indirectly; less benevolent objectives are discussed in the following section.

[2] According to the *BP Statistical Review of World Energy 2019*, Iran holds the world's fourth-largest proved crude oil reserves (155.6 Thousand million barrels), and the world's second-largest proved natural gas reserves (31.9 Trillion cubic metres).

One way to address the economic efficiency of integrating downstream activities is to investigate how far business, which is unconstrained by issues of social policies and of development, handles integration. For example, the major international oil companies, the Seven Sisters, faced few political constraints and they were vertically integrated along the entire supply chain, from the oil field to the gasoline station. OPEC changed that in the 70s by disaggregating the downstream from the upstream, and consequentially diminishing the power of the Seven Sisters.

3.1 Local subsidies (or taxing export)

It is well known that petrol prices are low in many developing countries relative to industrialized countries. Petrol prices are even lower in OPEC and GECF Member Countries[3] (see the discussion in Section 5). Although it is hard to justify subsidizing petrol as a social policy in the sense of favoring the poor, it can be socially optimal in a broader economic sense. A dynamic resource theoretic explanation was proposed in Kalymon (1975) and applied in Abodunde and Wirl (1985) showing substantial but diminishing differences between export and domestic prices. A static version of the model (also used in Moghaddam and Wirl (2018)) is sufficient to illustrate this argument for price differentiation. The government maximizes social surplus, which consists of domestic consumer surplus ($U(q^d)$, where q^d = domestic consumption) plus export revenues ($P(q^x + Q)q^x$, where q^x = export volume, P = market price depending on total exports, and Q = other exports), minus costs (C):

$$\text{Max}_{q^d,\, q^x} \quad U(q^d) + P(q^x + Q)q^x - C(q^d + q^x).$$

Therefore,

$p^d = U' = C'$ and

$P^x(q^x + Q) = C' - P'q^x > p^d$.

Therefore, the domestic price equals the marginal extraction cost when exports are taxed and more expensive. This justifies offering fuel at subsidized prices to domestic consumers and industries.

[3] www.opec.org,and www.gecf.org

This preferential provision could provide additional benefits, ranging from conventional producer surplus to overall economic development. That could, in turn, provide incentives for private domestic investments into human capital, etc. These aspects are addressed below in a separate subsection.

3.2 Industrial Organization

Vertical integration can offer substantial gains. This hypothesis seems to be even vindicated by the history of the oil industry until the 70s, as demonstrated by the Seven Sisters. The first explanation of vertical integration is the existence of (technical) economies of scope between upstream and downstream activities. There are various reasons for this, such as transport costs (e.g., a power station at a coal mouth, see Joskow 1985), technical aspects (e.g., using associated gas as input for refining and as a feedstock for petrochemicals), coordination and other technical synergies between extracting, refining and related industries. The second reason (from the Industrial Organization literature) is that integration can avoid the double marginalization caused by non-competitive firms up- and downstream.

An additional explanation of integration falls into the realm of determining the optimal boundaries of a firm. This is a fundamental question of economics and the answers, actually just attempts, have been so far rewarded with three Nobel prizes (Ronald Coase, Oliver Williamson, and Oliver Hart). There are two competing and partially overlapping theories. The *Theory of Transaction Cost* originated from Coase (1938) but was further developed by Oliver Williamson (1996), who received for the Nobel Prize in 2009. This work argues that market transactions can be costly due to the potentially opportunistic behavior of contract partners, the unavoidable incompleteness of contracts, and the bounded rationality of economic agents. Therefore, integration of activities with high transaction costs within a firm can be efficient even if the in-house provisions cost more.

The acquisition of crude oil by a refiner seems to involve little transaction costs, given that of oil is a commodity and well-established markets exist. Integration can create value in sharing processes that overlap in a refining and chemical unit and create cost synergies. It also allows producers to switch product yields between refining and chemicals, depending on which products are more valuable to them.

The alternative or better complementary theory is that of *property rights*.[4] It addresses the question: what is the benefit of owning property? Property rights allow the owner to determine all issues that are not specified in contracts (Hart, 1995). In a world with incomplete contracts (the same assumption as in the *Theory of Transaction Cost*), the owner can capitalize on contractual limitations in accordance with their own needs. The theory departs from the premise of incomplete contracts[5] and assumes unverifiable ex-ante investments, coupled with ex-post cooperation[6]. Therefore, the theory of property rights has two important implications: 1) integration only makes sense for substantial synergies, since exploiting synergies partially destroys incentives; and 2) if integration is efficient, then the party which has to take the crucial investment decisions should own the property.

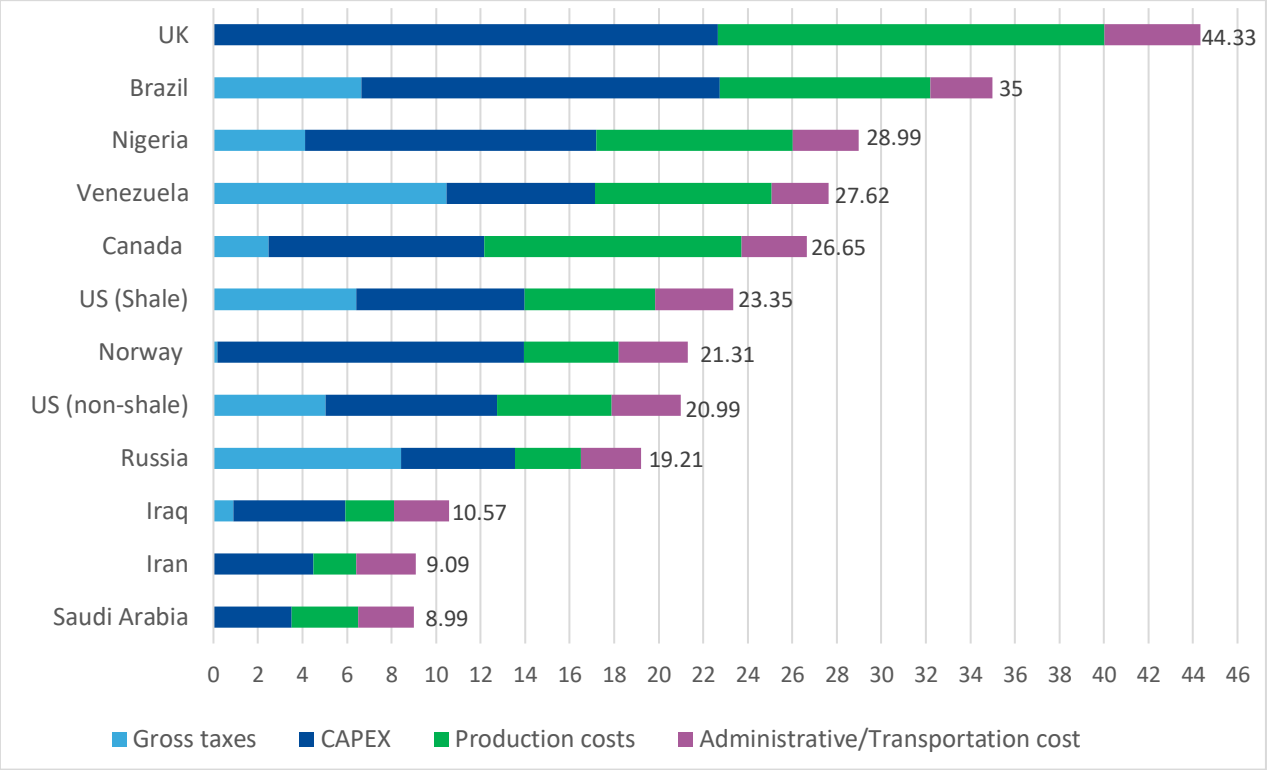
Whichever of the above reasons justifies integration, the empirically testable implication is that integrated firms should be characterized by higher profitability, adjusted for the opportunity costs of the input (crude oil or natural gas) because the oil rent is independent of the gains or losses from integrating refining. Moreover, if an integration of producers acquiring refiners were profitable, then vertical integration would reverse but otherwise to mimic the strategy of the Seven Sisters in the past.

3.3 Comparative Advantage

Given the importance of international trade, production is at the location, that allows delivering the final goods to consumers at the lowest total costs. Therefore, transport costs can be crucial even in a global market and free trade and the natural gas market is a prime example (Dehnavi et al., 2015). The UK and Norway's remaining resources lie in deep offshore waters and, as seen in Figure 2, the average cost of producing energy from oil and gas resources is higher than in which the fields are onshore like in Saudi Arabia, Iran, and Iraq.

