Oil in the Long Term

Abhishek Deshpande, Ph.D.
Executive Director, Head of Global Oil Market Research & Strategy, J.P. Morgan

Dr. Abhishek Deshpande, Ph.D., of J.P. Morgan, participated in an industry panel on the commodity markets at the JPMCC's 3rd Annual International Commodities Symposium, which was held at the University of Colorado Denver Business School in August 2019. This panel session was held in the university's CoBank Lecture Hall.

Introduction

- The global energy basket has diversified significantly since 2000 with oil and coal losing share to gas and renewables. In this article we argue that the factors relevant to oil prices in the long term are not just demand but also supply-side variables.

- According to the International Energy Agency's New Policies Scenario (NPS) the share of fossil fuel powered by demand growth will slow down as renewables penetrate the energy sector. A major structural shift is expected to emerge in the transportation sector where electricity is seen making headways as the Electric Vehicle (EV) market expands.

- According to our JPM models, oil demand would track IEA's NPS oil demand at a trend GDP growth within JPM Demand Estimates Case 1 scenario. In this scenario the demand does not peak until 2040. However, oil demand is expected to peak in the early 2020s and decline gradually thereafter in all other scenarios defined later in this article.

- Given the uncertainty around global oil balances in the long term, investors in general remain wary of investing in oil especially if returns are likely to be challenged by the peak demand theory, or low-cost shale production in the medium term, or oil producers shifting their extraction of resources ahead of any pre-announced climate-based policy implementation. Such negative sentiments in the industry, along with depressed deferred prices along the forward curve driven by U.S. shale supply, have inadvertently impacted investment decisions since 2014 and will likely continue to do so in the medium term. We argue that a lot of assumptions around demand growth and implementation of climate-based policies are untested.

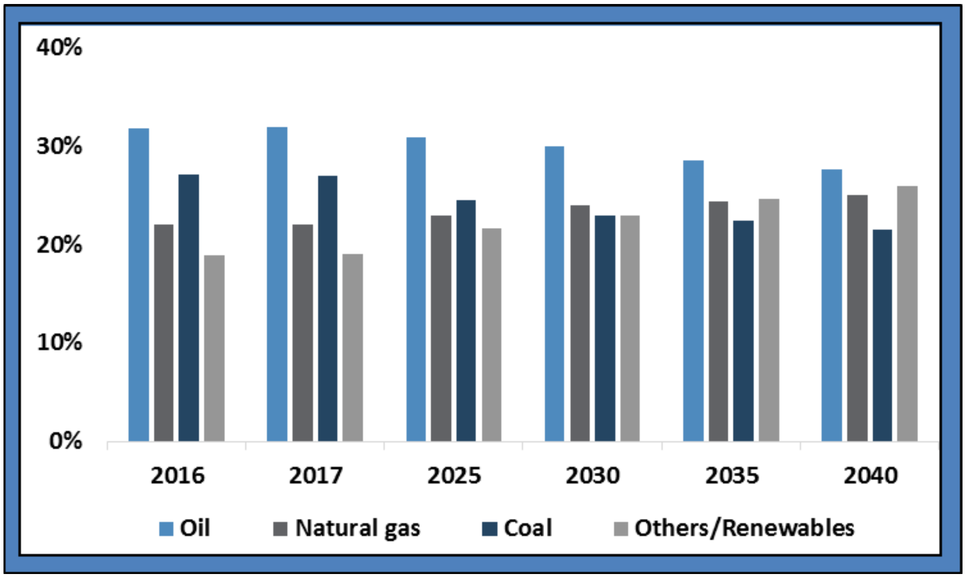
- Currently most Environmental, Social and Governance (ESG) and climate change investors are underweighting or completely avoiding investments in oil and coal. But given the lack of investments in the sector and demand for oil being driven predominantly by non-OECD economies where population growth is on the rise, oil as an asset class should end up providing positive returns and these investors could miss out on this opportunity. Additionally geopolitics will always be core to oil at least in the next decade.

The global energy basket has diversified since 2000 as the share of oil and coal declined whilst the share of natural gas and renewables rose. In this article we have tried to find the factors relevant to oil prices in the long term and argue it is not just demand but also supply-side factors that one needs to consider along with investor appetite for fossil fuels. We have constructed an optimization model to estimate what key swing producers, such as Saudi Arabia, need to consider when targeting oil price maximization. This is relevant from both investment decisions, but also from long-term price scenario perspectives.

