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**An Introduction to Market Participants
and Behavioral Trading in Commodities**

Ilia Bouchoev

Pentathlon Investments and CQL*

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ABSTRACT

This article examines the commodity-market ecosystem through the real optionality embedded in physical assets. It explains how the relatively predictable behavior of asset owners underpins many widely used trading strategies. It also shows how the rapid growth of derivatives markets has changed the composition of market participants and how their behavioral biases have reshaped the structural equilibrium in the futures markets.

Using crude oil — the largest and most liquid commodity futures market — as its primary example, the article describes today's main market participants and explains how they interpret and trade the market. It also shows how the existence of large and opaque over-the-counter (OTC) market can cause regulatory reports to misclassify participants, complicating traditional analyses of hedging and speculative pressure.

* ib@pentinv.com

The Ecosystem of Commodity Markets

Unlike financial markets, commodity markets are closely tied to physical production, consumption, inventories, trade flows, weather, and geopolitical events. Their ecosystem is organized around the real optionality embedded in four pillars of commodity infrastructure: production, storage, transportation, and processing.

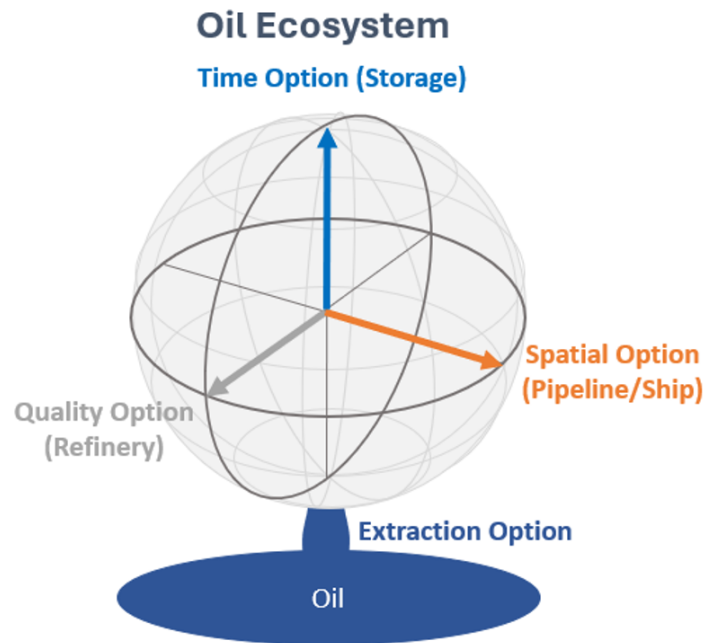
A commodity producer effectively holds a call option on the commodity price, with a strike price equal to the cost of production. When the market price exceeds that cost, revenue rises broadly with the price; when production becomes uneconomic, output is likely to be curtailed. This nonlinear relationship resembles a call option payoff. Storage, transportation, and processing assets also create real options, but on the spread between output and input prices. Their strike prices are likewise determined by operating costs.

The assets used for storage, transportation, and processing function as spread options on time, location, and quality. When commodity production exceeds immediate consumption, the surplus must be stored. In such periods, excess near-term supply tends to push the spot price below the futures price, creating a market condition known as contango. A storage owner can monetize the asset by buying the relatively inexpensive commodity in the spot market and selling futures at a premium. In effect, storage gives supply and demand time to rebalance. When the spot price later rises relative to futures — a condition known as backwardation — the owner withdraws the commodity, sells it in the spot market, and buys back the futures. This relatively predictable pattern makes storage an option on time, allowing supply to be shifted from periods of abundance to periods of relative scarcity.

Supply and demand can also become regionally imbalanced, creating an opportunity for owners of transportation assets such as pipelines and ships. When the price spread for the same commodity across two locations exceeds transportation costs, the asset owner can buy in the lower-priced market and sell in the higher-priced one. Processing assets create a related cross-product, or quality, option on the spread. A processor that converts a raw commodity into a usable product — such as an oil refinery — has an incentive to operate only when the spread between processed-product and raw-material prices exceeds processing costs.

