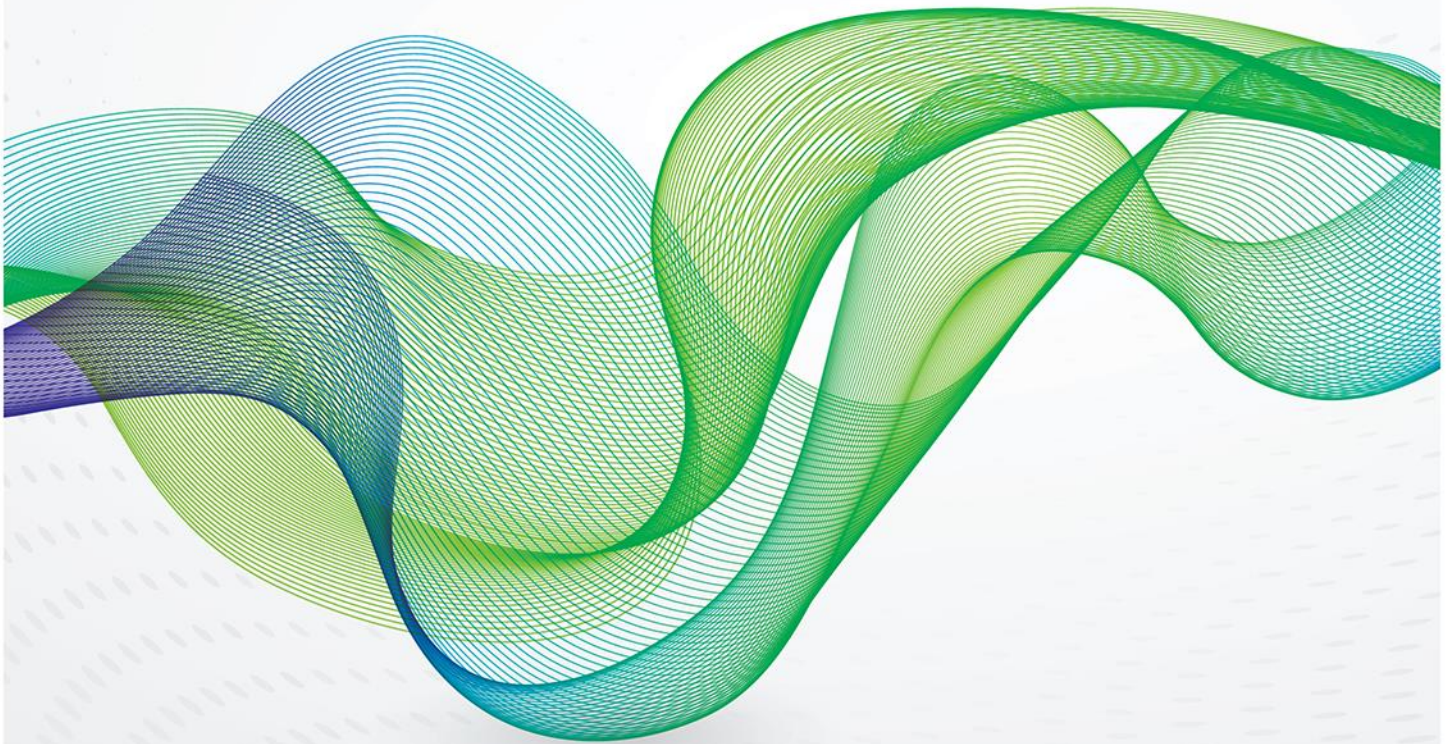


September 2018

# IMO 2020 and the Brent–Dubai Spread



## 1. Introduction

In October 2017, the International Maritime Organization (IMO) decided to limit sulphur content in all marine fuels from the current 3.5 per cent to 0.5 per cent, commencing in January 2020.<sup>1</sup> Meeting these requirements will involve huge effort by the refining and shipping industries. Investments in the energy industry are notoriously large, risky, price sensitive and come with long lead times and gestation periods. Given these features, and as the implementation deadline approaches, most of the adjustments will need to be reflected in terms of movement in relative product prices.

So far, most of the literature has focused on the IMO 2020 impacts on the refining and shipping sectors. Relatively little has been done to assess the impact on the prices of global oil benchmarks. This paper attempts to fill this gap. Specifically, we analyse the impact of IMO 2020 on the Brent–Dubai (BD) spread, the key price differential which regulates oil flows between the two biggest oil markets: the Atlantic basin and Asia. We begin by discussing the relationship between the Brent and Dubai benchmarks, and factors that drive this relationship. We then construct a simple crude yield comparison between the Brent and Dubai baskets using existing forward curves for products and freight. We find that the forward prices for oil products and shipping costs are consistent with the forward swap spread for BD. However, under certain circumstances, high sulphur fuel oil (HSFO) may have to find a home in the power sector. If HSFO is forced to compete with coal, the BD spread may have to widen to almost \$10 per barrel. Nevertheless, the BD spread will eventually adjust back to historical levels (and relatively quickly), driven by storage economics, investments in shipping and upgrading refinery units.

## 2. The Brent–Dubai oil pricing complex

Brent<sup>2</sup> is the key international oil benchmark<sup>3</sup>, with some three quarters of world crude oil production<sup>4</sup> linked to its price. While a majority of Asian sour crude is priced against the Dubai benchmark, it is generally accepted that the Dubai benchmark itself is a derivative of Brent.<sup>5</sup> Still, the Dubai benchmark serves an important market role, with at least 18 million barrels of oil per day traded in the region indexed to its price<sup>6</sup>. By trading it as a differential to Brent, market participants express their views regarding the relative values of sour crude oil grades in Asia relative to the sweet grades in the Atlantic basin. More importantly, they use the spread as a hedging tool for oil purchased on a Brent-related basis and sold on a Dubai pricing basis.

With the bulk of international oil trade currently done ‘East of Suez’, Asia has become the key region for setting international oil prices<sup>7</sup>. The BD differential<sup>8</sup> is a key tool for mitigating risk and acts as a signal regarding fundamental supply and demand conditions. Given that Asia is short crude oil, it pulls barrels from the Atlantic basin, which is long crude. A narrow BD spread (strong Dubai relative to Brent) would indicate strong demand in Asia, abundant supply in the Atlantic, or both. If the spread (plus the cost of shipping oil from the Atlantic basin to Asia) is less than the Dubai-related bids in Asia, the ‘arbitrage opens’ and oil will likely flow between the two markets. In contrast, a wide BD spread is usually an indicator of relatively poor demand in Asia or tight supply in the Atlantic, or both.