Energy Diversification

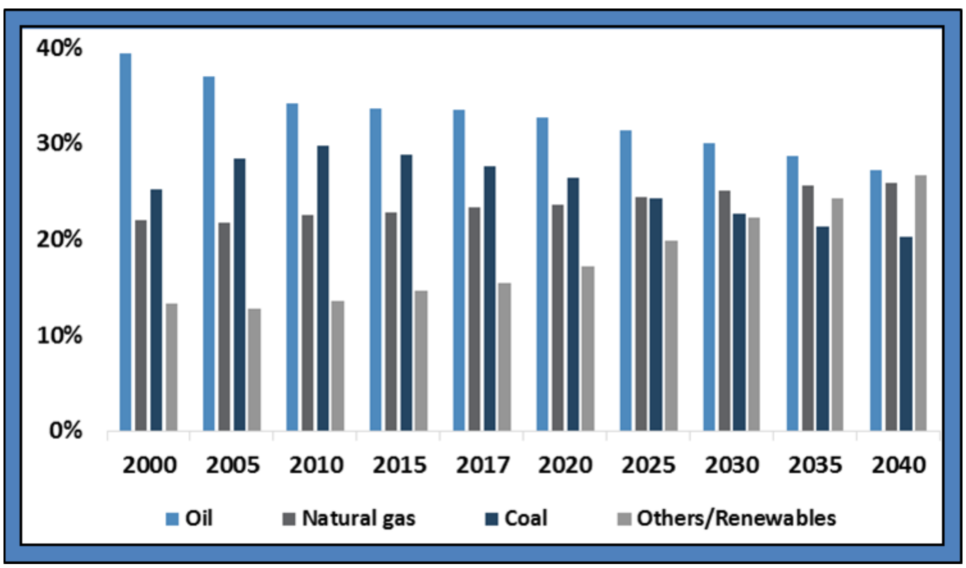
According to the International Energy Agency's New Policies Scenario (IEA NPS), the share of fossil fuel-powered demand growth will slow down as renewables penetrate the energy sector. A major structural shift is expected to emerge in the transportation sector where electricity is seen making headways as the electric vehicle (EV) market expands. Electricity consumption for transportation is expected to grow at a CAGR of 7.2% between 2017 and 2040 versus oil, at a CAGR of 0.6%. On the industry front which includes manufacturing facilities, while the outlook remains optimistic until 2025, its contribution falls after this point in time owing to a slowdown in Chinese demand as the Chinese economy sees a structural shift towards a more service-based economy. **While renewables take a larger share of the global energy basket in the future, the impacts of cleaner sources, along with energy efficiency, are already visible in the energy intensity of GDP, which has come down by a third between 1990 and 2015.** It is expected to continue declining in the future as noted by the IEA in its latest World Energy Outlook (WEO) 2018.

Figure 1
IEA NPS Energy Basket Diversification (2000-2040)



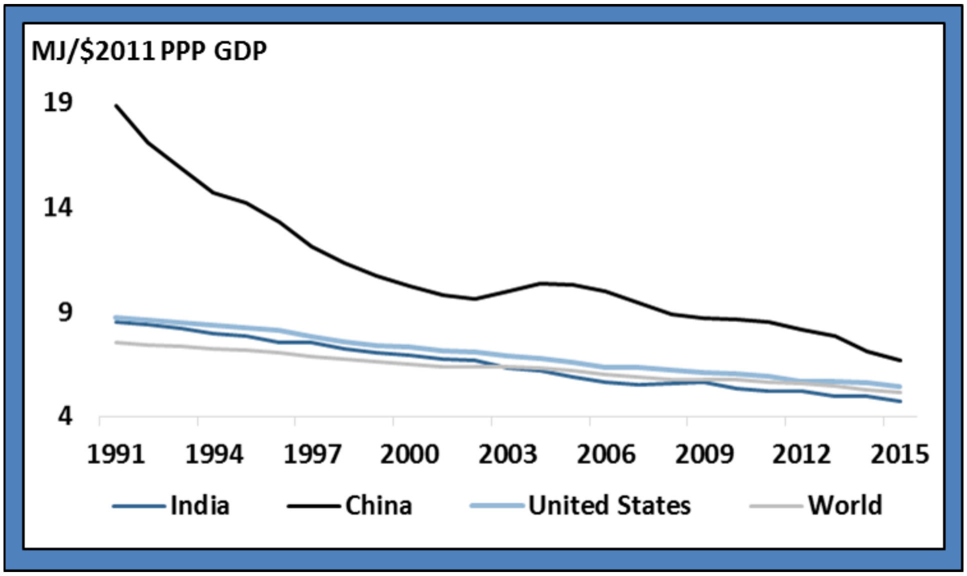
Sources: J.P. Morgan Commodities Research, IEA WEO 2018.

Figure 2
BP Energy Basket Diversification (2000-2040)



Sources: J.P. Morgan Commodities Research, BP.

Figure 3
Energy Intensity



Sources: J.P. Morgan Commodities Research, World Bank.

Table 1
IEA Change in Energy Intensity under NPS and SDS Scenarios (% change)

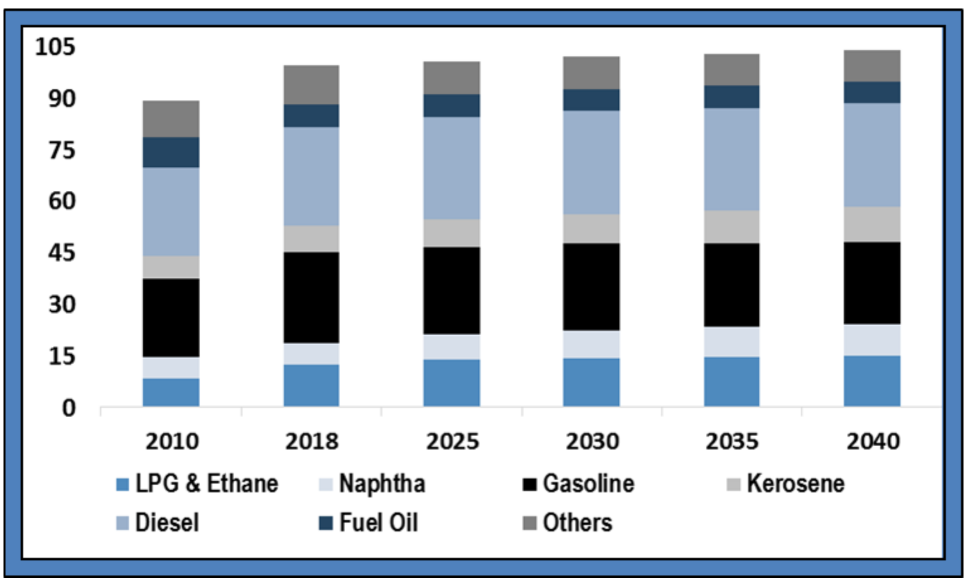
	NPS		SDS	
	2017-2025	2025-2040	2017-2025	2025-2040
World	-18%	-33%	-27%	-38%
India	-22%	-29%	-33%	-50%
China	-31%	-33%	-31%	-44%
US	-9%	-30%	-18%	-33%

