Newswire Tone-Overlay Commodity Portfolios

Adrian Fernandez-Perez[§,a] Ana-Maria Fuertes[b] Joëlle Miffre[c] Nan Zhao[d]

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We propose a method to overlay the tone of commodity-specific newswires upon the commodity characteristics traditionally used in long-short portfolio allocations. Implementing the tone-overlay strategy on 26 commodities generates substantial risk-adjusted profitability gains relative to the corresponding plain-vanilla traditional portfolios. Recession risk and limits-to-arbitrage risk emerge as key channels for the observed outperformance. The benefits of the tone-overlay tactical allocation are more pronounced when it focuses on very salient pessimistic or optimistic newswire tone in line with theories of limited investor attention. The tone-overlay approach is shown to be more effective than alternative approaches to embed newswire tone into traditional commodity allocations such as the equal-weight style-integration and double-sorting.

***Keywords*:** Newswire tone-overlay; Sentiment; Commodity futures; Tactical allocation; Salience.

***JEL classifications*:** Q02, G12, G14.

[§] This paper has benefited from comments by Robert Carver, Ilias Chondrogiannis, Emmanuel Eyiah-Donkor (discussant), Thomas Raffinot (discussant), George Skiadopoulos, Michael Tamvakis, Sandrine Ungari, and Adam Zaremba as well as participants at the 2023 IFABS International Finance and Banking Society conference in Oxford, 2023 FEM Financial Economics Meeting in Paris, 2023 CEMA Commodity and Energy Markets Conference in Budapest, 2023 Société Générale Quantitative Finance Annual Conference in London, 2022 International Conference on Computational and Financial Econometrics, London, 2020 International Symposium on Forecasting (virtual), and seminars at the University of Piraeus, Greece, University of the Balearic Islands, Spain.

[a] Auckland University of Technology, Auckland, New Zealand. E-mail: adrian.fernandez@aut.ac.nz
[b] Bayes Business School, City, University of London. E-mail: a.fuertes@city.ac.uk. *Corresponding author.*
[c] Audencia Business School, Nantes, and Institute Louis Bachelier, Paris. E-mail: jmiffre@audencia. com
[d] Barclays Corporate and Investment Bank, London. E-mail: nan.zhao@barclays.com.

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1. Introduction

Recent advances in textual processing have enabled powerful analytical tools to extract sentiment from news and social media posts inter alia.[1] Tetlock (2007) measures the extent of pessimism or low sentiment conveyed by the daily column "Abreast of the market" of the *Wall Street Journal* and investigates whether and how it affects subsequent stock returns. Low market returns are observed after pessimistic news tone followed by a reversal to fundamentals. A host of subsequent research has documented that the overall tone of news stories is a useful "window" into investors beliefs and moods, optimistic or pessimistic, with cross-sectional predictive ability for stock returns (e.g., Tetlock et al., 2008; Garcia, 2013; Kelley and Tetlock, 2013; Ferguson et al., 2015). Therefore, the debate is no longer whether sentiment affects stock prices but instead how to measure investor sentiment, quantifying its effects and uncovering the underlying channels.

As regards the latter, the theoretical underpinning for much of this empirical research is the model of De Long et al. (1990) which defines sentiment as the deviation of the stochastic beliefs of irrational noise traders from the (Bayesian) rational arbitrageurs' beliefs. The unpredictability in retail traders' beliefs generates a risk that deters arbitrageurs from aggressively betting against retail trades in the short term. The implicit assumption is that only retail traders are influenced by sentiment. Challenging this assumption, a growing literature suggests that institutional investors are also subject to similar behavioral biases and hence, their collective trades also induce a mispricing (e.g., Edelen et al., 2016; De Vault et al., 2019, You et al., 2022).

A relatively sparse literature has studied the pricing role of investor sentiment in commodity futures markets which represent per se an interesting laboratory given the very low presence of

[1] Sentiment is the overall attitude of investors – pessimistic or optimistic – towards a particular financial market that does not always fully reflect the fundamentals. The British economist John Maynard Keynes argues that the presence of heightened uncertainty in periods of economic stress opens the door for sentiment, that he calls the "animal spirits", to influence investors' decisions (Keynes, 1936).

retail investors.[2] Through a time-series analysis, Gao and Süss (2015) identify a significant pricing role of market psychology in sectoral commodity futures markets using broad sentiment proxies constructed from equity market data, while Brandt and Gao (2019) and Smales (2014) show that news sentiment influences crude oil and gold futures prices, respectively. The cross-sectional pricing ability of sentiment for commodity futures returns has been supported recently in Fernandez-Perez et al. (2020) and Fan et al. (2023) by showing that a significant premium can be captured through the long-short allocation of futures contracts by sentiment signals projected from Google "hazard fear" search volume and commodity-specific Tweets, respectively.

This paper contributes to the scarce literature on newswire tone in commodity markets in various aspects. First, it puts forward a novel method to exploit commodity-specific newswire tone with a view to improve extant trading models. Second, by documenting the added premium that investors earn by embedding newswire tone into traditional commodity characteristics, it provides fresh evidence on the relatively recent contention that sentiment also influences the trading decisions of institutional investors. Third, the analysis uncovers recession and limits-to-arbitrage risks as two complementary channels for the tone-overlay benefits. Fourth, the paper documents the superior efficacy of the tone-overlay strategy proposed versus other strategies, such as style-integration and double-sorting, that investors could alternatively use to embed newswire tone into a traditional commodity allocation. We elaborate on each of these aspects next.

We begin by articulating a method to overlay the predictive content of commodity-specific newswire tone upon traditional commodity characteristics – the newswire *tone-overlay* hereafter. If sentiment transmits to commodity futures prices via trades in the short-term, as prior studies suggest, then efforts are warranted to re-design extant commodity allocations more efficiently by

[2] According to open interest data for hedgers (commercials), speculators (non-commercials), and non-reportable traders (small traders) from the Commitment of Traders Reports of the Commodity Futures and Trading Commission, the proportion of small/retail traders as of 2014 is about 13% (Bhardwaj et al., 2016). By contrast, retail investors can account for up to 32% of the total US equity trading activity (see *Factbox: The U.S. retail trading frenzy in numbers*, Reuters, January 29, 2021).

additionally exploiting the short-term predictive ability of newswire tone. Take the basis signal or the price gap between the front and second-nearest contracts as an example. The tone-overlay strategy tilts the basis up (down) for the commodities that have attracted salient optimistic (pessimistic) newswires making them even more attractive long (short) candidates.

Thus, this paper is the first to study the benefits of embedding newswire sentiment into commodity characteristics traditionally used as signals for commodity premia extraction. We do so by implementing the novel tone-overlay tactical allocation on a cross-section of 26 commodities using an array of traditional signals – basis, momentum, hedging pressure, relative basis or convexity, skewness, basis-momentum and liquidity. We evaluate out-of-sample the benefits of the tone-overlay strategy as regards the premium captured, downside risk profiles, and risk-adjusted performance versus the underlying "plain vanilla" traditional portfolios, and versus the long-short portfolio formed by the standalone newswire tone (in levels or shifts) signal.

Overlaying the commodity-specific newswire tone upon a traditional commodity characteristic is fruitful as it facilitates portfolios with a larger premium and smaller downside risks than the traditional portfolios. In consequence, the risk-adjusted performance of traditional portfolios is notably enhanced as suggested by Sharpe ratio gains of 0.69 on average. As they exploit both the newswire tone and traditional commodity characteristics, the tone-overlay portfolios also beat the long-short portfolio based solely on the newswire tone (level or shifts) signal. Overall, these findings suggest that there is substantial cross-sectional predictive ability in the newswire tone – the commodities subject to more salient-pessimistic newswires underperform in the subsequent week the commodities subject to the more salient-optimistic newswires – and this predictive ability is best harnessed in conjunction with that of traditional signals. Given the low participation of retail traders in commodity futures markets, the findings indirectly suggest that institutional traders are also swayed by sentiment. The tone-overlay efficacy survives the consideration of transaction costs and is not spurious as suggested by a placebo test.

Second, the conditional analysis of the benefits generated by the tone-overlay reveals important insights. The benefits are very pronounced in recession (high aggregate uncertainty) environments. This finding suggests that commodity futures investors are more strongly influenced by news stories in hard times. This evidence, together with our indirect tests that give more bite to the sentiment interpretation of news tone pricing than to the information interpretation, serve to confirm Keynes (1936) contention that uncertainty and hardship open the door for “animal spirits” to influence investors’ decisions. Moreover, the tone-overlay affords greater gains in financial stress periods which is consistent with the notion that any mispricing is more difficult to arbitrage away when speculators experience funding liquidity constraints.

Third, the benefits of the newswire tone-overlay strategy are found to improve when the tactical overlay accounts for financial market conditions. Specifically, it pays to carry out a more aggressive tilting for salient pessimistic newswires during stressed (“high TED”) financial markets and vice versa in calm (“low TED”) markets. This evidence is consistent with the so-called confirmation bias or the behavioral approach to decision-making which results from people’s tendency to search for, or pay more attention to, information that is consistent with their existing beliefs – commodity investors decisions follow more closely the negative news in “bad” times when pessimism is the prevalent market outlook, and vice versa in “good” times.

A final useful set of results stems from confronting the novel tone-overlay approach with two other approaches to embed newswire tone into traditional commodity signals – the equal-weight style integration (EWI) and double-sorting. The tone-overlay allocation strategy brings the most fruition to portfolio managers which can be attributed to its flexibility. For instance, it can increase the signal-to-noise ratio by focusing on the salient optimistic/pessimistic newswires identified in a time- and commodity-heterogeneous way using the historical tone distributions.

Our paper contributes to the literature that highlights the role of limits-to-arbitrage in commodity futures markets. Acharya et al. (2013) develop an equilibrium model where producers have hedging demands and speculators can experience capital constraints. The key prediction is that during financial stress, when speculative capital liquidity dries out, the arbitrage activity needed to correct any mispricing is hindered. Our finding that the benefits of the commodity tone-overlay strategy are more pronounced in high TED environments endorses this prediction. As argued by Gao and Süss (2015), the two necessary conditions for sentiment to influence price formation – speculative demand and arbitrage constraints – are present in commodity futures markets (see also Etula, 2013; Fernandez-Perez et al., 2020; and Fan et al., 2023).