[4] Attributed to Alchian and Demsetz and more recently to Grossman and Hart (1986), Hart and Moore (1990). Hart (1995) is a good summary and Oliver Hart received the Nobel Prize in 2016 for his contribution to the theory of property rights.
[5] Although the assumption of incompleteness of real world contracts seems realistic if not almost self-evident, it faced substantial critique from important authors defending the complete contract setup, see e.g., Tirole (1999).
[6] Nash bargaining in the Coasean spirit in order to leave no money on the table.

Figure 2. Average cash cost to produce a barrel of oil or gas equivalent (in real 2016$)



Source: Rystad Energy UCube, 2016

A successful domestic downstream industry requires an advantage, whether absolute (of the Adam Smith type, given a country's resources it can produce the good in question at the lowest costs, of course accounting if necessary for transport costs), or comparative (a la David Ricardo, i.e., the country has an advantage to go downstream relative to investing into the production of other goods compared with competitors).

As can be seen in Figure 2, oil extraction in countries like the UK and Norway that must rely on offshore reserves, and even conventional oil production in the US (not to mention fracking), are more expensive compared to Saudi Arabia, Iran or Iraq in which the fields are near the surface. Therefore, MENA and other OPEC countries have not only a comparative but also absolute advantage in oil production. However, to what extent will this advantage aid MENA and OPEC countries in transitioning toward downstream integration?.

Given a country's crude oil reserves, it is conceivable that the domestic population has more interest in the chemistry of hydrocarbons than of metals. As a result, this larger domestic pool of

talents allows for more efficient production of refined products and petrochemicals, but less for metallurgy or other things like Philosophy. Other reasons for a potential comparative advantage are from the theory of industrial organization such as an advantage from the local proximity between oil production and refining, which holds, e.g., for coal mining and electricity production, compare Joskow (1985) and how lignite extraction is coupled with electricity production in Germany (the *Energiewende* and current protests notwithstanding). However, this advantage is threatened if not eliminated by granting the national oil company a monopoly in refining.

3.4 Spillovers

Going downstream provides an opportunity for countries to invest in the education system by creating spillovers. A large body of literature, theoretical and empirical [most of it based on the endogenous growth theory developed by Romer (1986, 1990) who was rewarded by a Nobel prize in 2018], emphasizes the importance of spillovers from knowledge, capital, infrastructure and other public goods on economic development. Hundreds of papers analyze how different kinds of spillovers can counter the otherwise unavoidable decline of the marginal product of capital.

It is conceivable that a country could benefit from going downstream by creating economy-wide positive spillovers, if the relevant extractive industry only required simple labor. Because downstream industries demand skilled labor (e.g., engineers), going downstream could provide opportunities and incentives to invest in education and human capital. Governments can incentivize Science, Technology, and Engineering and Mathematics (STEM) topics over humanities if tertiary education is subsidized. However, this policy can face a crucial and expensive transition phase if skilled labor is not available domestically and it becomes necessary to hire expats. This is presumably costly, delivers little or no local benefits, and could precipitate negative social costs.

3.5 Development

From a normative perspective, export revenues can be used to foster domestic development. This may result from investments into education, but can also result from industrial investments with comparative advantages. One option is to build on the comparative advantage, which results from resource availability. Going downstream, in the case of refining, petrochemicals, and even transport can aid domestic developments. However, if this comparative advantage is only due to energy

prices substantially below world market prices, then this comparative advantage is questionable and exists only on paper, although this argument is also used (or abused) to hand out subsidies for fuels (as argued above).

The objective of going downstream is not only to accrue the value-added in the downstream industry and other gains from vertical integration as discussed above (and found questionable). The reason is that this policy can serve additional development goals like providing jobs and career opportunities. However, the later justification is not applicable if downstream activities are abroad, e.g., in the cases of the retailer Q8, or of Aramco's recent expansion into the Asian market that makes the company on track to become one of the world's largest chemical companies.

3.6 Hedging

If an upstream firm faces substantial volatility in its core business, but less or even negative correlations characterize downstream profits, then going downstream can serve as a hedge against vagaries in the country's upstream profits.[7] Intuitively, the hedging argument applies to all industries in which profit margins are negatively correlated (or uncorrelated) with the oil price. Ghoddusi and Wirl (2019) show that refineries (maybe also other downstream industries including airlines) offer such a hedge because low fuel prices reduce demand for refined products and therefore the margins earned. Ghoddusi and Wirl (2019) demonstrate that this argument applies, even in the absence of negative correlation.

A meaningful hedge requires that the orders of magnitude are comparable and, as a result, the scope of this policy becomes limited for most resource exporting countries. Global investment portfolios (as run by sovereignty funds) and active investments[8] presumably provide a better hedge against the vagaries of the oil market.

[7] Note that hedging at the company-level is socially unproductive, since investors can always hedge their risk by diversifying their investment.

[8] More than a quarter of sovereign wealth funds, collectively worth $8 trillion, are held by Kuwait, the UAE, Saudi Arabia, and Qatar. The funds turn out to become more adventurous according to *The Economist*, Sovereign wealth, sovereign whims, p 33, June 15th 2019.

3.7 Climate Change

Our last normative argument for entering into downstream and/or carbon-intensive industries depends on two premises: (a) climate change will pose a serious constraint on worldwide economic activities and, (b) carbon capture and storage (CCS) will finally live up to its decade-old promise. Existing and depleting natural gas and crude oil fields can serve as deposits for carbon dioxide produced from energy-intensive activities. Given the advantage that many Middle Eastern countries have in terms of solar potential, energy-intensive industries need not only rely on domestic hydrocarbons, but can develop solar power to counter the second law of thermodynamics in order to close cycles without any CO_2 escaping economically. If CCS proves workable and the costs for carbon removal in industrialized countries turn out to be large, then resource exporting countries could have a substantial comparative advantage in all kinds of energy intensive industries (of course, coupled with CCS, i.e., by reinjecting the CO_2 into the then empty fields and sealing them) in spite of the above addressed obstacles at the moment and the involved transport costs of the final energy intensive products (including external costs). In short, 'win-win' policies are potentially available for resource exporting countries and the environment.

4. Political economy

Energy exports offer policymakers in developing countries a wide range of normative and positive options that are not economically benign. The resource curse which is documented in many papers (Tsui 2011; Cabrales and Hauk 2011) has a political rather than an economic origin. Because this paper focuses on downstream activities, the problem of the resource curse is only briefly addressed in the following section.

4.1 Security of supply

A political but possibly still normative objective for domestic downstream industries is the security of supply, which has technical benefits and can counter unfavorable political circumstances, like sanctions, embargoes, or other threats. Iran, Russia, and Venezuela are examples of countries that

want to have a sufficient supply of refined products to hedge against the negative effects of international sanctions[9].

4.2 Lobbying

Although an industry that consists of only a few firms has to face substantial hurdles in order to obtain privileges like low input prices, small number of firms may compensate this disadvantage by a higher degree of organization due to mitigating the free rider problem of groups with many members. The economic reason is that energy subsidies, say to a domestic steel industry, have a substantial impact on the industry's profit but impose only negligible benefits to the population (at least in countries with non-negligible populations and ignoring external costs). This applies to lobby at large where therefore often special beats public interest due to avoiding the tragedy of the commons in the lobbying process (Olson, 1965). If the argument of positive spillovers due to subsidizing, e.g., of a local petrochemical industry, is accepted, then Becker (1983) offers a more positive view of competition among pressure groups: proposals that create less deadweight loss will beat those associated with a higher deadweight loss. In other words, lobbying competition (with free entry for each group seeking subsidies or minimizing their tax load) need not be efficient in a perfect and normative sense but can eliminate at least (highly) inefficient policies, e.g., subsidizing universities but taxing cigarettes and alcohol.

The threat of lobbying and rent seeking (Tullock 1967; Posner 1975) can justify investments into downstream activities over financial investments. A financial portfolio is always threatened by social needs or rent seekers' demands, while physical investments provide a commitment that no financial portfolio can match. In particular, entering refining provides a commitment device that few if any financial portfolio can offer. However, even this positive argument for downstream activities comes with big political caveats that are addressed below.

[9] Other examples outside of our focus area include South Africa, which went as far as to produce gasoline from coal (by the Fischer-Tropsch method developed in Nazi Germany due to its lack of crude oil) to counter sanctions against the former Apartheid regime. Wirl and Yegorov (2016) study the sanctions against Iran in a game theoretic context (a sequential game between the 'West' and Iran).

4.3 Elites

A unique feature of many oil and gas exporting countries is that the price of refined products, particularly gasoline, are absurdly low [see: Moghaddam and Wirl (2018), Table 1]. Subsidized prices are not only offered to industry for the reasons outlined above, but to the general population for non-productive and purely consumptive purposes.

