The Light Sweet-Medium Sour Crude Imbalance and the Dynamics of Price Differentials
1. Introduction

The current sweet-sour crude oil imbalance is creating challenges for producers and refineries alike.\(^1\) While OPEC\(^*\) is striving to balance the market by the first half of 2019, unplanned outages from countries like Venezuela, Iran and Canada and OPEC\(^*\) cuts have contributed to a large deficit in medium/heavy sour crudes. This is having a big impact on key market outcomes including trade flows, the dynamics of crude price differentials, and refining margins. The crude imbalance is also complicating planning and risk management decisions, especially at times when the International Maritime Organization (IMO) will enforce a new 0.5% global sulphur cap on bunker fuels from the 1st of January 2020.

Global crude supplies have historically been dominated by heavier sour grades, with the medium sour grades constituting the bulk of global oil production, currently accounting at about 45% of global production (see Figure 1).\(^2\) This trend persisted since the early-2000s and as a result, oil refiners in the past decades, invested heavily in complex plants capable of processing such heavier and sour crude amid expectations that heavier sour grades will keep dominating the future trajectory of global oil production. But the rapid increase in US shale production in recent years meant surging supplies of light sweet crude which transformed the quality of the marginal barrel coming into the market, creating multiple challenges for producers, refiners and consumers. This Energy Comment attempts to examine the dynamics of the sweet-sour crude price differentials, represented by the Brent-Dubai (BD) price spread, and to assess how supply factors can impact the crude quality imbalance between light/heavy oil and sweet/sour crude and hence the price crude spreads in 2019.

Figure 1: Global oil production by quality, Jan 95 – Jan 19

Note: See Table 1 for a description of the crude quality classes. Source: OIES.

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\(^2\) The crude quality classification used throughout this Energy Comment is defined in the table shown in Figure 1.
Table 1: Crude quality classes

<table>
<thead>
<tr>
<th>Crude quality classes</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Light sweet</td>
<td>API level equal to or greater than 35°, sulphur content less than 0.5%. Includes ultra-light.</td>
</tr>
<tr>
<td>Light sour</td>
<td>API level equal to or greater than 35°, sulphur content equal to or greater than 0.5%.</td>
</tr>
<tr>
<td>Medium sweet</td>
<td>API level equal to or greater than 26° and less than 35°, sulphur content less than 0.5%.</td>
</tr>
<tr>
<td>Medium sour</td>
<td>API level equal to or greater than 26° and less than 35°, sulphur content equal to or greater than 0.5%.</td>
</tr>
<tr>
<td>Heavy sweet</td>
<td>API level less than 26°, sulphur content less than 0.5%.</td>
</tr>
<tr>
<td>Heavy sour</td>
<td>API level less than 26°, sulphur content equal to or greater than 0.5%.</td>
</tr>
</tbody>
</table>

Source: OIES.

2. The origins of the crude quality imbalance

Since 2012, most of the growth of global oil production has been concentrated in ultra-light and light crude originating from the US, surpassing that of heavier grades (i.e. medium and heavy crude) by 1.7 mb/d as of November 2018 (before the new round of the OPEC output cuts), and by 2.6 mb/d as of January 2019 (see Figure 2). Likewise, the production growth of sweet crude has been higher than that of sour crude up until 2016 when US shale production momentarily halted due to the collapse of the oil price before resuming and matching the latter throughout 2018.

