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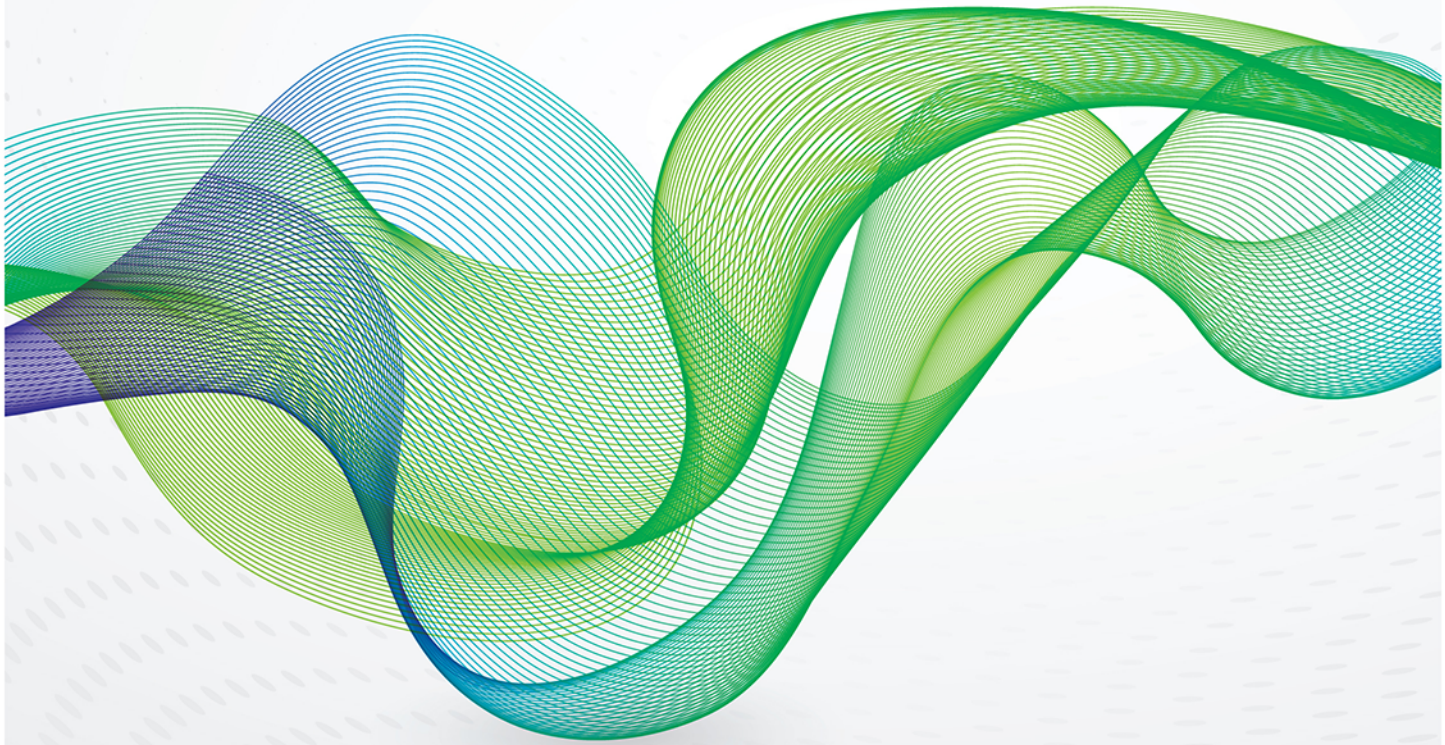
Energy Quantamentals: A Tale of Two Algorithms and OPEC+



OIES ENERGY COMMENT

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Most analysis of the oil market usually starts with estimation of supply and demand for physical oil. The imbalances between supply and demand are then used to calculate the resulting changes in inventories, which are subsequently mapped to expected price changes using various statistical techniques, such as linear regressions.

What is often not emphasised is that oil prices are not driven by fundamental factors directly, as neither OPEC+ countries nor many oil consumers actively buy and sell oil futures. Instead, prices can be primarily driven, at least in the short term, by the behavior of traders, and their reaction not only to fundamental news but also to various macroeconomic factors. When oil market fundamentals are broadly balanced, as they currently are, other non-fundamental factors rise in importance. As a result, oil prices become much more sensitive to how traders, or more precisely, their computerized algorithms, respond to these non-oil fundamental drivers.