The politico-economic reason behind this, is that governments and elites use this and other means to buy the support of local populations [see: Guriev and Treisman (2019); Boucekkine et al. (2016)]. This argument is confirmed by the extreme example of Norway, in which a democratic government subject to re-elections does not apply this policy, and the empirical analysis in Moghaddam and Wirl (2018) shows that less economic liberty goes hand in hand with higher subsidies.

4.4 Power, empire building and corruption

A well-established observation in the academic literature on industrial organization, is that managers' motives for building empires (see Donaldson 1984 and Jensen 1986, 1993) explain a substantial share of real world mergers and acquisitions. This motive applies a fortiori to politicians and that could also explain the move to integrate downstream operations.

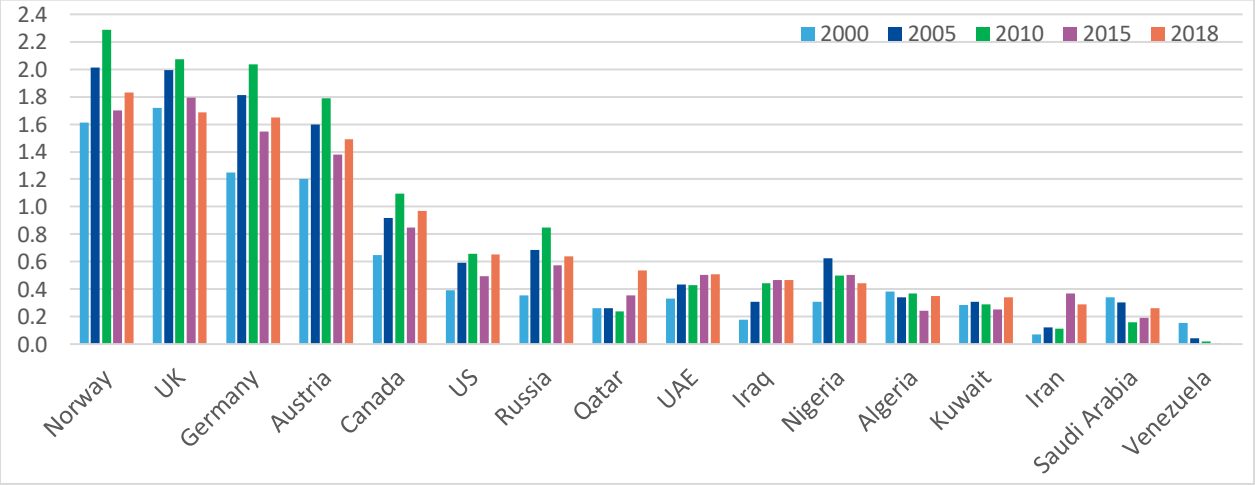
Politicians as well bureaucrats, (Niskanen 1971), and managers are interested in the three big Ps: power, pay, and prestige. Spearheading a large industrial complex at home is going to deliver all three at a substantial scale, in terms of power through the discretion to choose highly paid managers. In terms of pay, large-scale investments into the local export industry, such as refining, petrochemicals, and airplanes may allow the political elite to extract privileges, maybe even bribes, from international and national firms hunting for big contracts. In terms of prestige, the building of huge infrastructure projects will always be connected to the individual who initiated the project. There are many examples, e.g., the Nasser dam in Egypt, or a very old one, the University of Vienna was founded by Duke Rudolf the IVth, called the founder, in the 13th century and still remembered as such (e.g., in the official university's letterhead). Indeed, many if not most development projects fall into this category and at least were influenced by this effect. Last but not least, all such initiatives can be used by politicians to claim that they positively affected labor markets.

5. The explanatory power of the different explanations

5.1 Domestic subsidies

Figure 3 compares gasoline prices in selected resource exporting countries to those in Europe and other oil exporting countries like Norway, the United States, and Canada. Adetutu and Weyman-Jones (2019) state that refined product prices include an element of market power that may justify a subsidy in industrialized countries. They find that the policy failure of subsidizing refined products beats the market failure by magnitudes. Accounting for global warming[10] and the externalized cost of carbon, the implicit subsidy is even much larger. Product prices in Norway (see Figure 3) refute the idea that the local population must receive refined products under preferential terms. This contrasts prices in OPEC countries and suggests that the low refined product prices found in most resource exporting countries are hardly defendable on the normative argument outlined in Section 3.1. Instead, a substantial fraction of this discount is presumably used as a means to buy the current support of local populations. Gonand et al. (2019) recently showed that higher fuel prices in Saudi Arabia could lead to substantial intergenerational gains in welfare, as well as domestic and export revenues. Moshiri (2020) found that, in Iran, adapting to such policies requires a substantial scope of price due to significant price elasticities for gasoline.

Figure 3. Gasoline retail prices in resource exporting countries compared with some industrialized countries (in real 2018$ price per liter)



Source: GECF Secretariat based on data from the GECF GGM 2019

[10] OPEC even embraced the Paris agreement, https://www.opec.org/opec_web/en/press_room/3432.htm

Large fuel subsidies are not only economically questionable but also politically risky. It is easy and even beneficial for politicians to introduce subsidies, but very costly to eliminate them or to phase them out. This situation is aggravated for energy price subsidies, because energy demand is very sluggish. This also applies to subsidize fuel for a particular industry. Low prices have and continue to increase domestic demand; most MENA countries are the most energy intensive per capita or per unit of GDP. Slowing unsustainable energy demand growth will require even higher price jumps in the future. Rising fuel prices harm consumers, as well as powerful interest groups, who chose their past investments geared to low fuel prices. Many of those investments are characterized by large time constants of adjustment. In the case of households, they have bought during the regime of heavily subsidized refined product prices, say, a car expecting to use it for 10 years, installed heating and air conditioning that will also last more than a decade and built a house that will last for many decades. Any policy of removing or even only reducing subsidies will devalue the existing stocks of capital and durable goods and will thus face severe opposition. Low oil prices from 2015 to 2017 gave OPEC decision makers a unique opportunity to move domestic prices closer to world market prices. This opportunity seems to have been wasted by the UAE,[11] Iran,[12] and Indonesia.

5.2 Industrial organization

At first sight, the case of vertical integration seems to be vindicated by the history of the Seven Sisters, which were integrated along the entire supply chain. The empirical question about the benefit of integrating the up- and downstream has to be addressed. If this were the case, then integrated firms would be characterized by higher profitability, adjusted for the opportunity costs of diminished reserves, because oil rent is independent from the gains or losses of vertical integration.

Returns to integration (more broadly seen) seem to be negative according to *The Economist* (2011). Many international oil companies face a discount in the order of 20-40% in their market capitalization. Consequently, some started to disintegrate according to *The Economist* (2011): "Statoil [since 2018 Equinor] and Marathon … and on July 14th ConocoPhillips announced that in

[11] Over the past 20 years, energy subsidies cost the UAE $7 to $10 billion (Strategy and Middle East, 2020).
[12] According to the Iran Fuel Conservation Company (http://ifco.ir/), gasoline subsidies in Iran amount to $45 million per day. In 2017-18, the Iranian government subsidized gasoline by more than $5.5 billion.

2012 it would separate its profitable "upstream" oil exploration and production business from the low-margin "downstream" jobs of refining and marketing." However, the situation has changed since oil prices collapsed in mid-2014 when profits from upstream activities started to decline in a low price environment. In order to offset the negative impacts of low prices on their financial situation and, in addition to the efforts to decrease the costs in the upstream sector, major oil and gas companies increased their downstream activities to diversify their portfolios.

Table 1. Herfindahl-Hirschman Index (HHI) for the refining industry in OPEC countries

Country/ Company	HHI	Country/ Company	HHI
Algeria	10000	**Iran**	10000
Sonatrach	*100%*	*NIOC*	*100%*
Iraq	10000	**Kuwait**	10000
INOC	*100%*	*KNPC*	*100%*
Nigeria	3610.871	**Saudi Arabia**	10000
PHRC	*47%*	*Saudi Aramco*	*100%*
WRPC	*28%*	**UAE**	6648.282
KRPC	*25%*	*ADNOC*	*80%*
NDPR	*0%*	*Emirate Oil*	*12%*
Venezuela	10000	*METRO Oil*	*7%*
PDVSA	*100%*		

Source: Authors' calculation

We do not know of any refinery in the world that demonstrates substantial cost savings from coordinating upstream and downstream activities, whether they be operational or in terms of investments. Even if such gains existed, transporting gasoline costs significantly more than transporting crude oil, thereby lowering export revenues. Based on this argument, establishing refineries that match local demand makes sense provided sufficient scale exists. This should hold for most OPEC countries, with the exception of some smaller sheikdoms. Even this favorable argument comes with a big caveat. Granting refining to a national monopoly entails all the social costs of monopoly of economic inefficiency and rent seeking (Tullock, 1967). The additional aspect of domestic refining related to the security of supply in a politically uncertain world is addressed below.