A branch of the sentiment literature suggests that the predictive ability of sentiment for the cross-section of asset returns increases during economic downturns and in periods of heightened aggregate uncertainty (see e.g., Garcia, 2013; Birru and Young, 2022, for equities, and Fan et al., 2023, for commodities). Our evidence from the novel perspective of tone-overlay commodity portfolios adds to these studies and echoes Keynes' (1936) seminal idea that the "animal spirits" (collective beliefs or sentiment) are more likely to influence decision making in times of hardship.

The paper is also related to a theoretical and empirical literature which establishes that "salience" plays a key role in investors' decision making because of limitations in the cognitive process known as attention (e.g., Hirshleifer and Teoh, 2003; Bordalo et al., 2012, 2022; Cosemans and Frehen, 2021). For instance, the evidence in Hirshleifer and Teoh (2003) suggests that investors allocate attention to the most salient news in financial statements. As the information available to investors expands exponentially, their attention is increasingly strained and challenged; or as Herbert Simon, Nobel Laurate in Economics, concisely puts it "a wealth of information creates a poverty of attention". Accordingly, the salience of information emerges as a key component in framing decisions – the most salient news stories influence investors' perceptions which, in turn, affect their decision making. Building upon this intuition, theoretical models predict that asset prices ought to react mostly to salient news (Bordalo et al., 2012, 2022). Our novel finding that the tone-overlay strategy generates larger benefits vis-à-vis the traditional allocations when it focuses on the most salient pessimistic/optimistic newswire tone confirms this prediction and supports this literature from a commodity market perspective.

Lastly, various practical implications arise from the paper. It provides a way to enhance traditional strategies to generate alpha. The commodity tone-overlay portfolios can be potentially useful to equity investors given their sizeable performance gains in high inflation periods and their relatively low correlations with the broad equity market. Lastly, the results serve to validate proprietary news analytics software that assigns sentiment scores to commodity newswires.

The paper proceeds as follows. The tone-overlay method is presented in Section 2. Section 3 discusses the data. Section 4 examines the main results on the tone-overlay merit in various dimensions. Section 5 provides further evidence and robustness tests, and Section 6 concludes.

2. Methodology

2.1. Tilting a traditional signal by salient newswire tone

The news tone-overlay strategy that we propose seeks to embed the salient tone or "pitch" of recent commodity news into traditional commodity characteristics (or signals) used in long-short portfolio allocations. These well-known characteristics include the basis (Erb and Harvey, 2006), momentum (Miffre and Rallis, 2007), hedging pressure (Basu and Miffre, 2013), relative basis or convexity (Gu et al., 2023), skewness (Fernandez-Perez et al., 2018), basis-momentum (Boons and Prado, 2019) and Amihud's illiquidity (Szymanowska et al., 2014). Appendix Table A.1 provides signal definitions and key references. For expositional simplicity, all signals are congruently defined so that higher values predict larger increases (smaller decreases) in futures prices and thus, they recruit candidates for the long leg of the portfolio; smaller values predict larger decreases (smaller increases) in prices and hence, recruit the shorts.

The main objective behind the tone-overlay method is to generate benefits by adjusting, or tilting, a given traditional signal at each portfolio formation time towards (away from) those commodity futures contracts which have been recently the subject of salient optimistic (pessimistic) news stories, be they facts or opinions. The method is quite flexible in that, for instance, the identification of "salient" newswires permits commodity heterogeneity and time variation, and the tilting of pessimistic versus optimistic tone can differ over time, inter alia.

Let $x_{i,t}$ denote a traditional characteristic measured at time *t* for commodity *i*. Let the news-tone characteristic be an index, $0 \leq TONE_{i,t} \leq 100$, as explained in the next section, such that high (low) values above (below) 50 convey optimistic (pessimistic) sentiment about the commodity price course, i.e., up (down). We denote the tone-overlay signal, $x_{i,t}^{TONE}$, that is, the traditional signal tilted upwards/downwards according to the recent salient newswire tone.

To provide some intuition, let us focus on the *basis* as sorting signal to extract the risk premium using the notation T_n to indicate the *n*th nearest futures contract. Suppose that the *i*th commodity is characterized at portfolio formation time *t* by a positive basis or downward term structure, $basis_{i,t} = ln\left(f_{i,t}^{T_1}/f_{i,t}^{T_2}\right) > 0$, which characterizes the backwardation state – the commodity is a good candidate for the long leg of the basis portfolio. If the recent news tone on the *i*th commodity is optimistic (pessimistic), this basis signal is tilted upwards (downwards) resulting in the tone-overlay basis (hereafter, $basis_{i,t}^{TONE}$) which is more (less) positive than the original basis. According to the tone-overlay basis signal the commodity *i* is classified as an even more (less) attractive candidate for the long portfolio than according to the original basis. Vice versa, if $basis_{i,t} < 0$ and hence, the *i*th commodity is a good candidate for the short leg of the basis portfolio, the basis signal is tilted down (up) with pessimistic (optimistic) tone, so the tone-overlay basis signal identifies the *i*th commodity as a more (less) attractive candidate for the short portfolio than the original basis signal.

Formalizing this idea, let $x_{i,t}$ denote any (fundamental) commodity signal of interest, and $x_{i,t}^{TONE}$ the tactical signal that results from overlaying the newswire tone upon it. We define the tone-overlay signal $x_{i,t}^{TONE}$ as a function of the traditional signal, $x_{i,t}$, the news tone signal,

$TONE_{i,t}$, and a parameter vector, $\boldsymbol{\theta}$, that introduces flexibility in the overlay. Formally,

$$x_{i,t}^{TONE} = f(x_{i,t};\ TONE_{i,t}, \boldsymbol{\theta}) \qquad (1)$$

where $\boldsymbol{\theta} = (\tau_{i,t}, \sigma_{i,t}, \pi, \boldsymbol{\delta}_t)'$ with $\boldsymbol{\delta}_t = (\delta_t^+, \delta_t^-)'$. More explicitly, we propose the following framework to obtain the newswire tone-overlay signal at each portfolio formation time *t* as

$$x_{i,t}^{TONE} = x_{i,t} + \delta_t^+ I_{i,t,(1-\pi)}^{TONE+} \tau_{i,t}\sigma_{i,t} - \delta_t^- I_{i,t,\pi}^{TONE-} \tau_{i,t}\sigma_{i,t} \qquad (2)$$

where $x_{i,t}$ denotes the traditional signal (e.g., basis) observed for commodities $i = 1, \ldots, N$ cross-sectionally standardized (demeaned by $\bar{x}_t$ and scaled by σ_t), with $I_{i,t,(1-\pi)}^{TONE+}$ and $I_{i,t,\pi}^{TONE-}$ denoting the optimistic and pessimistic newswire indicators, respectively, that hinge on the *salience* parameter π. The intensity of the tone overlay is governed by the tone *tilting* parameter τ_{it} as a proportion of the commodity-heterogeneous and time-varying historical volatility of the traditional signal, $\sigma_{i,t}$, as estimated from $\{x_{i,t-L+1}, \ldots, x_{i,t-1}, x_{i,t}\}$. Finally, the *asymmetry* parameters $\boldsymbol{\delta}_t = (\delta_t^+, \delta_t^-)$ allow the tone-overlay strategy to embed asymmetries in the predictive role of pessimistic and optimistic newswires. We elaborate next on each parameter.

The tone-overlay framework allows the portfolio manager to acknowledge commodity heterogeneity in the identification of salient news tone. This is accomplished by taking into consideration the historical distribution of news tone that is specific to each commodity to determine $I_{i,t,(1-\pi)}^{TONE+}$ and $I_{i,t,\pi}^{TONE-}$, that is, the indicators of salient optimistic and pessimistic newswire tone. Furthermore, through the *salience* parameter π the tone-overlay framework can accommodate different investors' choices as regards the degree of salience of the tone to focus upon. Let $z_{i,t,\pi}$ and $z_{i,t,(1-\pi)}$ with $z_{i,t,\pi} < z_{i,t,(1-\pi)}$ denote, respectively, the bottom πth and top (1-π)th percentiles of the historical distribution of newswire tone specific to the *i*th commodity over a prior window of L weeks, i.e. $\{TONE_{i,t-L+1}, \ldots, TONE_{i,t-1}, TONE_{i,t}\}$. We define $I_{i,t,(1-\pi)}^{TONE+} = 1$ if $TONE_{i,t} > z_{i,t,(1-\pi)}$, and $I_{i,t,(1-\pi)}^{TONE+} = 0$ else, likewise $I_{i,t,\pi}^{TONE-} =$ 1 if $TONE_{i,t} < z_{i,t,\pi}$, and $I_{i,t,\pi}^{TONE-} = 0$ else. Thus, the current news tone on commodity i is categorized as optimistic or pessimistic in the context of its own distribution. This is an important feature since a news tone value of 70 might represent a salient optimistic tone for commodity *i* but not for commodity *j* in the context of their respective historical distributions. The tone-overlay approach, Equation (2), thus permits heterogeneity across commodities and time in the identification of salient tone. If the newswire tone for the *i*th commodity is not salient, there is no newswire tone overlay and the relevant signal is the traditional signal, $x_{i,t}^{TONE} = x_{i,t}$. If the portfolio manager chooses e.g., $\pi = 0.10$ (10th percentile) then the tone-overlay is only triggered for extreme/salient tone $TONE_{i,t} > z_{i,t,0.90}$ (optimistic) or $TONE_{i,t} < z_{i,t,0.10}$ (pessimistic). Thus, the parameter π allows the investor flexibly to filter the salient tone.[3]

