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MARKET MICROSTRUCTURE FACTORS IN THE DETERMINATION OF OIL PRICES

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ABSTRACT

On 20 April 2020 the West Texas Intermediate (WTI) oil futures price for May delivery turned negative for the first time in history. Other crude prices also posted very low values and their volatility soared, far more than that on stock markets. This article analyses the differences between the spot and futures markets for crude, demonstrating the key role they played in the source and subsequent correction of this event, which affected above all WTI contracts more than Brent. The article also highlights the increasingly significant presence of oil exchange-traded funds (ETFs) and their growing use as a retail investment instrument.

Keywords: oil prices, COVID-19, volatility, ETFs, futures, spot prices.

JEL classification: Q41, G15, E44, Q43, G41.

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Introduction. The physical market and reference prices

We normally talk about the "oil price" as though it were a single uniform good, but in practice it is not. The end-use of crude oil is its transformation into fuel and plastics. The return on this transformation process is determined by refining technology and by the quality of the crude, defined chiefly by its density and sulphur content. This quality varies according to the source of the crude, of which there are almost as many varieties as there are oilfields.[2]

Oil trading has been concentrated in a limited number of reference qualities, which comprise the core of international crude trades both in the physical and financial markets, against which the different varieties of oil are compared to set their price. Each type of crude is thus traded following a price formula defined by the spread or premium over one of these reference markers.[3]

The market mainly uses three references, depending on the source and sale destinations. Hence, Brent is used as a reference to determine the price of crude from Europe and Africa;[4] WTI is the main reference for US, Canadian and Mexican oil production; and Dubai and Oman crudes are the reference for the price in the Middle East and east and south-east Asia.[5]

Specialist agencies[6] monitor the physical market and transactions; and they evaluate and publish the spot and forward prices of the reference crudes and the spreads for the different varieties. Notable among these is the Dated Brent price, published by Platts (now part of S&P Global), which is the daily evaluation of the price of physical North Sea

1 The authors are grateful to J. Ayuso, R. Gimeno, E. González, J. Ibáñez and A. van Rixtel for their comments.

2 Crudes are described as heavy or light, according to their density, and also as sweet or bitter, according to their sulphur content. For example, the North Sea crudes are light and sweet (with a low sulphur content), and those of the Persian Gulf are heavier and more bitter. For an introduction to the market, see Amic, E. (2005) "The Oil Market as a World Market" in H. Geman (ed.) Commodities and Commodity Derivatives, John Wiley & Sons, UK.

3 For physical shipments, the spreads or premia, apart from the quality of the crude, also depend on location, period and means of delivery (the so-called *incoterms* or terms of international trade).

4 Different premia from Brent set the price of the different varieties of North Sea, Black Sea, Mediterranean, Nigerian, etc. crudes.

5 From purchase at source until reaching the refinery, a shipment can be traded on several occasions and with different premia or spreads over the course of the successive transactions.

6 They are known as PRAs (Price Reporting Agencies). The most representative agencies in this market are Platts (now part of S&P Global), Petroleum Argus and ICIS.

oil shipments with assigned delivery dates, and a proxy for the spot price of this crude.[7] In turn, transactions in Cushing, Oklahoma, of acceptable varieties of light and sweet crude are used to determine the WTI spot price.[8]

The reference crudes act as a physical underlying asset for an organised financial derivatives market (crude futures, swaps and options) that attracts numerous financial agents and is essential for price-setting at the global level. In particular, many physical crude transactions are valued using the futures price as a reference.

WTI-Brent spread

The relative price of Brent against WTI is not constant over time and may vary enormously according to market circumstances and changes in the quality of the crude. Its magnitude and path is useful for studying the workings of Brent and WTI as reference prices in this market.

Chart 1 tracks historical Brent and WTI prices. Until 2011, WTI traded at a premium over Brent which chiefly reflected the transport costs[9] of shipments in the Atlantic (geographical arbitrage). However, since the growth of production in 2010 of crudes associated with WTI, in particular of crude from bituminous sands (mainly in Alberta, Canada) and of shale oil extracted using fracking techniques in the interior of the United States, this relationship turned around and its volatility increased, with WTI being priced at a discount in relation to Brent. Also, the increase in Cushing storage capacity and in connections with other points in the country, and the lifting in 2016 of the prohibition on US crude exports, raised WTI's position as a global reference crude, likewise influencing the relative prices between the two references.[10]

Oil futures

The biggest-volume financial contracts on oil are monthly futures for WTI, quoted on NYMEX (now part of CME), and for Brent, quoted on ICE (London).[11] Monthly

7 As production from the Brent field has diminished, other crudes (Forties, Oseberg, Ekofisk and Troll) have been included in the Dated Brent and forward evaluation, and the delivery period considered has also been extended to between ten days and one month. The evaluation of Dated Brent prices reflects the spot market value of the most competitive grade (Forties, normally) at 16:30 GMT. Daily production of these crudes is 1 million barrels, approximately. See "Platts Dated Brent vs other 'Brents'", April 2020, S&P Global Platts.

