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King Abdullah Petroleum Studies and Research Center

The Challenges in Measuring Global Oil Production

September 2019

Doi: 10.30573/KS--2019-WB26

About KAPSARC

The King Abdullah Petroleum Studies and Research Center (KAPSARC) is a non-profit global institution dedicated to independent research into energy economics, policy, technology and the environment, across all types of energy. KAPSARC's mandate is to advance the understanding of energy challenges and opportunities facing the world today and tomorrow, through unbiased, independent, and high-caliber research for the benefit of society. KAPSARC is located in Riyadh, Saudi Arabia.

This publication is also available in Arabic.

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Key Points

Oil production data is critical for understanding the short-term oil market and global energy balances. Many data providers focus on immediate snapshots, leaving international organizations to provide accurate data on energy balances.

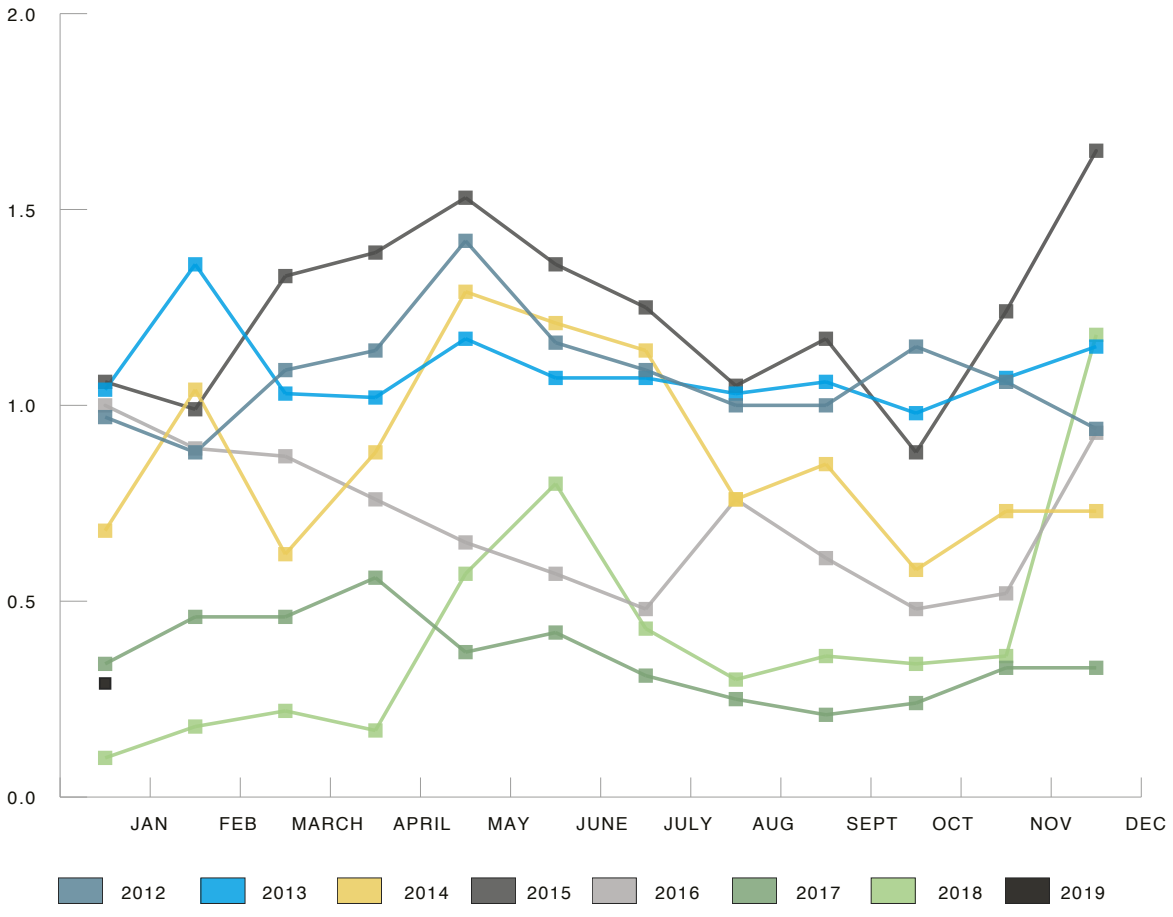
There is a need for a holistic view of global energy balances in which data on oil demand is matched by that on oil production.