The extent of the traditional signal tilting at time *t* when tone is salient is dictated by the parameter τ_{it} (with $0 < \tau_{i,t} < \infty$) as a proportion of the commodity-specific historical volatility of the traditional signal; the subscripts *i* and *t* indicate that the tilting can be commodity-heterogenous and time-varying. The closer the *tilting* parameter $\tau_{i,t}$ is to zero ($\tau_{i,t} \approx 0$) the lesser the tone-overlay ($x_{i,t}^{TONE} \approx x_{i,t}$) and the allocation is effectively dictated by the traditional signal. The fixed tilting parameter value $\tau_{i,t} = \tau = 0.9$ implies that for all commodities and at each portfolio formation time *t* the signal $x_{i,t}$ is tilted by almost a full standard deviation of its distribution over the past *L* weeks $\{x_{i,t-L+1}, \ldots, x_{i,t-1}, x_{i,t}\}$. Thus, the component $I_{i,t,(1-\pi)}^{TONE+}\tau_{i,t}\sigma_{i,t}$ indicates that the original signal is tilted upwards by $\tau_{i,t}\sigma_{i,t}$ when the tone is salient optimistic ($I_{i,t,\pi}^{TONE+}$=1). The commodity-heterogenous and time-varying tilting of the news tone can be done, for instance, by setting $\tau_{i,t}$ at the current (cross-sectional

[3] Bordalo et al. (2022) survey several models of salience and bottom-up attention in economic choice. These models consider different settings, but they share the intuition that "when *decision makers* choose, the attributes of choice options act as stimuli […] The attributes of an option are then differentially salient depending on (*a*) their contrast with the attributes of other options, (*b*) the extent to which they are surprising compared to retrieved normal values, and (*c*) the prominence with which they are displayed. The attention of *decision makers* is allocated bottom up to salient attributes, which are then overweighted, while non-salient attributes are underweighted." Our tone-overlay method proxies these effects through the parameter π in Equation (2) through which the investor can focus on the salient newswire tone.

standardized) tone, $TONE_{i,t}$, or at the tone shift from the previous portfolio formation time $t-1$ to the current one, $\Delta TONE_{i,t}$. These different tilting approaches will be studied in the paper.

Pessimistic news tend to attract more attention than optimistic news (negativity bias) in stressed market conditions which further depresses investors' mood and induces them to take cautionary positions to avoid losses, inducing prices to drop further – this downward spiral is the essence of a bear market (see e.g., Edmans et al., 2007, Kamstra et al., 2017). Vice versa, in a booming financial market environment any favourable development can disproportionately lift investors' mood which leads to higher prices, in turn, encouraging a "rosier" mood – this upward spiral is the essence of a bull market when greed grows relative to fear. This behavioural intuition motivates a flexible tone-overlay strategy that permits a time-varying parameter vector $\boldsymbol{\delta}_t = (\delta_t^-, \delta_t^+)$ with δ_t^- and δ_t^+ in the range 0-1. Accordingly, the portfolio manager can deploy the allocation dynamically, namely, a stronger tilting of the original signal for pessimistic than optimistic newswire tone ($\delta_t^- > \delta_t^+$) in "bad" times, and a stronger tilting for optimistic than pessimistic newswire tone ($\delta_t^- < \delta_t^+$) in "good" times.

2.2. Newswire tone: a "new" commodity characteristic

The tone-overlay approach proposed, Equation (2), hinges on the newswire tone characteristic denoted $TONE_{i,t}$ that we measure commodity by commodity at each portfolio formation time. $TONE_{i,t}$ is a combination of the sentiment scores assigned by *RavenPack News Analytics* (RPNA) to newswires from wide-reach sources: Dow Jones Financial Wires, Wall Street Journal, Barron's and MarketWatch.[4] The newswires are wide in nature including unscheduled news such as natural disasters, war and conflict, and political events, scheduled news such as press conferences, releases or updates of macroeconomic indicators, alongside forecasts, discussions, and opinion

[4] A branch of the literature on the asset pricing role of sentiment utilizes proprietary news sentiment data from platforms such as RPNA, *Thomson Reuters News Analytics* (TRNA), and *Alexandria Technology*. See e.g. Heston and Sinha (2016), Leinweber and Sisk (2011), and Groß-Klußmann and Hautsch (2011) for equities, and Brandt and Gao (2019) and Smales (2014) for crude and gold futures, respectively.

articles. RPNA assigns a sentiment score to each entity-specific news story which conveys, in the case of a commodity as news entity, the likely short-term price course according to the story. For instance, take a newswire on demand growth projections for copper stemming from electric car production. The news entity is copper and the entity-level newswire is assigned an optimistic sentiment score (> 50) because a rise in copper demand ceteris paribus means upward pressure on its price. A newswire about an expansion in OPEC supply conveys ceteris paribus downward pressure on crude oil prices and thus, the news item is assigned a pessimistic (< 50) score.

Apart from the broad business and financial news coverage, our motivation for using RPNA news-sentiment scores is that they are based on ratings from a pool of financial experts' surveys. Financial experts rate each entity-specific newswire as conveying "positive" or "negative" sentiment (direction) and the extent of it (salience or strength). An algorithm blends the ratings into a sentiment score. Thus, indirectly our analysis will serve as scrutiny on the usefulness of the proprietary RPNA news-sentiment data. The relevant inputs for our $TONE_{i,t}$ signal are:

a) Entity Name, an identifier of the entity (i.e., gold or crude oil) discussed in the newswire. An entity-level record is constructed by RPNA for each of the commodities mentioned in the newswire. A single newswire can thus generate multiple commodity-level news items.

b) Relevance, an index between 0 to 100 that indicates the relevance of the news item for the corresponding entity. If the commodity plays a high role in the main thrust of the newswire, then the *relevance* is close to 100 – e.g., the relevance for copper of a newswire on the growing demand for copper caused by electric car production is high, while the relevance of the newswire for any other metals briefly mentioned is low. To mitigate the noise-to-signal ratio in the $TONE_{i,t}$ measure, we only consider the news articles with *relevance* above 90 for the i^{th} commodity.

c) Event Novelty Score (ENS), an index between 0 and 100 assigned to each entity-level news item that represents how novel it is within a 24-hour window. The first story about an entity within a 24-hour window receives a score of 100 as it is the most novel. Subsequent similar-content stories about the entity within the same day are assigned lower ENSs following a decay function. *d) Event Sentiment Score* (ESS), an index between 0 and 100 assigned to each entity-level news item that quantifies the overall tone of the story for the entity. The ESS reflects whether the news story (facts and/or opinions) anticipates an upward or downward commodity price movement. An ESS value of 50 indicates neutral sentiment for the commodity. An ESS above 50 indicates positive/optimistic sentiment (bullish) and below 50 negative/pessimistic sentiment (bearish).

With the RPNA metadata at hand, we begin by measuring a commodity-specific newswire tone signal at the start of each sample week as follows. Let K_1,..., K_7 denote the number of articles published on the 7×24-hour window preceding the portfolio formation time *t* (Monday-end). Since it is reasonable to assume that the impact of news on asset prices lessens with the staleness of the news (Tetlock, 2011), we employ an exponentially-weighted average for the news on days $t-1$ to $t-7$. Our commodity-specific news tone index avoids look-ahead bias by encapsulating the ESS of all the intra-day newswires relevant to the *i*th commodity within the 7×24-hour window preceding time *t*. Formally, the newswire tone signal blends the ESS data as

$$TONE_{i,t} = g\left(ESS_{t-7(K_7)}, \ldots, ESS_{t-7(1)}, \ldots, ESS_{t-1(K_1)}, \ldots, ESS_{t-1(1)};\ \gamma, \phi_{d(k)} \right), \quad (3)$$

where γ and $\phi_{d(k)}$ are parameters. More explicitly, we construct the newswire tone index as

$$TONE_{i,t} = \frac{\sum_{d=t}^{t-D+1} \gamma^{t-d} (\sum_{k=1}^{K_d} \phi_{d(k)} ESS_{d(k)})}{\sum_{d=t}^{t-D+1} \gamma^{t-d}}, \quad 0 \leq TONE_{i,t} \leq 100 \quad (4)$$

where $ESS_{d(k)}$ is the sentiment score assigned by RPNA to the *k*th newswire on day *d* relevant to commodity *i*; we denote $d = t$ the first 24-hour window preceding the Monday-end (which is set at 5 p.m. Eastern time for all commodities), $d = t - 1$ the second 24-hour prior window and so on. The parameter $0 < \gamma \leq 1$ captures the daily news impact decay; $\phi_{d(k)}$ is the within-day news *novelty* score appropriately normalized so that $\sum_{k=1}^{K_d} \phi_{d(k)} = 1$, with K_d the total number of newswires on the *i*th commodity published on day *d*. To illustrate, suppose that the *i*th commodity has received coverage by six news items in total on the 7×24-hour window preceding the portfolio formation time *t* distributed as follows: four items on the Monday, two items on the preceding Sunday (one day ago), and one item on the prior Tuesday (6 days ago). The newswire tone of commodity *i* at time *t* is calculated using Equation (4) more specifically as

$$TONE_{i,t} = \frac{\gamma^6 ESS_{Tue,i} + \gamma^1 (\sum_{k=1}^{2} \phi_{Sun(k),i} ESS_{Sun(k),i}) + \gamma^0 (\sum_{k=1}^{4} \phi_{Mon(k),i} ESS_{Mon(k),i})}{\gamma^6 + \gamma^1 + \gamma^0} \quad (5)$$

where $ESS_{Mon(k),i}$ is the tone of the k^{th} news story about commodity *i* released in the 24-hour prior to portfolio formation time *t*, $ESS_{Sun(k),i}, k = 1,2$ the tone of each of the two news stories published on the preceding 24-hour period (time $t - 1$), and so forth.