Figure 2: Growth of global oil production by API gravity and sulphur content, Jan 12 – Jan 19

This rapid growth of light sweet supplies originated almost entirely from the US and is expected to continue for years to come (see Figure 3). In annual terms, light sweet production in the US almost doubled since the beginning of this decade, accounting for 69% of the total in 2018 compared to 39% in 2010. Since 2014, US producers alone added over 3.0 mb/d of new ultra-light and light sweet production in the market, accounting for the bulk of global growth of such crude.
In 2018, the imbalance between light sweet and heavier sour crude supplies has been aggravated both by involuntary and voluntary production cuts, at a time when US shale production registered the strongest growth on record adding over 1.3 mb/d of new light sweet crude in the market on a year ago. The US withdrawal from the Joint Comprehensive Plan of Action (JCPOA) in May 2018 and the announcement of the re-imposition of Iranian oil sanctions, as well as the continued deterioration of the Venezuelan output led to important loses in the medium/heavy sour category (see Figure 4). Despite the US granting oil waivers in November, our data show that between May 2018 and January 2019 the market lost about 1.1 mb/d of medium sour Iranian barrels. At the same time, Venezuelan production continued its downward trajectory declining by 1.1 mb/d since January 2016, of which 0.4 mb/d are medium sour and 0.65 mb/d are heavy sour barrels. In 2019, the unfolding geopolitical developments in Iran and Venezuela are expected to intensify the crude imbalance amid the expiration of the US oil waivers in May and the increased uncertainty over Venezuela’s production outlook following a fresh round of US sanctions targeting the country’s oil sector.

The implementation of the OPEC+ output cuts of 1.8 mb/d since January 2017 has also taken large volumes of heavier crude off the market, albeit the output hikes in the second half of 2018 more than offset the lost barrels. Indicatively, the GCC3 (i.e. Saudi Arabia, Kuwait and the UAE) and Russia alone returned more than 1.6 mb/d of withheld medium-sour crude as of November relative to the start of the year. However, the renewed pledge of the OPEC+ producers to cut output by 1.2 mb/d from January 2019 for an initial period of six months means that an important source of medium and heavy barrels will be taken off the market anew, as US light sweet production will continue to rise. As can be seen in Figure 5, in January 2019 Saudi Arabia curbed about 0.7 mb/d of medium sour production relative to November, while it has announced that it is planning to reduce production further to 9.8 mb/d by March. If the Kingdom delivers on its promise, this will result in a loss of about 1.2 mb/d of medium sour supplies in total, only from Saudi Arabia for the first quarter of 2019. In the meantime, outside OPEC, Canada self-imposed its own output cuts of 0.32 mb/d starting in January 2019 for an initial period of three months, due to the record discounts for its heavy crude amid a large crude build up in storage and rail capacity bottlenecks. In November, the discount on Western Canada Select (WCS) which is a heavy blend reached close to a record $51/b below WTI, but since the announcement of the output cut, the spread between the two has narrowed significantly and in January 2019 the gap fell below $10/b.

Notes: Projections of US production are based on IEA estimates. Source: OIES.
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Taken together, these developments led to the Brent-Dubai and WTI-Dubai spreads collapsing in 2018, signalling to a shortage of heavier sour crude globally (see Figure 6). Historically, the Brent benchmark which is a basket of lighter and lower sulphur grades produced from the North Sea has traded at a $3-4/b premium to Dubai, which is a sour basket of heavier crudes. That said, the sustained declining trend in price differentials that began since May 2018 is also reflective of the light sweet glut that dipped the Brent-Dubai spread from around $3.2/b on a monthly basis down to $0.3/b in January 2019. Similarly, the WTI-Dubai spread collapsed well into negative territory around -$7/b on average. Considering thus that the global medium/heavy production is expected to fall further in 2019 due to the sanctions on Iran and Venezuela, as well as the OPEC+ output cuts, the sweet-sour imbalance is expected to get worse.

Figure 6: Sweet/Sour crude spreads, Jan 14 – Jan 19

3. Assessing the risks to the sweet/sour crude spreads

To quantify the impact of various oil risks on the trajectory of the sweet/sour crude spreads in the year ahead, we employ a standard VAR forecasting model with additional information from exogenous variables referred to as VARX. The sweet/sour crude spread is represented by the Brent-Dubai (BD) price differential and the vector of exogenous variables includes the monthly changes in global crude oil production by quality. The latter series is constructed based on country-based estimates of production by quality due to ENI’s World Oil Review and IEA’s reported monthly crude oil production since 1995; indicatively by light sweet, light sour, medium sweet, medium sour, heavy sweet and heavy sour as these classes are defined in Table 1. The model is estimated recursively at monthly frequency from January 1995 to January 2019 and allows for 24 autoregressive lags.