A growing number of commercial data providers using ship tracking and satellite technology are generating significant amounts of data on crude oil flows and oil storage, leading to a growing need for analytical interpretation.

Data provided by governments is often subject to political constraints, and there is a clear need for independent national agencies to be able to accurately track oil production.

Large oil producers have an interest in publishing timely and accurate data to ensure that signals given by output changes are quickly picked up by oil markets.

Figure 1. Range between the highest and lowest OPEC oil production estimates (Mbbl/d) by selected third parties.



Source: Energy Aspects.

Summary for Policymakers

Timely and accurate oil production data is critical for understanding both the short-term oil market and for global energy balances. In the absence of reliable official data from many key oil producing countries, oil market analysts rely on a range of independent estimates, including those from media and energy organizations and consultants. The OPEC Secretariat uses six of these organizations which it terms 'secondary sources': the International Energy Agency, the Energy Information Administration, Platts, Argus, Energy Intelligence and HIS-CERA. Other 'third-party' organizations that monitor oil production include, *inter-alia*, Bloomberg, Reuters, the Middle East Energy Survey (MEES) and Energy Aspects. Many of the current data providers, notably media organizations, tend to focus on month-end snapshots, leaving larger energy organizations and consulting firms to provide more accurate data on energy balances, which are revised over time.

Third-party estimates are necessary either because some oil producing countries do not release data or the data provided by governments is subject to political constraints. Typically, these organizations only closely monitor major oil producers such as OPEC countries and key non-OPEC members such as Mexico. There is a clear need for independent national agencies to be able to accurately track oil production and to publish such data on a timely basis.

The methodology used by traditional oil production data providers involves garnering information from multiple sources. This includes confidential government sources, official statistics, and port and shipping data. However, in recent years a new class of commercial data providers using ship tracking and satellite technology have emerged. They have the ability to generate significant amounts of data on crude oil flows and oil storage.

While there is plenty of information on oil production, there is less reliable data on oil consumption, especially in key markets such as the Middle East and China. This is required for a holistic view of global energy balances in which data on oil demand is matched by that on oil production.

Oil production data is becoming more transparent thanks to the growing number of independent organizations tracking oil flows. However, data from third-parties remain estimates and only oil producers are able to provide timely and accurate data on their own oil production. Large oil producers have an interest in publishing their data to ensure that the signals given by output changes are quickly picked up by oil markets.

Background to the Workshop

Despite the critical importance of accurate and timely oil production data, there is scarce academic literature on the methodology used to collect it. Little has been written about the so-called 'secondary sources' and their methodologies. Secondary sources is a term used to describe the organizations that provide monthly oil production data used by the OPEC Secretariat in some of its reports. They include two energy agencies, the Energy Information Administration (EIA) and the International Energy Agency (IEA); three news agencies, Energy Intelligence, Petroleum Argus and S&P Global Platts; and one commercial entity, IHS Markit.

The KAPSARC paper, "OPEC Oil Production Data: The Role of Secondary Sources" (Mollet and Al Muhanna 2018) analyzed the methodologies these organizations use. The paper found that most of the organizations use similar methodologies and that oil production statistics from some countries are particularly opaque.

Furthermore, the paper noted the growing number of commercial entities providing technology-driven oil production data from tanker tracking, notably through monitoring signals from the Automatic Identification System (AIS) and satellite imagery.

On Feb. 25, 2019, KAPSARC convened a number of global experts representing secondary sources, other independent oil production data collectors, the OPEC Secretariat, academic institutions and technology-driven data providers to discuss issues surrounding the collection of oil production data.

The scope of the workshop went beyond that of Mollet and Al Muhanna (2018) to look at global oil production, including in non-OPEC countries, and the roles of all entities, including the new generation of ship tracking and satellite companies.