8 There are also evaluations of other spot prices for transactions in Houston, Texas, and Midland, Texas, called WTI Houston and WTI Midland, respectively. For further details on WTI developments, see K. D. Miller, M. T. Chevalier and J. Leavens (2010) "The role of WTI as a crude oil benchmark", Purvin & Gertz Inc.

9 The cost of freight is volatile; it depends on the demand for ships for other routes or for storage and on the cost of the oil (fuel) itself.

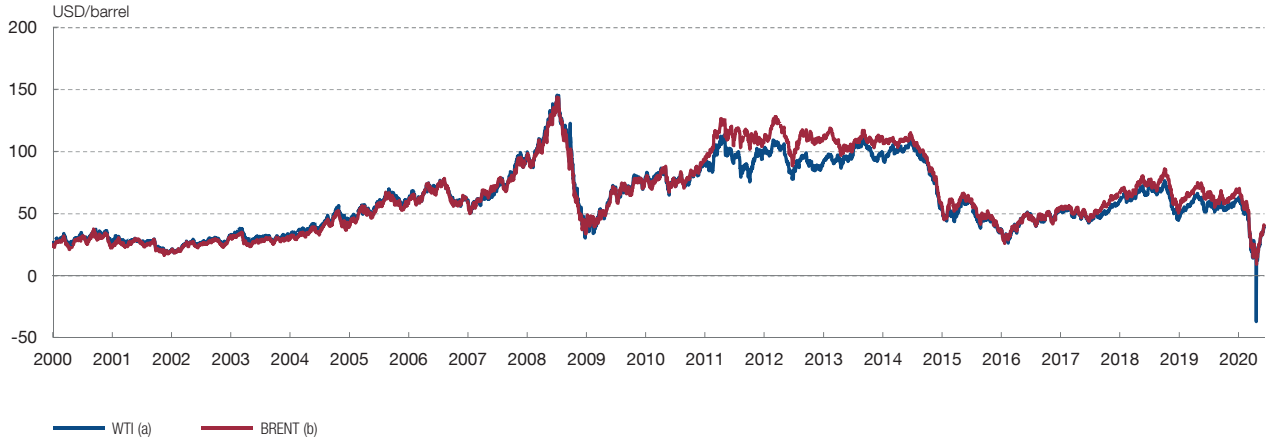
10 See D. Santabárbara (2017), "The Oil Market: Recent Developments and Outlook."

11 The DME Oman future is traded on the Dubai Mercantile Exchange (DME). It is the third most important reference globally and determines the official sale prices of Oman and Dubai crude oil, the historical markers established for crude oil exports from the Persian Gulf to Asia.

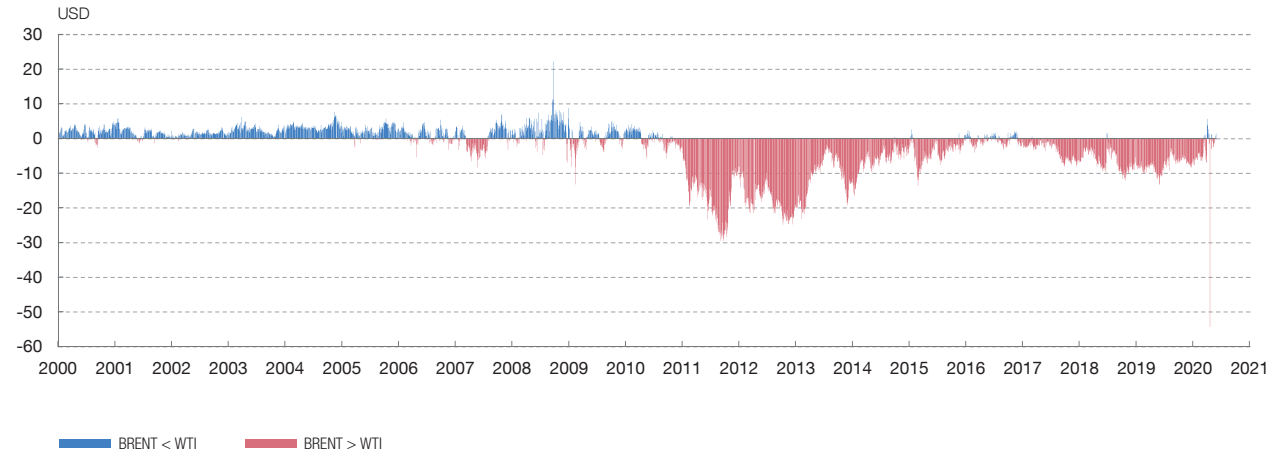
Chart 1
OIL PRICES

The different oil prices have historically followed parallel paths, with notable differences between the two.

1 OIL PRICES



2 PRICE SPREAD BETWEEN WTI AND BRENT



SOURCES: Thomson Reuters and EIA.

a https://www.eia.gov/dnav/pet/hist/RWTCD.htm.
b https://www.eia.gov/dnav/pet/hist/RBRTED.htm.