Although the balance between light and heavy oil and sweet and sour crude supplies in the market is not the only factor affecting the BD spread, our analysis explicitly focuses on the responsiveness of the price differentials to such crude quality imbalances that arise due to OPEC output policy decisions, geopolitical supply disruptions, the emergence of new supplies and other supply-driven factors. Amongst other factors that influence the BD spread (and which are not modelled here) include differences of the product yields of the two underlying baskets, the flow of marginal barrels between the Atlantic basin and Asia (i.e. arbitrage) and large shifts in the Brent outright prices.5

Figure 7 shows the in-sample forecasts generated by the VARX model compared to the actual evolution of the BD spread from January 1995 to January 2019. The one-step-ahead (i.e. static) forecast appears to fit the actual data relatively well, missing mostly the outsized increase of the spread in late-2004 and other positive and negative spikes throughout that can be attributed to intramonth volatility. Overall, sustained trends are more reflective of fundamental factors and clearly the static forecast performs well in capturing the response of the BD spread to such dynamics across time. The in-sample dynamic forecast that runs from January 2018 to January 2019 performs also well, having predicted correctly the direction of the monthly change of the spread in 9 out of 13 months. By January 2019, the model predicted a narrowing of the BD spread to $0.33/b compared to the actual $0.31/b. That said, the model over predicted consistently the changes in the spread in 2018 by about $0.5/b in absolute terms.

Figure 7: Forecasting performance of the BD spread model, Jan 95 – Jan 19

Source: OIES.

3.1. Baseline forecast of the Brent-Dubai price differential in 2019

Figure 8 presents the baseline assumptions of the growth of global oil production by quality in the year ahead and the projected evolution of the Brent-Dubai spread under the baseline case between February and December 2019. The baseline growth of non-OPEC oil production in 2019 is based on IEA’s Monthly Oil Data Services supply forecasts as of January 2019. This is held equal across all forecast scenarios. OPEC production is assumed to reach 100% compliance to the December 2018 pledged target of 0.8 mb/d in February 2019 and be sustained at that level for the remainder of the year. As of January 2019, OPEC producers achieved overall conformity level of 87% or 0.7 mb/d, 0.1 mb/d lower than pledged. For scenario purposes, production from Iran, Libya and Venezuela which are exempted from the output cut agreement is maintained throughout at January 2019 levels.

Overall, under our baseline case, light sweet production is assumed to keep dominating global growth in 2019, increasing by 0.9 mb/d on a year ago. On the other hand, medium/heavy sour production is assumed to decline by about 1.1 mb/d on a year ago, with most of the declines observed in the first half of the year as the OPEC and non-OPEC producers abide by their pledged output cut targets and Canada enforces its self-imposed cuts, before recovering in the second half of the year. It is worth

stressing that these losses of heavier crude do not take into account further supply disruptions from Iran and Venezuela, nor deeper output cuts from Saudi Arabia beyond its pledged target.

As can be seen in Figure 8, the baseline forecast predicts that the narrowing of the Brent-Dubai spread will persist throughout the first half of the year before gradually widening in the second half and stabilising in the final quarter within the $1/b and $2/b price range. Indicatively, ending-2019 the spread is estimated to widen to $1.3/b. Clearly, all else remaining equal, these results depict a situation in which the market is currently short of heavier sour crudes and any unanticipated disruptions of medium/heavy sour production (voluntary or involuntary) could push the BD spread in negative territory for longer and exacerbate the sweet/sour crude imbalance throughout the year.

**Figure 8: Baseline assumptions and forecast of the BD spread in 2019, Jan 17 – Dec 19E**

![Graph showing global production growth by quality and baseline forecast](image)

Source: OIES.