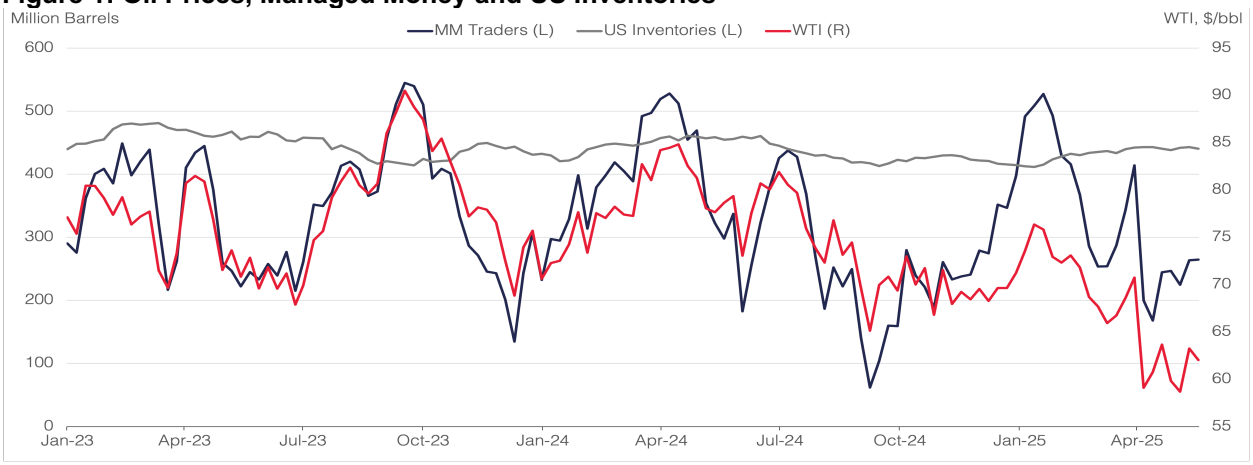
In today's market, two such algorithms appear to be fighting for dominance, pushing oil prices in opposite directions. One algorithm is designed to buy oil as a protection against inflation and geopolitical risks. The other algorithm is constructed to sell oil futures as a form of a portfolio insurance against risks of a global recession. The current market environment is essentially the tug-of-war between these two. This Energy Comment explains the rationale behind these two algorithms in more detail. It also argues that resulting imbalances in supply and demand for financial barrels and anticipation of stronger demand for oil futures at lower prices could be supportive of some of OPEC+ countries' recent decision to increase oil production.

The Oil Market Disconnects from Fundamentals

Measuring supply and demand for financial barrels is not straightforward due to the lack of publicly available data about positions held by various market participants. The primary data source is the Commitment of Traders (COT) report, which summarizes weekly futures and options positions held by different categories of traders. However, as highlighted in one of our previous articles within this series, COT reports mischaracterize the identity of several important groups of traders, and therefore, these reports can only be used with a degree of caution.[1]

The category of traders that has the largest impact on short-term prices is known as *managed money* (MM). This category combines several groups of financial traders, including long-only strategic oil investors and more dynamic long-short speculators, such as Commodity Trading Advisors (CTAs).

Figure 1: Oil Prices, Managed Money and US Inventories



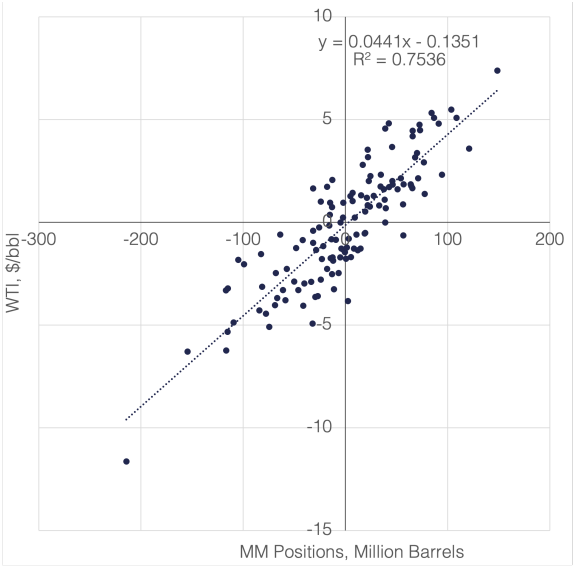
Notes: MM positions combine holdings in CME WTI and ICE Brent contracts. Source: CFTC, CME, ICE and EIA data.