2.3. Newswire tone-overlay tactical allocation strategy

In the main empirical section, we implement the tone-overlay method using a fairly simple or baseline parameterization: Equation (2) with $\pi = 0.10$ to identify *salient* newswire tone through the extreme deciles of the commodity-specific and time-varying historical tone histories, $\{TONE_{i,t-L+1}, \ldots, TONE_{i,t-1}, TONE_{i,t}\}$, as $I_{i,t,0.90}^{TONE+} = 1$ (optimism) if $TONE_{i,t} > z_{0.90}$ and $I_{i,t,0.10}^{TONE-} = 1$ (pessimism) if $TONE_{i,t} < z_{0.10}$; window *length* $L = 260$ weeks to estimate the historical volatility of the traditional signal ($\sigma_{i,t}$) and, as noted, to define salient newswire tone; *tilting* parameter $\tau_{i,t} = 0.9$; and pessimism-optimism *(a)symmetry* weighting parameter $\boldsymbol{\delta}_t = (\delta_t^+, \delta_t^-) = (1, 1)$; Equation (4) with daily news impact decay $\gamma = 0.9$ and within-day news novelty score $\phi_{d(k)} = \phi_d = \frac{1}{K_d}$. We study alternative parameterizations below.

On each portfolio formation time *t* (Monday), we sort the N commodities by the tone-overlay signal, $TONE_{i,t}$, obtained in turn for each of the traditional commodity characteristics (e.g., basis, hedging pressure and so on). We take long positions in the top quintile (Q1) with the largest $TONE_{i,t}$ that is expected to appreciate the most (or depreciate the least) and short positions in the bottom quintile (Q5) with the smallest $TONE_{i,t}$ that is expected to depreciate the most (or appreciate the least). The long and short constituents are equally weighted, the positions are fully collateralized and held for one week. Thus, the portfolio excess return is half the longs return minus half the shorts return ($Q1/2 - Q5/2$). The traditional portfolios follow the same approach.

2.4. Portfolio evaluation tools

The portfolio analysis is conducted in a manner that sidesteps look-ahead bias; namely, the long-short allocations carried out at each portfolio time *t* hinge solely on past data. The out-of-sample (OOS) performance of the tone-overlay portfolios is appraised using various metrics.

We summarize the portfolio excess returns through the mean or risk premium alongside the volatility (StDev), and downside risk profile (standard deviation of negative portfolio returns or semi-deviation, maximum drawdown, and 1% Cornish-Fisher Value-at-Risk). As risk-adjusted performance metrics, we adopt the Sharpe ratio (SR) and non-normality robust Sortino and Omega ratios. To provide statistical significance to the Sharpe ratio gain of the j^{th} tone-overlay strategy versus the underlying j^{th} traditional strategy, we deploy the Ledoit and Wolf (2008) test for the hypotheses $H_0: \Delta SR_j \leq 0$ versus $H_A: \Delta SR_j > 0$, with $\Delta SR = SR_{overlay,j} - SR_{trad,j}$.

We also measure the risk-adjusted performance of the portfolios through the certainty equivalent return (CER) which can be interpreted as the guaranteed (risk-free) excess return that gives the investor the same utility as the expected utility of the risky portfolio. Formally,

$$CER_P = \left(\frac{52}{T}\right) \sum_{t=0}^{T-1} \frac{\left(1+R_{P,t+1}\right)^{1-\nu}-1}{1-\nu} \tag{6}$$

under the assumption of power utility and relative risk aversion coefficient $\nu = 5$ as in Brandt et al., (2009), with T denoting the number of OOS weeks. A positive CER indicates that the risky portfolio is preferred over the risk-free asset. The significance of the CER gain in the j^{th} tone-overlay portfolio vis-à-vis the underlying traditional portfolio, $H_0: \Delta CER_j = 0$ vs $H_A: \Delta CER_j \neq 0$ with $\Delta CER_j = CER_{overlay,j} - CER_{trad,j}$, is gauged through the GMM test of Anderson and Cheng (2016). Finally, we measure the risk-adjusted profitability gain of the tone-overlay strategy as the intercept (alpha) of spanning regressions of the tone-overlay excess returns onto the excess returns of the corresponding plain-vanilla traditional portfolio.

3. Data and Descriptive Statistics

3.1. Data

The analysis is conducted on 26 commodity futures contracts comprising 5 energies, 4 grains, 4 livestock, 5 metals, 3 oilseeds and 5 softs. We collect settlement prices and daily dollar trading volume from *Refinitiv Datastream*, and open interest (number of futures contracts outstanding) from the CFTC's *Commitment of Traders Report*. Futures excess returns are calculated with the front-end contract prices as $R_{i,t} = \ln\left(f_{i,t}/f_{i,t-1}\right)$, up to the end of the month preceding the maturity month; the positions are then rolled to the then second-nearest contract to avoid any erratic price behavior near maturity. For the estimation of transaction costs, we collect data on the minimum tick size of the commodity and the physical units deliverable per contract (or contract multiplier) from the corresponding exchange(s) where the commodity futures contracts are traded. Due to RPNA data availability, the sample period runs from January 3, 2000 to May 31, 2020.

We employ also various indicators of the macroeconomic/financial environment: *i*) the monthly NBER "1-0" recession vs. expansion chronology, *ii*) the daily Aruoba, Diebold and Scotti (2009; ADS) real time index of US business conditions based on a dynamic factor model that exploits data on many macroeconomic variables, including employment, industrial production, real income and sales, *iii*) the daily TED spread (3-month LIBOR minus 3-month U.S. T-bill rate) to proxy funding liquidity conditions, and *iv*) the year-on-year monthly US CPI inflation.[5] Daily observations are averaged to weekly, and monthly observations are interpolated to weekly.

[5] Besides its continuous nature, two advantages of the ADS index are that it is released in real time at the daily frequency whereas the NBER data is only available monthly and with long release lags. The ADS index data are from the website of the Federal Reserve Bank (FRB) of Philadelphia and the CPI and TED data are from the website of the FRB of St Louis FRED.

3.2. Descriptive statistics

As shown in the right-hand panel of Table 1 the newswires coverage is broad at 369,231 articles per commodity on average over the sample period, with large heterogeneity (from a low of 15,282 newswires for frozen orange juice to a high of 3,607,532 for crude oil). Our $TONE_{i,t}$ signal is designed to quantify for each commodity at each portfolio formation time *t* the overall "pitch" or sentiment of the relevant newswires in the preceding week (7×24 hour window). As noted, one of the inputs to construct the $TONE_{i,t}$ signal is the *relevance* score from 0-100 that indicates the role played by the entity (commodity) in the newswire. To achieve a good signal-to-noise ratio, we adopt a *relevance* score above 90. This very conservative newswire-filtering criterion implies that $TONE_{i,t}$ is effectively constructed from a total of 44 newswires per week on average across commodities ranging from 3 newswires/week for livestock to 153 for energies.[6]

[Insert Table 1 around here]

The average pairwise commodity correlations in newswire tone, $\bar{\rho}_{ij} = \sum_{i \neq j} \rho_{ij}$ with $\rho_{ij} = corr(TONE_{i,t}, TONE_{j,t})$, presented in Table A.2, echo the pattern found in excess returns; namely, the tone of newswires is more correlated within sector than across sectors. For instance, the average correlation of newswire tone for crude oil with the newswire tone of other energies stands at 0.32 but it is negligible at 0.05 (with grains), -0.02 (livestock), 0.09 (metals), 0.04 (oilseeds) and 0.04 (softs). Another noticeable pattern is that the within-sector commodity correlations in $TONE_{i,t}$ are lower than those in returns; e.g., 0.35 vs 0.56 for energies, and 0.25 vs 0.60 for metals which is aligned with the evidence in Fan et al. (2023) from sentiment proxied by Tweets. This evidence suggests that news stories largely contain commodity-specific investor moods and beliefs (sentiment) rather than fundamental information whereas the returns reflect to

[6] There are news items for all commodities in all sample weeks before the filtering by $Relevance > 90$. However, after the filtering, there are no news items for some commodities in certain weeks *t*, so we set the news tone to neutral ($TONE_{i,t} = 50$) and thus, there is then no tilting of the traditional signal.

a larger extent fundamental supply/demand factors with stronger within-sector commonality.

As shown in Table 1, the tone of commodity-specific newswires has changed over the sample period as suggested by the standard deviation and range of $TONE_{i,t}$ per commodity. The autocorrelation in news tone (AC1) is uniformly positive for all commodities at 0.52 on average. Thus, if the newswire tone for commodity i on week *t* is downbeat there is about 52% chance that the newswire tone will also be downbeat on the following week. By contrast, the AC1 of the commodity excess returns hovers closely around zero (average absolute correlations at 0.01) confirming the stylized fact of scant time-series return predictability from own past returns.

One may ask to which extent the newswire tone measure calculated for each commodity at each sample week, $TONE_{i,t}$, is simply a reflection of broad market sentiment. To address this question, we utilize data on three general market sentiment proxies. One is a widely-used general sentiment proxy in the academic literature which is constructed by Baker and Wurgler (2007; BWsent). A second one is the Federal Reserve Bank of San Francisco sentiment index extracted from economic-related news articles in 24 major U.S. outlets including the *New York Times* and the *Washington Post* using the methodology of Shapiro et al. (2020; FEDsent). The FEDsent index has been shown to predict movements in survey-based consumer sentiment measures (Shapiro et al., 2020). Finally, we consider the CBOE's VIX also known as the investors' "fear index".[7] Figure 1 presents box plots of the correlations of each of the commodity-specific newswire tone measures, $TONE_{i,t}$, $i = 1, .., N$, with each the three broad market sentiment proxies.

[Insert Figure 1 around here]

The absolute correlations are small at 0.159 on average across commodities with notable differences across commodities which align well with the small commodity newswire tone

[7] The data for the "orthogonalized" BWsent index, the FEDsent index and the VIX are from the websites of Prof. J. Wurgler, the FRB of San Francisco and the FRB of St. Louis, respectively.

correlations, $corr(TONE_{i,t}, TONE_{j,t})$ discussed earlier, especially across sectors.[8] Accordingly, the tone-overlay strategy proposed hinges on the predictive ability of commodity-specific newswire sentiment for futures returns beyond that of the prevailing broad market sentiment.