Sources: J.P. Morgan Commodities Research, IEA.
NPS = New Policies Scenario
SDS = Sustainable Development Scenario

Oil Products Demand

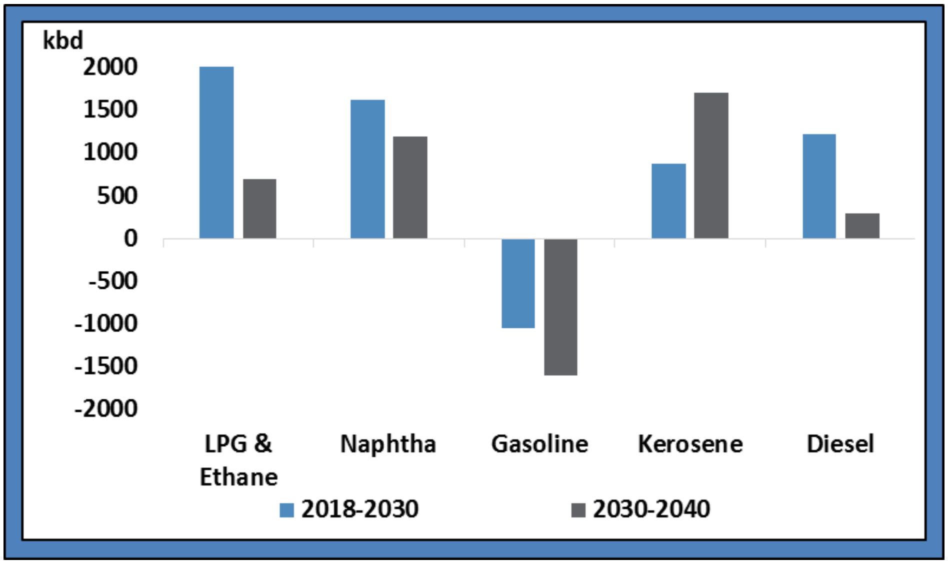
Oil products demand has changed significantly since 2010 with growth dominated by light ends such as gasoline and liquefied petroleum gas (LPG) including ethane and diesel. **Total oil demand has increased by 1.2 mbd per annum on average between 1990 and 2018 and by 1.3 mbd per annum between 2010 and 2018.** However, with the advent of EVs and technological efficiencies, the demand for gasoline is expected to drop by 2.6 mbd between 2018 and 2040 according to the IEA. Fuel oil demand, which has weakened since 2010, is also expected to drop further by 0.4 mbd by 2040 from 2018. The implementation of a global limit on sulphur in bunker fuel by the International Maritime Organization beginning on 1 Jan 2020 (IMO2020) is one of the main drivers for this expected decline alongside the substitution of fuel oil for power generation. IEA predicts that the largest increment in demand will be in naphtha and LPG, including ethane. These products are mainly used in the petrochemical sector. Jet kerosene is another product that will substantially increase in demand. Additionally, energy efficiency will be a strong driver for lower demand for products in energy-intensive industries.

Figure 4
IEA NPS Oil Products Demand 2010-2040



Sources: J.P. Morgan Commodities Research, IEA WEO 2018.

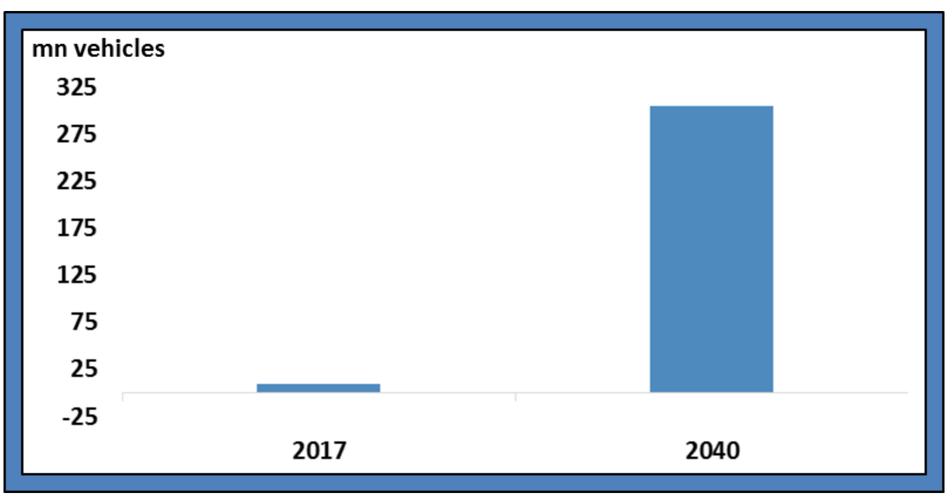
Figure 5
Oil Products Demand Change



Sources: J.P. Morgan Commodities Research, IEA WEO 2018.