<sup>1</sup> International Maritime Organization, ‘Frequently Asked Questions: The 2020 global sulphur limit’, [http://www.imo.org/en/MediaCentre/HotTopics/GHG/Documents/FAQ\\_2020\\_English.pdf](http://www.imo.org/en/MediaCentre/HotTopics/GHG/Documents/FAQ_2020_English.pdf)

<sup>2</sup> Brent is a ‘brand name’ for a basket of North Sea grades: Brent, Forties, Oseberg, Ekofisk, and recently added Troll (BFOET). For more details see: <https://www.spglobal.com/platts/plattscontent/assets/files/en/our-methodology/methodology-specifications/crude-oil-methodology.pdf> page 16.

<sup>3</sup> For a good definition of an oil benchmark, see Chapter 3 of Johnston, O. (2018). *The Price Reporters: A Guide to PRAs and Commodity benchmarks*, London: Routledge.

<sup>4</sup> ICE: <https://www.theice.com/article/brent-crude/the-worlds-leading-crude-oil-benchmark>

<sup>5</sup> See for instance, Mabro, R. and Horsnell, P. (1993). *Oil Markets and Prices*, Oxford: OUP; Horsnell, P. (1997). *Oil In Asia*, Oxford: OUP; and Fattouh, B. (2012). *The Dubai Benchmark and its Role in the International Oil Pricing System*, Oxford: OIES.

<sup>6</sup> ‘FAQ: Dubai Crude’, Platts McGraw Hill Financial:

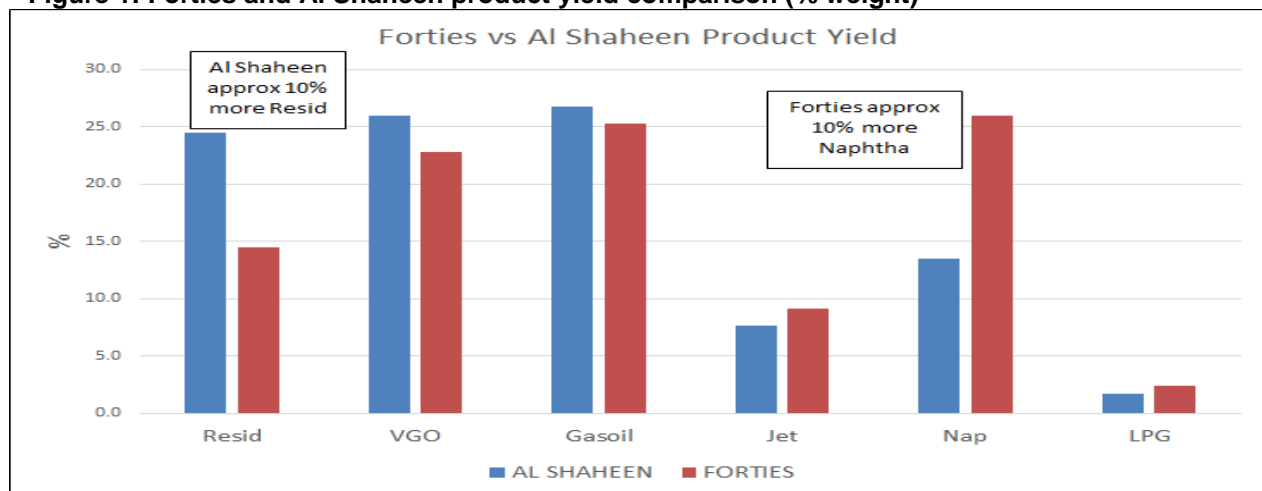
<https://www.platts.com/IM.Platts.Content/MethodologyReferences/MethodologySpecs/Dubai-Crude-FAQ.pdf>

<sup>7</sup> See Imsirovic, A. (2014). ‘Oil Markets in Transition and the Dubai Crude Oil Benchmark’, in *Oxford Energy Comment*, Oxford: OIES.

<sup>8</sup> Brent–Dubai spread can be traded either as a ‘swap-swap’ spread (Brent swap minus Dubai swap usually over a calendar month) or as an EFS (exchange for swaps, where Brent futures are traded or ‘exchanged’ for Dubai swaps).

Firstly, the value of the BD spread is determined by several factors, including the product yield of the two underlying baskets. The lowest-priced crude within each basket sets the price; this would ordinarily be Forties (37.3° API density, 0.845% sulphur) for Brent, and Al Shaheen (29° API density, 2.3% sulphur)<sup>9</sup> for Dubai. Figure 1 illustrates the difference in terms of yields between the two oil grades: Forties yields more desirable/higher-priced products (LPG, naphtha, and jet fuel) compared with Al-Shaheen, which yields more residual oil (resid). The most significant difference can be clearly seen in the figure. There is roughly 10 per cent difference between resid and naphtha yields. Interestingly, there is roughly the same percentage difference in their low-sulphur fuel oil (LSFO) and high-sulphur fuel oil (HSFO) yields as well (which cannot be seen in the figure, but will be explained later). It follows that the higher quality of the Brent basket, under normal market conditions, justifies a positive spread (premium of Brent over Dubai).

**Figure 1: Forties and Al Shaheen product yield comparison (% weight)**



Source: Total website. Resid stands for 'residual fuel oil'; VGO for 'vacuum gasoil'; Gasoil for 'gasoil'; Jet for 'jet fuel'; Nap for 'naphtha'; and LPG for 'liquefied petroleum gas'.

Secondly, Asia has traditionally depended on OPEC sour crude for its refinery base slate. OPEC policy decisions impact the balance of sweet to sour oil in the market, and hence the BD spread. This is illustrated in Figure 2. For example, OPEC decisions to cut output generally lead to a narrowing of the spread, while the 'free for all' in 2014 and the 'price war' in late 2015 led to a major widening of BD. Conversely, the OPEC/non-OPEC agreement in December 2016 resulted in a sharp narrowing of the spread.<sup>10</sup>

Thirdly, the flow of marginal (arbitrage) barrels regulates the spread: a narrow BD spread would incentivize arbitrage imports from the Atlantic basin into Asia. The arbitrage would be 'locked in' or hedged by purchasing the BD spread, driving it higher until enough barrels have moved and the arbitrage is closed. Eventually, a closed arbitrage would put pressure on the Atlantic basin and Brent would fall until it is cheap enough relative to Dubai for the arbitrage to open again.<sup>11</sup> Furthermore, the arbitrage is driven by the costs of moving the barrels between regions. Therefore, freight costs tend to be essential in making the arbitrage work. The higher the freight element is in the cost of moving the barrels between the two markets, the less likely it is to happen. If this is the case, the bids for imported oil in Asia may have to increase to facilitate the imports. This would tend to narrow the BD spread<sup>12</sup>.