4. Main Empirical Results

4.1. Does the tone-overlay generate benefits versus traditional allocations?

We first deploy the newswire tone-overlay strategy with the baseline parameterization $\{\tau, \pi, \boldsymbol{\delta}, L\} = \{0.9, 0.10, (1,1), 260\}$ for Equation (2), and $\{\gamma, \phi\} = \{0.9, 1/K\}$ for Equation (4). Table 2 summarizes the out-of-sample performance of seven traditional portfolios (left panel) and the corresponding tone-overlay portfolios (right panel). For completeness, the left panel includes also the long-short portfolio formed according solely to the newswire tone signal in levels ($TONE_{i,t}$) or as weekly shifts ($\Delta TONE_{i,t} = TONE_{i,t} - TONE_{i,t-1}$). Since we use $L = 260$ week windows in Equation (2), the first available excess return is for the initial week of January 2005.

[Insert Table 2 around here]

The results strongly establish that the tone-overlay portfolios enhance performance and improve the downside risk profile of the underlying traditional long-short portfolios (as borne out by smaller absolute Cornish-Fisher VaR and maximum drawdowns for the tone-overlay portfolios). To illustrate, the tone-overlay portfolios report pervasive Sharpe ratio gains over the corresponding traditional portfolios ($\Delta SR_{overlay-trad}$) ranging from 0.592 to 0.818. These gains are not only economically attractive but significant statistically as suggested consistently by the Ledoit and Wolf (2008) test. Likewise, the sizeable certainty equivalent gain ($\Delta CER_{overlay-trad}$) further suggests that the tone-overlay significantly enhances the traditional allocations. Finally, the alphas of regressions of the tone-overlay portfolio on the corresponding traditional portfolio

[8] For instance, the correlation of $TONE_{gold,t}$ with BWsent and FEDsent is negative at -6.3% and -7.7% and with VIX is positive at 3.1% which may reflect the "flight-to-safety" feature of gold in periods of financial turmoil and recessions, namely, adverse broad market sentiment represents "optimism" for gold.

are positive at the 7.59% p.a., ranging from 6.12% p.a. (hedging pressure) to 9.80% p.a. (basis-mom), and strongly significant at the 1% level or better as suggested by Newey-West *t*-statistics.

Altogether this evidence reveals, firstly, that there is useful cross-sectional predictability in the returns of commodity futures from their recent newswire tone; namely, a salient commodity-specific optimistic (pessimistic) tone exerts upward (downward) pressure on the futures prices.[9] Secondly, given that commodity futures speculators are mainly institutional, the sizeable benefits generated by embedding newswire tone into traditional allocations through the tone-overlay method are indirect evidence that institutional investors' decisions are swayed by sentiment.

Figure 2 further documents the merit of the tone-overlay portfolios dynamically over the sample period by plotting their cumulative Sharpe ratios vis-à-vis those of the corresponding traditional portfolio allocations. The first Sharpe ratio plotted is based on an initial window of L=260 weekly excess returns which is sequentially expanded by one week at a time. Remarkably, the plots suggest that the tone-overlay strategy helps in alleviating the poor performance of the traditional portfolios since the late 2000s Global Financial Crisis.

[Insert Figure 2 around here]

Finally, even though our key proposition is the tone-overlay strategy as a refined version of the traditional allocations to increase their efficacy at capturing premia, it is useful to examine the performance of the long-short portfolio formed according to newswire sentiment, $TONE_{i,t}$, or changes thereof, $\Delta TONE_{i,t}$, as a standalone signal. Interestingly, with a premium capture of 5.71% p.a. and a Sharpe ratio of 0.6811 (a premium capture of 6.36% p.a. and Sharpe ratio of 0.7001)

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[9] Equation (2) exploits the optimistic/pessimistic newswire tone mispricing. An alternative approach is to exploit the price correction (see e.g., Baker and Wurgler, 2006; Fernandez-Perez et al., 2020). We deployed the reverse tone-overlay strategy that tilts downwards (upwards) the traditional signal when the newswire is salient optimistic (pessimistic) by switching the signs of the optimism and pessimism indicators in Equation (2). The resulting portfolios do not generate any benefits versus the traditional portfolios as borne out by a premium of -1.53% p.a. on average across portfolios (ranging from -4.08% to 3.53%), an average Sharpe ratio differential (ΔSR) of -0.5095, and an average CER differential (ΔCER) of -0.0133. This confirms that it pays to exploit the mispricing as our tone-overlay method does, rather than the correction.

the standalone-tone (and Δtone) portfolio is very competitive vis-à-vis traditional allocations as shown in Table 2 (left panel).[10] This finding confirms that the newswire tone contains short-term predictive ability for the cross-section of commodity futures returns. However, with a premium capture of 9.18% p.a. and a Sharpe ratio of 1.0682 on average the tone-overlay portfolios bear more fruition than the standalone-tone allocation. This is not surprising given that the latter (by contrast with the tone-overlay portfolios) neglects the predictive ability of traditional signals.

4.2. Placebo test on tone-overlay efficacy

Before proceeding further in the analysis, we conduct a placebo test seeking to confirm that the efficacy of the tone-overlay strategy, namely, tilting the traditional signals by news tone, reflects the predictive content of salient optimism/pessimism as opposed to data mining or sheer "luck". To do so, we carry out a sectoral non-matching of the commodity news tone as explained next.

We documented earlier that the correlations between $TONE_{i,t}$ for commodities in different sectors $i \neq j$ are very low (c.f., Table A.2). For instance, the average correlation between the media tone of commodities in the energy and grain sectors is 0.0202. Building on this evidence, the placebo test is deployed as follows. The i^{th} commodity is assigned $TONE_{j,t}$ with $j \neq i$ denoting a randomly drawn commodity from another sector. Since $TONE_{j,t}$ conveys scant sentiment about commodity i, we conjecture that these randomized-tone overlay portfolios do not hone the corresponding traditional portfolios but rather worsen them by adding noise in the traditional allocations signal rather than overlaying predictive ability. Table 3 presents the results.

[Insert Table 3 around here]

The findings confirm our conjecture. The randomized-tone-overlay allocations report pervasive risk-adjusted losses over the corresponding traditional allocations ($\Delta SR_{toneovl-trad} < 0$) ranging

[10] The standalone-tone portfolio and standalone-Δtone portfolio are highly correlated above 0.70 with the latter performing slightly better as seen in Table 2. These results align well with the evidence in Fan et al. (2023) from Twitter-proxied commodity sentiment suggesting that while the level of optimism/pessimism is important, the predictive ability of sentiment shifts is somewhat stronger.

from -0.0843 to -0.6779 at -0.3473 on average across portfolios. Thus, we can assert that the efficacy of the tone-overlay strategy previously reported is not spurious (i.e., a result of "luck" rather than skill or an artefact of data snooping) but rather a reflection of the ability of commodity news tone to predict the cross-section of commodity futures returns over the subsequent week.

4.3. Tone-overlay benefits: mispricing or risk channel?

We have demonstrated that embedding the tone of commodity-specific newswires into traditional (sorting) signals is beneficial for tactical allocation. This prompts the question: Do the benefits generated by the tone overlay reflect compensation for additional fundamental risks or mispricing? To address this question, we revisit the long-short portfolio formed according to the standalone $TONE_{i,t}$ signal, Equation (4). The absolute correlations between the excess returns of this standalone-tone portfolio and traditional commodity risk factors are very small ranging between 0.0021 (momentum) and 0.0747 (convexity), as shown in Table A.3. The findings are similar for the standalone-Δtone portfolio. This evidence suggests that the premia capture of the standalone-tone (or Δtone) allocation is not compensation for exposure to extant commodity risk factors. In particular, the weak overlap between the standalone-tone portfolio and the portfolios formed by signals strongly linked to the fundamental backwardation-contango cycle (e.g., basis, hedging pressure, and convexity) suggests that the newswire tone mostly conveys sentiment.

The above evidence is complemented by time-series spanning tests carried out through regressions of the standalone-tone portfolio excess returns on a constant, the commodity market factor MKT (excess returns of a long-only equally-weighted and weekly-rebalanced portfolio of all commodities), and the basis, momentum, hedging pressure, convexity, skewness, basis-momentum, and liquidity factors. Table 4 presents the results.

[Insert Table 4 around here]

Across specifications, the standalone-tone portfolio alpha is economically and statistically significant and undistinguishable from the mean raw excess return of the standalone-tone portfolio, (c.f., Table 2). This result aligns well with the very small adjusted-R^2 statistics and suggests that the standalone-tone portfolio premium is not compensation for exposure to commodity risk factors. The evidence stacks up suggesting that the newswire tone, $TONE_{i,t}$, contains predictive ability for the cross-section of futures returns over and above that of well-known factors, including those unequivocally associated with fundamentals such as basis, hedging pressure and convexity. The unreported (in the interest of space) spanning regressions for the excess returns of the standalone-Δtone portfolios confirm these findings.

Further to address the question of whether the benefits generated by the tone-overlay strategy reflect compensation for additional risk-taking or a sentiment-induced mispricing, we perform the post-formation reversal test of Jegadeesh and Titman (2001) on each of the standalone-signal (traditional and tone) portfolios. Accordingly, each portfolio formation time *t* is treated as day 0, and we calculate for each of them the sequence of post-event excess returns from week 1 to week 104 in event time. We average the excess returns on post-formation week 1 to week 104 across all events. Figure 3 plots the cumulative average excess returns.

[Insert Figure 3 around here]

A return reversal is suggestive of a mispricing mechanism, namely, the price overreaction is eventually corrected after investors detect the mispricing and arbitrage it. By contrast, steadily positive post-formation returns are suggestive of a risk-taking mechanism. Figure 3 shows that the post-formation returns of the standalone-tone portfolio eventually reverse consistent with the notion that the $TONE_{i,t}$ signal conveys sentiment about the commodity which exerts a temporary overreaction in its price. By contrast, a reversal is not observed in those strategies that hinge on signals unequivocally linked to commodity fundamentals (e.g., basis and hedging pressure).