The workshop addressed the following key questions:

- How reliable are oil production numbers published by secondary sources and what is the role played by the Joint Organisations Data Initiative (JODI) in improving the accuracy and reliability of this data?
- Should we pay more attention to non-OPEC data at a time when OPEC is increasingly collaborating with non-OPEC parties?
- Has information generated via satellites and ship tracking become reliable and widespread enough to qualify as robust oil market data?
- Many oil production estimates, especially for OPEC countries, are calculated using exports as a base while adding domestic consumption and factoring in inventory changes. Given that the latter are often opaque and hard to estimate, would it make sense for markets to focus on exports that have a direct impact on global oil markets?

OPEC Oil Production: How Accurate Is the Published Data?

Month-end OPEC oil production data published by third parties, which integrates the six secondary sources as well as other third-party agencies such as Reuters and Bloomberg, are estimates based on a mix of confidential sources, port data and tanker tracking. A review of the data from 2012 shows that the variation in the range between the highest and lowest daily oil production estimates published by third-parties has narrowed in recent years from as much as 1.5 million barrels per day to a typical range of 500,000 barrels per day. However, even at these lower levels the differences are big enough to significantly alter global liquids balances. Larger OPEC producers have the broadest ranges of estimates, though third-party data providers have recently been in greater agreement over oil production in key countries including Iraq, Kuwait and Venezuela. There is evidence that geopolitical events affect third-party estimates, resulting in a higher range of production estimates; some data providers are picking up on production changes while others are failing to do so. Production estimates for countries experiencing geopolitical events whose effects are hard to gauge in the short term are particularly uncertain. The range between the highest and lowest estimates published by third parties for Libya and Nigeria, countries that have experienced recent turmoil, is 10% and 20%, respectively. Some of the smallest producers that have joined OPEC recently, such as the Democratic Republic of Congo, Equatorial Guinea and Gabon, show the biggest ranges. This could reflect the fact that third-party sources still need to develop reliable sources of information within these countries.

Some of the biggest challenges in improving production estimates include the lack of any benchmarks, or an agreed 'source of truth,' against which to confirm the accuracy of estimates. A major risk factor that potentially undermines the reliability of such estimates is convergence. Many third parties speak to each other when preparing their estimates, and this may encourage the elimination of outliers through 'groupthink,' however unintended. The narrowing range of estimates in recent years could be the result of such a convergence. There is also the potential for data to become politicized, as official production figures may be adjusted for political purposes (e.g., national pride or in light of OPEC quota discussions).

One possible retroactive benchmark for third-party data are figures from the Joint Organisations Data Initiative (JODI), collected by the International Energy Forum (IEF) Secretariat in Riyadh. Such data is typically published with a two- or three-month delay and subsequently revised where necessary; though most third-party sources tend not to revise their figures. With the exception of the EIA and the IEA, third-party sources see their role as providing a month-end snapshot and insist their data are estimates or assessments. Third-party estimates are predominantly used by traders and oil market participants when taking short-term financial and physical positions in the oil market.

Whereas third-party estimates are collated in a process taking at most a few days, JODI requires many steps and actors. Its process is as follows: National statistics offices collect information from oil companies using a JODI questionnaire and then pass on the information to JODI partner organizations. The JODI partners review the data, check for outliers, compare them with secondary sources before sending them to the IEF. The IEF then rechecks the data, integrates and publishes it.

JODI's work has become increasingly complex, with the number of data inputs rising from 42 to 240 since it was established in 2002. There is effectively a trade-off between timeliness and completeness. In addition to the lack of trained personnel, many national statistics offices face challenges related to the confidentiality enshrined in some concession agreements and political interference in the publication of sensitive data.

Some OPEC countries send different datasets to JODI and the OPEC Secretariat, making it hard to compare the data. For example, the United Arab Emirates reports oil and condensate figures to JODI and well-head production to the OPEC Secretariat. There is evidence that countries with non-transparent policies are using the secondary sources data they send to JODI as their real production figures.

Non-OPEC Data Deserves Closer Attention

Much of the attention to month-end oil production figures is on OPEC countries that, between them, account for around a third of global oil production. OPEC oil production estimates are typically published by secondary sources and other third parties on the first day of the subsequent month, following in-house data collection. These organizations will wait for official data before publishing the oil production figures of other key producers such as the United States (U.S.) and Russia. However, the structure of the global oil market is such that the marginal barrel sets the price. Small changes in the apparent or actual fundamentals lead to sharp swings in prices, making it essential to get accurate and timely figures from all producers.