<sup>9</sup> We are using TOTSA assay database:

[https://www.totsa.com/pub/crude/index2.php?expand=5&iback=5&rub=11&image=middle\\_east#](https://www.totsa.com/pub/crude/index2.php?expand=5&iback=5&rub=11&image=middle_east#)

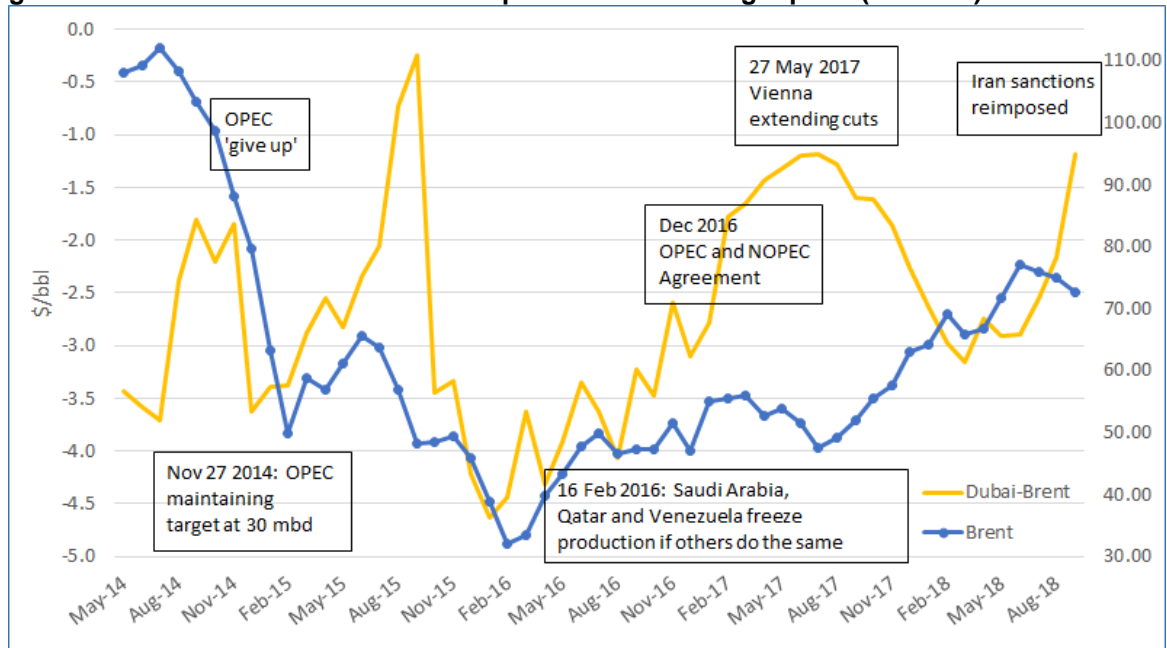
<sup>10</sup> This is just one of the factors influencing the BD spread, but it is often the dominant one.

<sup>11</sup> This is a theoretical concept. In practice, the existence of large buyers and sellers as well as greater liquidity in the Brent contract make the relationship 'sticky'. See Imsirovic, A. (2014). 'Oil Markets in Transition and the Dubai Crude Oil Benchmark', *Oxford Energy Comment*, Oxford: OIES.

<sup>12</sup> This depends on the shipping market. If the market is weak, ship owners may have to absorb the additional cost. However, in a balanced market, they are likely to pass the cost on to the charterer.



**Figure 2: The Evolution of Dubai–Brent spread v Brent outright price (2014–18)**

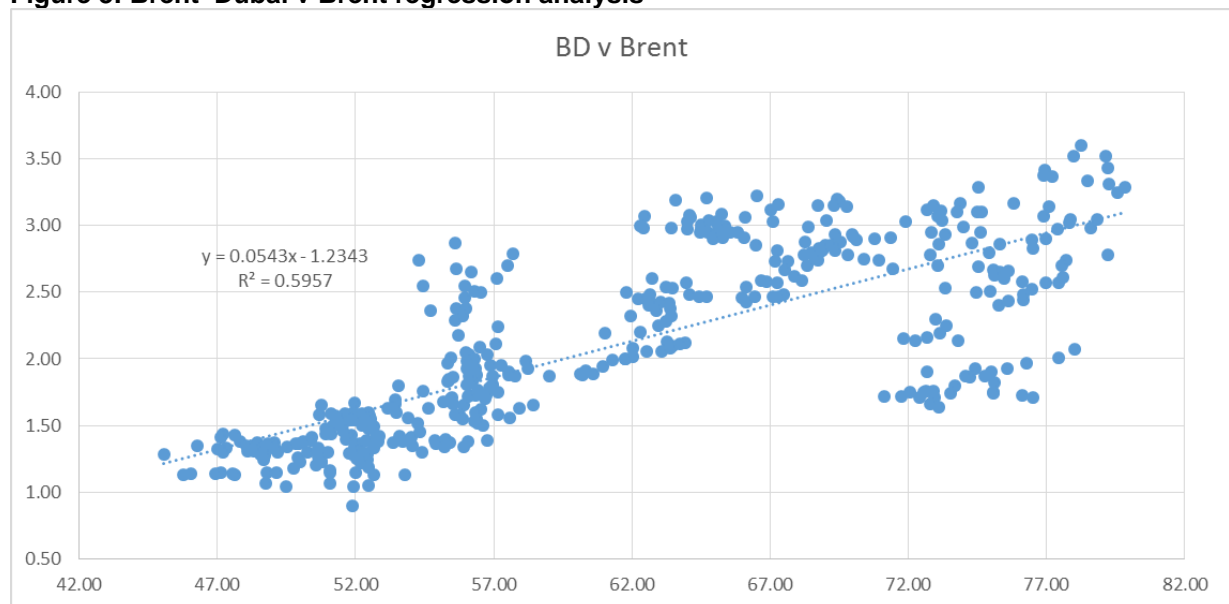


Source: Intercontinental Exchange (Brent) and Platts (Dubai) settlement prices.

It is important to point out that the recent flood of US oil exports into Europe and Asia does not necessarily change this – once loaded, US oil is essentially ‘Brent’ from the pricing point of view, as US crude exports compete with the Brent-priced crudes in the Atlantic basin and Asia.

Fourthly, Brent is a far more liquid oil contract, while the Dubai contract can be ‘sticky’<sup>13</sup>. At times of large movements in the Brent flat price, Dubai swaps lag and the BD spread widens. This is well illustrated in Figure 3 below, which shows the strong relationship between Brent outright prices and the BD spread.

**Figure 3: Brent–Dubai v Brent regression analysis**



Source: Authors’ own calculations.

<sup>13</sup> See Imsirovic, A. (2014). ‘Oil Markets in Transition and the Dubai Crude Oil Benchmark’, *Oxford Energy Comment*, Oxford: OIES.