The other justification for vertical integration as a mean to avoid double marginalization[13] falls apart if the downstream industry is competitive, which seems to hold for refining and similar energy-intensive industries (see Table 2).

Similarly, the justifications of integration by transaction cost and property rights theories fail to explain why upstream firms should overtake downstream firms. Of course, designing a refinery with respect to the chemistry (accounting for sulfur content and gravity) of the incoming crude(s) may offer an advantage, but at the cost of sacrificing the advantage from blending different crudes in order to meet changing demand patterns. We do not know of substantial cost savings from coordinated upstream and downstream investments. Even if this were the case, then the downstream firm should overtake the upstream firm according to the theory of property rights, because the crucial investments seem to happen downstream once oil production is set up and there is not much to choose (e.g., the location is given). Indeed, there is a substantial merger and acquisition (M&A) activity from downstream firms in the upstream sector. More precisely, 65% (and 75% at the asset level, i.e. in fields, tight oil, shale oil, deep-water, conventional, reserves and resources, natural gas etc.) of all M&A activities in the oil industry according to Özgur and Wirl (2019).

Table 2. Herfindahl-Hirschman Index (HHI) for the refining industry in importing/industrialized countries

Country/ Company	HHI	Country/ Company	HHI	Country/ Company	HHI	Country/ Company	HHI
Norway	5421	*ConocoPhillips*	*12%*	*Dow*	*0.01%*	*Murphy Oil*	*0.89%*
ExxonMobil	*35%*	*British Petroleum*	*11%*	*Edgington*	*0.15%*	*NCRA*	*0.46%*
Statoil	*65%*	*Innovene*	*11%*	*Ergon*	*0.24%*	*Paramount Petroleum*	*0.28%*
Canada	1568	The United States	752	*ExxonMobil*	*11.49%*	*Petro Star*	*0.38%*
North Atlantic Refining	*6%*	*Age Refining*	*0.06%*	*Farmland Industries*	*0.63%*	*Placid Refining*	*0.27%*

[13] In the classic case of double marginalization, "*an upstream industry sells an intermediate good to a downstream industry, which in turn produces a final product that it sells to consumers. Then, because the upstream and downstream industries independently engage in noncompetitive pricing, the firms in each industry only see the effect of their output restriction on their own profits, and do not see that their output restriction also affects the profits of the firms in the other industry"* (Hamilton and Mqasqas 1996).

Imperial Oil	*27%*	*Alon USA*	*0.35%*	*Flint Hills Rescources*	*4.32%*	*San Joaquin Refining Co.*	*0.14%*
Irving Oil	*13%*	*American Refining Group*	*0.06%*	*Foreland*	*0.01%*	*Shell Oil*	*4.60%*
Shell Canada	*16%*	*Big West*	*0.37%*	*Frontier Oil*	*0.84%*	*Silver Eagle Refining*	*0.07%*
Petro-Canada	*14%*	*Big West Oil*	*0.14%*	*Giant Industries*	*0.57%*	*Sinclair Oil*	*0.77%*
Ultramar (Valero)	*11%*	*British Petroleum*	*8.51%*	*Greka Energy*	*0.05%*	*Suncor*	*0.34%*
Chevron	*3%*	*Calcasieu*	*0.17%*	*Hess*	*0.35%*	*Sunoco*	*5.38%*
Sunoco	*4%*	*Calumet Lubricants*	*0.32%*	*Holly Corporation*	*0.62%*	*Tenby Inc.*	*0.02%*
Husky Energy	*2%*	*Cenex*	*0.31%*	*Hunt Refining*	*0.19%*	*Tesoro*	*3.14%*
Co-operative Refineries	*5%*	*Chevron*	*5.70%*	*Hunt Southland Refining*	*0.10%*	*Total*	*1.32%*
The UK	1201	*Citgo*	*4.64%*	*Kern Oil*	*0.14%*	*Trigeant*	*0.09%*
Total	*12%*	*Colorado Refining Co.*	*0.15%*	*Lion Oil*	*0.40%*	*U.S. Oil and Refining*	*0.20%*
Total and Murco	*5%*	*ConocoPhillips*	*12.47%*	*Little America*	*0.14%*	*United Refining Company*	*0.37%*
Chevron	*11%*	*Countrymark Co-op*	*0.13%*	*Lunday Thagard*	*0.05%*	*Valero*	*13.81%*
Shell	*13%*	*Cross Oil*	*0.04%*	*Lyondell-Citgo*	*1.53%*	*Western Refining*	*0.61%*
Petroplus	*6%*	*Crown Central Petroleum*	*0.57%*	*Marathon Ashland Petroleum*	*6.41%*	*Wyoming*	*0.07%*
ExxonMobil	*16%*	*Delek Refining Ltd.*	*0.31%*	*Motiva Enterprises*	*4.26%*		

Source: Authors' calculation

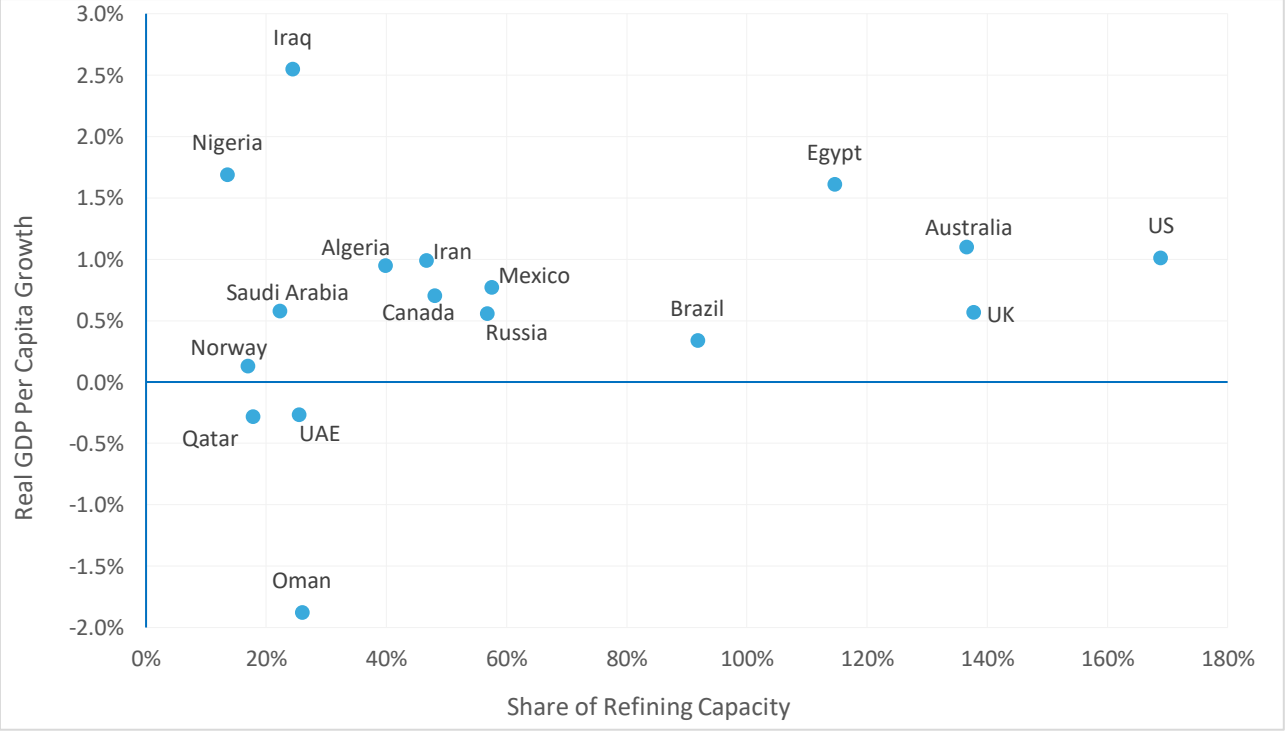
5.3 Comparative advantage, development and spillovers

There are natural experiments that may explain if resource exports stimulated the development of downstream industry. Among the OECD countries, Norway, the UK, the Netherlands, Canada,

Russia, Australia, and South Africa give insight as to how the downstream industry follows the upstream and how successful these strategies are. Neither the UK nor Canada entered the downstream business on a grand scale, despite local oil industries and the proximity of large markets. The chemical industry in the Netherlands is located around the port of Rotterdam and is not dependent on gas from the Groningen field. Similarly for Australia. Despite the high transport costs of coal, we do not see much related downstream activities in Australia such as specializing in energy intensive industries, i.e., to sell energy intensive goods, which have presumably lower transport costs (but not all, e.g., cement), instead of coal. In short, resource availability did not stimulate local downstream activities. However, Norway and Russia began exporting refined products, as indicated in Figure 1, due to nearby export markets.