[1] See I. Bouchouev (2024), Who is Who in Financial Barrels? Oxford Institute for Energy Studies, https://www.oxfordenergy.org/publications/energy-quantamentals-who-is-who-in-financial-barrels/.

Figure 1 shows how closely the positions held by the MM category of traders resemble the trajectory of oil prices over the last few years, making it obvious the increased influence of these traders. To illustrate physical and financial barrels side-by-side, **Figure 1** also shows the path of US inventories, which are significantly less volatile than either prices or MM positions. This confirms the well-known but not frequently publicized fact that in the short-run oil prices simply cannot be explained by fundamentals alone that change only slowly. Instead, prices are more driven by the behavior of traders, reacting to oil market fundamentals and other factors.

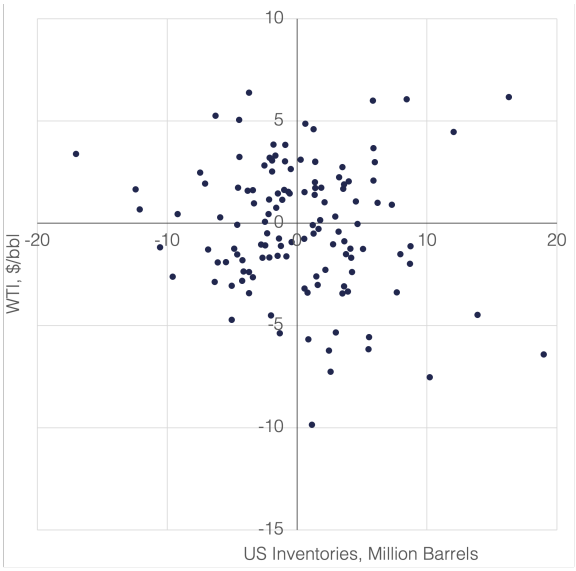
To see this relationship more clearly, **Figure 2** presents the same data in the form of a scatterplot for weekly changes in prices and MM positions. It highlights the remarkably strong co-movement between the two. The slope of this graph provides us with a useful rule of thumb that 100,000 contracts (100 million barrels) of buying or selling futures by MM trades, causes oil price to change, on average, by approximately $4-5/bbl. We will use this rule of thumb later to assess the impact of future potential buying and selling on prices.

Figure 2: Oil Prices and Positions of Money Managers



Notes: WTI and MM position changes are calculated using Tuesday's data, corresponding to weekly COT and ICE reposts. MM positions combine holdings in CME WTI and ICE Brent contracts. Source: CFTC, CME and ICE data, author's calculations.

Figure 3: Oil Prices and US inventories



Notes: WTI and inventory changes are calculated using Fridays' data, corresponding to weekly US EIA reports. Source: CME and EIA data, author's calculations.

In contrast, a similar graph for weekly changes in oil prices and inventories is basically a random noise, as illustrated by **Figure 3**. Here, the US oil inventories are used, as it is one of the most transparent high-frequency sources of oil inventory data. The graphs for global inventories are broadly similar, showing virtually no relationship between contemporaneous changes in oil prices and inventories.

