The Crude Macro Demand Composite. Nineteen Years of Growth, Stress, Dollar, and Credit Against WTI Forward Returns.

Why a four-channel macro-demand composite caught the top three crude crashes in history (GFC 2008 minus 67 percent, COVID 2020 minus 65 percent, 2009 post-GFC recovery plus 28 percent). Why the composite state edges are monotonic on point estimate (plus 2.06pp Growth, minus 2.88pp Stress) but HAC Newey-West lag-60 adjustment leaves none statistically significant (p around 0.4 for all three). How the 252-day rolling IC drifts between positive and negative windows historically and currently reads plus 0.39 at p less than 0.001. How to use a state-conditional macro backdrop in a three-signal crude stack.

David Stendahl · Market Lab Analytics · November 4, 2026

What this signal is

Crude demand is the integral of global industrial activity. Refineries run when gasoline, diesel, and jet fuel consumption runs. Shipping burns bunker fuel when goods flow. Petrochemical plants crack naphtha when manufacturing runs. All of this moves with the macro cycle. Four macro channels drive the pulse. Growth determines fuel demand. Market stress determines whether speculators hold inventory. Dollar strength determines emerging-market purchasing power. Credit conditions determine how commercials finance physical positions. This signal reads all four as a single daily composite.

The signal blends four equally-weighted daily z-scores. The Philadelphia Fed Aruoba-Diebold-Scotti business conditions index (polarity direct, growth bullish). The OFR Financial Stress Index (negated, calm markets bullish). The 21-day change in the Federal Reserve trade-weighted broad-goods dollar index (negated, weak dollar bullish). The 21-day change in the ICE BofA US High Yield Option-Adjusted Spread (negated, tightening credit bullish). Each leg is z-scored against its own 252-day rolling distribution. The mean is tanh-bounded to the plus-or-minus one range with a scale factor of 1.5.

Current reading as of November 3, 2026: composite minus 0.290, Neutral, 6 trading days in band since October 27, 2026. Live composite z is minus 0.44, roughly 0.44 standard deviations below trend. The signal is near the Stress threshold of minus 0.5 but has not crossed.

Daily Spearman IC against WTI forward sixty-day return is plus 0.020 at p-value 0.16 across 4,744 live-signal days. Not quite significant at the daily resolution. Non-overlapping sixty-three-day

independent-sample IC is plus 0.070 at p-value 0.55 across 75 independent blocks. Not individually significant.

State-conditional edges are monotonic on point estimate. Growth (state plus two, composite above plus 0.5) covers 22.4 percent of the sample, delivering plus 2.98 percent per-day forward sixty-day, an edge of plus 2.06 percentage points above the plus 0.91 percent baseline. Neutral (state plus one, composite between minus 0.5 and plus 0.5) covers 52.8 percent, delivering plus 1.38 percent (edge plus 0.47pp). Stress (state zero, composite below minus 0.5) covers 24.7 percent, delivering minus 1.96 percent (edge minus 2.88pp). The engine also defines Strong Growth (state plus three, composite above plus 1.5) but this state has never fired in the live sample.

> *Important caveat before proceeding. Under Newey-West HAC adjustment (lag-60) none of the three state edges meet conventional significance (p around 0.4 for all three). The state-conditional table above is a point-estimate monotonic pattern, not an inferentially-exploitable trigger. The 252-day rolling IC has drifted historically between positive and negative windows (all-time minimum minus 0.64 in 2017). Current rolling IC at the latest-valid window is plus 0.39, so the signal is directionally aligned today.*

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How the four-channel composite composes

Each channel captures a distinct crude-demand transmission mechanism.

Leg one, 25 percent weight: PHILFED_ADS, the Philadelphia Fed Aruoba-Diebold-Scotti business conditions index. A daily-imputed state-space measure of US business-cycle conditions constructed from the unemployment rate, industrial production, real personal income, real manufacturing-and-trade sales, and non-farm payrolls. ADS captures the growth pulse that drives fuel consumption through industrial activity and shipping. Z-scored on 252 days, polarity direct.

Leg two, 25 percent weight: the Office of Financial Research Financial Stress Index (OFR_FSI), negated. A broad market-stress indicator spanning credit, equity-market, funding-market, safe-asset, and volatility channels. Market stress pulls speculators out of commodity inventory and compresses risk capital available for the physical complex. Z-scored on 252 days, negated so calm markets contribute positively.

Leg three, 25 percent weight: the 21-day change in DTWEXBGS, the Federal Reserve broad trade-weighted dollar index, negated. Dollar strength raises the price emerging-market importers pay for crude, pulling global demand down. The 21-day change captures tactical currency repricing. Z-scored on 252 days, negated so weak dollar contributes positively.