Together, these four real options — the producer's call option on price and the spread options on time, location, and quality — form the physical ecosystem of many commodity markets. Figure 1 illustrates this ecosystem for oil, although a similar structure applies broadly across other commodity markets.

Figure 1. The Real-Options Ecosystem



Source: Pentathlon Investments.©

Commodity assets are highly valuable because of volatile prices, but they are also costly and time-consuming to build or acquire. The long lag between an investment decision and the start of operations exposes investors to substantial risk: by the time an asset is completed, commodity prices — and therefore the investment's value — may have changed dramatically. Consequently, few investors can afford to leave these investments unhedged. They typically hedge in derivatives markets, where the risk may be transferred repeatedly and distributed across many participants.

If the behavior of key participants in physical commodity markets is predictable, can traders mimic it without owning the underlying assets? This is precisely what many professional commodity traders seek to do, which is why participant-driven trading can be crucial to success or failure in commodity derivatives.

Hedging Pressure: From Physical Assets to Virtual Commodities

The first academic theory to explain how market participants' behavior affects commodity futures was the theory of normal backwardation, proposed by Keynes and Hicks.¹ It holds that commodity futures markets are naturally in disequilibrium because producers, facing

¹ See Keynes (1923, 1930) and Hicks (1939).

substantial non-diversifiable downside price risk, must sell futures below fair value, defined as the expected spot price. This discount compensates speculators for providing liquidity and taking the other side of producers' short futures positions, and it later became known as the commodity risk premium.

This framework was subsequently extended and generalized by many authors, becoming known as the theory of hedging pressure.² Its modern formulation encompasses a broader range of participants — including inventory and inflation hedgers, algorithmic traders, and retail traders — whose behavior has altered the structural disequilibrium in hedging markets originally described by Keynes and Hicks.³

This theory of hedging pressure inspired five decades of empirical research testing whether long-only speculators can profit by taking the other side of producers' hedging flows.⁴ However, many conclusions from these earlier studies have become less relevant, particularly since the COVID-19 pandemic, as commodity markets evolve and the composition of their main participants changes rapidly.

Commodity markets can no longer be analyzed solely through the simplified Keynesian producer-speculator framework. They have grown more complex, and the behavior of newer participants now exerts a much greater influence on prices. To illustrate this evolution and the scale of today's commodity derivatives markets, we examine crude oil — the largest, most important, and most liquid commodity futures market.

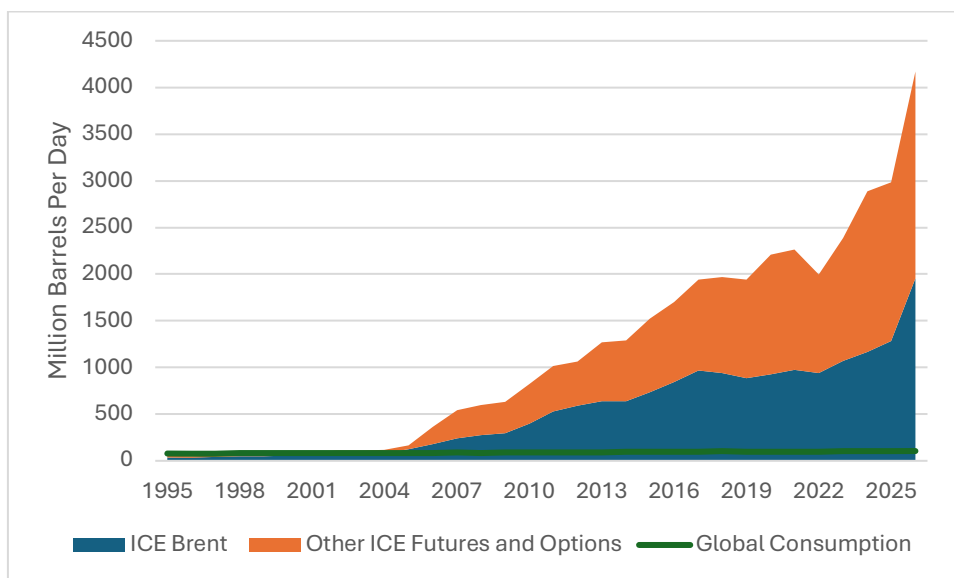
Figure 2 compares global oil consumption of approximately 100 million barrels per day with average daily trading volumes in Brent futures and options. These derivatives now trade more than 4 billion barrels per day—about 40 times physical consumption. Including WTI, the second-largest oil contract, along with futures on other crude grades and refined products and over-the-counter transactions, total petroleum derivatives volume routinely exceeds 6 billion barrels per day and, on certain days in 2026, reached 10 billion barrels.

