Negative Futures Crude Prices -

Correlation of OPEC-Plus Supply and Existing VLCCs-FPSOs & Onshore Storage Indifferences

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الأسعار الآجلة السلبية للنفط الخام -

الارتباط بين عرض الأوبك بلس والناقلة النفط العائمة لتخزين الانتاج وتوزيعه ومؤشرات التخزين البرية

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جامعة الجزائر 3 – الجزائر

Received: 29/06/2020 **Accepted:** 02/12/2020 **Published:** 30/06/2022

Abstract:

This article attempts to explain the various interactions of crude market agents that resulted in a negative oil price in 2020. The study examined Contango conditions and modelled onshore storage capacity and FPSO demand. The empirical results show that in a case of perfect oligopolistic competition, the marginal cost of petroleum inventories would take the position of the price-cost difference for short-term deliveries. So, we point out that the OPEP-Plus producers could serve as Stackelberg's leaders by setting production quotas in the short future.

Keywords: Futures price, oil ETFs, OPEC-Plus, COVID-19, petroleum storage.

(JEL) Classification: D43, L11, Q47, G13.

ملخص:

يحاول هذا المقال شرح التفاعلات المختلفة لوكلاء السوق الخام التي أنشأت أسعار نفط سلبية خلال سنة 2020. حيث قمنا بتصميم نموذج Contango وتحليل حجم الطلب الخاص بناقلات النفط العائمة بالإضاقة إلى التخزين البري. تظهر النتائج التجريبية أن التكلفة الحدية لمخزونات النفط ستحل محل تباين الأسعار وتكاليف التسليم للعقود الآجلة في ظروف المنافسة الاحتكارية. أخيرًا، تم تأكيد فرضية تموقع منتجي أوبك بلس يمكنهم من قيادة الأسعار الآجلة وفقا لنموذج Stackelberg من خلال تنظيم حصص الإنتاج على المدى القصير.

الكلمات المفتاحية: سعر العقود الآجلة، صناديق الاستثمار المتداولة للنفط، أوبك بلس، COVID-19، تخزين البترول.

الترميز الاقتصادي(JEL): D43، L11، Q47، G13.

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I-Introduction :

Commonly oil price changes are computed separately from other commodities market due to the oil field imperfect competitive characteristics. Whereas supplies from OPEC-Plus are denominated as Stackelberg initiative, in which large producers like Russia and KSA move first and then the small suppliers follow sequentially. Others proposed Nash-Cournot competition approach for calculating crude prices, where futures price are composed alternatively in perfect competition to oligopolistic conditions scope.

While large crude suppliers might conduct marginal revenues optimization policy, where all producers take advantage from high oil prices in maximizing profits. But at the same time large producers can turn crude market into an oligopolistic structure by supply glut forcing a significant prices decline. As a result small producers that have high marginal cost will be eliminated from the industry due to sub-zero prices and market became an oligopoly for dominant producers.

Since information concern the global oil industry and U.S. oil production are not yet steady and are not so far near to as the bottom neck suggest. North Sea Brent benchmark might not have the same market conditions as the WTI that basically provides to market players prevention from negative price zone. But London intercontinental Exchange a major world commodity trading exchange works to provide clearing stand by services for negative Brent physical delivery trading contracts due to global crude oil market conditions.

Otherwise, the scarcity of storage areas that ignited WTI sub-zero price does not seem possibly to recover in the near future contacts delivery, despite the fact that crude prices now can switch below zero likely to help traders avoiding negative prices trap.

1. Research problem and sub-questions:

This paper tries to provide detailed explanations upon reasons behind the dramatic drop of futures crude oil contract prices in commodity exchanges through the following key question: **Under which market conditions futures crude oil contracts could be traded negatively in commodity futures exchanges?**

In order to find accurate evidences for the main research problem, we expanded the analysis and investigations to include the following areas:

1- How oil markets arrived to a situation where traders have to pay to get out of crude physical delivery?
2- Could Brent benchmark prices ever fall into negative territory?
3- How hitting storage capacity and corona virus affected future crude prices?
4- What is the role of floating storages and global corporate strategic petroleum reserves?
5- What is industry's next chapter of sub-zero prices after OPEC-Plus agreement?