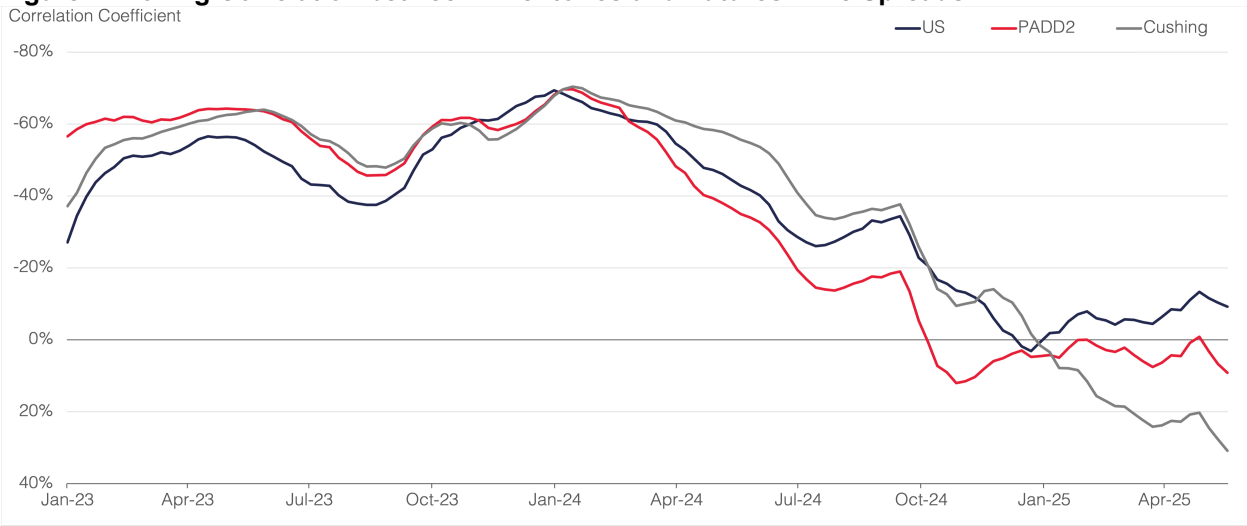
A fundamental analyst might challenge this statement by arguing that one should be comparing inventories to time spreads instead of prices. This is the relationship that has served as the primary foundational building block for modelling oil prices for decades, as it was supported by the theory of storage.[2] Furthermore, instead of using inventories data for the entire US, an analyst could also argue for using more

[2] See I. Bouchouev (2023), Virtual Barrels, Chapter 3, Springer, https://link.springer.com/book/10.1007/978-3-031-36151-7.

localized inventories in Cushing, OK, which is the delivery point for the WTI contract, or inventories in the PADD2 region that includes Cushing, OK among other important US storage locations. In addition, a statistician might add to the challenge by stating that neither prices nor inventories are considered to be stationary, in which case the statistical methods of linear regressions become meaningless.[3]

Figure 4 addresses these challenges at once and confirms our previous observation that the conventional fundamental modelling framework no longer holds and as of recent, it can no longer explain oil price movements. Figure 4 show inventories for all three main US locations: Cushing, the PADD2 region, and for the US overall. We further normalize inventories by their corresponding maximum storage capacities. This makes all inventory variables statistically stationary justifying an application of a linear regression. We then correlate normalized inventories to futures time spreads - which are also stationary by construction – and test the relationship between inventories and time spreads, the bedrock of the fundamental analysis. The strength of the relationship between two statistically stationary variables is measured by the correlation coefficient. In **Figure 4**, we plot this coefficient on the rolling one-year basis. This makes it easier for the readers to see that the dynamics of this relationship is indeed changing.

Figure 4: Rolling Correlation between Inventories and Futures Time Spreads



Notes: Correlations are calculated using one-year rolling lookback period. Inventories in Cushing, PADD2, and US are normalized by their corresponding maximum storage capacity. F1-F2 is the spread between the first and the second maturity WTI contracts. Source: CME and EIA data, author's calculations.

In general, correlations between inventories and time spreads are expected to be negative, as by the theory of storage, higher inventories should lead to weaker time spreads, and lower inventories to stronger time spreads. In fact, this theory has been well supported by empirical data. The average historical correlations, starting from 2011 when the Cushing data became publicly available until 2022, between normalized Cushing, PADD2, and US inventories and WTI prompt time spreads are negative 60%, 70%, and 66%, respectively.

One can see, however, that all of these correlations started to break down in the middle of the last year. More recently, they completely fell apart, fluctuating around zero. This confirms that even the most reliable fundamental relationship between inventories and time spreads is now failing to explain the behavior of oil prices.

[3] For a more comprehensive discussion of this point, we refer to C. Alexander (2001), Market Models, Wiley.