Lastly, geopolitical events play an important role, depending on whether they affect sweet or sour grades. For example, disruptions in Libya in the past have affected the availability of sweet, naphtha-rich barrels that it produces, and the implosion of the Venezuelan economy has had an impact on exports of its heavy, sour grades of oil. If this works in the same direction as the absolute price movements, the resulting effect can be large. For example, the loss of Libyan production in 2017 supported both the sweet Brent complex and flat price, thus supporting the BD spread; however, as Figure 2 illustrates, this effect is not always easy to separate from the other effects such as OPEC decisions.

In addition to the above factors, the IMO decision to limit sulphur content would also influence the BD spread by changing the relative values of fuels. But before analysing the potential impact of IMO 2020 on the BD spread, it is important to discuss how the shipping and refining industries would adjust to the new sulphur limits.

### 3. IMO 2020 and its Impacts on the shipping and refining sectors

Marine bunkers are a serious source of environmental pollution. While amounting to only 7 per cent of transport sector demand, marine bunkers create about 90 per cent of all the SO<sub>2</sub> emissions in the sector<sup>14</sup>. The International Maritime Organization is reducing the maximum permitted sulphur content for marine shipping ‘bunker’ fuels, from 3.5 per cent to 0.5 per cent, effective from 1 January 2020<sup>15</sup>. This change will have several consequences for the refining and shipping sectors. The effects will be felt globally, but less so in North America and parts of Europe already subject (since 2015) to the Sulphur Emission Control Area restriction of 0.1 per cent. The bunker fuel oil market currently accounts for 3.2 mb/d of demand.

The redistribution of this demand will be the shipping industry’s problem. The only available solution for vessels to continue using high-sulphur bunker fuel is to install an exhaust-cleaning system known as a ‘scrubber’. The final deadline is 1 March 2020, beyond which it will not be possible for a vessel to load HSFO without a scrubber. Alternatively, shippers will need to use a lower-sulphur fuel, either a new very low-sulphur fuel oil (VLSFO) or, more likely (at least initially), marine gasoil (MGO). The latter has a maximum sulphur content of 0.5 per cent and is already familiar to most ship owners. ‘Slow steaming’, travelling at lower speed, which results in a non-linear fuel saving, may also result in some loss in demand. Finally, vessels powered by liquefied natural gas (LNG)<sup>16</sup> are likely to see increased use as more of these vessels enter the market.

The redistribution of current supply is the refining industry’s problem. Its options are to alter refinery configuration to maximize gasoil production at the expense of fuel oil and naphtha; to use upgrading units, such as cokers and hydrocrackers, to crack the heavier fuel oil molecules into lighter components; to use a hydrotreater to desulphurize their fuel oil production sufficiently to make it compliant with the new regulations; to blend high-sulphur fuel oil with alternative low-sulphur fuels, to produce a product which is compliant; to find an outlet to burn it for its calorific value or, most relevantly for this paper, to run a less sulphurous crude through the refinery resulting in lower-sulphur products.

Significant column inches have already been devoted to the impact of IMO 2020 on the refining sector<sup>17</sup>. The overall impact will depend on a number of factors, including adjustments made by refineries to accommodate the new sulphur limits; the uptake of scrubbers by the shipping community;

<sup>14</sup> Goldman Sachs (2018). *The IMO 2020: Global Shipping’s Blue Sky Moment*, GS.

<sup>15</sup> Under MARPOL Annex VI, the global sulphur cap for fuel oil used on board ships is reduced initially to 3.50%<sub>m/m</sub> (from the current 4.50%), effective from 1 January 2012; then progressively to 0.50%, effective from 1 January 2020, subject to a feasibility review to be completed no later than 2018. International Maritime Organization, ‘Prevention of Air Pollution from Ships’: <http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Air-Pollution.aspx>

<sup>16</sup> There is a possibility of using LPG and other fuels, but at this stage, this comes at a much higher cost.

<sup>17</sup> For example, see Goldman Sachs (2018). *IMO 2020: Implications for global refining equities ... May 2018*. GS; Joswick, R. (2018). *Making Waves*, S&P Global Platts; Thompson Reuters (2018). *IMO 2020 – Challenges and Impact of the Sulphur Conundrum*.



availability and price of alternative fuels; compliance (or, more precisely, non-compliance) with regulation; and changes in the relative prices of oil products.

The impact will vary over time. However, given that refinery additions<sup>18</sup> cannot exceed those already scheduled to come online in 2019 (it takes a long time to build a new refinery), the new specification will need to be met by the existing refining system as of January 2020. Refineries will need to increase diesel yield at the expense of gasoline and vacuum gasoil (VGO), and increase overall refinery utilization (increase runs). Also, some existing fuel oil will need to find an alternative home, probably in the power sector, or be stored. These adjustments will cause the relative prices of fuels to change.

Much of the impact is already visible by looking at the forward curves. Lighter, clean product cracks, such as diesel and naphtha, are currently priced at a large premium to HSFO in 2020 versus prompt levels. This is well illustrated in Figure 4 and Figure 5 below: as refiners and bunker fuel distributors prepare for the new sulphur limit in January 2020, stocks of new, compliant fuels will need to be built while existing inventory of non-compliant HSFO will need to be depleted. Reduced demand for HSFO will result in excess supply by the second quarter of 2019, with its price roughly \$100/MT by the end of the year. We show this change in Figure 4 versus naphtha, as this is the basis of our model of BD behaviour. However, it can be seen even more clearly in Figure 5, which depicts the same price fall versus LSFO, which will be a basis of the new compliant fuel blend.

It is important to note that this key price relationship both drives, and is driven by, technological factors. The relative prices of oil products both drive refinery adjustments and stimulate needed investments, the latter constrained by the time required to bring new refining capacity and the return on investment. Wider inter-product spreads and higher LSFO–HSFO differentials are required to incentivize refineries to reduce HSFO output, and for end-users to adopt scrubbers or move to alternative fuels. Scrubber uptake and refinery upgrades will, in time, narrow these product spreads. In short, this is a dynamic system with multiple moving parts making forecasting difficult<sup>19</sup>.

The adjustment process by the refining and the shipping sectors, the attractiveness of alternative fuels at different points in time, and possible impact on prices are well covered by the existing literature<sup>20</sup>. In a nutshell, the excess supply of HSFO will initially either need to be stored (if the contango structure provides sufficient incentive) or be burned in the power sector<sup>21</sup>. The latter outlet only exists in regions with relaxed environmental standards where it can compete with LNG or coal. At the limit, the delivered price of HSFO to such regions should find an initial floor around the price of LNG, and then coal in terms of calorific value. HSFO is already pricing below LNG in the forward market, but has \$180/MT to go to reach a floor versus the coal-equivalent price in Asia.<sup>22</sup>

<sup>18</sup> Any spare refining capacity (relative to demand) in the 2019/20 period is likely to emerge in China and the Middle East. However, this is hard to predict as refinery projects notoriously get delayed.