Figure 4 provides a bird's eyes view of how refining, as a share of oil production, affects growth. It shows no positive correlation and a somewhat negative correlation for a number of OPEC countries. The hypothesis that refining, when coupled with oil extraction, delivers spillovers that foster development is questionable, and not only because of the birds' eyes view in Figure 4.

Figure 4. Real GDP per capita growth vs. share of downstream activities (an average of 2009-2018)



Source: GECF Secretariat based on data from the GECF GGM 2019, BP Statistical Review of World Energy 2019

Refining does not employ a large number of people, with employment ranging between 180 for a small refinery up to 5000 for a large refinery. This is small compared to the large investments required to build a refinery and to generate economy-wide spillovers. Nor is refining more technologically advanced than extraction; the opposite may be true given the recent technological breakthroughs in extractive industries. Petrochemicals require higher skilled labor and have the potential for research-related spillovers, unless the chosen petrochemical plants produce 'commodities' only rely on cheap fuel inputs. In the absence of local gas demand, a local petrochemical industry has a comparative advantage over exporting natural gas given the high transport costs for natural gas either in long pipelines or as liquefied natural gas.

According to OPEC (WOO, 2016), a significant number of investments are set to occur in OPEC member countries through to 2021. Almost 8 million barrels per day (mb/d) of new investments in refining capacity and around 2.2 mb/d of new investments in distillation units, including 1.7 mb/d of additional crude distillation capacity and 0.44 mb/d of additional condensate splitters, will be added to the refining sector. Furthermore, distillation capacity is set to reach 13.3 mb/d by 2021. Most of these expansions are expected to come from Qatar, Iran, Saudi Arabia, Kuwait and the UAE. It is estimated that about $66.5 billion is needed to implement these capacity additions during the 2016-2021 period. The large Saudi Arabian petrochemical firm SABIC seems to be a prime example of a downstream industry that is trying to capture spillovers, provide jobs[14], and benefit from a comparative advantage of cheap natural gas. However, it is questionable that the objective is domestic development, because all recent downstream expansions are taking place abroad.[15] This seems to refute the above arguments of a strategy of capturing local spillovers and thereby fostering development.

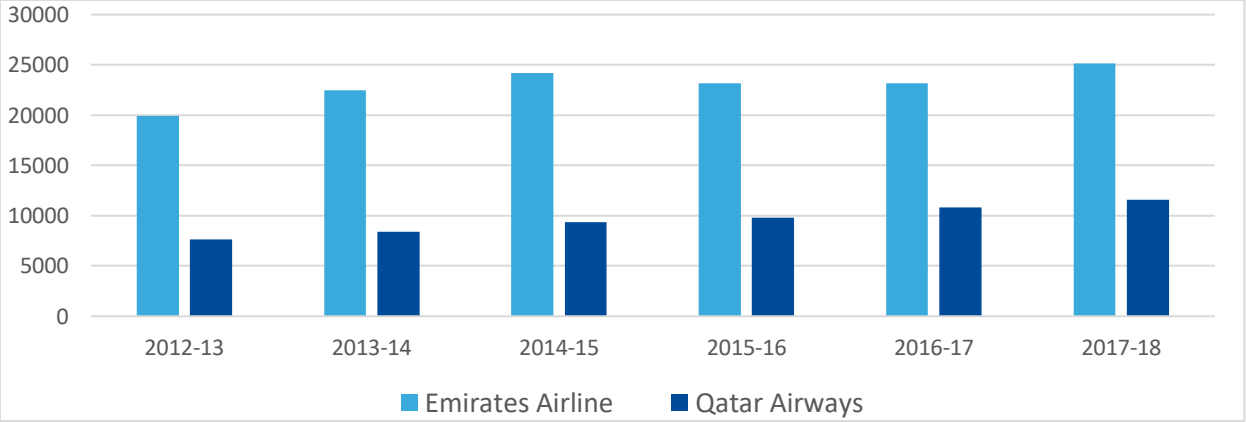
Therefore, one has to look for subtler measures of spillovers and how resource exports and an associated downstream industry stimulate local development. One way is to look at the oil content of exported non-oil commodities. Some oil and gas exporting countries went down the value chain, beyond refining and petrochemicals, by entering the airline business industry. This policy is

[14] The Economist (2012), Nov 24th 2012, Where are the jobs for the boys?, https://www.economist.com/middle-east-and-africa/2012/11/24/where-are-the-jobs-for-the-boys

[15] According to the recent column of "Schumpeter" in *The Economist*, April 20th, p 62, Saudi Aramco looks east: Aramco's intention to go public is borne out of the interest in paying for going downstream not only at home but also abroad in particular in Asia. Last year it acquired a giant refinery and petrochemical complex in Johor, Malaysia, and announced a joint venture with Abu Dhabi located in India.

aggressively pursued by some Persian Gulf countries (Dubai – Emirates, Abu Dhabi – Etihad, Qatar – Qatar Airlines, Saudi Arabia - Saudia) and this policy could have the potential to teach the domestic labor force high-value skills, from cleaning services to engineering. Figure 5 shows the impressive revenues generated in these countries, despite the need for costly foreign labor. However, it is questionable how much of these revenues are due to cheap kerosene (also granting tax advantages) and given the reliance on foreign labor, the spillovers to the locals (maybe to local industry, e.g., catering but which employs migrant workers and not locals) are questionable. Of course, not only Persian Gulf but also many other countries ran (but much less still do it today) operated a national (i.e., also nationalized) airline, because of the conceived benefit of better international connections aiding domestic industries. This may apply to *Emirates* establishing Dubai as an international center of finance.

Figure 5. Emirates Airline and Qatar Airways revenue and operating income (million real 2018$)



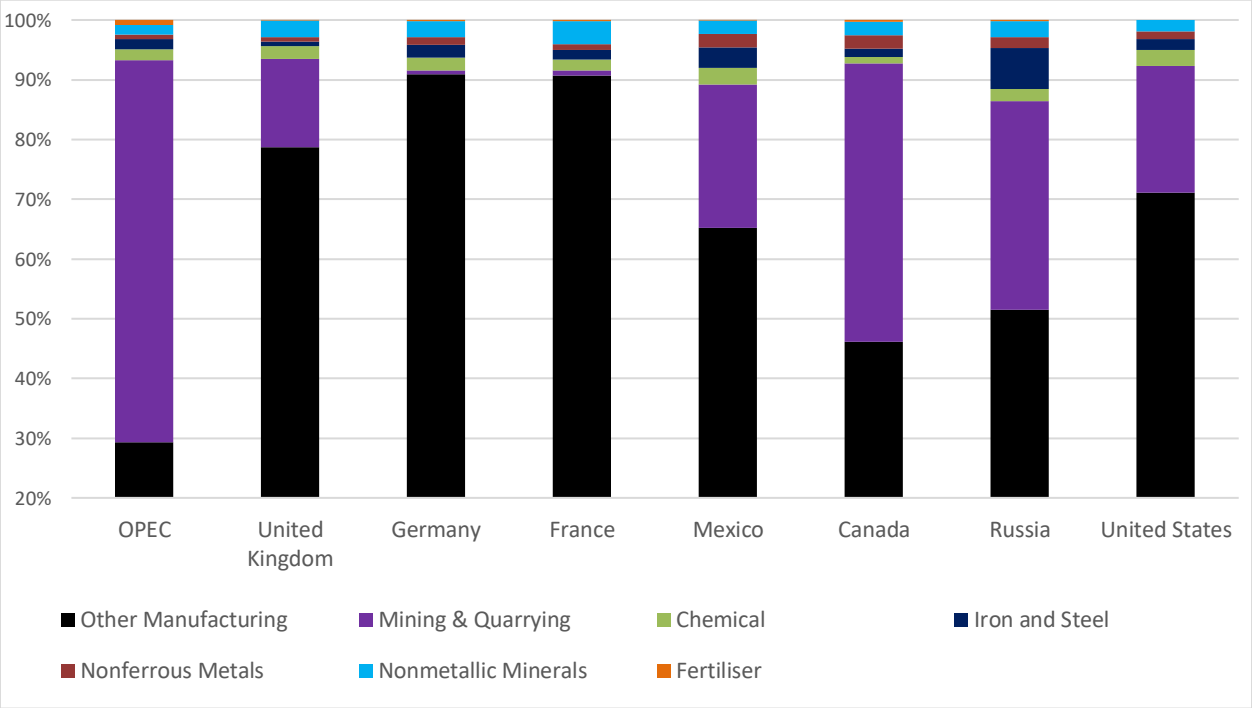
Source: The Emirates group annual report 2013-2018, and Qatar Airways Group financial statements 2013-2018

Another way is how the access to resources triggers incentives for students to choose STEM fields, like chemical and petroleum engineering. This interest could lead, at least in the medium term, to a comparative advantage of a downstream industry. Unfortunately, we could not find reliable and comparable data and leave this issue to future research[16]. We only found such indications in Iran, where between 35-40% of students choose to specialize in engineering, compared to only a quarter of students in Germany. Approximately 24% of Iranian engineering students have begun their academic education in fields related to hydrocarbons.