2. Hypotheses:

Under the assumption of no-price discrimination of perfect competition and oligopolistic condition in crude oil market. We would take into account two conjectures: augmenting marginal cost of crude storage for net oil importers, and linear supply chart, in order to calculate global supplies under alternative market conditions that would be:

$$\delta c\left[Q_{NO}+\Delta Q_{NO}\right]=a-b\left[Q_O+Q_{NO}+\Delta Q_O+\Delta Q_O\right]$$

Assuming $\frac{\Delta Q_{NO}}{\Delta Q_O}=\frac{-b}{b+c\delta}$

3. Research objectives:

This essay attempts to analyze the pricing mechanisms of crude oil contracts for future delivery, and find out the relations of VLCCs, floating production storage and offloading to the physical delivery. Whereas, modeling onshore storage capacity of net oil importers countries to production levels and prices mainly under perfect competition and oligopolistic market conditions. Finally we try to determine the causality of negative futures crude oil contract.

4. Previous studies and analysis

4.1 Related studies: Energy economics researches have tall outrigger discussed the crude market components and oil prices construction. Recent papers tried to figure out the role of the organization of petroleum exporting countries in controlling production and market as whole. (Rosendahl, Kverndokk 2011). Others investigated oil market development from an oligopoly to perfect competitive market (Huppmann, Holz 2012). OPEC production policy collaboration ranges, other attempts to understand the swinger role of KSA in oil market and its impact on prices (Nuno and Nakov 2013). The most advanced researches have created models of OPEC reactions to prices change for specific market factors such as global demand, supply capacity and market rivals (Ritz and Behar 2017).

4.2 Previous analysis:

1- The breakdown of crude oil prices below zero obviously caused by global lack of storage capacity are signs from tight oil market conditions to suppliers, telling market forces will send prices to negative if producers do not reduce supply glut.

2- Rejecting West Texas Intermediate's May contacts mightily a financial matter rather than petroleum economics. Traders left acquiring contracts while the next day is contact expiration or delivery at the Oklahoma stockpile hub. But with no more storage space available, traders found themselves offering prices to clearing their obligations. Tight oil market conditions still up because crude production still above global consumptions.

3- On the other hand, production cuts agreement set in 12 April between OPEC-Plus members may bring market suppliers officially to reduce their output since 1 May. But still more supplies to arrive to the U.S. by June from the Middle East, approximately 10 million barrels from Iraq and 40 million barrels from KSA. In the same contest market indicators from Non-OPEC suppliers are disappointing as U.S. oil outputs has not dropped enough as considerably as monthly data provided from U.S. Energy Information Administration.

II .Methods and Materials:

1. Oil storage economics and marginal supply cost

A large numbers of oil future contacts traders basically try to inquire why we store crude oil in stockpiles in many regions in the world. Simply put, it is essential to understand first the concept of storage economics.

The breakeven price of crude oil of industry supply marginal cost, it illustrates the production cost per barrel generated by global crude oil suppliers. It is obviously for producers that

any price below 65$ per barrel let's say 50$ per barrel would immediately a large part of global oil producers to uncertain prospective.

On the other hand, it is clearly for exchange commercial traders to expect from market forces an immediate response to reproduce equilibrium. By putting market pressures on producers to reducing existing investments in order to lowering productions in the future which could send prices up to the break-even point again. For instance, if investment capital declined in the U.S. oil industry in 2020-2021, market analysts expect that crude oil prices to be revived again more rapidly, comparing to the increasing prices twofold in the first term of 2016 in less than a year.

If crude oil storage spaces are available, commercial traders are making profits from this process. In Oklahoma hub the substantial stockpile storage in the United States, market traders pay monthly 0.75$ per barrel as to store crude oil, therefore when price annually increases by 10$ per barrel they could generate 3.25$ per barrel this means 13% average yearly profit calculated at actual prices range. Despite the fact, if there is shortage in demand, suppliers remain holding contacts and storing crude oil while production keeps going and storage capacity commence to give out.

2. Supply downtrend velocity

Alongside with negative oil crisis, market analysts presume that there is no enough evidence to believe production downturn even with prices below zero. According to U.S. Energy Information Administration expectations, U.S. production may decline by 2.75 to 3.15 million barrels per day at the end of 2020, plus a significant decrease of 1.5 million barrel per day decline in the second half of the year due to capital investment spending slash. Which mean removing over around 70 million barrels supply in the next 4 months average from the estimated 950 million barrels per day overflow.

Jointly, oil industry shrinks by 5.3% this year which is equivalence of 3 million barrels per day of supplies in the first quarter 2020 suppose no attempt to turndown production. Market analysts rely on negative oil prices to shutoff spare production (150 million barrels of crude oil removed). As a result, assuming no potential would be layout to shut down production from 950 million barrels of market saturation, it would be 800 million barrels accommodating in 2021. (See figure.1).