The growth in demand for oil is being hotly debated at present as alternate energy sources and EVs pose a threat to the demand for the commodity in the future. **Today there are ~1.1 billion cars on the road globally, nearly all fueled by oil. Electric cars account for just 1% of current annual car sales.** Under the IEA's NPS, the global car fleet expands by 80% by 2040. **Yet global oil demand for passenger cars barely changes, from 21.4 mbd today to just over 23 mbd in the late 2020s and ending just above today's level by 2040.**

Figure 6
Global Electric Vehicle Fleet



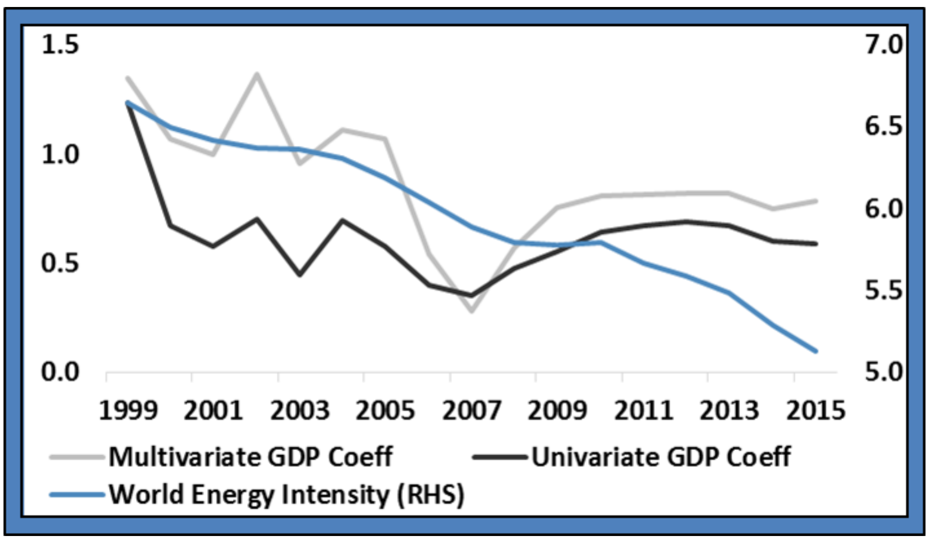
Sources: J.P. Morgan Commodities Research, IEA.

Modeling Different Scenarios for Oil Demand

IEA has identified multiple scenarios that shape the diversification of our energy requirements. The New Policies Scenario takes into account targets announced by countries as of mid-2018 and the commitments made in the Nationally Determined Contributions under the Paris Climate Agreement, setting energy-related CO2 emissions on a slow upward trend to 2040. Under its NPS, IEA expects electricity, renewables, and efficiency gains to cap the growth in coal consumption. The policy assumes demand growth in oil to come predominantly from petrochemicals, trucks, planes and ships and that would more than offset the decline in oil demand from cars, which is expected to peak in the mid-2020s.

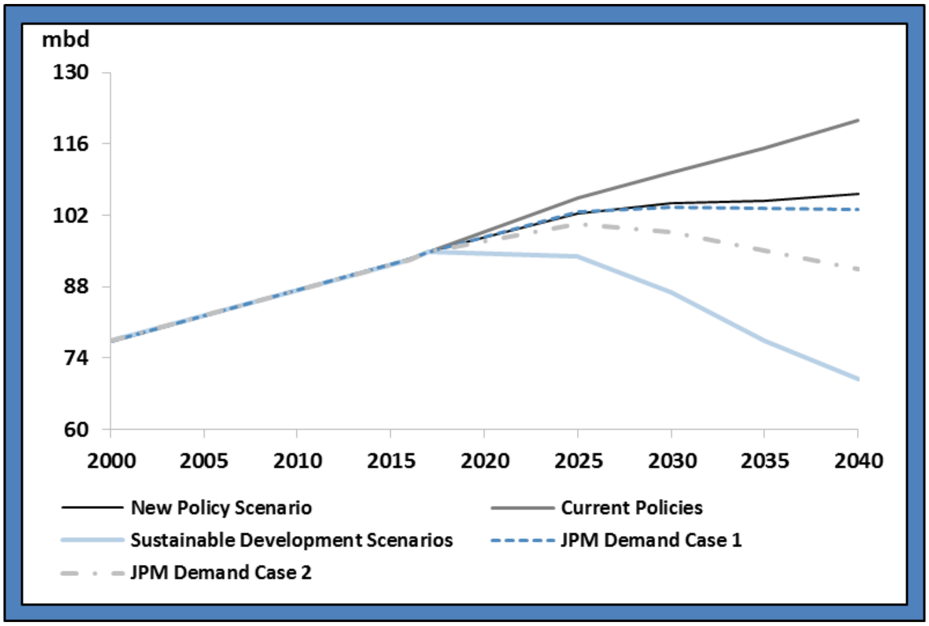
The Sustainable Development Scenario (SDS) of the IEA is aimed at delivering on the Paris Agreement. The Paris Agreement's aim is to limit the increase in global average temperatures to "well below 2°C above pre-industrial levels." To achieve these set climate goals, SDS assumes the use of low-carbon technologies to change global energy consumption patterns. This scenario hinges on renewable energy technologies.