<sup>19</sup> This would make the payback periods for such installations longer. This is why some banks are offering ship owners various hedging strategies if they opt for such installation. Such hedging narrows the spreads.

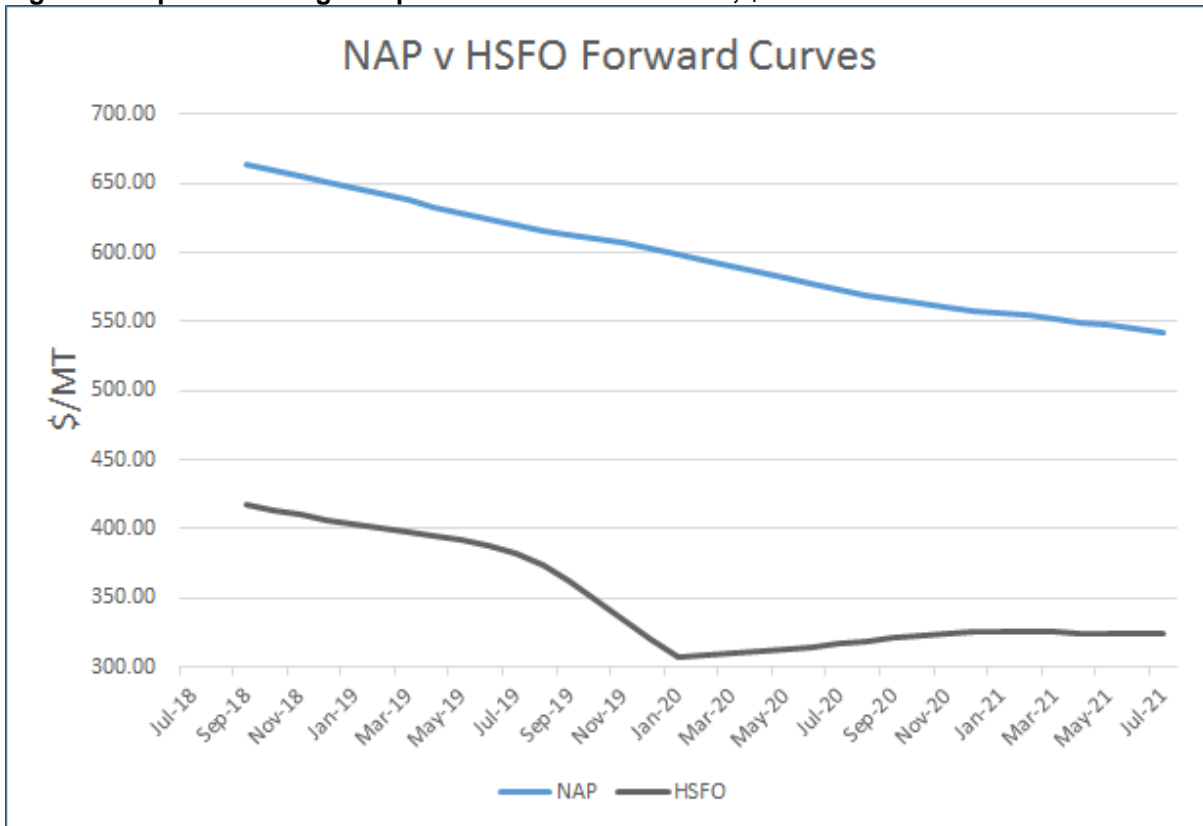
<sup>20</sup> For example, see Goldman Sachs (2018). *IMO 2020: Implications for global refining equities ... May 2018*. Goldman Sachs (2018). *The IMO 2020: Global Shipping's Blue Sky Moment*, GS.

<sup>21</sup> For example, Saudi Arabia has been substituting its 'crude oil burn' with cheaper HSFO. See Platts Bunkerwire, 10 September 2018.

<sup>22</sup> At the time of writing and (using coal calorific value at is 26.45 MMBTU/MT):

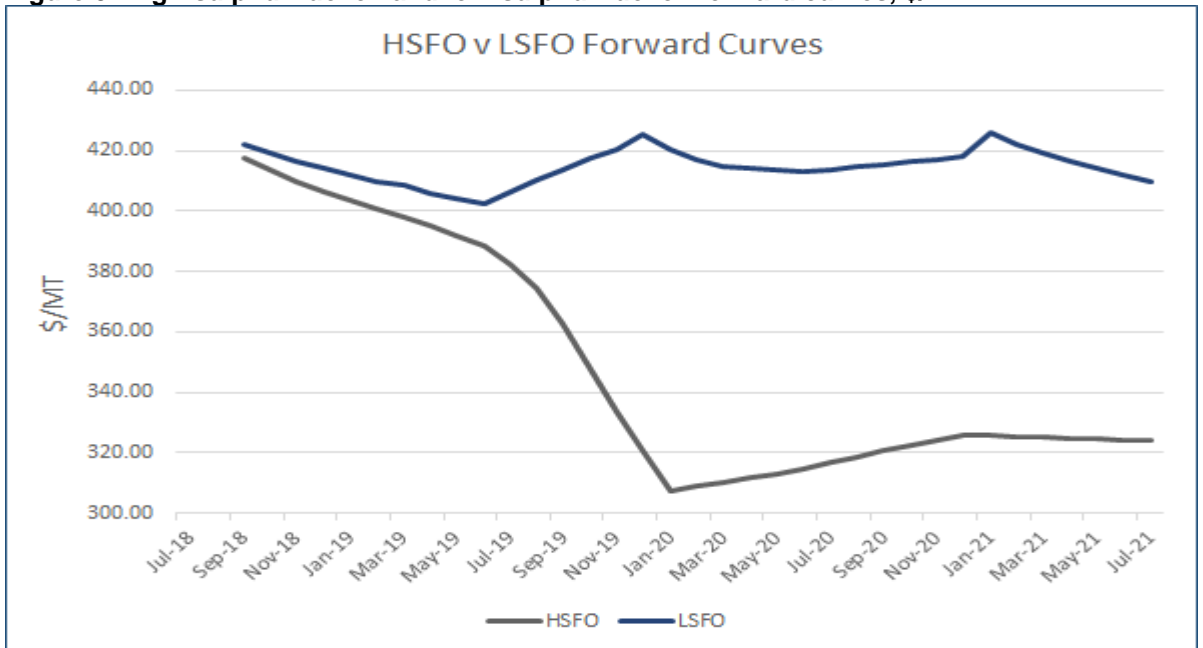
Cal 20 HSFO price: \$312.56/MT or \$7.83 per MMBTU; Cal 20 API2 Coal price: \$88.658/MT or \$3.35 per MMBTU; multiply the difference by 39.9225, which is 6.287 (MMBTU/bbl) \* 6.35 (bbl per MT); so, 3.5% Fuel would need to be \$180/MT cheaper to compete with coal.