4.4. Conditionality of the newswire tone-overlay benefits

The purpose of this section is to shed light on the mechanisms underlying the performance gains of the tone-overlay. For this purpose, we study the tone-overlay outperformance in different environments. First, we consider recessions versus expansions according to the "1-0" NBER chronology and the ADS index as a continuous real-time indicator of US business conditions. Second, we consider high versus low financial stress according to the TED spread as funding illiquidity measure. For each state variable, we use the sample median as threshold.[11] The tone-overlay strategy is deployed as hitherto with the baseline parameterization $\{\tau, \pi, L, \boldsymbol{\delta}\} = \{0.9, 0.10, 260, (1, 1)\}$ in Equation (2) and $\{\gamma, \phi\} = \{0.9, 1/K\}$ in Equation (4).

[Insert Table 5 around here]

Although the risk-adjusted profitability gains (ΔSR) generated by the tone-overlay strategy are for the most part significant in both "bad" (recession, low ADS, high TED spread) and "good" times, it is noticeable that the ΔSR are more pronounced in the former scenario: 1.6543 (NBER recession) versus 0.4862 (NBER expansion) on average across portfolios, 0.9812 (low ADS economic activity) vs 0.3177 (high ADS), and 0.8064 (high TED) vs 0.6443 (low TED).

On the one hand, these results dovetail nicely with the seminal conjecture of Keynes (1936) that the "animal spirits" (collective moods and beliefs nowadays known as sentiment) are more likely to influence financial trading decisions and hence, induce a mispricing in "harsh" times when investors are burdened by aggregate uncertainty and shrinking economy activity. Our findings add to experimental evidence from the psychology literature suggesting that agents are more receptive to advice and opinions, even poor ones, when they are fearful and anxious (e.g. Gino et al., 2012) and to empirical evidence from the behavioral finance literature suggesting that investors are more likely to follow also non-fundamental signals in times of high uncertainty (e.g., Kahneman and Tversky, 1973; Kumar, 2009). Quantifying the overall sentiment of *New York Times* articles, Garcia (2013) establishes that the predictive ability of news sentiment for stock

[11] As noted, the components $\sigma_{i,t}$, and $\{I^{TONE+}_{i,t,(1-\pi)}, I^{TONE-}_{i,t,\pi}\}$ of the tone-overlay Equation (2) are obtained from windows of $L = 260$ weeks for the traditional and $TONE_{i,t}$ signals prior to portfolio formation and consequently, the first available excess return is for the first week of January 2005. Thus, we cannot address the question of whether commodity futures prices have become more susceptible to news tone post-financialization since the literature roughly dates the start of the financialization to the mid-2000s.

returns is higher in recessions. Birru and Young (2022) further show that uncertainty is the key channel through which broad sentiment induces equity mispricing in recessions.

On the other hand, the conditionality of the tone-overlay on funding liquidity suggests that limits to arbitrage could temporarily delay the elimination of mispricing induced by commodity-specific newswire tone. Thus, our evidence endorses the theoretical predictions from the Acharya et al. (2013) model, and their evidence for oil and gas futures markets, suggesting that any mispricing is more likely to persist in periods when arbitrage capital dries out.[12] A similar conditionality on TED spreads is found in the premium of a long-short strategy by the "hazard fear" signal extracted from Google searches in Fernandez-Perez et al. (2020) and by the social-media sentiment signal proxied by Twitter activity in Fan et al. (2023).

In sum, the evidence offers two channels for the tone-overlay benefits. One is the recession (high uncertainty) environment acting as conduit for the commodity-specific newswire tone into commodity futures traders' decisions and hence, inducing a mispricing. The other is limits-to-arbitrage due to funding constraints in financial stress that hinder the correction of the mispricing. These two channels are not necessarily equivalent since macroeconomic contraction and financial stress, although related, do not always come hand in hand as borne out, for instance, by a moderate correlation between the ADS economic activity and TED spread at -0.31 (see Borio et al., 2018).

4.5. Alternative parameterizations of the tone-overlay

Having established that the tone-overlay strategy that adopts the baseline parameterization is able to generate substantial benefits vis-à-vis the corresponding traditional portfolios, we explore alternative designs of the tone-overlay strategy to shed further light on the sources of the tone-overlay benefits, and to provide recommendations to researchers and portfolio managers.

[12] The empirical analysis in Acharya et al. (2013) suggests that arbitrage capital was largely withdrawn from the commodity futures market in the aftermath of the late 2000s Global Financial Crisis. This is buttressed by the fact that various investment banks around the world, e.g., JP Morgan and Deutsche Bank, downsized or closed their global commodity trading units in the early 2010s (Ross and Terazono, 2013).

We deploy the tone-overlay approach, Equations (2) and (4), for various plausible values of each one of the parameters while keeping the remaining parameters at their baseline values. Starting with the daily news decay parameter γ in Equation (4), we plot in Figure 4 the Sharpe ratio gain of the tone-overlay strategies for $\gamma = \{0.1, \dots, 0.9, 1\}$ with 0.9 our baseline choice. The last case $\gamma = 1$ (non-decay) ascribes the same importance to all the days within the prior week and thus, the $TONE_{i,t}$ signal is an equally-weighted average of the daily news sentiment.

[Insert Figure 4 around here]

The Sharpe ratio gain of the different tone-overlay strategies for daily news impact-decay parameter $\gamma = \{0.1, \dots, 0.9, 1\}$ peaks approximately when γ is in the range 0.9 to 1. The Sharpe ratio gain declines for $\gamma < 0.9$. Thus, the parameterization $\gamma \geq 0.9$ (slow newswire impact-decay or high within-week persistence) is more effective. The analysis thus confirms that not only the high-novelty news released in the 24-hour period immediately preceding the portfolio formation time *t* matter, but also the then stale-newswires released on the prior days within the same week. These results reinforce, from the different perspective of commodity futures investors, the findings in Tetlock (2011) that investors react to the tone of stale or redundant news. We can thus further assert that the $TONE_{i,t}$ signal proxies for commodity-specific sentiment but does not reveal fundamental information about the commodity that is not already possessed by traders.

Next, we test the sensitivity of our results to the choice of *tilting* parameter, $\tau_{i,t}$, which, alongside the historical volatility of the traditional signal ($\sigma_{i,t}$), governs the intensity of the tone-overlay. We report in Table 6, Panel A, the Sharpe ratio gains of the tone-overlay strategy with fixed *tilting* parameter values $\tau_{i,t} = \tau = \{0.4, 0.6, 0.8, 0.9, 1, 1.2, 1.5\}$ in Equation (2), where $\tau = 0.9$ is the value that we adopted in the baseline setting. We entertain two more general *tilting* parameter settings which are commodity- and time-specific, motivated as follows. Suppose that the current news tone of commodities *i* and *j* is optimistic, $TONE_{i,t} = 90$ and $TONE_{j,t} = 70$, and identified as salient according to their corresponding historical distributions, i.e. $I^{TONE+}_{i,t,(1-\pi)} =$

$I^{TONE+}_{j,t,(1-\pi)} = 1$. If the traditional signal exhibits also similar historical volatility (over the prior $L = 260$ week window) for these two commodities, the tone-overlay with fixed tilting parameter τ would not discriminate between them; i.e., identical upward tilting of the traditional signal. The tone-overlay equation can exploit differences in newswire tone levels by adopting a (cross-sectionally standardized) tilting parameter $\tau_{i,t} = |\widetilde{TONE}_{i,t}|$ where $\widetilde{TONE}_{i,t} = \frac{TONE_{i,t} - \overline{TONE}_t}{\sigma_{TONE,t}}$ with $\overline{TONE}_t$ and $\sigma_{TONE,t}$ denoting, respectively, the cross-sectional mean and standard deviation of $TONE_{i,t}$ at time *t*. Since the shifts in newswire tone from one week to the next may carry more cross-sectional predictive content for commodity futures returns than the newswire tone itself, we consider another plausible setting for the *tilting* parameter, $\tau_{i,t} = |\Delta\widetilde{TONE}_{i,t}|$.

[Insert Table 6 around here]

The results show that, among the fixed tilting parameter settings $\tau_{i,t} = \tau$, adjusting the traditional signal upwards or downwards by about one full standard deviation of its historical distribution, i.e., $\tau = 1$, is very effective by generating on average across portfolios the largest Sharpe ratio gain (ΔSR) of 0.71. The tone-overlay portfolios with $\tau = 0.9$ and $\tau = 1.2$ follow closely with ΔSR of 0.6871 and 0.6886, respectively. Allowing for a more general commodity-heterogeneous and time-varying tone tilting as dictated by the weekly shift in news tone, $\tau_{i,t} = |\Delta\widetilde{TONE}_{i,t}|$, accrues the largest ΔSR of 0.7962 on average across portfolios outperforming the tone-overlay strategy based on tilting dictated by the tone level $\tau_{i,t} = |\widetilde{TONE}_{i,t}|$.

Next, we examine the role of the news *salience* parameter π to define the percentiles of the commodity-specific historical tone distribution $\{TONE_{i,t-L+1}, \ldots, TONE_{i,t-1}, \; TONE_{i,t}\}$ that trigger the salient pessimistic and optimistic tone tilting action for the traditional signal. We consider $(\pi, 1-\pi)$= {(0.01, 0.99), (0.05, 0.95), (0.10, 0.90), (0.15, 0.85), (0.20, 0.80), (0.25, 0.75)} with $(0.10, 0.90)$ representing our baseline case. The results are shown in Panel B of Table 6. Noticeably, the more extreme the thresholds the greater the tone-overlay performance gain

(ΔSR) in line with predictions from salience theory (e.g., Bordalo et al., 2012, 2022) – the more salient the news tone, the greater the over-reaction or mispricing. The 5th and 95th percentiles result in the largest Sharpe ratio gain of 0.76 on average across portfolios, which decreases from 0.69 (10th and 90th) monotonically to 0.44 (25th and 75th). These findings confirm that commodity news tone is a good predictor for the cross-section of excess returns, especially, when it is extreme. With a lower Sharpe ratio gain of 0.34, the 1st and 99th percentiles turn out to be too conservative, meaning that very few newswires have salient tone. Thus, there is little overlay and in effect the traditional signal prevails $x_{i,t}^{TONE} \approx x_{i,t}$. Overall, this evidence confirms that commodity futures prices overreact more to optimistic/pessimistic commodity-specific newswires that are more salient, and highlights the merit of the tone-overlay strategy as it can harvest this phenomenon.