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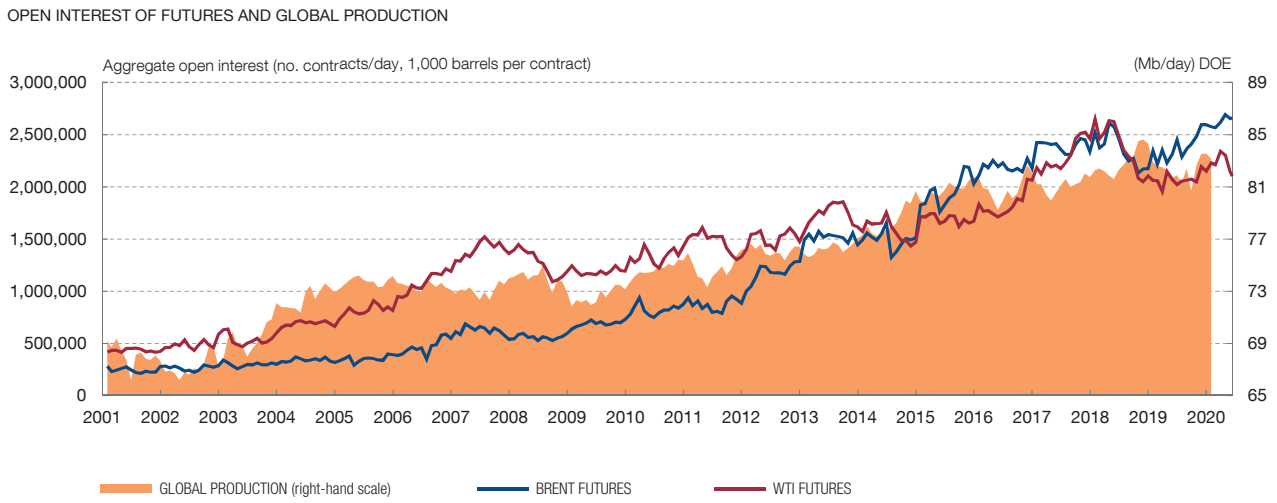
maturities stretching up to eight (ICE) and ten (NYMEX) years into the future are traded, and the size of the contract is 1,000 barrels.

In the case of WTI futures, on the contract expiry date the seller shall physically deliver the oil in Cushing, in a designated storage or pipeline facility, from which the buyer shall withdraw it.[12] Conversely, for Brent futures, there is the option (used

12 Pipelines from various producer regions arrive at Cushing and connect with tanks and refineries in many points of the United States; accordingly, Cushing was chosen as a delivery point for futures contracts. The WTI reference is used to define light and sweet crudes from various sources.

Chart 2
PHYSICAL OIL AND OIL FUTURES MARKET

Both the physical production of oil and the oil futures markets have grown in the past 20 years.



SOURCES: Bloomberg and DOE.

preferentially) to cash settle on the expiration of the contract having regard to the difference between the futures price and the ICE Brent Index price.[13]

From a historical perspective, the development of the futures market and other oil derivatives has contributed to changing the crude trading landscape, which is now concentrated in a small number of financial contract references. Thus, the open interest (the number of active contracts at all maturities) of WTI and Brent futures has risen from 900 million barrels (Mb) in 2003 (equivalent to 12 days' production at that time) to 4,400 Mb, equivalent to around 50 days of current daily global production (see Chart 2).

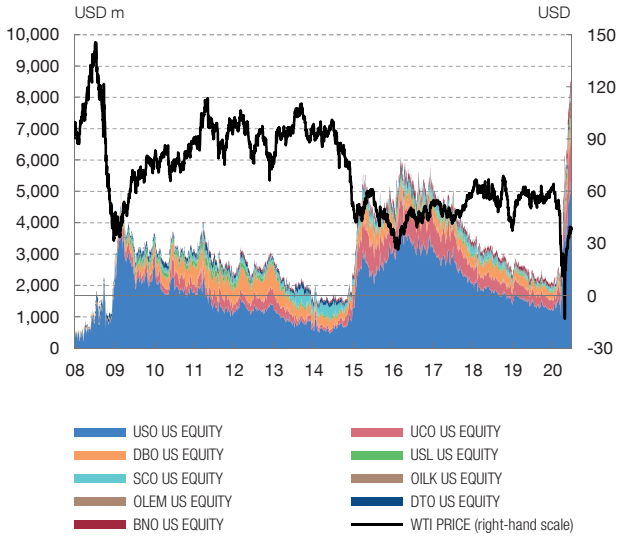
Many participants in this market are not only seeking a hedging instrument against unfavourable price movements that may affect their physical shipment transactions; rather, they are trading these derivatives as just another component in their investment portfolios. Taking a long (purchase) position in futures is a direct and simple means of having exposure to the price of crude without having the physical product. If it is wished to keep the position open beyond the expiry date of the futures contract, the contract must be sold before its expiration and another future with a subsequent expiry date bought. This rollover of the open position may entail a cost or return depending on the term structure of the futures curve. It entails a cost if the curve of futures prices has a positive slope (the price increases for maturities further ahead),

13 For further details on the contract and on the settlement process, see https://www.theice.com/products/219/Brent-Crude-Futures.