3. Analysis of negative futures crude contract price

Since the early of April, it was visible that crude oil market was facing an exceptional turmoil. Sell orders in Nymex were growing dramatically in overnight trading, which made future delivery contracts loose 30% of market value to 13.07$ a barrel for West Texas Intermediate. Prices continued to decline for the most important commodity in the world to mark minus 37.63$ as investors struggle to get rid of futures contact prior the expiration date. The key question is: *How oil markets arrived to a situation where traders have to pay to get out of crude oil futures contract?*

The negative price involved merely May's delivery of crude oil that exchanged in future markets. Simultaneously, trading take places for contacts expiration for 3, 6 and 9 months that are performed in the same trading session in Nymex platform. For traders, rather than finding out how to store oil they are all set to pay potential buyers in order to get out of contacts. As a result, a benchmark of crude oil for May's delivery plunge to minus 37.63$ just a day before contract's expirations.

On the other hand, the mounting of oil carriers and full onshore tanks clearly suggest that oil industry is running out of storing sites. Future oil contacts holders that are entitled to take delivery

at Oklahoma storage hub hardly appeal to get more tanks are found themselves compelled to compete for paying off to get rid of their contracts. This made U.S. crude oil benchmark falling below zero for the first time in oil industry.

Due to global demand decline and economies lockdown, storage prices have been increasing dramatically during March and April 2020. The leading oil market benchmark Brent has lost a significant value before OPEC Plus agreement take place in May, from around 70$ in January to 19$ per barrel in April. According to Clarksons Platou Securities, a cost of leasing large offshore oil carries of 2 million barrels for storage purposes jumped to 227.000$ per day in March 2020. (See figure.2)

Prices for futures crude oil contract delivery for 3 months and more were much more above the falling prices in spot markets, setting up new market structure called forwardation (or contango), which is a situation where future prices of a commodity is higher than the spot prices. It enables investors in the spot markets to buy and store cheap crudes oil in order to sell it later in future markets. Brent marked into the bargain 14$ per barrel gap compared to futures contract of 3 months in one phase.

Even expectations in the petroleum sector for the next chapter are positive due to global move to mitigate travel ban and economies lockdowns which would certainly boost global demand again. Hiring cost of oil carriers for storage purposes fallen in May to 780.000$ per day while Brent benchmark 3 months spread is under 5$. But still a systematic key point in oil industry that transformed fossil fuel to a liability rather than an asset.

4. Corona virus impacts on global demand

Global demand for crude oil had been declining dramatically since the spread of corona virus around the world, slashing out the fuel prerequisites for aircrafts, factories, local cars fuel consumptions and shipping merchandises. As existing storages capacity are running out of spaces, suppliers found themselves struggling to figure out potential locations to store excess oil being pumping out.

The theoretical evidence suggests that global oil demand will reduce continuously due to corona virus pandemic. In the meantime, this exceptional market situation requires storing the oil as long as it keeps produced while no demand. Energy economic fundamentals indicate that price shall fall down to zero level and might go negative further with the world run out of storage capacity. The important matter at this stage is *how much corona virus would decline oil demand?*

Goldman Sachs monthly report records a huge decline in demand for March by 250 barrels with average cut of 7.5 million barrel per day. With OPEC Plus agreement to cut market share take place in May, our analysis assumes that 7.75 million barrels per day would be taken away from crude oil markets until June, since countries still locking downs economies due to corona virus. As result, during the period extended from March until June global demand is decreasing approximately by 930 barrels in total that suppliers need to stock before demand reboots.

5. WTI vs. Brent delivery requirements

While West Texas Intermediate benchmark is moving on the way to maximum storage in Oklahoma stockpiles hub. Other international benchmark as well as Brent and doesn't have the identical delivery conditions like WTI, which would provide it a significant security from sub-zero prices. But Brent futures contract are being standing by to negative prices in London

Intercontinental Exchange, which is the world major supplier of crude oil clearing services and online trading for a wide range of future commodities.

At the moment, it is important for traders and producers to understand that current prices might drop below zero for both marketplace benchmarks Brent and WTI. Particularly, with the insufficient storage capacity in Oklahoma stockpiles hub prospective, which does not sending signals to market players to be improved by the end of 2020.