² See Cootner (1960), Stoll (1979) and Hirshleifer (1988), among many others.

³ Chapter 4 of Bouchoev (2023) provides a comprehensive discussion of this line of academic research and recent advances in the field.

⁴ Without attempting a comprehensive review of the extensive literature, we highlight several particularly influential contributions, including Basu and Miffre (2013), Cheng, Kirilenko and Xiong (2015), and Kang, Rouwenhorst and Tang (2020).

Figure 2. Global Petroleum Consumption and Daily Trading Volumes



Source: ICE, U.S. Energy Information Administration (EIA) data, author's calculation and graphic.

Because derivatives markets now dwarf physical oil consumption, producers' hedging needs alone are unlikely to determine price equilibrium. Who are the newer market participants, and how might their more complex behavior affect futures prices today?

Given oil's global significance and the exceptional complexity and sophistication of its markets, this introductory article identifies the sector's main participants. Their behavior shapes many of the mental models that professional traders use to develop commodity trading strategies.

Key Market Participants

The Commitment of Traders (COT) report is the industry's primary source of data on positions held by different categories of futures and options traders. It is published weekly by the Commodity Futures Trading Commission (CFTC) for U.S.-traded commodities and by ICE for certain European commodity markets. The report divides open interest among four main categories of traders:⁵

- Producers, merchants, processors, and users (PMPU)
- Swap dealers (SD)

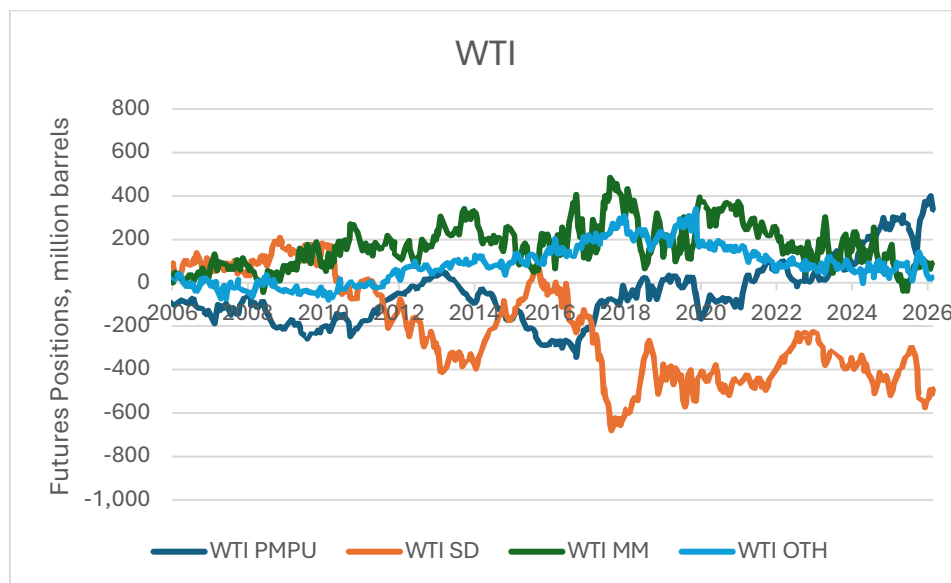
⁵ The CFTC and ICE have published these disaggregated reports since 2006 and 2011, respectively. We omit non-reportable (NR) traders because of their limited significance in oil markets.