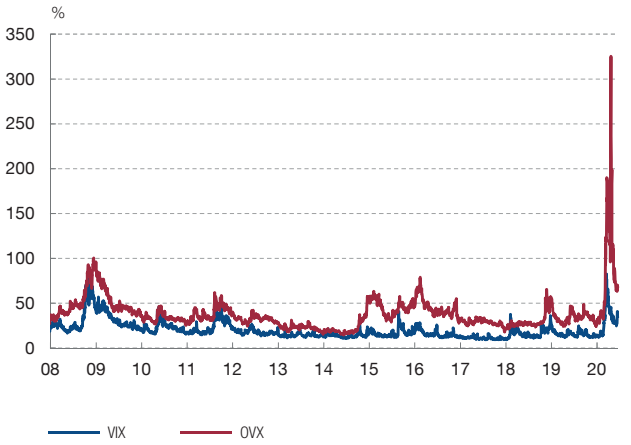
Chart 3
OIL ETFs

The capitalisation of the main oil ETFs has grown since the global financial crisis, enabling individual investors to invest in this market. However, the oil market evidences greater risk than the secondary market.

1 ETF. MARKET CAPITALISATION



2 STOCK MARKET AND OIL PRICE VOLATILITY



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SOURCES: Bloomberg and Chicago Board Options Exchange.

which is known as contango in the futures market. However, it involves a return if the futures term structure has a negative slope (futures expiring further ahead are priced below more imminent futures), which is known as backwardation in the futures market.

This means of operating has become increasingly important in the market, especially with the emergence of oil exchange-traded funds (ETFs). ETFs place these operations within reach of retail investors, who are shaping up as some of the most prominent players on the oil futures market (see Chart 3.1). Hence, although oil volatility usually exceeds volatility on the securities markets (see Chart 3.2), the capitalisation of the four main oil ETFs has doubled in volume compared with the situation prior to the global financial crisis, and it has held on a rising trend in recent months. This has led market regulators to express an interest in exploring (and, where appropriate, limiting) the market share in the hands of these funds so as to help ensure appropriate risk management and to mitigate the excessive potential impact that their trading strategies may have on prices.[14]

14 For further details see: https://www.sec.gov/Archives/edgar/data/1327068/000117120020000357/i20342_uso-s3a4.htm.

The COVID-19 crisis and factors that explain negative prices

The price of the WTI future for May expiring on 21 April was put under stress on 20 April, leading it to be quoted negatively for the first time in its history, while its volatility posted new record highs.[15] This extreme event came about after a chain of circumstances in the crude oil market.[16] In the closing months of 2019, Brent and WTI prices increased with backwardation in the oil futures market (see Charts 4.1 and 4.2). However, the production glut and the lack of agreement between the OPEC countries and Russia prompted a fall in short-term prices and flattened the curve in early February (see Charts 4.3 and 4.4). Physical oil traders took advantage of the situation to build up crude at low prices, which led to a significantly greater than expected need for oil storage which was close to the maximum storage available.

In this situation of surplus supply, the health crisis gave rise to a negative demand-side shock that was as unexpected as it was unprecedented. It particularly affected transport, and therefore the demand for petrol and aviation fuel (see Chart 5). The subsequent agreements in April to cut oil production did not suffice to check the decline in spot and futures prices with imminent expiry dates, and futures curves adjusted to the new supply and demand expectations, evidencing an even more marked contango in oil futures prices (see Charts 4.5 and 4.6).

Inventories kept on growing after the decline in demand and storage capacity began to be scarcer. Tank storage of WTI crude increased rapidly and peaked in all strategic geographical areas worldwide (see Chart 6). In Cushing, used storage capacity soared in April, reaching close-to-peak levels (see Chart 7), and with the uncertainty over whether still-free capacity was already committed. In this situation, and given that, for technical reasons, halting production in many oil wells is not straightforward, the flow of barrels towards Cushing continued to increase at a high pace. Additionally, many oil-producing companies in the United States have very high debt levels, which impose considerable liquidity needs on them. To meet these needs, they need the positive cash flows that crude oil sales generate, even if such sales have to be at very low prices.

On 20 April, the day before the expiry of the WTI futures contract for May, holders of these contracts had to choose whether to maintain the contract and take physical delivery in May, or sell the contract that day. Given that the WTI future is exclusively a physical delivery, market participants, among which the main ETFs,[17] with open