6. Storage levels and futures price in perfect and monopolistic market conditions

First, we can compute future equilibrium prices according to the following linear equation in perfect market condition, which demonstrates the settlement of onshore and offshore crude storage capacity in parallel with production levels.

$$b\left(\Delta Q_{NO}+\Delta Q_0\right)\geq\left(\alpha-1\right)c\frac{\Delta Q_0}{Q_0-\Delta Q_0}$$

$$\Delta Q_0\frac{\delta bc}{b+\delta c}\geq\left(\alpha-1\right)c\frac{\Delta Q_0}{\left[Q_0-\Delta Q_0\right]}$$

$$Q_0-\Delta Q_0\geq\left(\alpha-1\right)c\frac{b+\delta c}{b\delta c}$$

$$\frac{\Delta Q_0}{Q_0}\leq1-\frac{\left(\delta Q_{NO}-1\right)}{Q_0}\times\frac{b+\delta c}{b\delta}$$

$$\frac{\Delta Q_0}{Q_0}\leq1-\left[\frac{\delta\left(a+c\right)-2\delta c-b}{c\left(\delta\left(a-c\right)-b\right)}\right]\times\frac{b+\delta c}{\delta c}$$

In like way, futures crude oil contract divergence comprises setting supplies upper the market demand by ΔQ_0 in order to take control of market prices by large oil suppliers $\left(\Pi_{MST}\geq\Pi_0\right)$.

$$\Delta_{OPECplus}\geq\left(\alpha-1\right)c\frac{\Delta Q_0}{Q_0+\Delta Q_0}$$

$$1+\frac{\Delta Q_0}{Q_0}\geq\frac{\delta\left(a+c\right)-2\delta c-b}{c\left(\delta\left(a-c\right)-b\right)}\times\frac{b+\delta c}{\delta}$$

That being the case of $\frac{-b}{\delta c}\leq\frac{\Delta Q_0}{Q_0}\leq\frac{b}{\delta c}$ which enables indifference market behaviors of Russia and KSA to oligopoly unconsumed crude in storage hubs (see table.1).

In order to identify futures crude price based on storages fill ups function, we applied storage factor functions in perfect, monopoly and oligopoly crude market, the result is shown as:

$$\prod_{PT} \geq \prod_{MST} (PPT - c)[Q_0 - \Delta Q_0] \geq (PMT - c)[Q_0 + \Delta Q_0]$$

$$\left(P_0 + \frac{\delta bc\Delta Q_0}{b - \delta c} - c\right)(Q_0 - \Delta Q_0) \geq \left(P_0 - \frac{\delta bc\Delta Q_0}{b + \delta c} - c\right)(Q_0 + \Delta Q_0)$$

$$\frac{2\delta bc\Delta Q_0}{b + \delta c} + 2c\Delta Q_0 \geq 2P_0\Delta Q_0$$

$$\frac{Q_0}{Q_{NO}} \geq \left(\delta c - \frac{c}{\frac{b + \delta bc}{a + c}}\right)\frac{b + \delta c}{\delta bc}$$

$$\frac{Q_0}{Q_{NO}} \geq \left(\delta - \frac{a + c}{b + \delta bc}\right)\frac{b + \delta c}{\delta bc}$$

Consequently storage factor plays a major role in optimizing futures crude price in oligopoly market condition, as long as total supply above demand. Conversely to monopolistic and perfect competition market terms when storage factor has negative effects on futures crude contract prices (see table.2).

7. Market exchanges halt

The predominant traders for futures crude oil contracts in Nymex attempted to seek for potential buyers before contracts' expirations, which force price cut to 5 dollar per barrel in the morning trading session. But was not enough for sellers to get out of contracts, as no buyers in the market. As a result, the trading clearance for West Texas Intermediate contracts quickly switched to maximum price cut to approximately 37.36$ below zero.

With no buyers for futures crude contract, physical crude market rooted by WTI clearance dropped as well, forcing refiner companies to offer negative prices for barrel (over 50$ per barrel). Some investors such as bank of china group investment limited choose to set held contracts near to total costs, which referred to risk free market strategy. Though, to settle 1.500 futures contracts equivalent to 1.5 million barrels of crude, the bank would have to pay off around 57 million dollar. Other investors did not customize their accounts positive after prices begin plunging below zero to cap up lost capital.

In overnight crude oil markets, some brokers prohibited traders to deal with 3 months futures contract to avoid similar market risks. With no buyers in oil markets, exchange trading funds moved to forward their holding contracts to 6 months delivery, to avoid failure if prices go negative. As a result, global crude markets shifted to another trading level, WTI 3 months delivery contracts dropped by 70% to 5.70$, London Intercontinental Exchange wasn't an exception as Brent futures dropped to 19.39$ per barrel leading other references to sub zero level as well as Dubai-Oman for Persian Gulf oil delivered to the Asian markets and West African and Russian crude.