- Managed money (MM)
- Other reportables (OTH)

Unfortunately, the COT report must be interpreted with considerable caution because its regulatory classifications can be misleading. This mischaracterization limits the practical relevance of much of the published academic research, particularly for the largest crude oil derivatives market. Because understanding participant behavior is critical to trading commodity derivatives, the classification problem warrants further explanation.

Figure 3 shows the historical futures positions of the four trader categories in the WTI market. Swap dealers (SDs) hold the dominant short positions because North American oil producers typically hedge over the counter with their lending banks, often in exchange for favorable credit terms. Many producers can also pledge physical oil reserves rather than cash as collateral for OTC derivatives, thereby avoiding the substantial margin requirements imposed by futures exchanges. Consequently, producers rarely trade futures directly, and only a small share of genuine producers' futures positions appears in the producers, merchants, processors, and users (PMPU) category, despite its label.

Figure 3. Trader Positions in WTI Futures



Source: CME, CFTC data, author's calculation and graphic.

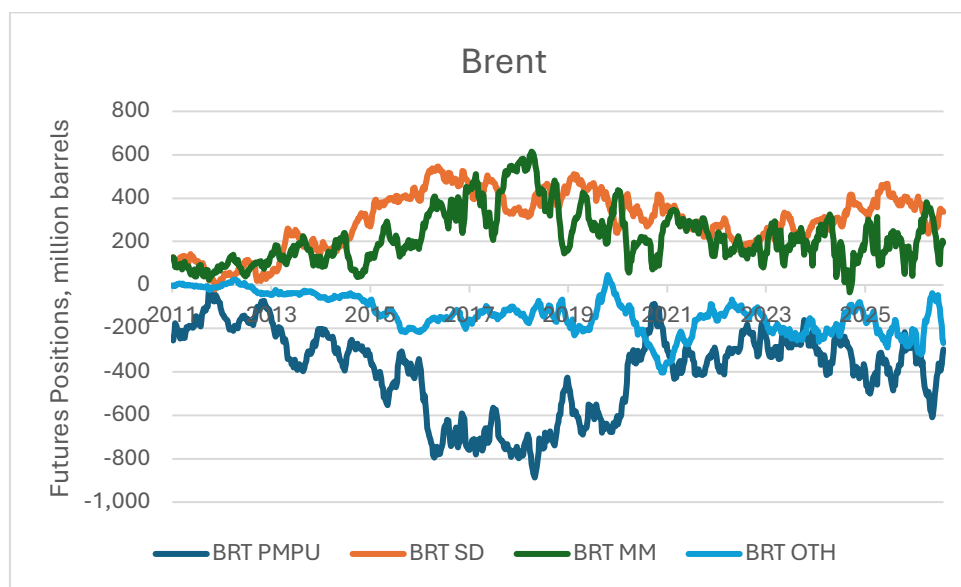
PMPU positions fluctuate substantially and may be either long or short. At the time of writing, the category holds near-record net long futures positions — an exposure inconsistent with the conventional business model of a producer. In practice, PMPUs are dominated by professional physical trading houses that also own storage and transportation assets. Because their hedging and speculative activities are intertwined, some acquire physical

assets partly to support speculative trading. Their strategies generally seek to monetize the real spread optionality associated with time, location, and quality.

WTI PMPU traders pursue multifaceted strategies. For example, they may hold short futures positions against oil stored domestically while simultaneously holding long WTI and short Brent futures to hedge U.S. oil exports. More broadly, these positions may monetize the location-arbitrage optionality embedded in ships and pipelines.

As Figure 4 shows, SDs and PMPUs behave differently in the Brent market. Unlike in WTI, Brent swap dealers are almost always net long futures because international consumers, such as airlines, typically hedge more aggressively than oil producers. Moreover, a larger share of Brent-linked production is controlled by state-owned companies and sovereign entities that tend to avoid derivatives markets. Their governments may instead manage price risk through taxation, subsidies, or rainy-day funds.