15 In June, the OVX was still over 60%, while the VIX was around 30-35%.

16 For further details, see Box 2 of the Quarterly Report on the Spanish Economy, *Economic Bulletin,* 2/2020.

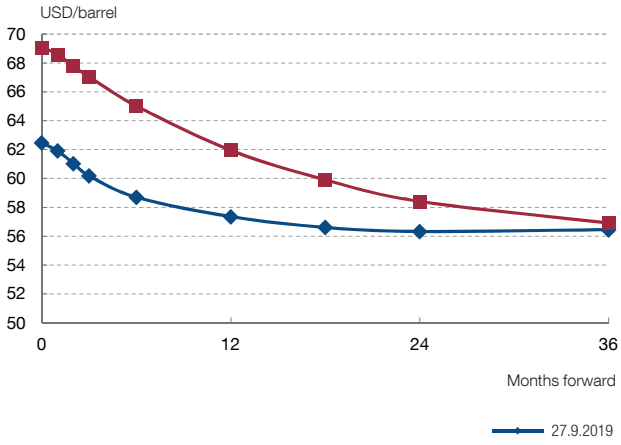
17 Although the main crude oil ETFs began to correct their position in the future contract for May, in the previous week the main oil ETF (USO) was the fourth most actively traded ETF in the United States on the morning of Monday 20 April, with more than USD 500 million changing hands before lunchtime in New York as the WTI spot price plummeted.

Chart 4

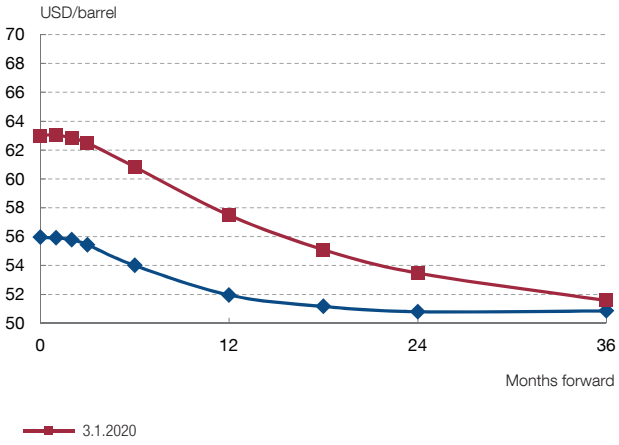
OIL FUTURES CURVES

The shortest-dated oil prices had risen in 2019 Q4. However, the curve flattened in early February, turning positive in April.

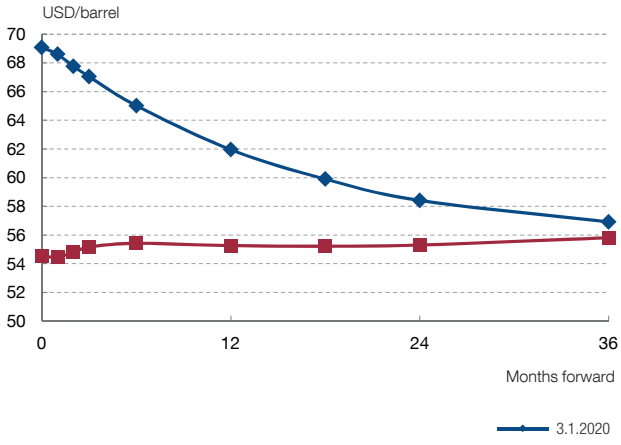
1 BRENT. INCREASE IN PRICE AND BACKWARDATION



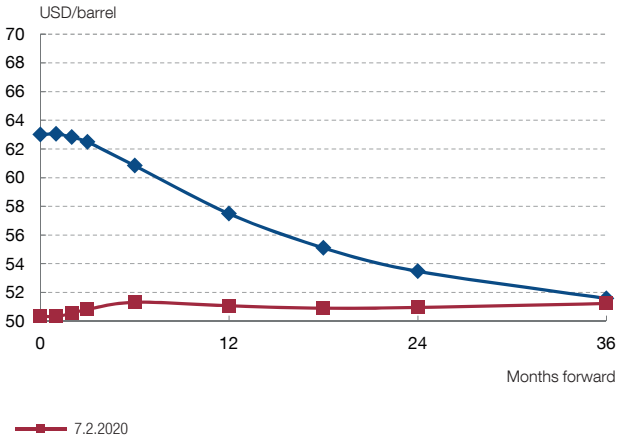
2 WTI. INCREASE IN PRICE AND BACKWARDATION