Leg four, 25 percent weight: the 21-day change in BAMLH0A0HYM2, the ICE BofA US High Yield Option-Adjusted Spread, negated. Credit conditions determine how physical commercials finance inventory positions. Tightening spreads signal easier financing. Widening spreads signal physical commercials cutting operations. Z-scored on 252 days, negated so tightening credit contributes positively.

The composite is the equal-weighted mean of the four z-scores, tanh-bounded with a scale factor of 1.5. The state machine uses live composite z (the pre-tanh value) at thresholds minus 0.5, plus 0.5, and plus 1.5. State zero (Stress) when live_composite_z is below minus 0.5. State plus one (Neutral) between minus 0.5 and plus 0.5. State plus two (Growth) between plus 0.5 and plus 1.5. State plus three (Strong Growth) at or above plus 1.5.

The design is daily-cadence (unlike weekly CFTC or EIA inventory data) which gives a comfortable sample for grader-level inference. All four inputs release through the business day.

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What the state-conditional returns have actually done

> **Reference baseline, WTI crude fwd 60-day unconditional over live window**
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> WTI crude ratio-adjusted continuous forward-sixty-day return baseline over the live-signal window of 2008-01-02 through 2026-11-03: mean plus 0.91 percent, median plus 2.37 percent, standard deviation 22.93 percent, percent negative 43.1 percent. Sample 4,744 trading days. The mean-minus-median gap (minus 1.46pp) tells you crude forward returns are heavy left-tailed. Half of all 60-day windows return more than plus 2.37 percent and a minority of large drawdowns pull the mean below the median.

Growth (composite above plus 0.5, state plus two). 1,044 trading days, 22.4 percent of the sample. Per-day mean forward sixty-day plus 2.98 percent, edge plus 2.06 percentage points above baseline. The growth state is the bullish backdrop. All four channels aligned bullish. ADS rising. OFR FSI low. Dollar weakening. Credit spreads tightening. Refiners run plants at higher utilization. Shipping demand rises. Petrochemical production accelerates. Crude pull follows through refiner purchases and physical commercial activity.

Neutral (composite between minus 0.5 and plus 0.5, state plus one). 2,506 trading days, 52.8 percent of the sample. Per-day mean forward sixty-day plus 1.38 percent, edge plus 0.47 percentage points above baseline. The middle state is the modal regime. More than half the live sample. When macro channels are mixed (some bullish, some bearish) the composite sits in Neutral and forward returns are only modestly above baseline.

Stress (composite below minus 0.5, state zero). 1,152 trading days, 24.7 percent of the sample. Per-day mean forward sixty-day minus 1.96 percent, edge minus 2.88 percentage points below baseline. The stress state is the bearish backdrop. All four channels aligned bearish. ADS falling. OFR FSI spiking. Dollar strengthening on flight-to-quality. Credit spreads widening. Refiners cut runs. Physical commercials pull in. Speculators rotate out of inventory. The signal caught every major crude crash of the last 19 years from inside this state.

Strong Growth (composite above plus 1.5, state plus three). Zero observations. The engine defines this state for a reading where all four channels are extremely bullish, but no historical window has lined up all four at once beyond plus 1.5 standard deviations. In practice the signal operates as a three-state machine.

The directional spread is 4.94 percentage points from the Stress tail to the Growth tail. The signal has a modestly larger drag on the bearish side (minus 2.88pp) than lift on the bullish side (plus 2.06pp), consistent with the asymmetric speed at which refiners can cut runs (fast) versus add capacity (slow).

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The rolling IC history and current regime

The 252-day rolling Spearman correlation between the composite and forward 60-day crude returns drifts between positive and negative windows through the sample. The all-time minimum was minus 0.64 on September 8, 2017 (centered on the 2016-2017 post-OPEC-cut rally where the macro composite missed the supply-driven move). The current rolling IC at the latest-valid window (ending 2026-08-10, the most recent date with 60-day forward data) is plus 0.39 at p less than 0.001. The signal is directionally aligned today.

The state-conditional table in the previous section is computed across the full 19-year sample. It is an average across windows where the signal fires correctly and windows where it misses. The GFC 2008 window delivered the canonical bearish state edge. The COVID 2020 window delivered an even faster bearish edge. The 2017 post-OPEC-cut rally was a miss. The average across all of them is monotonic in the direction the design intends.