[16] However, such a comparison is biased due to the low share of female students in Middle East countries (maybe with the exception of Iran) because the take up of STEM fields (and even more of engineering) is primarily a choice of men all over the world, compare Cambridge Assessment (2017).

The value-added contribution of the mining and quarrying sector, which includes oil and gas extraction, to the industrial sectors of OPEC countries is around 77%. This is much higher than in countries such as the US, Canada, and the UK (see Figure 6). The value-added contribution of chemicals and fertilizers remains only slightly higher in OPEC countries than in Germany, which has no indigenous resources, Canada, and the UK, and almost at the same level as in Russia and the US. However, the total value-added of the iron and steel sector, as an energy-intensive industry, stood at $24840 million in OPEC which is lower than in other oil and gas-rich countries such as Russia ($29350 billion) and the US ($44925 million) in 2018. The lower value-added of iron and steel industry in OPEC makes economic sense in spite of domestic energy abundance because OPEC countries lack the main inputs of iron ore and coal.

Figure 6. Value added contribution of select industrial sectors in 2018

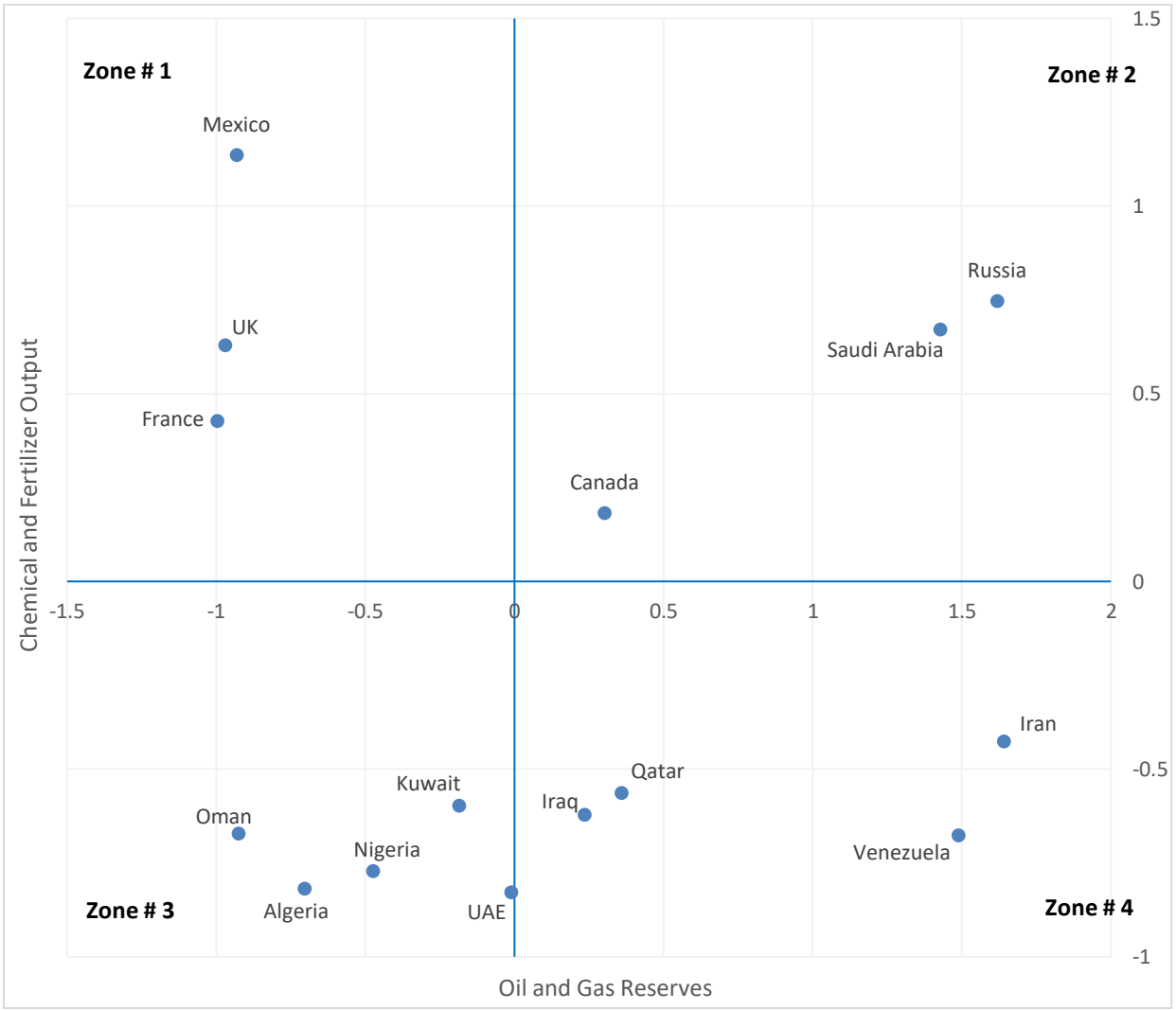


Source: GECF Secretariat based on data from the GECF GGM 2019

To understand whether having oil and gas reserves encourages countries to develop the chemical and fertilizer sectors, the chemical/fertilizer output is plotted against oil and gas reserves for select countries in Figure 7. Based on the chemical and fertilizer sectors' output and the level of their proven oil and gas reserves, the countries in our study are allocated in four different zones. In Zone 1 are countries without oil and gas reserves but chemicals and fertilizers make up the largest share of their industrial sectors, such as the UK and France. The countries in Zone 2 are among the top

oil and gas reserve holders and produce large volumes of chemicals and fertilizer. Countries in Zone 3 produce small amounts of chemicals and fertilizers, even though some hold oil and gas reserve. Finally, countries that have large oil and gas reserves but produce relatively low volumes of chemicals and fertilizers are found in Zone 4.

Figure 7. Normalized chemical and fertilizer output (average of 2010 to 2018) vs. oil and gas reserves



Source: Authors' calculation, GECF Secretariat based on data from the GECF GGM 2019, and BP Statistical Review of World Energy 2019

5.4 Hedging

Hedging is considered at some length in Ghoddusi and Wirl (2019). The authors show that combining exports of crude oil with refined products can serve as a hedging portfolio. Indeed, the

slump in crude prices since mid-2014 helped refiners because oil prices fell faster than the value of refined products, boosting margins. Low crude prices have crushed profits from oil and gas production, but helped downstream activities. This argument provides some justification for using downstream activities for hedging, but this policy is presumably inferior to a broader portfolio. Nevertheless, one can make a normative justification for downstream activities as a means to hedging by applying arguments from political economy and accounting for real political constraints that arise from elections, public support, and lobbying. This policy of going downstream is inferior to building and maintaining a global financial portfolio, in terms of expected return and volatility[17]. A well-rounded portfolio is much more resistant to political pressure, as parts can be sold to meet local financial demands, especially when oil prices are low and the hedge is needed most. Investing in domestic refinery capacities provides a commitment that no financial portfolio can offer. A financial portfolio faces the threat to be sold whenever oil prices are low and the hedge is needed most. This threat is can be observed in Norway, which scores high on all political and economic governance indicators (see: World Bank, 2019). Nevertheless, the Norwegian Conservatives proposed to plunder the Norwegian sovereign wealth fund to pay for pensions and healthcare expenditures. That the Social Democrats resisted was surprising, since the Conservatives are usually more worried about debt.