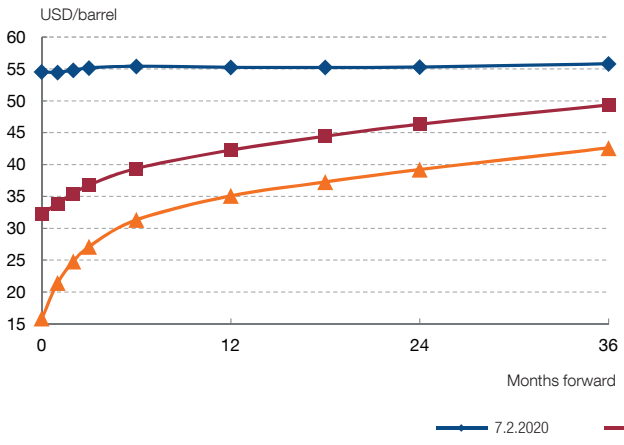
3 BRENT. FALL IN PRICES AND FLATTENING



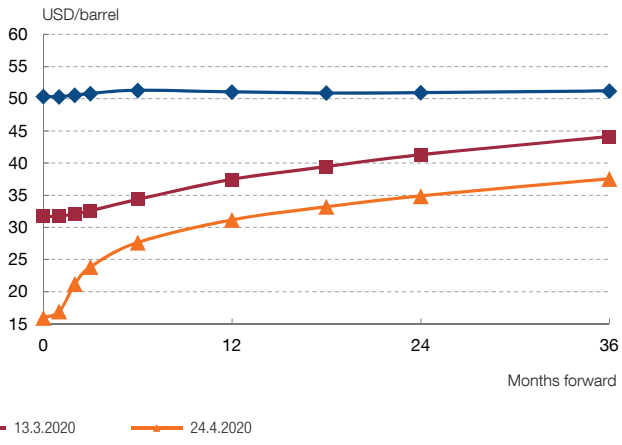
4 WTI. FALL IN PRICES AND FLATTENING



5 BRENT. FALL IN PRICES AND CONTANGO



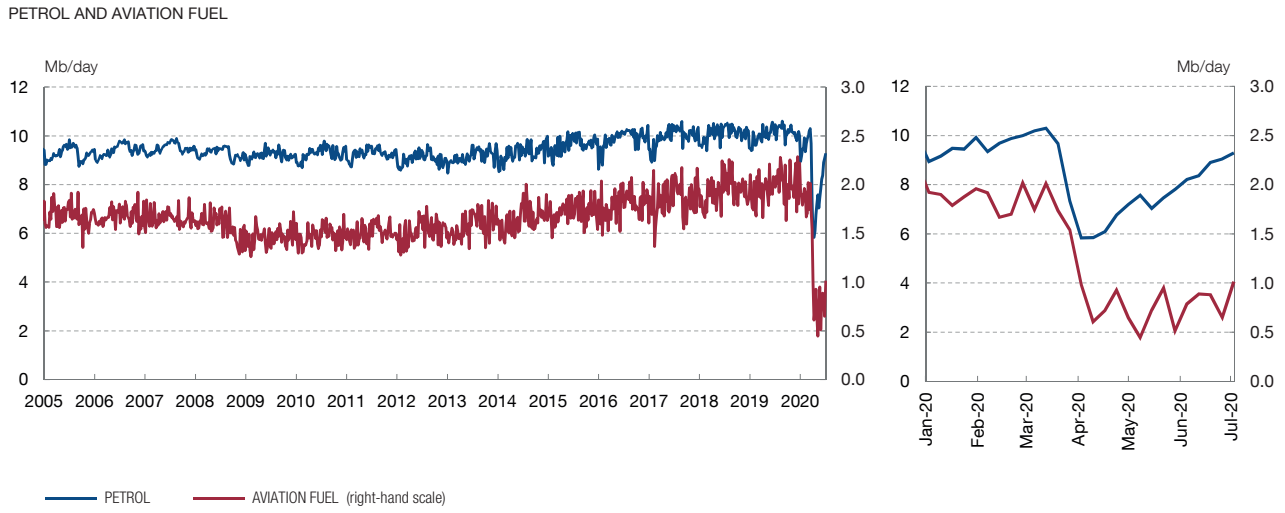
6 WTI. FALL IN PRICES AND CONTANGO



SOURCES: Bloomberg and Thomson Reuters.

Chart 5
DEMAND FOR FUEL

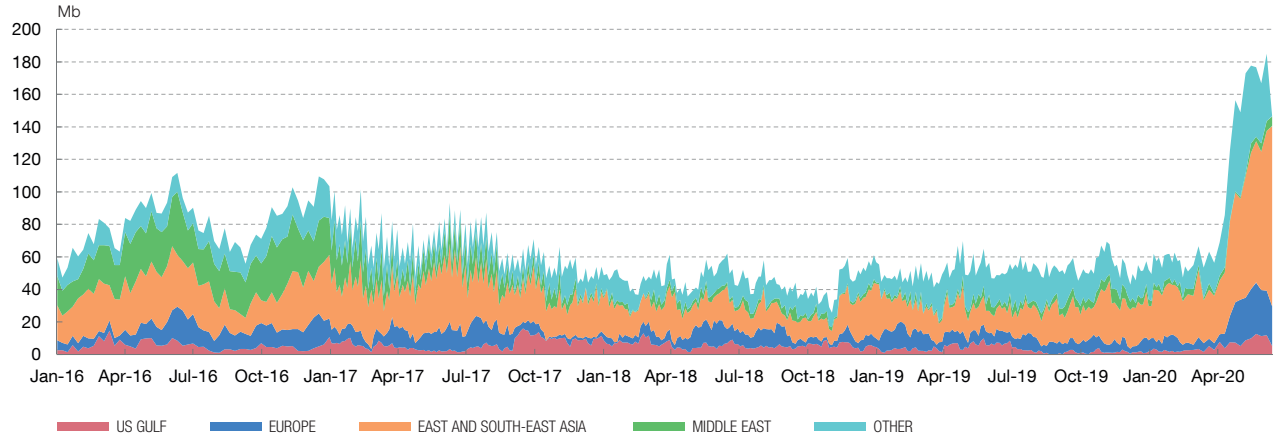
The demand for oil fell sharply further to the COVID-19 lockdown.