8. Refiners activities interruption

Along with global demand plunging, refiners have experienced a significant halt around the world. In U.S. oil market Royal Dutch Shell announced it would turn down some refining activities 3 months ahead, the same were happening through Asian and European oil markets. From March to June U.S. refineries operated approximately 13.70 million barrels each day, instead of average

amount 18.76 million barrels a day in 2019. Oil market analysts expect much more 35% refineries activities shut are ahead during 2020 of total capacity, since global demand still shrinking.

9. Commercial oil contract physical delivery

The majority of exchange trading funds and other futures commodities, moved to open new forwarded market positions in later months to avoid sub-zero prices. Nevertheless crude oil futures contract funds that are required a physical delivery in storage hubs. It is hardly ever occurring when an investor get attached to an out dated futures crude contract. In case you hold an expired 1000 contracts, your position in market will switch from a trader to a possessor of 1 million barrel of crude.

In U.S. most physical delivery for West Texas Intermediate are executed in Oklahoma stockpiles hub. The prices of an out dated futures contract would significantly dropped down and will be not associated to global oil markets when storage capacity run out. While global demand continued plunging, assets lift up in Oklahoma hub and much more remaining balances are formally allocated. During the period extended from March-April 2020, inventories at Cushing jumped 70 million barrels that is equivalent to 87% of total storage capacity of 90 million.

In such market conditions, a large number of investors concentrating on so-called call clearing price just a day before the expiration of futures contract delivered in May. In Nymex specifically traders hardly attempts to reach out the clearance price for their contracts. It ultimately includes exchanging at clearance contracts, enabling investors to sell and buy crude oil futures contract at any price fulfilling the requirements for valid contracts.

10. Crude exchange traded funds volatility

Most crude oil trading markets had been affected with under zero prices of West Texas Intermediate for May delivery, causing global oil prices to record 30 years down. Exchange trading funds in crude in Asia jointly lost around 94 million dollar overnight due to crude futures contracts.

Investment statistics from Chinese crude oil funds 24 hours before WTI futures contract went negative, illustrated more than 1.7 billion dollar of market position for one month physical oil delivery. But as prices reached minus 37.36$ per barrel now investors' assets became liabilities.

Transactions of crude oil exchange funds with negative prices were part of some markets expectations. CME Group of Chicago the operator of commodity futures exchange had sent signal to investors to be prepared for below zero futures contract energy prices, and offered a stress testing system in order to evaluate their ability to meet futures oil contract commitments.

On the other hands, OPEC Plus arrived to an agreement to reduce global supplies by start cutting roughly 9.7 million barrels from 1 May 2020, with potential to raise it to 10 million of total outcome. Although, with no buyers in spot markets for 30 days contracts that cause refineries shut down, it was not enough to stop negative prices in exchange crude oil trading funds. (See figure.3).

11. Commodity futures trading commission ongoing review

The London Intercontinental exchange and financial regulator for Brent benchmark already has been preceded a review of other non market evidences stand behind negative prices, including trading system genius test and market transparency. Meanwhile, official governments still believe that negative oil price is an expected market response of global economic conditions and oil market structure.

In oil futures exchange, the Commodity Futures Trading Commission an independent U.S. government agency, is undertaking a serious evaluation of data came from U.S. Energy Information

Administration concern current storing capacity. Even most evidences say that negative oil prices seemed to be originated substantially from market forces of supply and demand, in addition to futures commodity trading characteristics.

In the same context, the key question should be what is the principal role of crude market in expedite links between futures and spot prices at settlement dates. Nymex declared that negative futures crude oil contract is the fundamental economic explanation of dynamic market, in order to abolish worthless surplus of oil.

12. Negative prices and future crude market structure

Many reasons about crude market conditions became clear to believe that oil industry is heading toward a big shut down. With global demand collapse, sub-zero prices, unconsumed storage, high onshore and offshore tariffs and investors' loss had made many market watchers to believe that the termination of oil industry is the next chapter.

The leverage of price war between the largest oil producers Russia-KSA and corona virus entered petroleum industry into a significant structural distortion. In the first phase, the economies' obstructions led to global demand curve to slope down as manufactures and workshops closed, driving stockpiles capacity running out. That made investors use offshore storages expecting better prices would resume over again. This has caused soaring of maritime oil transportation.

The fear of global supply cut effects on employments, firms and countries macroeconomic variables are the major purpose of the joint efforts to lead OPEC Plus for a systematic production shut down. But these efforts were not enough to keep oil prices away from sub-zero, and petroleum industry termination became a fact in many regions.