The Tug-of-War Between Inflation and Recession Hedging

One of the key insights towards better understanding the behavior of different groups of market participants comes from the decomposition of their positions by trading frequency. The idea here is to segment the behavior of 'fast' and 'slow' traders whose motives to trade oil futures are clearly different. Such a decomposition turns out to be particularly important for the category of MM traders.[4]

We start by approximating positions held by 'slow' MM traders with some historical moving averages of total MM positions. These moving averages of positions can be used as a proxy for the behavior of long-term financial investors, such as pension funds and insurance companies. Their positions do not change frequently, reflecting long-term structural allocations to oil futures within diversified financial portfolios. The residual, or the difference between total MM positions and its moving average then represents 'fast' MM traders. We associate these 'fast' traders with dynamic quantitative hedge funds, many of which are often referred to as CTAs. To understand today's market dynamics better, it is critical to differentiate between these two major market participants.

We first focus on the behavior of slow-moving long-only oil investors. While it is difficult to generalize and describe their collective motivation to invest in oil futures, one can gain some valuable insights by looking at it holistically through the lens of the so-called risk-parity framework. In this framework, one assumes that all financial assets, such as stocks and bonds, are driven by two primary factors, growth and inflation.

While stocks and bonds naturally diversify each other with respect to the growth factor, the value of both assets tend to fall when inflation unexpectedly spikes. This is because the price of a financial asset is typically modelled as the discounted present value of the asset's future cash flows. Therefore, when inflation increases, leading to higher interest rates, the value of the asset is discounted by a larger factor. This reduces the asset's theoretical price and makes it less attractive to hold. To hedge against such unexpected spikes in inflation, a financial investor typically creates an inflation-hedging basket, which includes several assets that have historically performed well during prior inflationary episodes.

It turns out that statistically oil has been the best hedge against inflation. Historically, it has outperformed gold, real estate, and even inflation-protected bonds by a significant margin during the times when inflation spiked.[5] It should be noted, however, that the relationship between oil and inflation is quite complicated, as it is driven by multiple feedback loops often going in opposite directions.[6] In this article, we avoid making any statements about the causality, but in general higher inflation expectations result in stronger demand for oil futures.

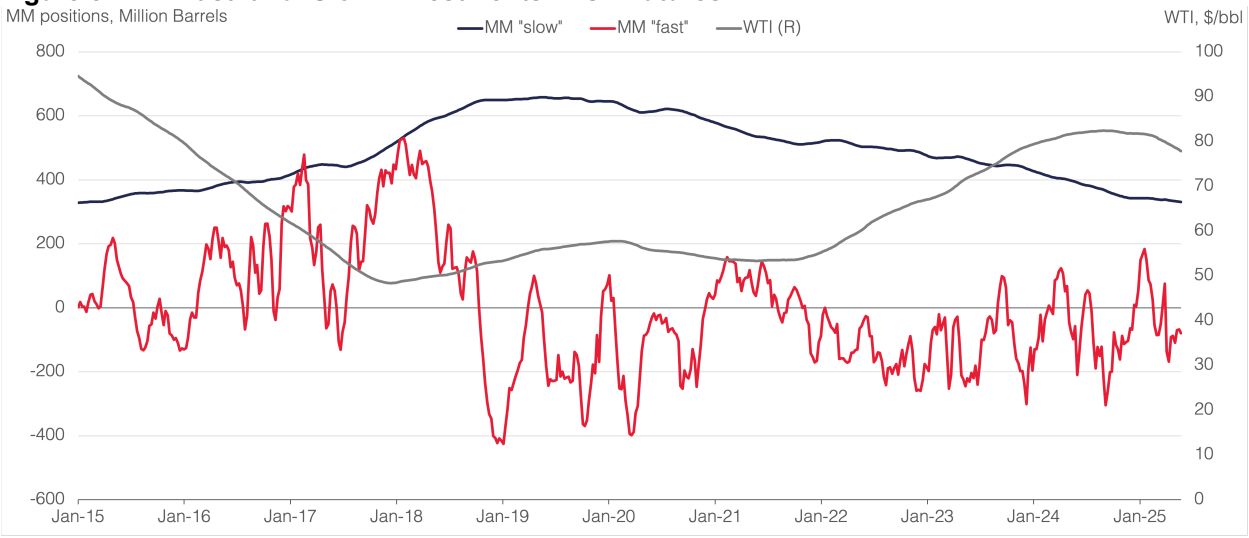
Since the decisions to invest in oil futures by this type of financial investors tend to be slow and long-lasting, to understand the recent changes, we look at the longer-term picture. **Figure 5** shows three-year rolling averages for both oil prices and positions held by MM traders, where the latter again is used to approximate the structural financial demand for oil futures. It should be noted that long-term oil positions appear to be inversely related to prices. This is somewhat intuitive, as long-term asset allocators often use various value-based metrics in their decisions. As a result, they tend to increase allocations when the asset is attractively priced and decrease them when the asset becomes more expensive. This is opposite to the behavior of 'fast' money, which we discuss later.