**Figure 4. Naphtha and high-sulphur fuel oil forward curve, \$/MT**



Source: ICE, 4 September 2018 settlements.

**Figure 5: High-sulphur fuel oil and low-sulphur fuel oil forward curves, \$/MT**



Source: ICE, 4 September 2018 settlements.

## 4. The IMO 2020 and its impact on the BD spread

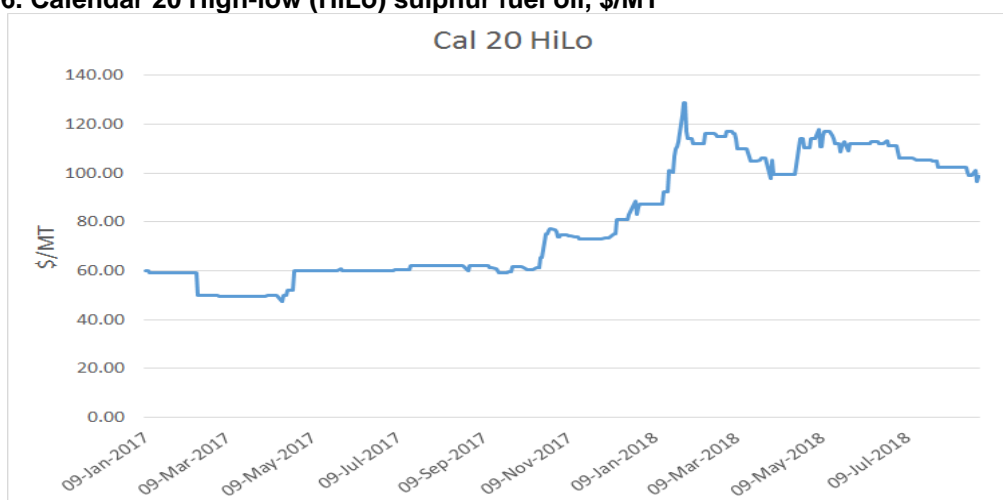
While most of the existing literature has focused on the impacts on refining and the shipping industry, in this paper we are specifically focusing on the impacts on the BD spread.

Heavier crude oils produce a larger percentage of fuel oil when refined; more sulphurous crude oils produce higher-sulphur oil products. More of the sulphur in a crude oil will end up in the fuel oil fraction, such that a 1 per cent sulphur crude oil will produce a fuel oil cut with a sulphur content higher than 1 per cent. The exact relationship between sulphur content in crude and the resulting sulphur content in fuel oil will vary from crude to crude. A crude with the same API and sulphur content as another, but with a lower fuel oil fraction, will likely produce more sulphurous fuel oil. In short, once the IMO 2020 regulations come into effect, all things being equal, the Dubai contract will most likely get penalized more than Brent, and the BD spread should widen.

For the purpose of this paper, we are using existing forward price curves to construct a simple model of BD spread behaviour. A key assumption is that all relevant information has already been absorbed by the market and priced into the forward derivative prices for naphtha, LSFO, HSFO and gasoil (GO)<sup>23</sup>.

As previously explained, the lowest common denominators in terms of value for the Brent and Dubai contracts are Forties and Al Shaheen. Al Shaheen has a sulphur content of 2.3 per cent, which implies it will produce fuel oil with a sulphur content of roughly 4.1 per cent<sup>24</sup>. Forties, at 0.84 per cent sulphur, implies production of 1.5 per cent sulphur fuel oil by the same metric. While both are above the 0.5 per cent required maximum for marine fuels in 2020, Forties-produced fuel oil should still hold some appeal to fuel oil blenders. Al Shaheen material will likely need to price itself into the power sector, unless discounted enough to garner sufficient interest from more integrated modern refineries with the ability to upgrade it sufficiently to meet specifications or break it into lighter products. The implications for lower-sulphur versus higher-sulphur (HiLo) fuel oil in 2020 are illustrated in Figure 6. It shows the movement of the 1 per cent versus 3.5 per cent (HiLo) sulphur fuel oil spread pricing in calendar 2020 in Europe. Following the IMO's October 2016 Marine Environment Protection Committee decision that the 0.50 per cent limit should apply from 1 January 2020, the spread widened significantly towards the end of 2017. By March 2018 it doubled, from \$60/MT to over \$120/MT, before settling at around \$100/ MT.

**Figure 6. Calendar 20 High-low (HiLo) sulphur fuel oil, \$/MT**



Source: ICE settlement prices, 4 September 2018.

<sup>23</sup> All the data are from CME or ICE, with the exception of LNG, JKM forward curves where we used GFI broker estimates.

<sup>24</sup> On average, atmospheric residue contains about 1.8 times the sulphur level of crude, though ratios will vary; see Joswick, R. (2018). *Making Waves*, S&P Global Platts.