Assuming OPEC-Plus begin reducing global supplies in the first step as the arrangement states to the level of 9.7 million barrels. Market factors are stuck on shale oil field for more production cuts, after the significant drop of futures crude contract price to minus 37.36 a barrel. Data from U.S. energy information administration shows 772 active shale rig counts before the lockdown, to hit 60% off in 5 years low in May 2020 by 320 rigs. Many market watchers believe that U.S. shale oil is heading toward a negative shock until 2021, as shale industry would have to resist ongoing global production dries and sub-zero prices.

Physical crude market had a severe damaged from negative prices, as producers would have to pay nearly 37 dollar to discharge from their assets from March-June. In addition non conventional oil companies in the U.S. are heading for a big wells shut down in order to limit their losses. More than 7.000 shale oil wells had been closed in North Dakota, the large U.S. shale oil producer, equivalent to 500.000 barrel per day and 37% of total province production.

OPEC-Plus agreement to jointly cut outputs by 23% up to 10 million per day may help markets to start recovering cycle. Although, prices war between Russia and KSA did not succeed to reach Aramco market share levels, the same with Russian oil exports that registered a net decline since 13 years. As a result, by June it might not be sufficient onshore or shipping tanks available, as producers continue outputs cutting of a total of 600 million barrel.

In the fact, global daily oil consumptions dropped down by 35%, from 97 million barrel a day before the crisis to 59 million barrel a day. The storage capacity will continue to reduce in 2020, but investors' expectations are positive about global consumption relief and prices in 2021.

13. Strategic oil reserves and floating storages VLCCs - FPSOs

Many market analysts in net importers countries suggest that surplus oil in the system might be transferred to corporate strategic reserves of IEA members, which have a total capacity of 1.5 billion barrels. For instance the U.S. has one of the biggest strategic oil reserves in the world with 730 million barrel of capacity, data delivered from U.S. energy information administration show 20% of the total capacity still empty or around 650 million barrels.

Although, accurate information about total countries oil reserves levels are not available. But if we assume 20% of their reserves are still empty, it refers to 300 million barrels capacity not filled up yet. Many industrialized economies attempted to take advantage of sub-zero oil prices to fill up their reserves. India for example has a total capacity of 67 million barrels of petroleum reserve, and intending to purchase 50 million barrels in May, June and July after expanding more spaces to store extra barrels.

Even offshore crude storage looks a good option in time of negative prices, but it might not be an easy task in oil industry as not all petroleum grades have the same storage features. There are around 802 of very large crude carriers in the world, some are publicly owned companies and the rest are joint ventures. In addition to more than 175 floating production storage and offloading (FPSO) that can receive around 1 million barrel of crude, often cartel oil firms owned these FPSOs and operating them far overseas in order to maintain competition and control oil markets. If prices go down than firms can use FPSOs and VLCCs to store up to 350 million barrels for 3-4 months before price reboots.

In addition, both refineries and commercial crude stockpiles could play a major role during negative prices. For instance the U.S. has 793 million barrels of storage capacity including crude in transit, refined products and pipeline fills and still 350 million of spare capacity not yet filled up.

III. Results and discussion:

1. Hypotheses test:

1-1 The function of global supply does not include existing storage capacity nor spare stockpiles costs, because since marginal production cost is an amounting function, crude storage would replace price-cost divergences for futures crude in both oligopoly and perfect market condition all the time.

1-2 Crude production would keep pumping since marginal operational costs are set under market rates for Stackelberg market leaders, which refers to linear supply chart. While the rest of OPEC-Plus members are scatter plot depending on marginal production costs.

2. Results and discussion:

The evaluation of OPEC-Plus impacts on futures oil price illustrate that non-OPEC producers could act as Stackelberg perfect competitors by adjusting production quotas in oligopolistic conditions, at such time futures crude prices might roughly fluctuate below zero assuming no spare storage readily available to absorb the oversupply:

$$\left(\left(\frac{OPEC^{Plus.\Pr od}}{OPEC^{Cap}}\times OP^{Quo}\right)\div\left(\frac{OPEC_t^{prod}}{Aggregate}\right)\right)$$

Parallel with OPEC-Plus perfect market competition of supply, negative futures crude could not be driven by prices power in the short run, since existing storage facilities have major impact upon traders' on hold contracts for physical delivery. In contract to the long run where market forces neglect stockpiles rooms effects to prices power leverage on futures crude contract $\left(\sum_n \beta_n^{OPPlus\,Price} = Futures_{price}^{SypplyOPEC-Plus}\right)$.