SOURCE: DOE.

Chart 6
OIL STORAGE IN TANKS

Oil inventories grew rapidly to maximum levels in all geographical areas.



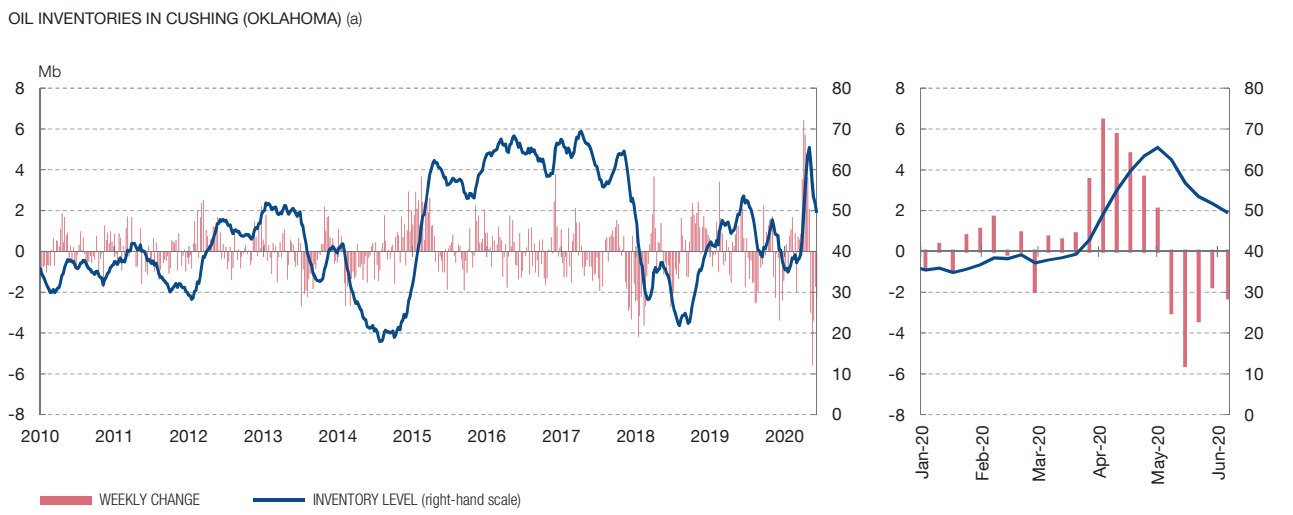
SOURCES: Bloomberg and Vortexa.

purchase positions and without the capacity to manage the physical crude in the event of delivery, were obliged to sell the contracts at increasingly lower prices, given the few counterparties ready to purchase the contracts (see Chart 8). Owing to the speed of the slump in prices, the imminence of expiry (and physical delivery) and operational constraints (scant demand and lack of storage capacity), most of the

Chart 7

WEEKLY CHANGE IN INVENTORIES IN CUSHING (OKLAHOMA)

Storage capacity used soared in April, reaching close-to-peak levels.



SOURCE: EIA.

a www.eia.gov.

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major physical market operators, who could have transported and stored the crude in another location at a sufficiently low price, were unable to enter the market to purchase. The outcome was that the end-price on 20 April of the WTI future for May was USD -37.63 per barrel, while the June contract closed at USD 20.43 per barrel (see Chart 8). At the close on 21 April, the contract closest to expiry was then that of June 2020, and it closed at a positive though very low price (USD 10 per barrel).