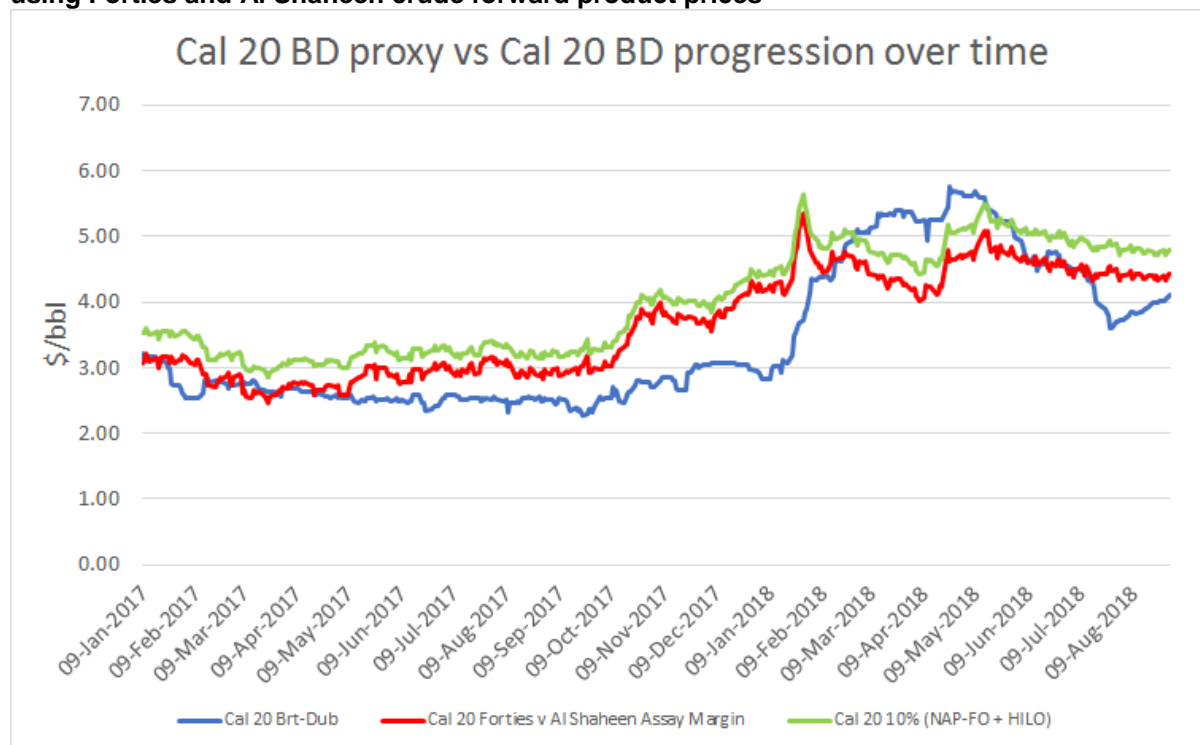


Sulphur content in fuel oil can be reduced using a hydrotreater, but these are not widely used and are more complex and not fungible compared with their distillate and gasoline equivalents; as such, the existing capacity currently devoted to lighter products could not be simply diverted if a sufficiently high price differential is reached. The other upgrading units are hydrocrackers and cokers but, again, existing capacity and that already scheduled to be completed will be all that is available when the regulations come into effect.

The most obvious way to compare the two grades of oil is in terms of their full assay fraction value (using forward curves for products). Figure 7 below illustrates this. Using values for calendar 2020 BD spread during the 2017–18 period (blue), we construct two forecasts. The first is a differential in the full assay fraction value between the two crudes multiplied by their calendar 2020 swap product values (in red). The second is a simplified yield differential between the two crudes (in green).

Forties yields (on a percentage weight basis) roughly 10 per cent more naphtha and 10 per cent less fuel oil than Al Shaheen. Forties will also produce roughly 10 per cent more LSFO and 10 per cent less HSFO than Al Shaheen. This is our simplified yield differential model, which we called the ‘10% model’ (in green)<sup>25</sup>. This simple model provides a good approximation for expected BD spread over the same period, as displayed in Figure 7.

**Figure 7. Actual BD swap spread 2017–18 v full assay model and our simple model forecasts using Forties and Al Shaheen crude forward product prices**



Source: Authors’ own calculations.

What is clear from Figure 7 is that our simple ‘10% model’ is fairly consistent with the full assay fraction model, as well as with the existing forward curves for BD. This implies that the forward curves for the BD spread fully incorporate all the forward prices as influenced by the IMO 2020 implementation. The reader may notice a dip in the spread after May 2018. This fall followed the announcement of the new sanctions on Iran by the Trump administration. This prompted expectations of a fall in Iranian oil exports, which are predominantly sour. Hence the BD spread narrowed. As the

<sup>25</sup> We are using a proxy formula of  $10\% \times ((\text{NAP-HSFO}) + (\text{LSFO-HSFO}))/7.45$  (7.45 industry standard bbl/MT conversion for crude oil). Reducing HSFO to parity with coal on an mmbtu basis and assuming no downside effect on LSFO is unlikely but simply illustrative of the most extreme possibility based on current curves.

case of the Iranian sanctions shows, the fundamental quality differential is just one of the many factors affecting the BD spread.

Another important impact of the IMO 2020 implementation will be on the freight costs, which directly affect the shipping economics governing the flow of oil from west to east, and hence the BD spread. For our purposes, the obvious cost to look at would be a VLCC freight rate from the North Sea to Asia. Such freight is normally negotiated on ‘lump sum’ basis, and does not readily trade on forward basis. We have used the ‘TD3c’ freight contract<sup>26</sup> as the best-available proxy that also trades several years forward. The value of this contract in 2020 (Figure 8 represents the existing forward freight market for TD3c contract, at the time of writing) implies an expected increase in transport costs between January 2019 and January 2020 of roughly \$1.00/ MT, or about, \$0.15 per barrel. This value is in sharp contrast with some industry expectations<sup>27</sup>. Given that the North Sea to China voyage is almost twice the distance of the ME to China (as represented in figure 8 by ‘TD3c’ contract), the increase in total freight cost resulting from IMO 2020 should be no more than \$0.30 per barrel. Overall, freight is subject to the shipping market conditions<sup>28</sup>, and includes many other factors, but the IMO 2020 impact is likely to be relatively small.

This modest increase in shipping costs may result in the BD spread narrowing by the same amount, in order to compensate for the additional cost of shipping. This would bring our simple forecast even closer to the actual values for BD spread shown in Figure 7.

This close prediction, based on underlying fundamental values and prices, also means that the market is not anticipating any major influence of other factors in 2020, such as new OPEC policy decisions or new geopolitical risks.

**Figure 8. Forward market for TD3c (VLCC size vessel Middle East to China) contract on CME**



Source: CME settlements, 4 September 2018.