Figure 7
World Energy Intensity versus GDP Coefficient in Multivariate and Univariate JPM Demand Models



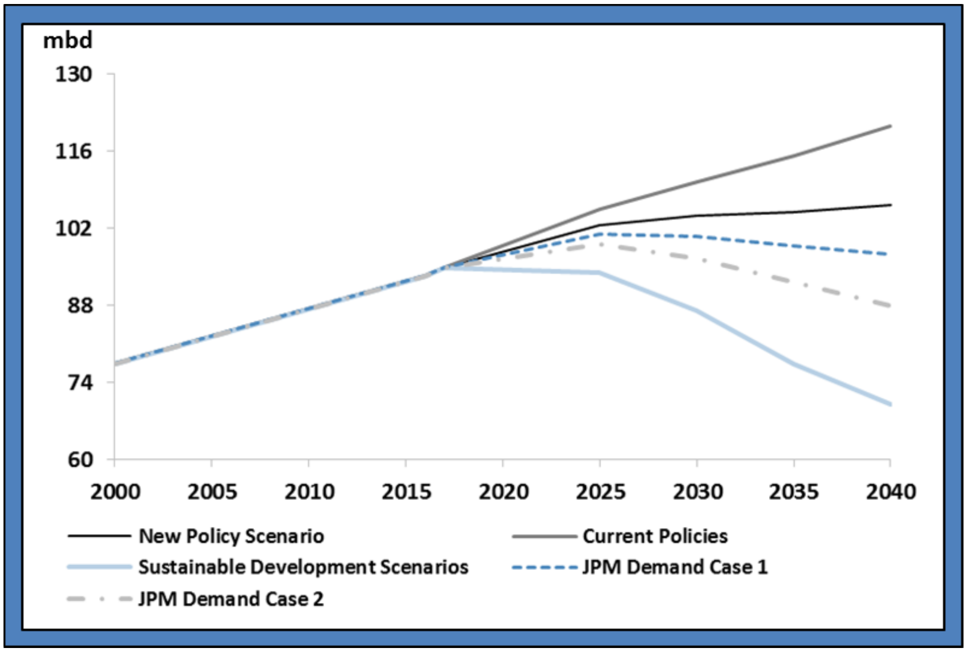
Sources: J.P. Morgan Commodities Research, World Bank.

Figure 8
Global Oil Demand - JPM Estimates with Trend GDP Growth



Sources: J.P. Morgan Commodities Research, IEA.

Figure 9
Global Oil Demand - JPM Estimates with Below Trend GDP Growth



Sources: J.P. Morgan Commodities Research, IEA.

In addition to the two scenarios above we have also plotted IEA's current policy scenario which acts as a yardstick for comparison purposes as it assumes no change in policies from 2018 leading to an increased strain on demand for all forms of energy and a major rise in energy-related CO2 emissions. We have also modeled J.P. Morgan scenarios for oil demand growth at trend global GDP growth of 2.4% and below-trend global GDP growth of 2% owing to structural shifts in the Chinese economy.

The GDP coefficient in our demand model averages 0.84 for the period 2011-2018, with the 2018 coefficient being 0.89.

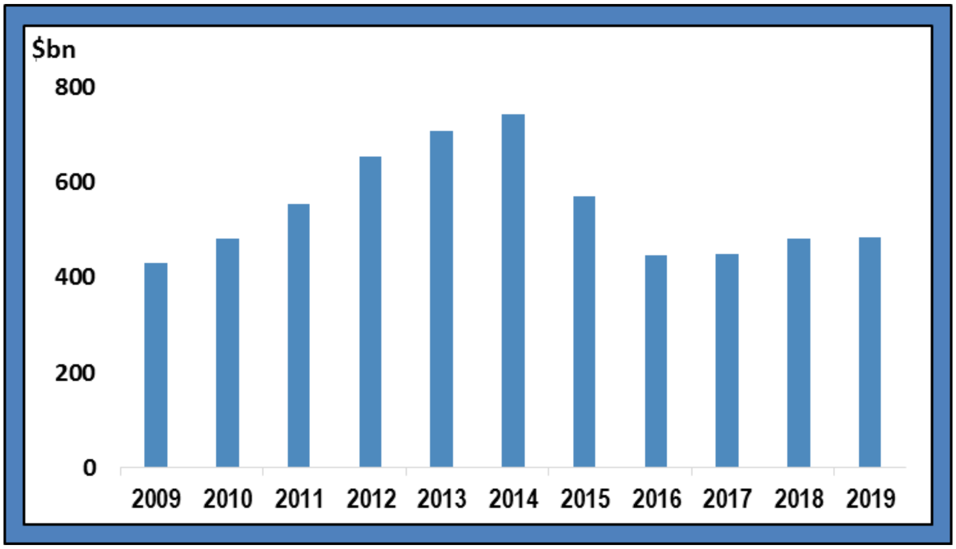
JPM Demand Estimates Case 1: We fixed the coefficients at 0.8 and 0.7 for 2021-2030 and 2031-2040, respectively, as we assumed limited energy intensity (as a function of GDP elasticity) change and the continuation of present demand conditions in the future.