Russia, which produces more oil than Saudi Arabia, releases initial data on oil production and oil exports on the first day of the following month via the energy ministry's Central Dispatching Department of Fuel Energy Complex (CDU-TEK). This data is widely accepted as accurate and not subject to political interference, as it is used as the basis for taxation by the country's tax authority.

Global oil market participants follow Russian data – like all other data – to understand global energy balances and, increasingly, to see whether the country is complying with OPEC's agreed production cuts. However, CDU-TEK measures oil production in mass rather than volume, i.e., in tonnes rather than barrels. This creates a major challenge when comparing Russian published production figures with those of other countries, as the mass of different crude grades have different volumes. Organizations that publish Russian production data typically use an average conversion factor but not always the same one. The BP Statistical Review and the Reuters news agency use 7.33 barrels per tonne while the EIA uses 7.23. A revision of this critical conversion factor is required, especially as the Russian crude slate is getting light as new fields come on stream.

There are further issues when comparing Russian oil production with other global producers, as the data supplied by the Russian Federal State Statistics Service (Rosstat) to JODI does not match JODI classifications (Table 1).

Table 1. Classification of Russian Hydrocarbons.

Product in JODI database	JODI methodology	Providing data from Rosstat for JODI
Crude Oil	Crude oil (incl. lease condensate	Only crude (excl. lease condensate)
NGL	Liquids recovered from gas seperation plants and gas processing facilities	Lease condensate
Other	Refinery feedstocks + additives / oxygenates + other hydrocarbons	N/A
Total	Total liquids	Crude oil (incl.lease condensate)

Source: Institute for Energy and Finance, Moscow.

Mexico is an example of a country with declining oil production, and whose data is closely monitored by oil market analysts but is often regarded as flawed. Nominally, Mexican oil data reporting follows IEA and JODI guidelines (Mexico is a member of the OECD but not the IEA), but some issues cast doubts on the quality of its data. This includes the fact that its data is rarely, if ever, revised; that Mexico's state oil company Pemex is the main source of information; and that the data is often inconsistent with other countries' oil trade data, notably that of the U.S. Official Mexican data also appears to ignore the small but growing volumes of crude produced by private oil companies. Following the country's 2013 energy reform, the responsibility for Mexico's oil production data was handed over to the nominally independent National Hydrocarbons Information Center (CNIH), mandated to track private company production. CNIH's ability to contribute to improving the quality and timeliness of Mexico's oil production data will depend on its capacity to withstand political pressure from the government, especially at a time when the country's oil production is falling.

Despite JODI's best attempts to collect global data, there are still major gaps in non-OECD countries' oil production data. Even the data from the U.S., which has some of the most advanced oil production data gathering systems in the world, appears to be flawed. Data from the EIA often does not match state-level data, and there are obvious gaps in data collection, including the lack of metering of oil trucked from oilfields. Secondary sources and other third-party agencies plug the gap in governmental data, but tend to focus their attention on OPEC countries. A considerable proportion of global oil production data remains unverified and, in some cases, undeclared.

To plug this gap, it is essential to understand and measure the entire oil logistics chain. As mentioned above, secondary sources assess OPEC production using exports as a benchmark and calculate production by deducting domestic consumption and factoring in stock changes. Monitoring inventory levels is critical to understanding the oil market, and a new generation of data providers are using satellite imagery to monitor stock changes in floating top tanks.

Likewise, data on oil consumption allows production to be gauged. Overall, consumption tends to be more opaque than production, especially in a key market such as China. Much short term data is generated based on historical trends, though such methodologies are flawed. In Gulf Cooperation Council (GCC) countries, for example, recent domestic energy price reforms have changed the demand trajectory. Monitoring petroleum products exports from GCC countries is increasingly important, as increased refining capacities and local changes in demand patterns are leading to more oil being exported as refined products. Oil going into strategic storage is another black hole for data, especially because key countries in the process of accumulating stocks, such as India and China, store their oil in underground caverns where they cannot be monitored.