5.5 Climate Change

The constraints from the Paris agreement imply a large shadow price for carbon emissions and, in an efficient context, a high carbon price (see: Nordhaus, 2019). This could offer financial incentives for climate mitigation policies and CCS. Oil and gas reservoirs can be utilized in geological sequestration, putting oil and gas producing countries in a unique position to meet global demand for energy intensive goods at comparably low cost and with the smallest carbon footprint. Of course, this means that transport costs must remain low so as not to counter this advantage.

In spite of obvious comparative advantages and with the initial signing of the Paris Agreement in 2015, or the commitments of MENA countries, we found no indication of concrete projects or plans in this direction.

[17] Saudi Arabia had to take a loss of $200 million from its stake in Uber alone (*The Economist*, October, 19th 2019).

Saudi Aramco, the biggest oil company in the world, has committed to reducing GHG emissions by funding research and development on high impact technologies that reduce cost and create significant environmental advantages. Aramco established a demonstration project at one of the Middle East's largest CCS facilities, which captures 45 million standard cubic feet of CO_2 per day. Meanwhile, Saudi Arabia's Vision 2030 plans to remove energy subsidies by 2023 in order to lower its budget deficit. The country announced a steep increase in gasoline prices in January 2018 and introduced a 5% VAT on most goods and services, including gasoline and diesel (Moghaddam and Wirl 2018).

By using Enhanced Oil Recovery technology, the Abu Dhabi National Oil Company has the capacity to capture 800,000 tonnes of CO_2 per year. The company's goal is to increase this capacity to 5 million tonnes of CO_2 per year by 2030. Last but not least, Iran's largest gas gathering project (AMAK), averts the flaring of around 180 million cubic feet of gas per day, and after dehydration, injects it into the pipeline for further consumption.

5.6 Politico-economic explanations

One of the strongest arguments for penetrating downstream industries is the political objective to ensure the security of domestic supply against the uncertainties of politics. South Africa, Russia, Venezuela, and most relentlessly Iran have had to face sanctions. Since our analysis could not produce strong economic efficiency arguments for expanding downstream activities in OPEC countries, we turn to politico-economic explanations. Elites have a natural inclination to expand their domain. Given the limits of organic growth for companies, even oil companies like NIOC and Aramco, CEOs equipped with a thick wallet are tempted to buy up other firms. Some decide to go downstream, not only for economic reasons, but to accrue size and importance, possibly, beyond their time of the ruling.

6. Conclusion and Policy Implications

Our analyses suggest that economic efficiency only provides a partial justification for the downstream activities pursued by energy exporting countries. The usual arguments presented by industrial organizations - avoiding double marginalization, transaction costs and property rights -

fail unless integrating downstream activities with local or regional markets. The policy makes economic sense if these markets (including neighboring markets) ensure efficient operational scale. The argument of hedging, explored in more detail in Ghoddusi and Wirl (2019), also justifies some downstream activities such as refining. Although it is inferior to standard financial hedging strategies, it provides a commitment that no financial portfolio can guarantee. However, the potential gains must be weighed against the costs of a local refining industry. Economically, if costly expats are needed for downstream industries but more important are the costs of a monopoly for the local market for refined products that allows for 'the best of all profits, a quiet life' according to Hicks. Therefore, they lack not only economic efficiency but attract rent seekers (Tullock 1967 and Posner 1975). The fact that nationalized oil companies run the refining business as monopolies add to those threats.

The arguments from development and spillovers provide more room for a defense but are ultimately not convincing if looking at the activities that countries pursue. It is also hard to pin down the comparative advantage of a local refining industry for exports overseas if accounting for costs: higher transport costs, the (at least temporary) need for foreign experts, and the loss (deadweight loss plus loss from rent seeking) associated with a domestic monopoly.

Allowing local populations to benefit from the national resource by providing refined products at favorable prices describes actual behaviour, but seems gravely mismanaged (Moghaddam and Wirl, 2018). Most energy exporting countries hand out large subsidies on refined products at a scale that is hardly defendable. Subsidies are not only inefficient, but also dangerous from a long-term perspective, because energy demand is very sluggish and fuels are linked to appliances (cars, heating, air conditioning, etc.). This applies to subsidizing the fuel inputs of a particular industry as well. As a consequence, low domestic prices have been building oil demand for decades, which cannot go on if these countries want to keep exporting.

Given the dynamics of high and growing demand, only very high price jumps can stop these developments. However, they are politically costly (if not suicidal) for many governments. In this case, sacrificing a downstream industry, even if it were efficient, can help stop inefficient subsidization because import prices are more transparent. Sacrificing a domestic refining industry can force a government to restrain subsidies for budgetary reasons, maybe even eliminating them

eventually. We see this as one of the most urgent needs for OPEC governments. The enormous difficulties are evident in the case of Ecuador. According to *The Economist* (October, 12th 2019), President Moreno raised the price of petrol from $1.85 to $2.39 per gallon and the price of diesel from $1.04 to $2.27 per gallon. This led to riots and violence until President Moreno gave in. The recent protests in Iran in response to increased gasoline prices, which at the time were cheaper than water, highlight the political difficulties of raising the domestic gasoline prices.

The normative explanations outlined in this paper provide little justification for actual policies. In contrast, positive and politico-economic explanations fare better. For example, sanctions and embargos can justify a local refining industry because domestic supply is lacking, even if that is more costly. The tendency for elites to amass influence and empire is another explanation for the integration of downstream activities. The promises of fostering development, creating local spillovers, and creating jobs can be used as a camouflage for private interests and corrupt officials. Some economic reasons exist for OPEC countries to go downstream; however, those opportunities are risky and seem to have been squandered. This poor implementation seems to be the result of political constraints and, in some cases, the grand and possibly misguided ambitions of bureaucrats.

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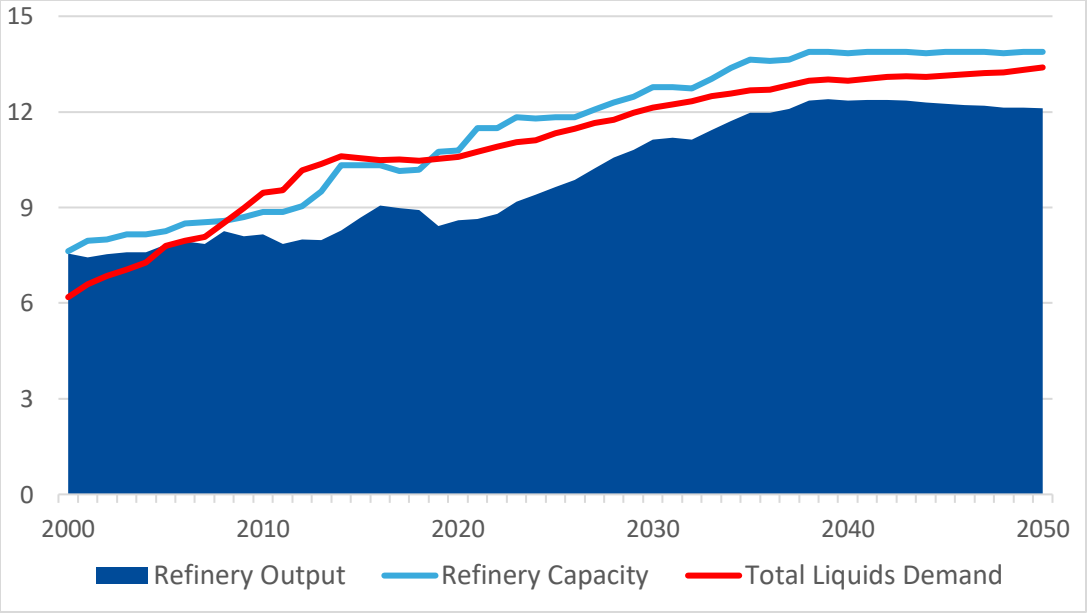
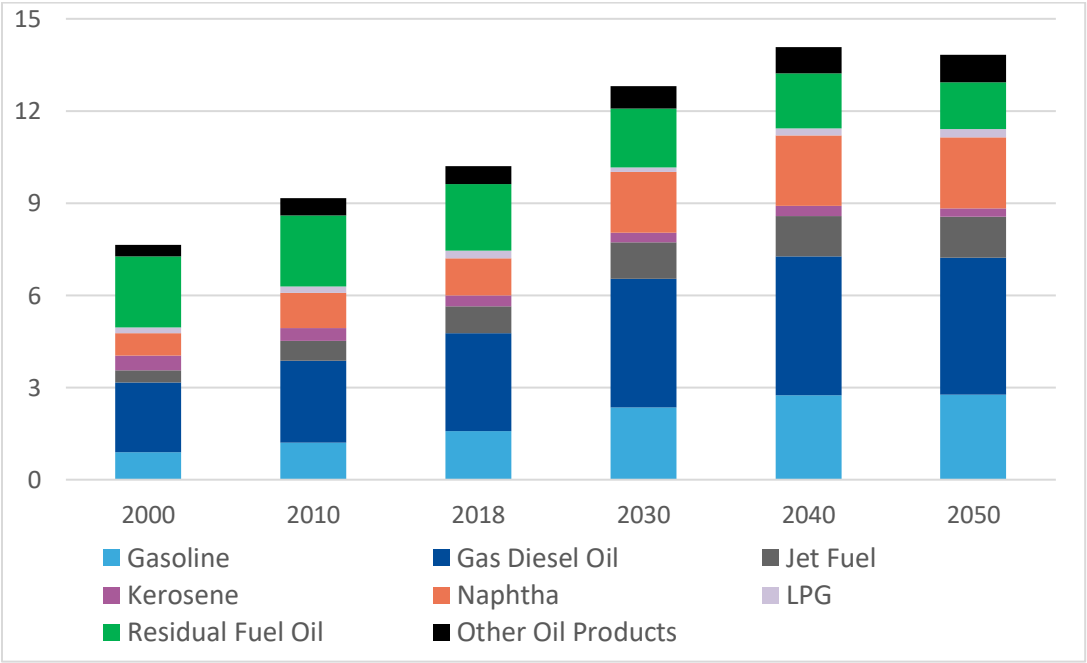
Appendix A