JPM Demand Estimates Case 2: We assumed the GDP coefficient to be 0.6 for the period 2021-2030 and 0.4 for 2031-2040 for both trend and below trend GDP growth rate. This scenario implies a larger impact from climate policy and energy efficiency on the energy intensity of GDP.

According to our models, oil demand would track IEA's NPS oil demand under a trend growth scenario within JPM Demand Estimates Case 1. In this scenario, the demand does not peak until 2040. However, oil demand is expected to peak in the early 2020s and decline gradually thereafter under the below-trend growth scenario for JPM Demand Estimates Case 1 and for both trend as well as below-trend scenarios for JPM Demand Estimates Case 2. In the absence of another commodities super cycle, we expect demand growth to peak early as the Chinese economy slows structurally and energy efficiency improves at a faster pace during 2030-40 versus in 2020-30. The continued decline in the energy intensity of GDP, diversification towards EVs, and other sources of energy will put significant pressure on oil products demand growth.

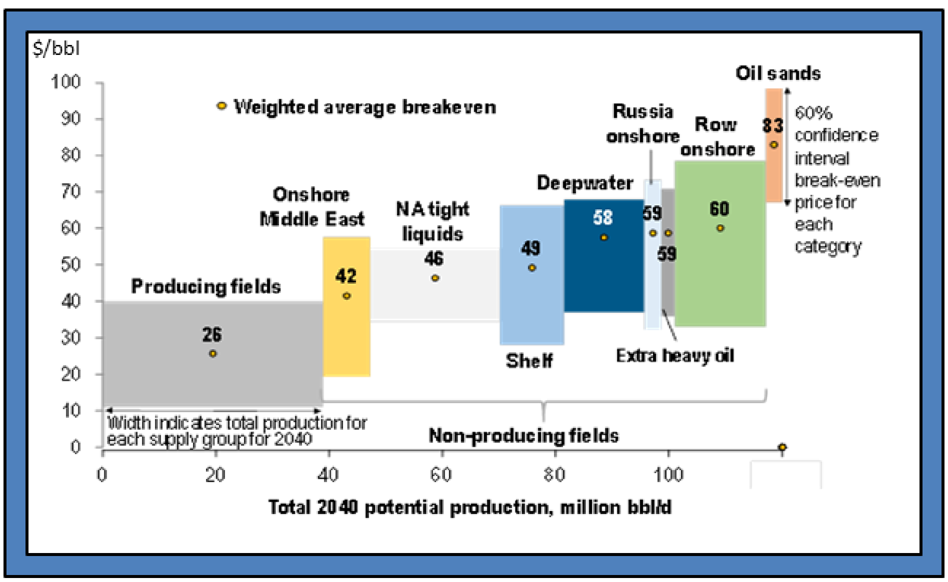
While there is still great uncertainty around the rate of slowdown in demand growth and which of the JPM or IEA scenarios listed above will materialize in the future, this uncertainty in the industry has kept investments in the sector in check as noted in global oil and gas (O&G) capex since 2014. One could argue that lower investments are partly driven by lower costs as costs have come down especially with technological advancement in the O&G sector in the aftermath of the oil price collapse that was led by U.S. shale resurgence. However the lack of clear direction for demand growth in the future and price elasticity of supply, especially supported by the short investment cycle in U.S. shale, has disincentivized producers globally to invest significantly in deep offshore development unlike in the past. A larger proportion of spending in non-OPEC continues to be dominated by the investment in the U.S. This was raised several times by producers, especially OPEC members, in the past couple of years as an upside risk to oil prices; however, such a risk has yet to materialize, and oil prices have found a new cap from U.S. shale in the near term and floor from OPEC+ actions in Dec 2016. It is becoming increasingly important for OPEC to work closely alongside their non-OPEC partners as it tries to help rebalance the markets that have remained imbalanced for the last five years largely due to supply-side issues. Looking ahead, the key question is how do oil-producing countries, especially those with high fiscal break-evens but low operating costs, try to maximize profits in a scenario where there is a potential risk not only to demand growth but also to supply growth (both to the upside and downside).

Figure 10
Global Oil and Gas Upstream Capex



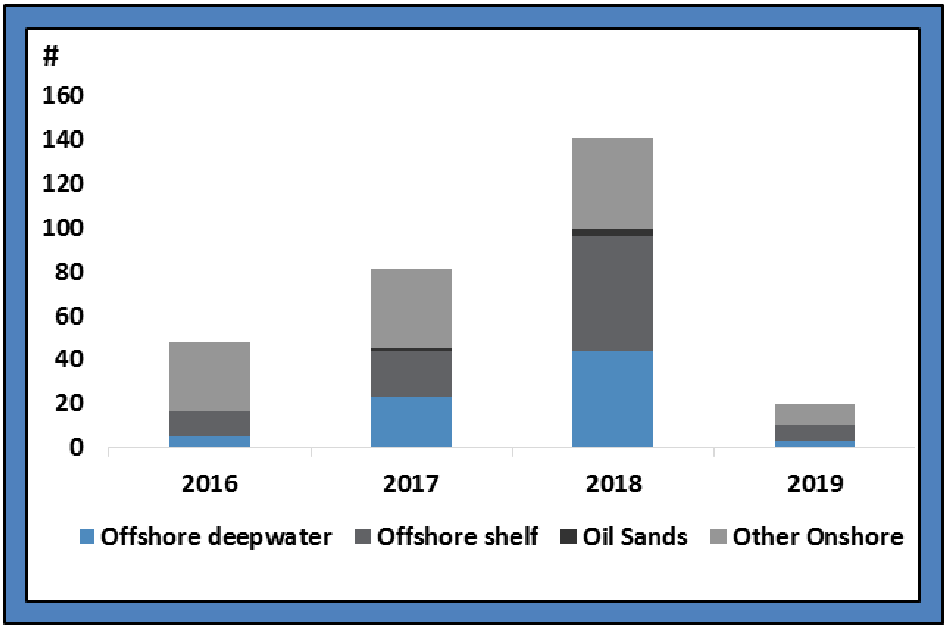
Sources: J.P. Morgan Commodities Research, Rystad Energy.