[4] A similar decomposition between fast and slow traders was also the key observation in the recent study by I. Bouchouev and W.-Y. Sun (2025), Myths and Mysteries About the Speculation in the Oil Market, KAPSARC, https://www.kapsarc.org/research/publications/myths-and-mysteries-about-speculation-in-the-oil-market/.

[5] See, for example, Neville et al. (2021), The Best Strategies for Inflationary Times, SSRN, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3813202

[6] See, I. Bouchouev (2024), Oil and the Macroeconomic Feedback Loops, Oxford Institute for Energy Studies, https://www.oxfordenergy.org/publications/energy-quantamentals-oil-and-the-macroeconomic-feedback-loops/

Figure 5: MM 'Fast' and 'Slow' Investments in Oil Futures



Notes: MM 'slow' is calculated using three-year rolling average of total MM positions in CME WTI and ICE Brent contracts MM 'fast' is the residual. Source: CFTC, CME and ICE data, author's calculations.

It is clear that such a structural financial demand has been declining after the COVID-19 pandemic. Over the past several years the correlation between oil and inflation also declined, as inflation has been more impacted by other factors, such as supply-chain challenges following the COVID-19 pandemic and more recently by the US tariffs. Thus, oil became less effective to long-term investors as an inflation hedge, yielding its place within the inflation-hedging basket to other assets, such as gold, TIPS and more recently even cryptos. This trend also applies, but perhaps to a lesser degree, to retail investors, whose participation in the oil futures and options markets continues to grow.

It should be emphasized that episodes of high inflation have occurred rather infrequently in the past, and some of these episodes coincided with oil spikes caused by geopolitical events. In other words, while the standard argument that justifies financial investments in oil futures is still supported by oil's strong performance during prior inflationary periods, oil futures are also often tacitly held as a hedge against unpredictable geopolitical events.

We can now shift our focus to 'fast' money. As stated earlier, these are modeled as the residual, i.e., the difference between total MM positions and its three-year rolling average that represents 'slow' money. Both positions are shown in **Figure 5**. One can see that 'fast' funds have been substantially short recently relative to their historical average – which as the residual has a zero mean by construction.

One of the reasons for such a large supply of short futures by the CTAs is the proliferation of the so-called 'crisis alpha' strategies.[7] The idea behind these strategies is to invest in highly dynamic strategies across asset classes, which are expected to perform well when many other financial assets are expected to suffer. Oil momentum is one of such strategies.[8]

Conceptually, this strategy is effectively trying to replicate the payoff of a put option on oil. Since oil options are known to be expensive, the replication of a put-option payoff by dynamically trading futures presents a viable alternative. This strategy involves selling futures aggressively when the market is already falling and buying them back when the market is rising. This strategy tends to diversify the long-asset portfolio precisely

[7] See, for example, C. Hamil et al. (2016), Trend Following: Equity and Bond Crisis Alpha, SSRN, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2831926.

[8] For more technical details on the oil momentum strategy, see I. Bouchouev (2023), Virtual Barrels, Chapter 5, Springer, https://link.springer.com/book/10.1007/978-3-031-36151-7

when it is the most needed, particularly during times of global economic shocks when the demand for oil declines, typically leading to lower oil prices.

Figure 6 illustrates the performance of basic one-month momentum strategies against holding long oil futures. This graph is sometimes referred to as the momentum smile, as it shows the stronger performance during extremes of high and low prices. In the case of the oil market, however, this graph looks more like a smirk, as the downside oil momentum significantly outperforms the upside momentum when the futures move away from their normal range. One can see that during four out of five years when buying and holding oil futures lost 50%, the oil momentum would have made at least as much, basically providing an attractive structural hedge to long futures holdings. Today, these one-sided downside momentum-type oil strategies are trying to hedge against the possible crisis of a global recession.

Figure 6: Momentum Smile

Notes: Momentum strategy holds long (short) WTI futures if the latest price is above (below) its 20-day moving average.
Source: CME data, author's calculations.