Figure 8. MENA crude refinery capacity, refinery output, and total petroleum products demand (Million b/d)



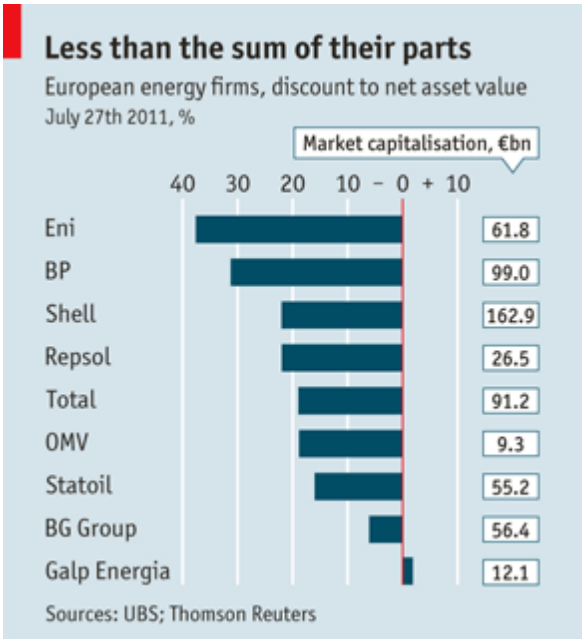
Source: GECF Secretariat based on data from the GECF GGM 2019

Figure 9. MENA refinery demand by petroleum product (Million b/d)



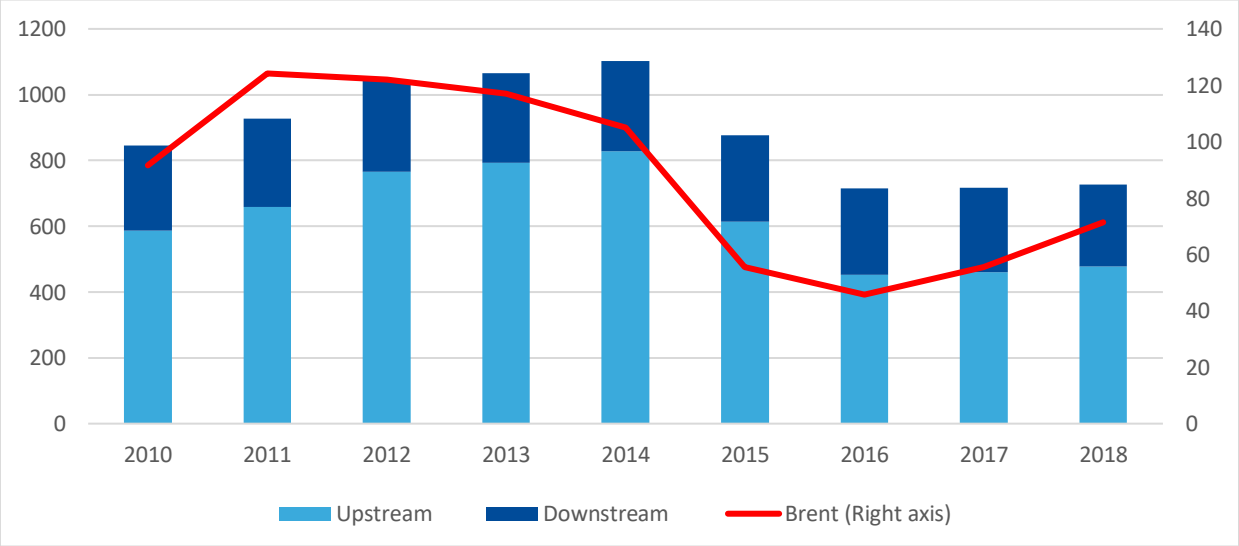
Source: GECF Secretariat based on data from the GECF GGM 2019

Figure 10. Costs of integrated oil companies



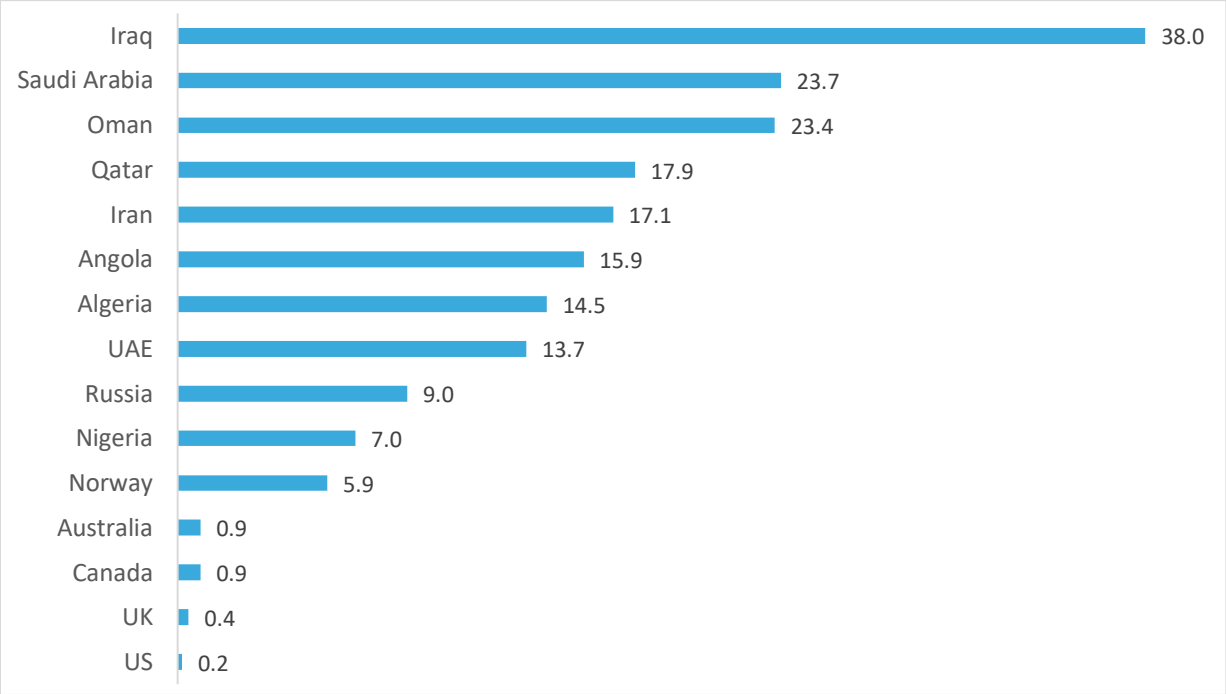
source: https://www.economist.com/business/2011/07/30/should-bp-split

Figure 11. Global investment in upstream and downstream oil and gas (real 2018$ billion), and Brent crude oil spot prices (2018$)



Source: IEA, World Energy Investment 2019

Figure 12. Oil rents (% of GDP) in 2017



Note: Oil rents are the difference between the value of crude oil production at world prices and total costs of production. The volatility of worldwide oil prices results in large fluctuations in the percentage of GDP because of the economy's reliance upon the petroleum sector.

Source: The World Bank (https://data.worldbank.org/indicator/NY.GDP.PETR.RT.ZS)