Edmans et al. (2007) find that on average a pessimistic mood has a stronger effect on stock market returns than an optimistic mood. Building on this, we report in Panel C of Table 6 the Sharpe ratio gains of the tone-overlay portfolios that result from various *optimism/pessimism* weightings as measured by the parameter $\boldsymbol{\delta}_t$ in Equation (2). We begin by considering fixed weightings $\boldsymbol{\delta}_t = (\delta_t^+, \delta_t^-) = \{(0,1), (0.2,1), (0.4,1), (0.6,1), (0.8,1), (1,1)\}$ where the first setting $(\delta_t^+, \delta_t^-) = (0,1)$ implies that only the pessimistic newswire tone is embedded into the traditional signal – our hitherto baseline case assumes mispricing symmetry $(\delta_t^+, \delta_t^-) = (1,1)$.

Next, we consider time-varying optimism/pessimism weights according to financial market conditions. Specifically, at each portfolio formation time *t* the tilting of the traditional is allowed to differ for salient optimistic/pessimistic newswire tone according to the value of the TED spread relative to the median of its historical distribution over the prior $L = 260$ weeks $\{TED_{t-L+1}, \dots, TED_t\}$; e.g., the tone-overlay design $(\delta_t^+, \delta_t^-)_{TED\uparrow} = (0,1)$ and $(\delta_t^+, \delta_t^-)_{TED\downarrow} = (1,0.4)$ means that in stressed financial markets only the pessimistic news tone triggers the tilting action, whereas in buoyant markets the tilting is stronger for optimistic than pessimistic tone.

It turns out that, among the various parameterizations (δ_t^+, δ_t^-) considered, a more aggressive tilting for pessimistic tone in bad times and for optimistic tone in good times with a parameterization such as $(\delta_t^+, \delta_t^-)_{TED\uparrow} = (0.4, 1)$ and $(\delta_t^+, \delta_t^-)_{TED\downarrow} = (1, 0.4)$ bears the most fruition with an average Sharpe ratio gain of 0.8398. This is consistent with a type of "confirmation bias" by which market participants over-weigh the pessimistic (and discount the optimistic) news stories in stressed financial markets and discount the pessimistic (overreact to optimistic) news stories in exuberant financial markets.[13] As a result, the overreaction and mispricing induced by negative (positive) tone is greater in bad (good) times. The performance of the standalone-tone long-short portfolio over market conditions buttresses this intuition, as shown in Panel I of Table A.4; namely, the performance is driven by the shorts (i.e., the commodities subject to most pessimistic tone) in "bad" times, and by the longs (most optimistic) in "good" times. These results are echoed by the standalone-Δtone portfolios in Panel II of Table A.4.

Panel D of Table 6 illustrates the merit of allowing the intensity of the newswire-tone overlay in Equation (2) to be proportional to the traditional signal's volatility ($\sigma_{i,t}$) which is estimated from the commodity-specific historical distribution $\{x_{i,t-L+1}, x_{i,t-L}, \dots, x_{i,t}\}$ over the previous $L = 260$ weeks. Ignoring this dispersion by setting $\sigma_{i,t} = \sigma = 1$ in Equation (2), leads to a non-negligible decrease in ΔSR of about 35% on average.[14] The intuition for the role of $\sigma_{i,t}$ is as follows. Suppose that the absolute or nominal tilting of the traditional signal (e.g., basis) as dictated by the *tilting* parameter is similar for commodity *j* and *i* as in the baseline scenario. Suppose also that the basis signal has been notably more volatile for commodity *j* than for

[13] Confirmation bias is the behavioural phenomenon by which investors filter out potentially useful information that does not coincide with their pre-conceived notions. As pessimism (optimism) is pervasive in bearish (bullish) markets, this bias can rationalize the-then discounting of positive (negative) news. Reassuringly, the reverse design $(\delta_t^+, \delta_t^-)_{TED\uparrow} = (1, 0.4)$, $(\delta_t^+, \delta_t^-)_{TED\downarrow} = (0.4, 1)$, materializes in a tone-overlay strategy with inferior performance as borne out by a Sharpe ratio gain of 0.7565.

[14] Inspecting the volatility estimates $\hat{\sigma}_{i,t}, i = 1, \dots, N$ obtained for the tone-overlay, Equation (2), across portfolio formation weeks we can assert that there is notable commodity heterogeneity, e.g., at the first portfolio formation time *t*=1 the $\hat{\sigma}_{i,t}^{basis}$ estimates from the *basis* history $\{x_{i,t-260+1}, x_{i,t-260}, \dots, x_{i,t}\}$ range from 0.0011 (copper) to 0.0743 (feeder cattle). Unsurprisingly, the volatilities are strongly persistent changing slowly over time as borne out by very high first-order autocorrelations within the 0.98-0.99 range.

commodity i in the recent past. Ignoring the latter implies that the basis signal receives a smaller tilting for commodity j than for commodity i because the greater volatility of the basis for commodity j partially "swamps" the shift in newswire tone vis-à-vis the similar shift in newswire tone for commodity i. Put differently, an identical tilting τ_t becomes smaller in the context of the more disperse traditional signal distribution. By embedding the latter, $\sigma_{j,t} > \sigma_{i,t}$, in Equation (2) the tilting for commodity j is scaled up so the tilting is effectively similar for both commodities.[15]

Next, in Panel E of Table 6 we report the ΔSR of the tone-overlay strategies for various *lengths* $L = \{52, 104, 208, 260, 520\}$ in weeks to define the historical distribution of the commodity (traditional and tone) characteristics. Recall that $L = 260$ is our baseline case. For comparability, these ΔSR are all based on the same number of weekly returns from week T_0 to T, with T_0 dictated by the longest $L = 520$ considered. The results indicate that as the observation window increases the efficacy of the tone-overlay improves as suggested by a notable increase in the ΔSR from 0.49 ($L = 52$ weeks) to 0.91 ($L = 260$ weeks). However, longer lookback windows are detrimental either because they conflate structural breaks (shifts) in the distributions or fail to capture the time-variation (excessive smoothing) as borne out by the smaller ΔSR attained.

Lastly, in Panel F of Table 6 the news-tone strategy takes into account the *novelty* scores of the news stories within each 24-hour period preceding the portfolio formation time t as $\phi_{d(k)} = \widetilde{ENS}_{d(k)} = \frac{ENS_{d(k)}}{\sum_{k=1}^{K} ENS_{d(k)}}$ in Equation (4), instead of weighting them equally as in our baseline setting $\phi_{k(d)} = \frac{1}{K}$. The results suggest that accounting for the within-day novelty score does not materialize in an improvement of the tone-overlay strategy. Consistent with our earlier findings for the newswire daily-impact decay γ in Equation (4), this evidence further suggests that

[15] The initial standardization of the traditional signal $\tilde{x}_{i,t}$ does not subsume the role of $\sigma_{i,t}$ in Equation (2) as it is based on the cross-sectional mean and variance, $\bar{x}_t$ and σ_t. Accordingly, the ranking of commodities by the traditional signal does not change after the cross-sectionally standardization while, by contrast, the ranking of commodities by the tone-overlay is influenced by the parameter $\sigma_{i,t}$ which captures instead the commodity-specific dispersion of the historical distribution of the traditional signal.

$TONE_{i,t}$ conveys investor sentiment (moods and beliefs) instead of new information.

Irrespective of the choice of parameters in Equation (2), the Sharpe ratio of a given tone-overlay portfolio exceeds that of the "plain vanilla" traditional counterpart. This corroborates the importance of incorporating newswire tone in traditional commodity allocations. Yet, the results broadly recommend an "optimal" parameterization of the tone-overlay approach, Equations (2) and (4) with: *i*) *tilting* intensity dictated by the news tone shifts $\tau_{i,t} = |\Delta\widetilde{TONE}_{i,t}|$, *ii*) strict *salient* tone dictated by the 5th and 95th percentiles of the commodity-specific tone distribution, *iii*) length $L = 260$ weeks for the empirical distribution of traditional and tone signals, *iv*) a more aggressive tilting for pessimistic (optimistic) tone in stressed (calm) financial markets $(\delta_t^+, \delta_t^-)_{TED\uparrow} = (0.4,1)$ and $(\delta_t^+, \delta_t^-)_{TED\downarrow} = (1,0.4)$, *v*) daily news impact-decay $\gamma = 0.9$, and vi) immaterial within-day news novelty $\phi_{d(k)} = 1/K$. This analysis implies that the prior evidence from the baseline tone-overlay implementation, although already rather compelling, is understated.[16]

5. Additional Results

In this section, we compare the efficacy of the tone-overlay method with alternative approaches that an investor could use to embed newswire tone into traditional allocations. Next, we appraise the potential benefits generated by the tone-overlay strategy for the broad equity investor. Finally, to assess the robustness of the key findings, we embed transaction costs and use holding periods longer than one week. Unless otherwise noted, we adopt the same baseline parameterization of Equations (2) and (4) as in the main section, to ensure comparability of results.

