
# Understanding Negative Oil Prices: Lessons in Risk Management

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On April 20, 2020, something strange happened in commodity markets, something many of us did not even know was possible. This is a story of model risk and liquidity risk (an unusual kind of liquidity risk that we rarely see).

## Strange Times

Oil prices around the globe had already fallen precipitously at the start of April, after talks between Saudi Arabia and Russia broke down. Prices had dropped from roughly $60 per barrel at the start of the year to $20 per barrel at the start of April. But on April 20th things got very strange.

On that day, the near-term NYMEX WTI Crude Oil futures contract[1], which was set to stop trading the very next day, opened at $17.73. Just past noon, the price of the contract started to decline rapidly. By 2pm it was trading below $1. And, it kept going down from there, past zero, all the way to −$40.32. And this was not some flash crash, some momentary blip. The price stayed down, closing the session at −$37.63.

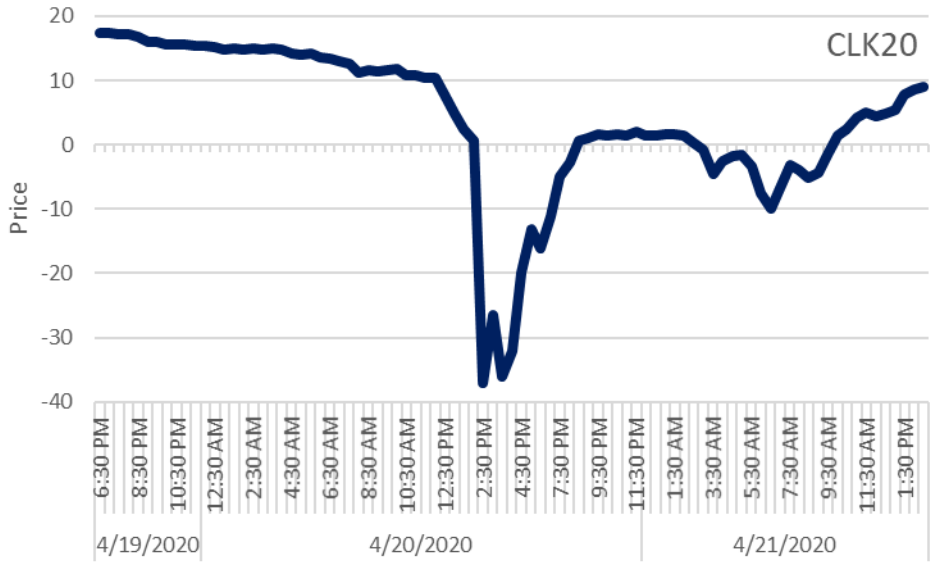


*Figure 1: May 2020 WTI Crude Oil Price. Source: Refinitiv and NYMEX.*

[1] For those not familiar with oil futures, this was the May 2020 contract, which, somewhat confusingly, stops trading on April 21st. It is called the May contract, because if you held the contract to expiration, you would be required to deliver or receive oil during the month of May.


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How was this possible? The ultimate cause may have been the feud between Saudi Arabia and Russia, and the drop in demand for oil brought about by COVID-19, but the proximate cause was a lack of storage capacity. From this, we can draw two valuable lessons, one about model risk and one about liquidity risk.

## Arbitrage Opportunity?

From Standard Oil, to the founding of OPEC in 1960, through to today, oil producers have sought to coordinate production and restrict supply in order to boost prices and maximize profits. When talks between Saudi Arabia and Russia broke down at the start of April, oil production increased. This happened at a time when most of the world was in full- or partial-lockdown in an effort to combat COVID-19. The lockdowns severely reduced economic activity and the demand for oil. As any student of economics knows, both an increase in supply and a decrease in demand will cause prices to fall.

What many students of economics and finance may *think* they know, is that the price of a good cannot be negative. A negative price, we are told, represents a clear arbitrage opportunity, and just as nature abhors a vacuum, markets abhor an arbitrage opportunity. The logic is simple: if a barrel of oil is trading at −$20, this means that you are willing to *give* me $20 to *accept* a barrel of oil. At that point, I could take the $20 and the barrel of oil, dump the oil down the drain, keeping the $20 as profit. Better yet, I could hold onto the oil, and sell it at some future date for some positive value, further increasing my profit.

There are problems with both these simple arbitrage strategies. First, you cannot just dump oil down the drain, at least not anymore, not in the United States. Sure, you might be able to dump a few gallons down the drain without anybody noticing, but each futures contract is for 1,000 barrels of oil, and thousands of contracts were being traded each hour. Dumping oil down the drain is not a viable strategy for eliminating this apparent arbitrage opportunity.

The second strategy is also not practical at scale. Maybe you could pick up a barrel of oil and store it in your garage, but transporting and storing millions of barrels of oil costs money. And this was the real problem, the proximate cause for the negative prices: as oil production increased and demand dropped, storage facilities began to fill up. As the end of April approached, there was simply no storage capacity available. In the short term, additional storage capacity could only be brought online at an extremely high price. Maybe I will be able to sell the oil for $10 in a month, but if it costs me $30 to store between now and then, then you are going to have to pay me roughly $20 to take that oil off your hands.