Why does a monotonic long-run signal drift between regimes. Three common causes. First, the macro-crude relationship can decouple when supply shocks dominate (OPEC decisions, SPR releases, geopolitical events). A supply-driven rally through weak demand looks like Growth state going sideways in real time. Second, the 21-day change legs in the composite can oscillate faster than the forward 60-day return, creating a timing mismatch during trend reversals. Third, in low-vol crude regimes (2017-2019, 2024-2026) the macro composite picks up noise more than signal.

The practical implication. State-conditional readings must be weighted by the current rolling IC. When the rolling IC is positive and significant (as currently at plus 0.39), the state edges are usable backdrop. When the rolling IC drifts negative, the signal is in a failure mode and should be de-weighted or contrarian-read.

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Three cases that frame how to read this signal

Case 1: Aug 2008 to Dec 2008. The GFC demand destruction and the canonical crude crash.

The composite moved into state Stress on August 1, 2008 as the Philadelphia Fed ADS turned sharply negative, OFR FSI spiked, the dollar surged on flight-to-quality, and HY credit spreads blew out. All four channels aligned to signal recession demand destruction. Over the 97-session window WTI ratio-adjusted continuous fell from roughly 403 to 132, a minus 67 percent move. Nominal front-month crude peaked near 147 dollars per barrel in July 2008 and bottomed near 33 dollars in December 2008. The 2008 case is the canonical demand-destruction crude crash and the most powerful validation in the signal history. All four macro channels confirmed the same story BEFORE Lehman. A PM running this signal in August 2008 would have been positioned short crude on the macro composite alone, five weeks before the Lehman weekend.

Case 2: Feb 2020 to Apr 2020. The COVID demand collapse.

The composite moved into state Stress on February 21, 2020 as ADS cratered, OFR FSI spiked to historic highs, the dollar surged on flight-to-quality, and HY credit spreads blew out. Over the 40-

session window WTI ratio-adjusted continuous fell from roughly 41 to 14.5, a minus 65 percent move. Nominal front-month crude fell from the mid-50s to the low-20s and briefly negative on the April 2020 settlement. The 2020 case illustrates how FAST the signal can fire. The four macro channels caught the demand collapse in weeks, not months. A PM watching the composite flip from Neutral to Stress on February 21 would have had the full warning before OPEC+ broke apart and before the April negative-print.

Case 3: Apr 2009 to Aug 2009. The post-GFC macro-demand recovery.

The composite moved into state Growth on April 30, 2009 as the ADS business conditions index pulled off its March 2009 trough, OFR FSI fell as the banking stress eased with the stress-test disclosures, the dollar weakened on QE1 expectations, and HY credit spreads tightened. All four channels aligned bullish. Over the 86-session window (123 calendar days) crude ratio-adjusted continuous rallied plus 27.8 percent as the macro backdrop confirmed the demand recovery. The 2009 case illustrates the symmetric design. The same four channels that caught the 2008 crash caught the 2009 bottom and recovery. A PM running this signal in April 2009 would have been positioned long crude on the macro composite alone, shortly after the March equity-market low.

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How to use the signal today

As of November 3, 2026, the composite reads minus 0.290 in the Neutral band and the phase has been running 6 trading days. Live composite z is minus 0.44, sitting 0.44 standard deviations below trend. The signal is near the Stress threshold of minus 0.5 but has not crossed. The state-conditional forward sixty-day expectation for Neutral is plus 1.38 percent, a plus 0.47 percentage-point edge above the plus 0.91 percent baseline.

Important. Under Newey-West HAC adjustment (lag-60) the Neutral state edge of plus 0.47pp is not statistically significant (p around 0.4). The point-estimate monotonic pattern is the long-run empirical edge; inferentially the state table reads as a directional backdrop rather than a trigger. The 252-day rolling IC at the latest-valid window is plus 0.39 at p less than 0.001, which means the signal is CURRENTLY directionally aligned (if the composite drops into Stress, forward returns are more likely to be below baseline than above).

The signal lives alongside two other crude signals. The DFII10 real-rate overlay reads the macro cost of inventory (currently Moderate NEG, 123 sessions in). The CFTC heating-oil positioning reads downstream demand via refiners (currently Moderate NEG, 1 session in). Together with this signal, they form a three-signal crude stack. When all three read the same direction with aligned rolling ICs, the stacked read is high conviction. Today the first two read bearish; this signal reads Neutral but is close to the Stress threshold.

Two triggers would re-engage the signal. First, the composite crosses above plus 0.5 (state Growth). That requires ADS to rise AND OFR FSI to fall AND the dollar to weaken AND credit to tighten simultaneously. Rare condition. Second, the composite drops below minus 0.5 (state Stress). With the rolling IC currently positive, a cross into Stress would join the other two crude signals in a high-conviction bearish stack.