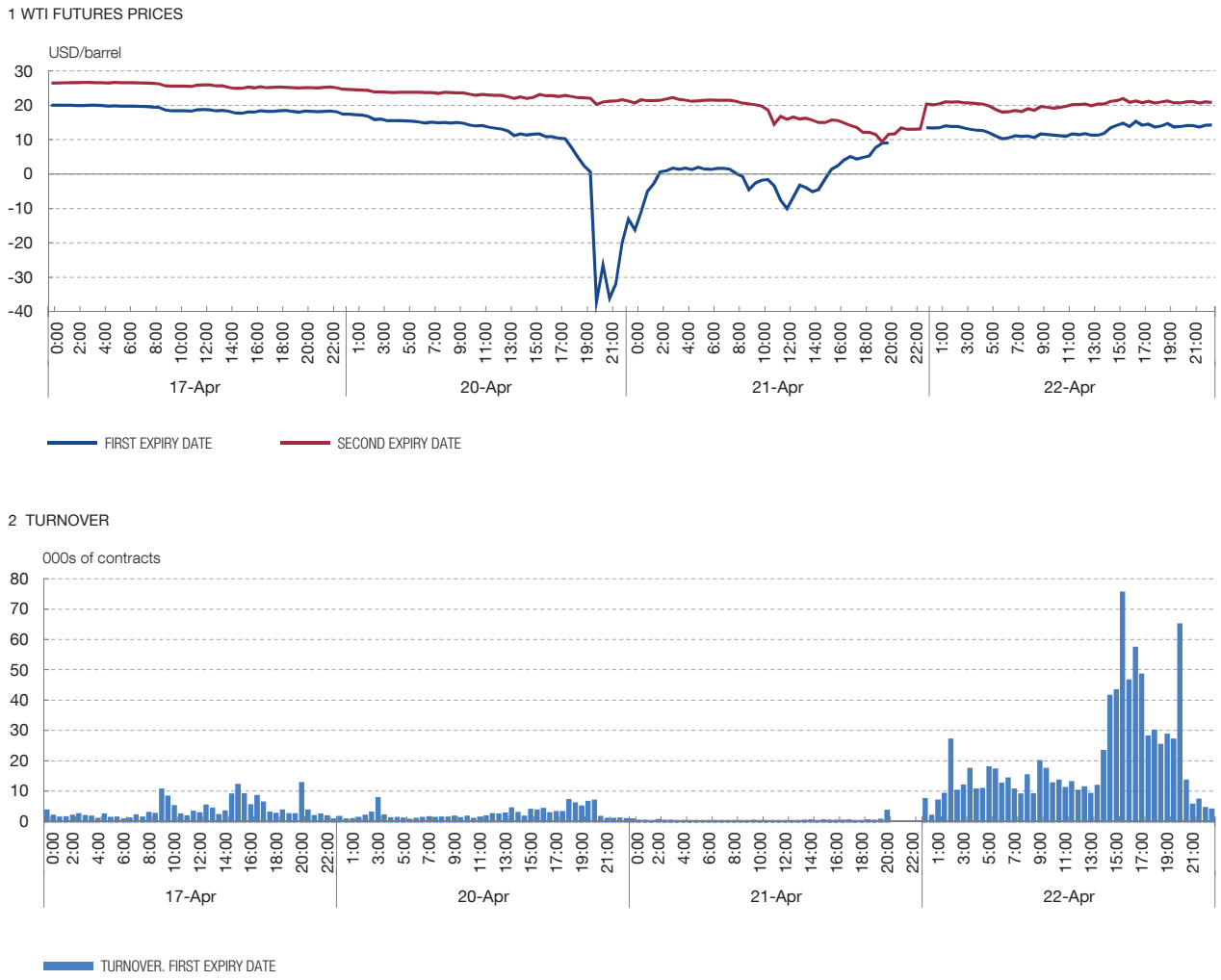
The demand-side problems and storage capacity tensions also affected ICE-quoted Brent futures prices, which fell to USD 19.33 per barrel on 21 April, a 19-year low (while the Dated Brent price closed at USD 9.12 per barrel), but far removed from the negative values seen for WTI. The reason for this differing behaviour in both futures contracts lies in the possibility the Brent futures contract offers to settle by differences (and not only in terms of the physical delivery), which eliminates the pressure to sell on the contract expiry date.

Given their relationship to WTI, contracts for the physical sale of crude in the US Gulf area also posted negative prices in this period.[18] However, the price of crude references did not have to fall into negative territory for there to be prices below or close to zero in the physical market. For example, in April, prices for heavy crudes such as Basrah

18 For example, the Argus Sour Crude Index (ASCI), a measure of US Gulf sour crudes that Saudi Arabia, Kuwait and Iraq use to set the price of their exports to the United States, turned negative.

Chart 8
WTI INTRA-DAY FUTURES

Prices turned negative on 20 April, only at the closest expiry date.



SOURCE: Bloomberg.

Heavy (Iraq) came to be set with discounts close to USD 12 per barrel compared with Dated Brent, when Dated Brent stood at around USD 10 per barrel.

Conclusions

The atypical event on 20 April in the futures market has evidenced some of the potential weaknesses of this market's microstructure, in both spot and futures terms. The futures market underwent a joint crude supply (positive) and demand (negative) shock. However, this joint shock affected WTI much more than it did Brent. The different characteristics of the futures contracts referenced to WTI (physical delivery) and Brent (physical delivery or settlement by differences) played

a key role in explaining the asymmetric effect of the supply and demand shock on these markets. Admittedly, there have been very special circumstances that have led to oil prices turning negative; but it cannot be ruled out that this may recur in the future. Hence, the Brent futures market, which would seem to be better protected than the WTI markets against shocks pressuring prices towards negative territory, announced that it would prepare its settlement systems for negative prices if it were necessary.

The movement in prices arising on the WTI derivatives market affected the physical oil market, since many crude sale contracts are referenced to the WTI or Brent futures price. Accordingly, the monitoring, oversight and design of the oil derivatives market is very important for the real economy, if it is wished to prevent bouts of high volatility impacting the economy as a whole.

Lastly, the growing importance and market share of oil ETFs, whose investors are generally individuals, advises more exhaustive monitoring. This is because the high volatility of the oil market poses an additional risk that may lead to high financial losses for participants. This is all the more significant if it is borne in mind that, following the April event, oil ETFs have become even more popular. As at June 2020, their market capitalisation was fourfold what it was at the beginning of the year.

17.7.2020.