Figure 4. Trader Positions in Brent Futures



Source: ICE data, author's calculation and graphic.

In contrast to WTI, the Brent PMPU category is consistently net short futures because most international oil in transit is priced against Brent futures and these transportation flows are typically hedged. A lesser-known feature of the oil market is that inventory hedgers — not producers, consumers, or speculators — hold the largest aggregate futures positions. Figure 4 reflects this pattern because the Brent PMPU category includes these traders. Inventory hedgers therefore play a central role in systematic trading signals, a topic examined in greater detail in CQL's research on commodity risk premia.

Finally, two COT categories are intended to capture conventional financial speculators. However, their behavior differs substantially, so treating them as a single group would be misleading. The managed money (MM) category includes hedge funds and institutional investors required to register with U.S. or European regulators. Most commodity trading advisors (CTAs), including systematic quantitative funds, are reported in this category.

However, this category excludes many large, sophisticated financial investors. Pension funds, for example, may hedge long-term macroeconomic risks such as inflation by investing in commodities through bank swaps, much as producers and consumers do. Their positions are therefore reported in the SD category and commingled with futures positions that banks hold on behalf of commercial end users.

Finally, the OTH category — particularly in the Brent market — should not be viewed as consisting only of small retail investors. Because European registration requirements are generally less stringent than those in the U.S., some large, even sovereign-controlled, financial entities can register offshore and report their positions as OTH rather than MM. The two categories are often combined as non-commercial (NC) traders in academic analyses of commodity speculation. Yet MM and OTH traders exhibit distinctly different behavior, and grouping them together obscures valuable information.

Untangling the behavior of market participants is difficult. Yet understanding how other participants are likely to act is like glimpsing an opponent's cards in poker: even limited insight can create a powerful, sustainable trading edge. Despite the complexity, modeling the behavior of different market participants is well worth the effort.

Modeling Trader Behavior as an Inverse Problem

Modeling trader behavior is a relatively new area of economic research compared with traditional fundamental analysis of supply and demand. However, the rapid financialization of commodity markets and the growth of new participant groups have made it critically important to professional commodity traders.

Unlike traditional econometrics, which typically uses linear regression for prediction, analyzing participant behavior is an inverse, or inference, problem. The objective is to reconstruct the underlying mechanism driving traders' behavior from observable market inputs and outputs, including positions reported by regulators and other sources. Conceptually, this can be expressed as the functional equation $y = f(x)$, where both x and y are observable and measurable, and the task is to recover the nonlinear function f . This problem requires an analytical approach distinct from traditional econometrics and is better suited to machine-learning methods.

To illustrate, Table 1 presents pairwise correlations among weekly changes in the positions of the four oil-market trader categories, along with each category’s correlation with price changes.

Table 1. Traders’ Positions and Price Correlations (WTI 2006-2026)

	PMPU	SD	MM	OTH	Price
PMPU	1.00	0.01	-0.50	0.04	-0.15
SD	0.01	1.00	-0.59	-0.19	-0.32
MM	-0.50	-0.59	1.00	-0.47	0.46
OTH	0.04	-0.19	-0.47	1.00	-0.14

MM positions have the strongest positive correlation with prices and are negatively correlated with the positions of all other trader categories, suggesting that those traders tend to take the opposite side of MM trades. It is therefore natural to begin modeling participant behavior with financial traders such as MMs. Because many follow momentum-based strategies, their behavior can be modeled using historical price indicators.

Several recently developed models seek to reverse-engineer hedge fund behavior from historical futures prices and reported regulatory positions.⁶ We will describe and compare these and related approaches in greater detail in forthcoming papers. These models mark only the beginning of a new stream of academic research on the inverse problem of participant behavior, to which we hope CQL will make an important contribution.

⁶ Boos and Grob (2023) employed signature plots and regularized linear regression, whereas Bouchouev and Sun (2025) developed a nonlinear neural-network to incorporate hedge fund position sizing. Sun et al. (2026) proposed an extension of this framework.

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