We can now summarize our findings in this tug-of-war between inflation hedging by risk parity funds and recession hedging via 'crisis alpha' momentum algorithms. As already mentioned, the structural demand from buyers for oil as an inflation hedge is rather cyclical. As shown in **Figure 5**, it is currently close to multi-year lows. As such, it is difficult to see that this demand can fall much further from already depressed levels, especially in the current environment of heightened geopolitical risks.

Furthermore, comparing the latest positions held by 'slow' money to their long-term average, one could argue that the pent-up demand for inflation hedging could be at least 100 million barrels. This, if executed over the remainder of this year, could easily amount to more than a half-million of financial barrels per day, largely negating an oversupply in a physical market of a similar magnitude. This structural demand for oil futures could spike rather quickly at any sign of further military escalation in the Middle East.

In contrast, as shown in **Figure 5**, the demand for recession hedging via oil momentum strategies is already highly elevated. In other words, the CTAs' positions are not too far from their maximum historical shorts. Such demand also tend to be rather cyclical and their futures holdings tend to mean-revert over time. Obviously, mean-reversion is a relatively slow moving process which does not have to start immediately, and in the short-term the financial demand for inflation hedging could decrease further and financial demand for recession hedging could increase. In terms of the impact on price, the latter is more important, as it affects the market faster. So the question is how much more can the financial demand for recession hedging rise from currently elevated levels, if it is measured by net short positions held by the CTAs?

By comparing current short positions to their historical lows, it appears that these funds could plausibly sell another 125-150 million barrels of futures. Using the correlation-based rule of thumb from our **Figure 2**, it is estimated that 125-150 million barrels of futures selling can move the price down by additional $5-7/bbl. In other words, from the perspective of financial supply and demand for oil futures, one could argue that the floor for Brent should be around $55/bbl, as at this price level there will be very few new oil sellers left.

A Financial Floor and the OPEC's Policy

Much has been said recently about possible drivers behind recent increases of oil production by OPEC+ members. Our view, however, is a bit simpler and is driven by two factors: one based on fundamentals, and arguably the more important one is based on flows and financial balances discussed in this article.

From the fundamental perspective, we posit that OPEC+ did proceed with production hikes simply because it is optimal for them to do so. We argue that supply and demand for oil have become increasingly unobservable. The only somewhat observable fundamental variable nowadays is inventories, which remain broadly unchanged despite previously apocalyptic projections about falling demand and rising supply and a resulting oil glut.[9] It is rational for the OPEC+ members to test the market and see whether pushing additional barrels could indeed translate in any increase in visible inventories, especially during the seasonally strong demand period.

However, equally and likely more important are the financial imbalances that we have outlined in this article. While this article has only looked at a few representative market participants and did not cover the behavior of producers, consumers and option hedgers, the tug-of-war between the demand for inflation and geopolitical hedging, on the one hand, and the demand for recession hedging, on the other hand, is the dominant price-driving factor in the current market environment.

Also as alluded in this article, both of these financial demands for oil futures are price sensitive. While the demand for inflation and geopolitical hedging can only increase from currently low levels, the demand for recession hedging is already nearly capped. In other words, the lower the oil price goes, the faster the pendulum could swing towards stronger financial demand and weaker financial supply for futures. This de-facto supports the risk-reward behind some of OPEC+ members' decision to increase production. The market could find support from financial buyers, regardless of marginal imbalances in fundamentals. Given highly elevated geopolitical risks today, it is hard to see many new discretionary short positions to be established at such low price levels. At the same time, the positions held by 'crisis alpha' funds appear to be not too far from reaching their maximum allocations. From this perspective, increasing oil production when the price is already low appears to present a reasonable risk-reward. The market seems to have agreed with this logic. Given the lack of new futures sellers at lower price levels, oil prices have subsequently rallied despite the announced increases in production.

[9] For example, IEA has recently substantially revised their prior demand estimates for the previous three years, and many sell-side analysts have followed the suit. See, for example, J. Lee (2025), Oil Market's Missing Barrels Have Gone Up in Smoke, Bloomberg, March 16, https://www.bloomberg.com/news/newsletters/2025-05-16/oil-market-s-missing-barrels-have-gone-up-in-smoke?sref=TBiwIc5E