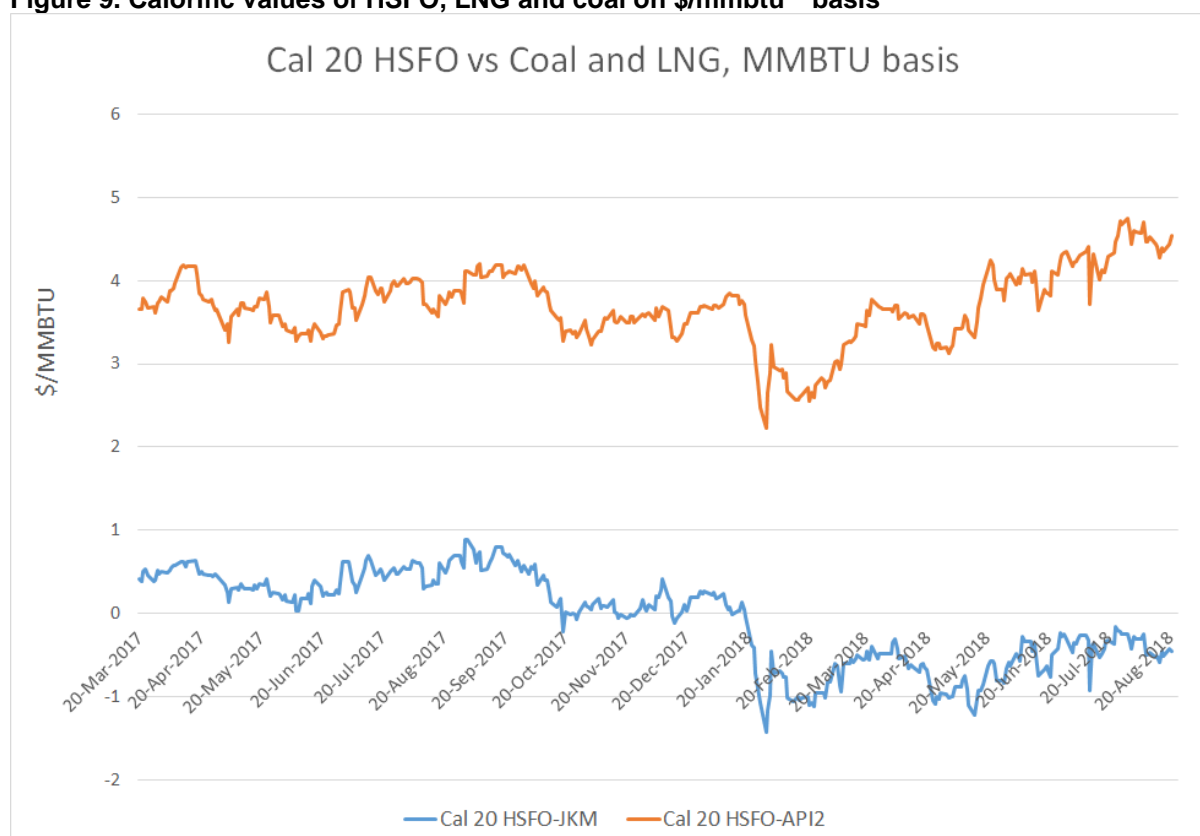
<sup>26</sup> TD3c rate is calculated on the Baltic Exchange and traded on both ICE and CME. It covers shipping from the Middle East to China for VLCC size vessels and is expressed in \$/MT.

<sup>27</sup> S&P Global see an increase by \$1.00–\$1.50/bbl. See Joswick, R. (2018). *Making Waves*. S&P Global Platts.

<sup>28</sup> As mentioned earlier, full costs may not be passed on to the charterer in loose market conditions.

Our model is based on the existing forward product prices and does not take into account the possibility of further discounting of HSFO values in 2020<sup>29</sup>. Figure 9 below shows delivered prices<sup>30</sup> of HSFO, LNG and coal in terms of their calorific values. It is clear from the graph that HSFO has been trading below the LNG price. This could well be one reason why Saudi Arabia may not be pursuing an aggressive strategy and substituting crude and fuel oil burning with LNG. On the other hand, delivered coal prices in Asia are still way below the HSFO prices – by a good \$4/mmbtu. At the extreme, HSFO would find its ultimate floor at the equivalent calorific price of coal, which is some \$180/MT below the current calendar 2020 prices of over \$400/MT. Our model suggests such a move would widen the BD spread in 2020 to over \$9.50 per barrel, significantly wider than the current<sup>31</sup> forward value (as depicted on Figure 7) of about \$4.00/bbl. Again, this is an extreme case, assuming all other factors influencing BD spread are unchanged.

**Figure 9. Calorific values of HSFO, LNG and coal on \$/mmbtu<sup>32</sup> basis**



Source: CME and ICE settlements, 20 April 2017–30 Aug 2018<sup>33</sup>.

## 5. Conclusion

The implementation of the IMO 2020 rules will have a potentially significant effect on the refining and shipping sectors globally. The size and direction of that impact will depend on decisions made in each of these sectors and the possibility and cost of removing some of the excess HSFO outside the transportation sector. Given the lighter, sweet nature of the Brent and heavier, sour nature of the Dubai baskets, the impact on the differential could be significant. While there may be debate

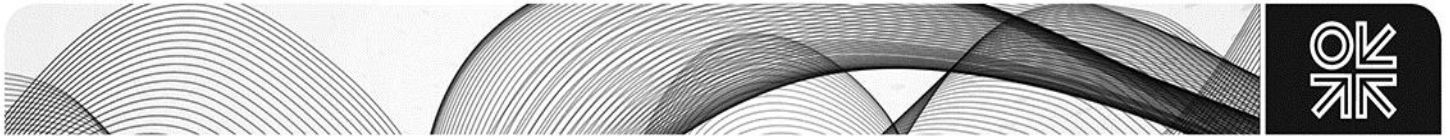
<sup>29</sup> We deliberately used the existing products market forward swap curves to avoid getting bogged down in myriad scenarios regarding the possible product differentials. Here, we consider only one possible extreme case where HSFO prices need to fall (as already mentioned in footnote #17) by another \$180/MT to reach parity with coal.

<sup>30</sup> We consider the Middle East because we see this region as a possible 'sink' for excess HSFO.

<sup>31</sup> At the time of writing (early September 2018).

<sup>32</sup> We assume mmbtu = millions of British thermal units = 252,000 kcal. Using Society of Petroleum Engineers for HSFO and coal conversions to mmbtu/barrel: <https://www.spe.org/industry/unit-conversion-factors.php>.

<sup>33</sup> JKM is Japan/Korea Marker. API2 is Rotterdam Coal Futures. Freight differentials calculated using TD3 forward curve.

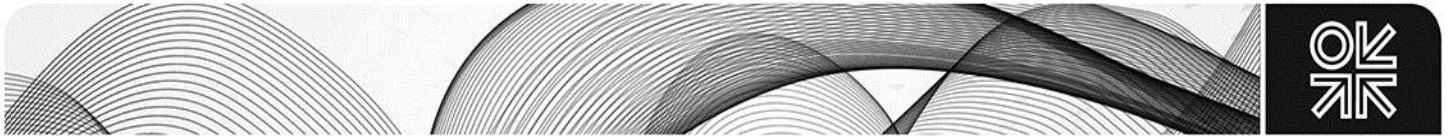


regarding the extent of the widening of the spread, there is no doubt regarding the direction. In terms of forward-trading derivative prices, light and sweet oil products have already appreciated relative to heavy sour ones. This has had the effect of widening the BD spread.

We designed a simple model of the BD spread using the least costly grades in the two respective baskets, Forties and Al Shaheen. Using forward (2020 swap) product prices, we constructed a forward curve for the BD swap spread in 2020. With emphasis on parsimony, we constructed a very simple '10% model' using naphtha/HSFO and HSFO/LSFO spreads to forecast forward BD curves. The model is consistent with a more complex one using full assay yields, and very much consistent with the existing BD forward curves. When adjusted for a possible change of the freight cost, the results are even closer.

The model can be used as a simple 'rule of thumb' in evaluating different product price scenarios. For example, it shows that, in a scenario where HSFO ends up competing with coal in the power sector, the BD spread could easily widen to almost \$10 per barrel. However, we show that a number of other factors influence the BD spread, and these have to be taken into account in any evaluation.





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