Empirical results illustrated that global storage spaces could bear up to 1.5 billion barrel of oil so far, without considering additional stockpiles facilities and equipments that are expected to be operational before the end of 2020. Although, in worst scenario of global over supply which may be caused by economies lockdowns and 930 million barrels of oil glut, there will be still 35% of commercial storage capacity spare which may be used in order to stabilize crude oil crude market in the short and medium terms. Even though, these data do not explore commercial derivatives oil prospective held by refineries that can offer more storage rooms.

IV-Conclusion:

Negative crude oil crisis might turn away financial investors in stock markets from investing in oil derivatives, since market non-stabilizer factors still alarmed due to OPEC-Plus prices war, corona virus impacts on oil demand and potential of long recession of global economy. By money market outflow, crude market vulnerability would be settle in new higher level that certainly reflects upon future prices in medium terms.

Global crude oil market seemly arrived to the break point, where negative prices compelling OPEC-Plus members and net exporting countries to make a significant reduce in outputs in order to eliminate the oversupply. Although, empirical results show zero interconnection between futures crude contract prices and market forces, but it is familiar with two principal factors of Stackelberg structure of crude market dynamics and storage facility system.

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Appendix:

Table (1): Linear combination of existing storage and market factors

Factors	Targeted Market Share	Targeted Price	Forecasted Demand	Market Demand
OPEC-Plus Supply	-	-	+	+
OPEC Supply	-	+	+	+
Real Price	-		-	+
Speculative Price	+		+	+
Storage fill up	+	-	-	

Observation: Most variables have positive reaction to pricing oil market tensions. Otherwise, speculative demand and price target shocks have negative linear impact on existing storage levels.

Table (2): Correlation of market supply and existing storage indifferences

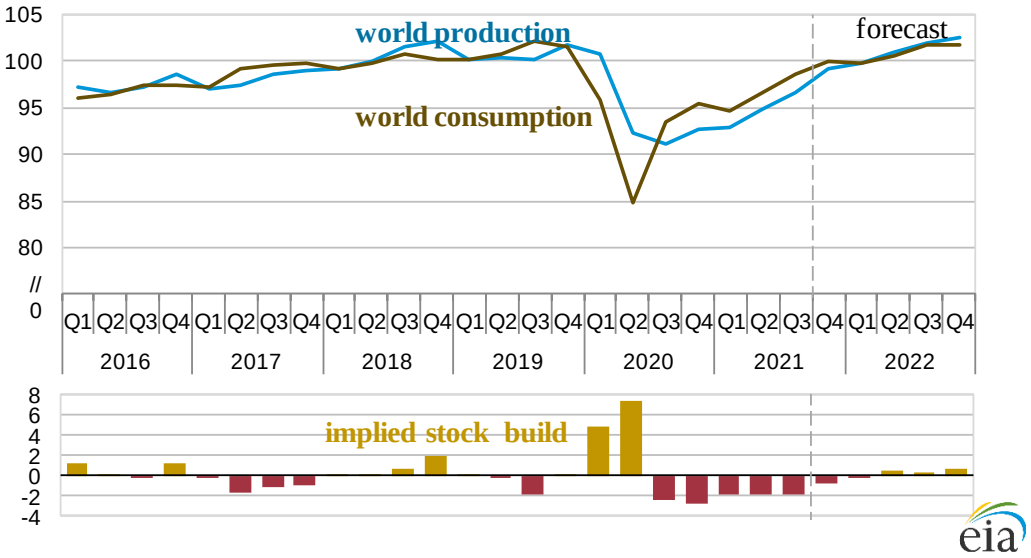
Correlation	*Model*	*KM**	*CCI***	*BH****
Price correlation to demand	*-0.28*	*-0.08*	*-0.07*	*-0.35*
Price correlation to commercial storage	*0.10*	*0.03*	*0.08*	*0.15*
Price correlation to OPEC-Plus supply	*0.20*		*0.19*	
Price correlation to OPEC supply	*0.06*		*-0.01*	

Source: Strategic interactions and price dynamics in the global oil market, Irma Alonso, Verginia Di Nino, Fabrizio Venditti, ECB Eurosystem, working paper series, page 21.

*KM refers to Kilian and Murphy 2014.
**CCI refers to Caladara, Cavallo and Lacoviello 2019.
***BH refers to Baumeister and Hamilton 2019.