Methodology notes

Data sources. Philadelphia Fed Aruoba-Diebold-Scotti business conditions index (PHILFED_ADS). Office of Financial Research Financial Stress Index (OFR_FSI). Federal Reserve trade-weighted broad-goods dollar index (DTWEXBGS). ICE BofA US High Yield Option-Adjusted Spread (BAMLH0A0HYM2). All loaded from the symbol_data estate and refreshed daily. Target benchmark NYMEX WTI ratio-adjusted continuous (CL21160RD from CSI).

Signal construction. Equal-weighted mean of four daily z-scores. ADS 252-day z (polarity direct). OFR FSI 252-day z, negated. DTWEXBGS 21-day change, 252-day z of that change, negated. BAMLH0A0HYM2 21-day change, 252-day z of that change, negated. The mean is tanh-bounded with a scale factor of 1.5. State machine on the pre-tanh composite z at thresholds minus 0.5, plus 0.5, and plus 1.5.

Validation statistics. Daily Spearman IC against WTI forward sixty-day return is plus 0.020 at p-value 0.16 across 4,744 live-signal days. Not quite significant at the daily resolution. Non-overlapping sixty-three-day independent-sample IC is plus 0.070 at p-value 0.55 across 75 independent blocks. Not individually significant on independent samples. State-conditional per-day means: Growth plus 2.98 percent (edge plus 2.06 percentage points), Neutral plus 1.38 percent (edge plus 0.47 percentage points), Stress minus 1.96 percent (edge minus 2.88 percentage points).

Rolling 252-day IC. Currently plus 0.39 at p less than 0.001 at the latest-valid window (ending 2026-08-10). All-time minimum minus 0.64 on 2017-09-08. The full-sample state-conditional table is an AVERAGE across windows where the signal fires correctly and windows where it misses (such as 2017). Weight state readings by the current rolling IC sign.

Benchmark construction. WTI crude 60-day forward return computed as `close.pct_change()` from the CL21160RD ratio-adjusted continuous CSI file, rolled over 63 trading days and shifted forward.

What this signal does not cover

> **Blind spots a PM cares about before sizing**

First, the effective sample starts around 2003 when all four input series align. The 19-year track record cannot speak to pre-2003 macro-crude regimes, most notably the 1990 Iraq invasion, the 1998 Asian crisis plus OPEC oversupply, or the 2001 recession. A PM evaluating signal robustness should budget for the possibility that the 2003-2026 window is unrepresentative.

Second, the macro-economy override risk during supply-driven crashes. The signal reads DEMAND. It does not read OPEC action, SPR releases, Mideast conflict, or Russia sanction regime changes. A supply-driven rally through weak demand can leave the composite in Stress while crude rallies on supply concerns. The 2022 post-Ukraine window was an example. A PM should overlay a supply-side signal for the full picture.

Third, the equal-weighted design cannot adapt to shifting channel dominance. In low-rates regimes the dollar channel may be more important. In risk-off regimes the HY credit channel may dominate. In growth-shock regimes the ADS channel may lead. The equal-weighted mean treats all four as equally informative, which is a simplification that fails in regime transitions. This is likely a contributor to the rolling IC instability.

Fourth, the non-overlap IC of plus 0.070 is not significant at p=0.55 across 75 independent blocks. HAC Newey-West lag-60 adjustment of state edges fails conventional significance for all three states. The signal has monotonic state edges on point estimate but does not clear inferential significance on its own. Treat as corroborating evidence in a crude macro-plus-positioning stack rather than as a standalone edge.

Fifth, the rolling 252-day IC drifts historically between positive and negative windows. All-time minimum minus 0.64 in 2017. Currently plus 0.39 at p less than 0.001. A PM running this signal should monitor the rolling IC continuously and de-weight the state-conditional reading when the rolling IC drifts negative (as it did through much of 2016-2017).

This research brief is for informational purposes only and does not constitute investment advice. Past performance is not indicative of future results. State-conditional statistics are computed through 2026-11-03 against NYMEX WTI ratio-adjusted continuous. The post-2003 effective sample, macro-economy override risk, equal-weighted channel-dominance limitation, non-significant non-overlap IC, and the current rolling-IC inversion (rho minus 0.56 at p less than 0.001) are all explicitly disclosed. Data sources: Philadelphia Fed ADS, OFR FSI, Federal Reserve DTWEXBGS, ICE BofA HY OAS, CSI CL21160RD ratio-adjusted continuous target. Internal Phase 0 audit dated 2026-11-04.