Figure 11
Real Brent Break-Even Price



Sources: J.P. Morgan Commodities Research, Rystad Energy.

Figure 12
Total Final Investment Decisions (FIDs)



Sources: J.P. Morgan Commodities Research, Rystad Energy.

Optimization of Oil Price and Demand for Profit Maximization: Saudi Arabia

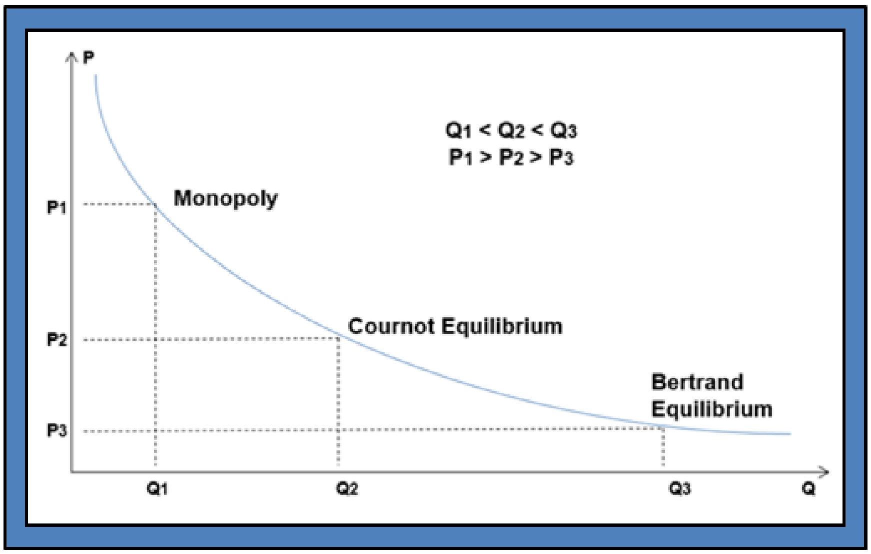
Producers such as Saudi Arabia are caught between a rock and a hard place when it comes to risk of oil demand from technology and alternate energy sources and also price elasticity of supply from short-term investment cycles. A model to optimize price would be prudent especially over a longer timeframe if it wants to maximize profits.

Cournot versus Bertrand Theory of Market Competition

In a typical monopoly, the sellers of oil would benefit from their strong and unique position in the market. Impediments such as high costs to new entrants give them the highest possible price to meet demand. However with OPEC, which is essentially acting as an oligopoly, producers need to also take into account the decisions and actions of their competition outside of the cartel when making pricing decisions. There are two basic models in the formal study of oligopoly: Cournot and Bertrand. In **Cournot analysis**, market demand equals the total amount on offer with an assumption that sales are determined by the firm whereas the price is arrived at by some unspecified factor. In **Bertrand analysis**, firms have a responsibility to meet customer demand after a firm determines the price at which it sells its output. (See Judd (1996).)

Bertrand theory of price competition would argue for potentially larger volumes sold at a given price (lower than the Cournot model), a price which would disincentivize EV transition or shale supply growth. However that is not a given as the transition to EV is not just driven by price but also by consumer spending trends and preferences. Additionally, shale production is also a function of technology. Essentially one could suggest a Cournot model for pricing would be an ideal solution for Saudi Arabia, which means that the Kingdom continues to stay in the cartel to maximize its profits and address the risks from marginal producers outside of OPEC. However, this is likely to work for the next 10 years (assumption). After this 10-year period, it may not be correct to assume if the Cournot model will still work as producers may want to maximize their production to increase resource utilization if we were to reach a peak demand scenario or a demand slowdown scenario causing markets to move from a Cournot to Bertrand model in the next two decades.

Figure 13
Cournot and Bertrand Equilibrium



Source: J.P. Morgan Commodities Research.

In the model below we have tried to assess the optimum price for Saudi Arabia in the long term. While the model is price-driven to meet a given demand in the market, it assumes OPEC and its non-OPEC partners will work together to address the issue of threat from demand decay, as well as supply from unconventional sources.