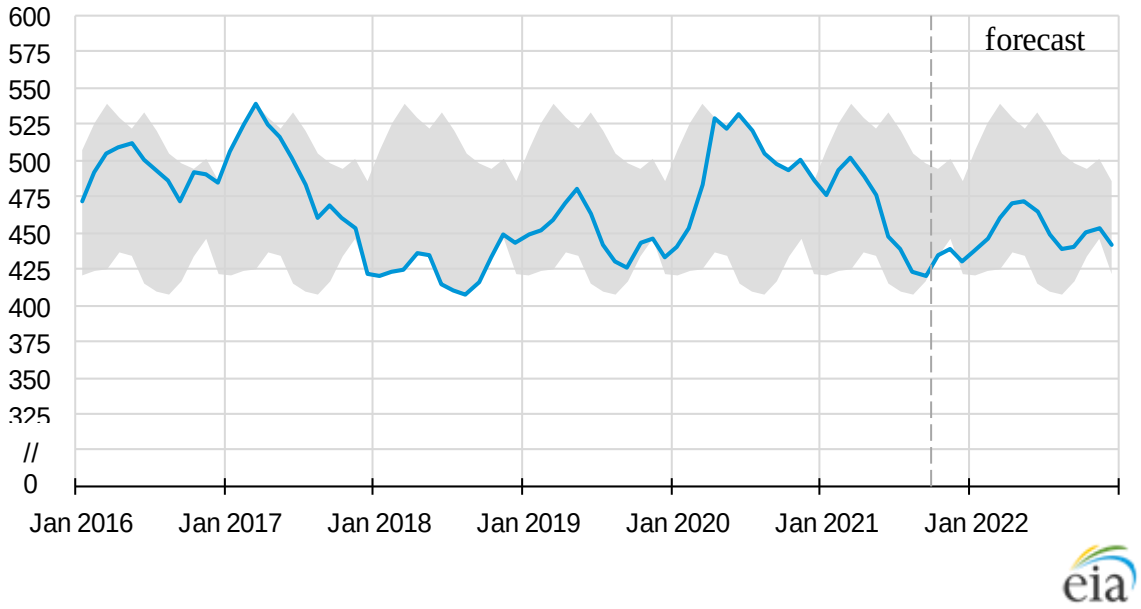
Figure (1): World liquid fuels production and consumption balance

million barrels per day



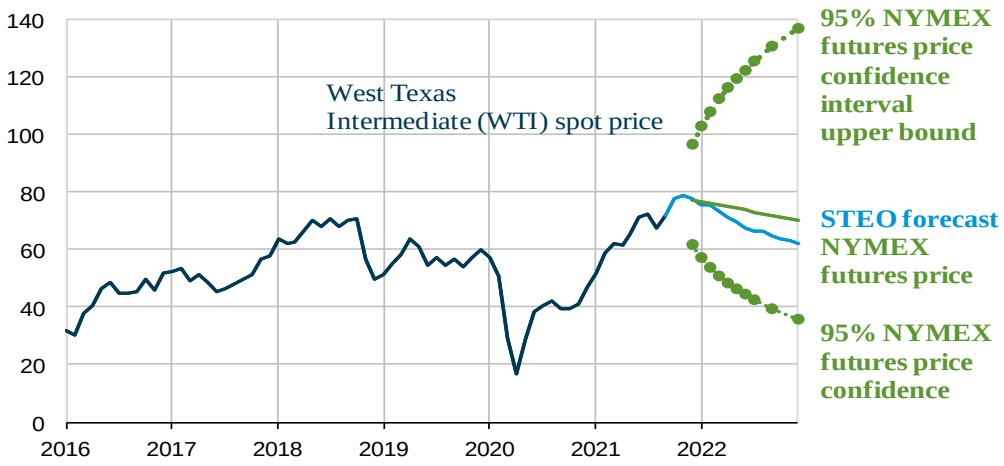
Source: U.S. Energy information administration, liquid fuels Jun 2020.

Figure (2): U.S. commercial crude oil tank storage inventories



Source: U.S. Energy information administration, short term energy outlook May 2020.

Figure (3): Volatility of financial options for Jun 2020 NYMEX WTI contract



Source: U.S. Energy information administration, energy market volatility survey Jun 2020. CME group, Bloomberg, L.P, Refinitiv and LSEG Business

How to cite this article by the APA method:

SADALLAH Daoud (2022). Negative Futures Crude Prices - Correlation of OPEC-Plus Supply and Existing VLCCs-FPSOs & Onshore Storage Indifferences, **Roa Iktissadia Review**, Algeria: University Eloued.12 (01), 233-246.