## Model Risk

There is a lesson in this story about model risk. Many pricing models contain variables, which, in normal markets, are easy to ignore. In normal markets we never stop to think about how much it would cost to store large quantities of cash, or the convenience of having our savings in a bank account, but these factors explain why investors have been willing to accept slightly negative interest rates in recent years (unlike with oil, the storage capacity of the banking system for cash, which is mostly electronic, is effectively unlimited, which is why we only see slightly negative rates). Similarly, when we model bonds, we spend most of our time looking at interest rates and credit spreads, rarely stopping to think about the recovery rate, which is often assumed to be fixed, even though a small change in the recovery rate could have a significant impact on the ultimate value of the bond.



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We often assume the storage cost of commodities is close to zero, and that we can either ignore this cost or assume it is fixed throughout time. As recent events make clear, this can be a very dangerous assumption to make.

## Liquidity Risk

Liquidity risk is the risk that you will not be able to buy or sell a security in the desired quantity near the current market price (Miller, 2019). Liquidity often plays a central role in large, unexpected price moves, from Black Monday '87 to the Quant Meltdown in 2007[2]. More often than not, a liquidity crisis is driven by a lack of demand. In the middle of 2007, nobody wanted to buy CDOs backed by mortgage backed securities. When two hedge funds run by Bear Stearns tried to sell some of these CDOs, there were simply no buyers. To sell any securities required a massive reduction in price. Soon after, in 2008, uncertainty around commercial paper caused buyers to flee that market. Demand for commercial paper all but disappeared causing one money market fund to "break the buck".

While the initial drop in oil prices was due to a decrease in demand, what drove prices deep into negative territory was a lack of *supply* in the storage market. What most of us did not realize prior to April 20th, is that we were approaching an inflection point in the short-term supply curve for oil storage. Up until this point, small increase in demand for storage would cause little or no increase in the price of storage; beyond that point small increases in the demand for storage would result in unprecedented price increases.

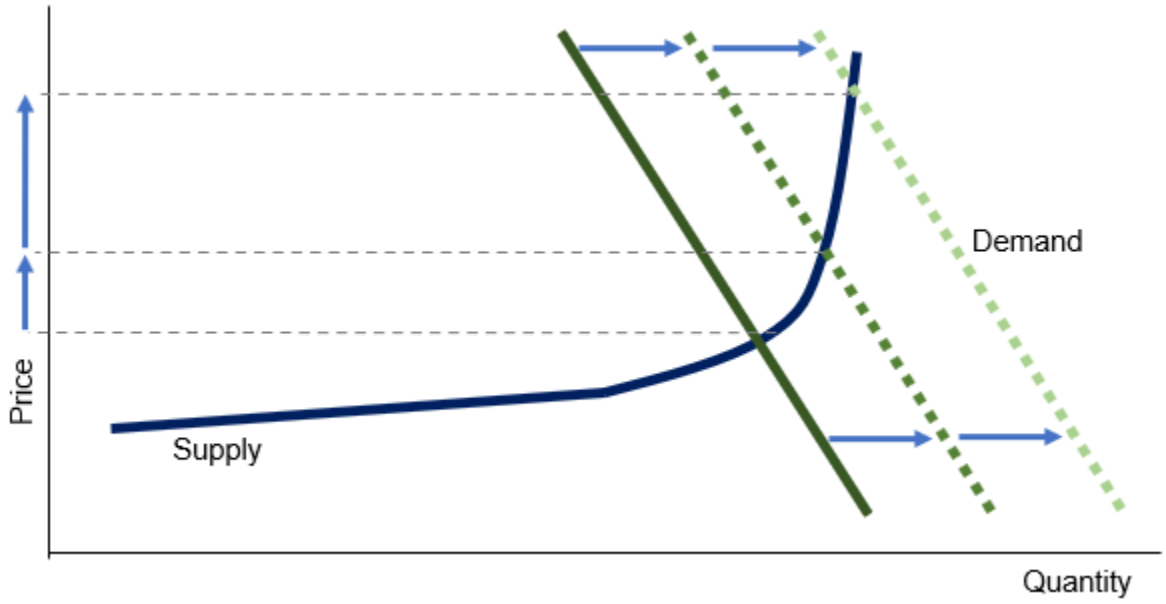


*Figure 2: Supply and Demand for Oil Storage*

[2] At Northstar, we have a number of tools for measuring liquidity risk, including measures of average daily volume, liquidity schedules, and liquidity stress tests. These liquidity measures can be applied to both exchange-traded and non-exchange-traded securities.



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On April 20th, the market hit the inflection point. After that, liquidity in the storage markets all but disappeared. Market participants needed to offer much higher prices to acquire any additional storage capacity. This is what drove oil prices deep into negative territory.

Liquidity is a function of time. Short-term and long-term liquidity can be vastly different. The flash crash on May 6th, 2010, was the result of too little short-term demand to absorb an extremely large burst of selling. If those same sell orders had taken place over days or even hours, there would have been more than enough liquidity, there just was not enough over seconds and minutes.

More oil storage capacity can be created in the long run. Maybe it will not be needed. Maybe demand will start to increase, and oil production will be curtailed. If not, will enough storage capacity be created to avoid negative oil prices in coming months? We will have to wait and see.

## Summary

On April 20th, oil futures traded at significantly negative prices, something that at first would seem to defy common sense and present a clear arbitrage opportunity. These negative prices were driven by a decrease in demand and a sharp increase in storage costs. The sudden increase in the price of storage can be seen as a type of liquidity risk, one driven by a lack of supply, rather than a lack of demand. That an often-overlooked variable, storage cost, was able to cause such a dramatic decrease in the price of oil provides an important lesson in model risk.



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## References

Miller, Michael B. 2019. *Quantitative Financial Risk Management*. Hoboken, NJ: John Wiley & Sons


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