New Technologies: Will 'Alternative' Data Be a Game Changer?

A new generation of oil market data providers has recently emerged, leveraging new technology to gauge oil trade flows and inventory levels. These providers can be classed into two types of companies: those that track oil tankers, and those that use satellites to track a range of oil-related activities, primarily inventory levels of floating top oil storage tanks. Such technology-driven data, also known as alternative data, is increasingly being used by oil traders and some secondary sources to provide scientific evidence of physical crude oil flows and global inventory levels. For the secondary sources, this adds one extra layer of information that can be used to establish production estimates.

Tanker tracking companies use the Automatic Identification System (AIS) signal, mandatory under International Maritime Organization rules, to track the routes and cargoes of oil tankers. Some tanker tracking companies state that the AIS is only one aspect of their service and that they collect other data such as bills of lading, information from port sources, customs declarations, shipping fixtures and data from shipping brokers. Such data providers do not claim to cover production, only exports, but are of use to those calculating production data as well as to oil traders looking for short-term market intelligence.

In the last few years, a new generation of companies has begun to use proprietary algorithms to process satellite images, allowing them to measure storage levels at tank farms that use floating top storage. Such companies claim global coverage, with the ability to constantly monitor up to 25,000 tanks or 5 billion barrels of storage. These companies have been boosted by the recent development of Synthetic Aperture Radar (SAR) technology that allows satellites to see through clouds, rain and fog.

However, while most oil storage tanks built in recent decades have floating lid tanks, some do not, making it hard to get a full picture of oil inventories. Furthermore, environmental regulations in the U.S. dictate that new oil storage tanks should have fixed tops. This means that companies using satellites for storage data will achieve an increasingly incomplete picture.

Information gleaned from alternative data providers is, by its nature, immediate, providing a head start on the work undertaken by secondary sources and other third-party data providers. Ship tracking companies recently identified a surge in exports of petroleum products from China, starting with middle distillates in late 2018, and followed by light distillates and naphtha in 2019. The unexpected surge in petroleum products exports, if maintained, would have an immediate knock-on effect on the wider Asia-Pacific region and, eventually, markets in other regions. Overall, the large number of refineries in China, many privately owned, means that there is little available data on refinery runs. For policy analysts, such data could provide evidence of a change in government policy aimed at limiting the amount of crude that independent Chinese refiners are allowed to import.

Valuable geo-political intelligence can often be obtained from satellite imagery. Recent examples in early 2019 include major stock builds in Iran, a notoriously opaque country, as U.S. sanctions bite, along with oil stock draw-downs by Venezuelan subsidiary Citgo as the regime seeks to maximize export revenues.

Technology is likely to continue to be used in obtaining oil market data. The next business leap will be using satellites to measure drilling rig activity, including in Russia, and monitoring other data feeds such as twitter posts that can give an idea of increased drilling activity and cell phone activity at refineries. The latter could indicate turnarounds and shutdowns.

There is a consensus that alternative data provided by technology-driven suppliers adds to the complex matrix of information available in an otherwise opaque market. However, it is unlikely to replace the secondary sources and their focus on human intelligence and analysis. The immediacy of the alternative data is particularly valuable to oil traders looking for information they can leverage, such as falling inventories.

Using Oil Data as a Wider Political Tool

Oil production data, and how it is released or withheld by resource-holding governments, can be influenced by political considerations. Governments in countries where oil production is part of the national political agenda typically tend to delay or massage data for political ends, especially when oil production is declining. Countries with large market shares have an incentive to reveal data so that the market responds to any production signal given by that country. Soft signaling, by which government officials send discrete signals to the oil market, often through informal media briefings, is a key tool for many OPEC producing countries. In many cases, the political message is more important than the data itself. However, the growing amount of alternative data means that oil producers are being outflanked by technology and will have to produce more accurate data. There is evidence that this is already happening: secondary sources are increasingly accepting data supplied by OPEC countries as accurate.

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About the Project

This workshop is part of a wider KAPSARC project aimed at understanding the functioning of the global oil markets.

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