Oil Price Maximization

$$\max_{wrt\ \{P_t\}} \pi = \sum_{t=1}^{50} (P_t Q_t - cQ_t)$$

P_t is price at time *t* and c is cost, Q_t is demand for Saudi oil

1.)
$Q_t = w_t \widetilde{Q_t}$; where $\widetilde{Q_t}$ is global oil demand

2.)
$\widetilde{Q_t} = g(EV, P);\ g_1 < 0\ ;\ g_2 < 0\ ;$
EV: Electric Vehicles

3.)
$EV = h(P);\ h_1 > 0$

Combining 2 and 3:

4.)
$\widetilde{Q_t} = g(h(P), P);\ \frac{dQ}{dP} < \frac{dQ}{dP}_{EV}\ ;$

5.)
$w_t = f(US\ shale,\ RoW\ supply); U.S. shale\ supply\ and$ *Rest of World (RoW) Supply*

5. a.)
U.S. shale = $k(P); k_1 > 0$

5.b.)
RoW supply = $r(P); r_1 > 0$

Combining 5, 5.a and 5.b

6.)
$w_t = f\big(k(P), r(P)\big) = \check{f}(P);\ \frac{dw}{dP} < \frac{dw}{dP}_{US\ shale} < 0$

Combining 1, 4 and 6

7.)
$Q_t = f\big(k(P), r(P)\big) g(h(P), P) = \tau(P)$

$\frac{dQ}{dP} < 0$

$$\max_{wrt\,\{P_t\}} \pi = \sum_{t=1}^{50} \left(\frac{P_t Q_t}{(1+\gamma)^t} - \frac{\mathrm{c} Q_t}{(1+\gamma)^t} \right)$$

OR

$$\max_{wrt\,\{P_t\}} \pi = \sum_{t=1}^{50} \left(\frac{(P_t - \mathrm{c}) Q_t}{(1+\gamma)^t} \right)$$

OR

$$\max_{wrt\,\{P_t\}} \pi = \sum_{t=1}^{50} \left(\frac{(P_t - \mathrm{c}) f\big(k(P), r(P)\big) g(h(P), P)}{(1+\gamma)^t} \right)$$

Hotelling's Rule and Green Paradox

A paper by Jensen *et al.* (2015) discusses the unintended consequences of climate policies. **The authors suggest that the green paradox arises due to the supply response from fossil fuel producers/resource owners due to climate policies such as carbon taxes. It tends to increase emissions for a short period of time.** Given the economic scarcity of fossil fuels, the price they command tends to be higher than the cost of extraction. Hence according to Hotelling's rule, the price net of marginal cost must rise at the rate of interest in non-renewable resource markets. However, the climate change externality invalidates the simple Hotelling's rule. In order to account for carbon costs, owners of non-renewable resources would bring forward their extraction of resources in a pre-announced global carbon tax.

Investor Paradox

Long-term investors remain wary of investing in oil especially if returns are likely to be challenged by the peak demand theory, or low-cost shale production in the medium term, or oil producers shifting their extraction of resources ahead of any pre-announced climate-based policy implementation. Such negative sentiments in the industry, along with depressed deferred prices along the forward curve driven by U.S. shale supply, have inadvertently impacted investment decisions since 2014 and will continue to do so in the medium term. We argue that the assumption of demand peaking due to energy efficiency and energy basket diversification from emerging economies is untested, and even if the eventual direction of the industry towards a low-carbon economy is assumed to be true, the jury is still out on the timing of such a change. It is precisely due to this uncertainty, the path towards higher volatility in oil prices is far more certain than the change in oil prices in the medium to long term. We also need to take note of the success rate of fully implementing climate-based policies around the world in the foreseeable future and the potential for another commodities super cycle led by other emerging economies such as India.

Currently most Environmental, Social and Governance (ESG) and climate change investors are underweighting or completely avoiding investments in oil and coal. But given the lack of investment in the sector and demand for oil being driven predominantly by non-OECD economies where population growth is on the rise, oil as an asset class should end up providing positive returns and these investors could miss out on this opportunity. Additionally geopolitics will always be core to oil at least in the next decade. The same may not be true for coal due to the abundance of natural gas and renewables to replace coal in the power sector. Finally, to quote the Red Queen (oil) to Alice (renewables) from *Alice in Wonderland*, "Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!"

Endnote

Dr. Deshpande presented on related topics at the JPMCC's 3rd Annual International Commodities Symposium on August 12, 2019. The symposium, in turn, was organized by Professor Jian Yang, Ph.D., CFA, the J.P. Morgan Endowed Chair and JPMCC Research Director at the University of Colorado Denver Business School.

References

Jensen, S., Mohlin, K., Pittel, K. and T. Sterner, 2015, "An Introduction to the Green Paradox: The Unintended Consequences of Climate Policies," *Review of Environmental Economics and Policy*, Vol. 9, No. 2, Summer, pp. 246-265.

Judd, K., 1996, "Cournot versus Bertrand: A Dynamic Resolution," Hoover Institution and National Bureau of Economic Research, April.

Author Biography

ABHISHEK DESHPANDE, Ph.D.
Executive Director, Head of Global Oil Market Research & Strategy, J.P. Morgan

Dr. Abhishek Deshpande is Head of J.P. Morgan's Global Oil Market Research and Strategy team. Prior to joining J.P. Morgan in 2017, Dr. Deshpande was Head of the Global Energy Research team at Natixis SA based in London and also worked at Indian Oil Corporation Limited. He has a doctorate in Chemical Engineering from Cambridge University & is a Fellow and Chartered Member of the Institute of Chemical Engineers and Energy Institute U.K. Dr. Deshpande also received *Petroleum Economist* & *Energy Risk* Awards in 2016 & 2017.