### 3.2. Iranian sanctions case

This scenario considers the re-imposition of US sanctions on Iran pass the expiration of the waivers in May 2019. Considering that there is still much ambiguity about the determination of the US administration to push Iranian oil exports down to “zero”, we consider a loss of 0.59 mb/d of Iranian production between May and December 2019, from 2.7 mb/d down to 2.1 mb/d, all else remaining equal. The month over month decline of Iranian output follows the same trajectory as it did in 2012.

Figure 9, which charts the projected evolution of the BD spread under the Iranian sanctions case, shows that other things being equal, the potential disruption of the medium sour Iranian supplies is expected to push the spread deeper in negative territory under which case the Dubai benchmark is expected to trade at around $1/b premium to Brent, before the spread narrows again but only marginally. Compared to the baseline forecast, the spread is expected to average $0.8/b lower and by December 2019 to offset the entire gains of Brent to Dubai, settling at $0.1/b as opposed to the baseline difference of $1.3/b.
3.3. **Venezuela crisis case**

Given the heightened uncertainty surrounding the prospects of Venezuela’s oil output in 2019, due to the political and economic crisis in the country escalating further and the US sanctions against PDVSA, this scenario emulates the fallout of Venezuelan production in the aftermath of the 2002 Venezuela Crisis by considering the month over month percent change in production in the first year of the episode. Accordingly, this scenario simulates that Venezuelan output declines by 0.65 mb/d to 0.6 mb/d in May 2019, from 1.26 mb/d in January, and stays around that level for the rest of the year.

**Figure 10: Venezuela crisis forecast scenario, Jan 17 – Dec 19E**

Source: OIES.
Figure 10 shows that the loss of about 0.6 mb/d of medium/heavy sour production from Venezuela, all else remaining equal, will result in the BD spread sliding well below -$1/b and staying negative around that level in the first half of the year. Thereafter the spread is expected to narrow and turn positive in the second half, albeit it remains subdued to less than $1/b. The net negative impact of the combined output losses from Venezuela on the BD spread average at $1.1/b relative to the baseline projections.

3.4. Saudi Arabia’s deeper cuts case

Considering that in the baseline forecast OPEC oil production remains constant at 100% compliance throughout, this scenario assesses the potential impact on the BD spread from Saudi Arabia deepening its production cuts beyond its pledged target. In January 2019, oil production from Saudi Arabia stood at 10.2 mb/d, 0.4 mb/d below reference production in October 2018 and 0.1 mb/d more than pledged. That said, the Kingdom announced that in February production declined further to 10.1 mb/d and it is planning to curb its production even further to 9.8 mb/d in March. Historically production cuts from Saudi Arabia impacted heavier sour crude supplies, but according to Argus this time around the Kingdom is also considering curbing production of lighter instead of medium/heavy sour crudes due to concerns over the strong prices of heavier supplies. Accordingly, this scenario simulates the case where Saudi production in February declines to 10.1 mb/d and in March to 9.8 mb/d, before gradually reversing back to the pledged target of 10.3 mb/d for the remainder of the year. As can be seen in Figure 11 however, this scenario further considers both cases in which the Saudi production cuts impact the supply of medium sour crude (referred to as KSA medium sour cuts), as well as a combination of light and medium sour supplies at a hypothetical rate of 60/40 (referred to as KSA light/medium sour cuts).

Figure 11: Growth of KSA crude production by quality under alternative scenario, Jan – Dec 19E

Forecast projections shown in Figure 12 reveal that by curbing its production beyond pledged target, all else remaining equal, Saudi Arabia is risking tightening even further the medium/heavy sour market. Indicatively, the BD spread is expected to dive and remain into negative territory in the first half of the year, $0.5/b lower on average than the baseline case, before turning positive as Saudi Arabia ramps-up its production and narrowing again year-end. Further, the results show that it makes little difference if Saudi Arabia replaces the cuts of medium/sour supplies with lighter sour crude, especially in the second half of the year.


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3.5. All in one go case

The final case combines the preceding forecast scenarios into one extreme scenario, albeit less plausible, that is intended to exert the outmost pressure on the sweet/sour crude spreads and provide useful insights regarding the limits and robustness of our modelled projections throughout. Evidently, Figure 13 shows that the occurrence of all the aforementioned events in the year ahead, will widen the BD spread into negative territory in the first half of the year, $1.5/b lower on average than the baseline, but again towards the end of the year the spread is expected to narrow as the large increases in the Brent price due to the supply shortages outweigh the pressure on the medium/heavy sour crudes. The net negative impact on the spread in this case exceeds the $2/b, higher than any preceding scenario.
4. Conclusion

The results show that the current supply outages and OPEC+ cuts do not only impact price levels, but also the price differentials between the key sweet-sour benchmarks. Since most of the supply losses are concentrated in the medium/heavy sour category, while most of the supply gains are concentrated in the light sweet category in part due to the strong growth in US shale, the light sweet-medium sour crude spread, represented in this paper by the Brent-Dubai price differential, has collapsed and at certain instances was trading at negative values. Looking ahead, our paper predicts that, other things being equal, the downward pressure on light sweet and medium sour crude spreads will persist throughout this year as losses from countries like Iran and Venezuela due to sanctions may accelerate and as Saudi Arabia and its partners are expected to maintain the cuts until the end of 2019. All else remaining equal, in some scenarios, our results show a decline in the spread of more than $1/b compared to the baseline scenario. This may have come as a surprise to some market analysts. Few months ago, the conventional wisdom was that the Brent-Dubai spread would widen as IMO rules start taking their effect and the shipping industry shifts towards consuming cleaner fuels including Marine Gasoil (MGO) and compliant low sulphur fuel oils. This should have the impact of increasing demand for light sweet crudes while lowering demand for sour crudes. What our results show is that IMO 2020 is only one of the many factors impacting spreads and supply factors are as important (if not more important) in determining movements in price differentials. In other words, the widening of the sweet-sour spreads may still occur as we enter 2020, but this is far from a forgone conclusion.

Our results also show that the current sweet-sour imbalance presents a challenge for OPEC and may complicate its efforts (particularly Saudi Arabia’s efforts) to balance the market. On the one hand, OPEC+ cuts are contributing to balancing the market in terms of cutting volumes and reversing the stock build-up that emerged in the last quarter of 2018; on the other hand, the surplus in light sweet crude persists. By cutting output, OPEC+ is tightening an already very tight medium/heavy sour market with potential implications on refining margins and eventually on global oil demand if complex refining margins weaken significantly. The key question facing OPEC+ producers is whether they should or can take any measures to resolve this quality imbalance or should they just leave it to the market mechanisms to resolve it. For now, the dominant view is that as demand for high sulfur fuel oil from the shipping industry falls when IMO 2020 rules enter into effect early next year and the demand for diesel rises (both directly and indirectly as diesel is diverted into blending to produce compliant fuel oils), the diesel margins will be high enough to compensate for weaker margins from other products and thus refinery run cuts could be avoided despite the relatively more expensive medium sour crudes. In fact, many analysts are even predicting that refining runs will have to rise to meet the additional increase in diesel demand from the shipping industry. As a result of these adjustments, it is expected that refineries’ relative demand for crudes with high yields of low sulfur vacuum gasoil (VGO) and diesel will increase, thus eventually widening the Brent-Dubai spread. But whether the price differential impact of such adjustments (assuming they occur in this fashion) will overwhelm the price impact of supply losses of medium sour crudes are yet to be seen.

7 In fact, the margins of other products such as gasoline, which have been recently quite weak, may witness a recovery. For instance, if Vacuum gasoil (VGO) (which is a straight-run product from the top end of vacuum distillation units widely run in catalytic crackers) is diverted into the fuel oil pool to create compliant fuel oil grades, gasoline production will fall and thus gasoline margins will recover.