5.1. Alternative approaches to the tone-overlay: EWI and double-sorts

Aside from single-sort portfolios, investors can deploy style-integrated portfolios that integrate many styles by simultaneously exploiting several asset characteristics; namely, long (short) the

[16] Harnessing together the best parameters identified in this analysis (Table 6) into an "optimal" tone-overlay strategy delivers an average Sharpe ratio gain ($\Delta SR_{overlay-trad}$) of 0.9295 and CER gain ($\Delta CER_{overlay-trad}$) of 8.11% versus the baseline tone-overlay gains of 0.6171 and 5.78%, respectively.

assets with strong buy (sell) recommendations across signals and ignore the remaining assets. The literature has proposed different style-integration methods as regards the weighting of each style (e.g., Brandt et al., 2009; Barroso and Santa-Clara, 2015). It turns out that the equally-weighted style integration (EWI) that ascribes the same importance to all the styles at each portfolio formation time is unrivalled in performance by more sophisticated approaches that estimate the weights based on past data according to some criteria (see e.g. Fernandez-Perez et al., 2019).

Our key proposition is to embed commodity-specific newswire tone into a traditional commodity characteristic through the tone-overlay framework encapsulated in Equation (2). Does the EWI portfolio that combines a given traditional signal and the newswire tone signal outperform the corresponding tone-overlay portfolio? To answer this question, we appraise each tone-overlay strategy against an EWI strategy deployed in a bivariate manner with the traditional signal at hand and the newswire tone-overlay signal.[17] Taking the basis signal as example, we confront the tone-overlay-basis portfolio that embeds the newswire tone into the *basis* through Equation (2), and the EWI portfolio that integrates the *basis* and tone signals. The latter is operationalized as $\tilde{x}_{i,t}^{EWI} = 0.5\tilde{x}_{i,t(basis)} + 0.5\tilde{x}_{i,t(TONE)}$ where $\tilde{x}_{i,t(k)} = \frac{x_{i,t(k)} - \bar{x}_{t(k)}}{\sigma_{t(k)}^{x}}$ are the cross-sectionally standardized $x_{i,t(basis)} = basis_{i,t}$ and $x_{i,t(TONE)} = TONE_{i,t}$ signals (see Table A.1). The standardization ensures that the signals $\tilde{x}_{i,t(k)}$ have zero cross-sectional mean and unit standard deviation. Likewise, we integrate the momentum and tone signals, and so on.

Table 7 presents in Panel A performance statistics on the tone-overlay and EWI strategies. To facilitate the comparison, both strategies follow the same extreme quintiles approach; namely, they allocate commodities with equal weights into the long (top quintile; Q1) and short (bottom

[17] A different question is whether the tone-overlay strategy adds value to the EWI portfolio based on the integration of all the traditional styles: basis, momentum, hedging pressure, convexity, skewness, basis-momentum and liquidity. To address it, we deploy the tone-overlay-EWI strategy using the this integrated signal $x_{i,t}^{EWI}$ in place of the traditional standalone-signal x_{it} in Equation (2). With a Sharpe ratio of 1.2427, maximum drawdown of 9.27%, and CER of 10.14% the tone-overlay-EWI portfolio notably improves upon the style-diversified EWI portfolio which yields 0.7550, 21.88%, and 6.3%, respectively.

quintile; Q5) legs of the portfolios according, respectively, to the $\tilde{x}_{i,t}^{TONE}$ and $\tilde{x}_{i,t}^{EWI}$ signals.

[Insert Table 7 around here]

Although the EWI approach has proved very resilient vis-à-vis a range of sophisticated style-integration methods in the literature, the results reveal that for the purpose of embedding news tone into a given traditional commodity characteristic, the tone-overlay strategy encapsulated in Equation (2) is a more effective solution. To illustrate, the Sharpe ratio of the tone-overlay strategy (ranging from 0.7071 to 1.3312 across portfolios) stands at an attractive 1.0682 on average, while the EWI strategy accrues smaller Sharpe ratios (ranging from 0.1535 to 0.8686) at 0.4511 on average. Table A.5 shows that the superior tone-overlay efficacy is not challenged when the EWI is deployed instead with the weekly newswire tone shifts, $\Delta TONE_{i,t}$.

Alternatively, portfolio managers could jointly exploit the commodity newswire-tone signal alongside a traditional commodity characteristic by constructing double-sort portfolios (see e.g., Fuertes et al., 2010, in the context of momentum and basis signals). Each week, we first sort the N commodities into two subsets in descending order of a traditional signal (e.g., basis) and, then sort each subset in descending order of the $TONE_{i,t}$ (or $\Delta TONE_{i,t}$) signal; each sort uses the median value of the relevant signal as threshold.[18] Then we allocate the high-basis and high-tone commodities ($N/4$) to the long leg and the low-basis and low-tone commodities to the short leg. Panel B of Table 7 shows that the tone-overlay strategy also outperforms the double-sorts.

Thus, we can assert that embedding the tone of commodity newswires into traditional commodity allocation signals through the tone-overlay methodology proposed in this paper is more effective than utilizing the EWI and double-sort strategies for the same purpose. This outperformance can be attributed to the flexibility of the tone-overlay approach. First, it identifies the salient newswire tone to trigger the "tilting" action only for extremely optimistic /pessimistic

[18] We use the median as threshold in the double-sorting to ensure comparability with the tone-overlay portfolios in terms of commodity diversification; namely, we thus end up with a similar number of commodities in the short and long legs of the double-sorted portfolios and the tone-overlay portfolios.

newswires. Second, it performs this identification in a commodity- and time-heterogeneous manner by exploiting at each portfolio formation time the historical distribution of newswire tone over a preceding long window. Third, it accounts for the volatility of the traditional signal to determine the tilting intensity and does so also in a commodity-and time-heterogeneous manner. Lastly, the tone-overlay flexibility permits alternative parameterizations which give scope for further profitability gains, as documented above.

5.2. Commodity tone-overlay benefits for the traditional investor

Three classic reasons have been adduced for the broad equity investor to consider commodity futures portfolios: *i*) additional alpha capture, *ii*) protection against inflation, and *iii*) risk diversification (e.g., Gorton and Rouwenhorst, 2006; Erb and Harvey, 2006). A natural question to ask is to which extent these classical arguments apply to the commodity tone-overlay portfolios vis-à-vis the underlying traditional portfolios. The evidence we have gathered hitherto supports the added value of the tone-overlay versus traditional allocations as regards the first reason. Now we study the inflation-hedging and diversification properties of the commodity tone-overlay portfolios. Table A.6 shows that, although the Sharpe ratio gains of the baseline tone-overlay portfolios versus the traditional portfolios ($\Delta SR = SR_{overlay} - SR_{trad}$) are generally attractive and statistically significant during both high and low inflation, they are more pronounced in high inflation which is a challenging environment for equities: 0.8849 (high inflation) vs 0.4598 (low inflation). These findings suggest that tactically overlaying the newswire tone upon a traditional commodity characteristic does not hurt the inflation hedging properties of commodity allocations.

Turning to the aspect of how the commodity portfolios co-move with the broad equity market, we plot in Figure 5 the rolling L-week correlations of the tone-overlay (and traditional) portfolio excess returns with the excess returns of the S&P500 index. The graphs track also the evolution of U.S. macroeconomic fundamentals in Panel A as conveyed by the Aruoba, Diebold and Scotti (2009; ADS) index of aggregate real business conditions, and the extent of financial market ("TED spread") stress in Panel B – we plot the deviations of the weekly ADS and TED from long-run path proxied by their rolling mean over the prior L-length window ($L = 260$).

[Insert Figure 5 around here]

The long-term cyclical variation in the extent of commodity and equity market integration revealed in Figure 5 – stronger when the macroeconomy slows down (low ADS) lowering the aggregate demand for commodities, and when financial markets are under stress (high TED) – dovetails nicely with the evidence in Büyükşahin and Robe (2014). The upward correlation trend post-2005 is largely reversed from the mid to late 2010s and increases again post 2018.[19] More important for the present purposes, the commodity-equity correlations are more favorable (lower) when the tone-overlay signal is used than when the plain-vanilla (traditional) signal is used. This result is rather consistent across commodity portfolios and over time. To illustrate, the average of the rolling correlations plotted in Figure 5 stands at 6.0% for the traditional commodity strategies and at -0.4% for the tone-overlay variants. An interpretation of this finding is that the tone-overlay strategy superimposes another commodity-specific signal (newswire tone) upon the traditional signal which allows for a better market segmentation. Thus, the tone-overlay enables not only a fruitful tactical commodity allocation, but it may also accrue diversification benefits to equity investors. Firm assertions in this regard would require analyzing the out-of-sample benefits of adding the commodity-based tone-overlay portfolios to the traditional asset mix of investors which goes beyond the scope of this paper (see Gao and Nardari, 2018).

5.3. Tone-overlay performance after trading costs

To which extent is the added value of the tone-overlay strategy eroded by transaction costs? To address this question, we measure the turnover of each tone-overlay (and traditional) portfolio as

[19] Büyükşahin and Robe (2014) show that besides macro fundamentals and financial stress, greater participation of speculators from 2000s onwards, in particular, hedge funds that hold positions in both equity and commodity futures, helps predict commodity-equity market linkages. Over the 2000-2010 period on average an increase of 1% in the overall commodity futures market share of hedge funds is associated with commodity-equity return correlations that are approximately 4-7% higher.

$$TO = \frac{1}{T-1}\sum_{t=1}^{T-1}\sum_{i=1}^{N}\left|w_{i,t+1} - w_{i,t^+}\right| \quad (7)$$

where $w_{i,t+1}$ denotes the target weight for the i^{th} commodity at portfolio formation time $t+1$, and $w_{i,t^+} = w_{i,t} \times e^{r_{i,t+1}}$ is the actual portfolio weight right *before* the rebalancing at $t+1$ with $r_{i,t+1}$ the weekly return of the i^{th} commodity from t to $t+1$. Thus, the portfolio TO captures the difference between a commodity's actual weight in the portfolio just before the rebalancing time $t+1$ and the actual target weight at $t+1$ on average across commodities and sample weeks. Figure 6, Panel A, shows that the TO of each of the tone-overlay portfolios is larger than that of the corresponding traditional portfolios. Firstly, this result is aligned with the parallel finding that the standalone-tone portfolio incurs a larger TO (as shown in Panel A of Figure 6) than the traditional portfolios. Secondly, the higher tone-overlay portfolio TO mirrors the previous observation that the autocorrelation in weekly $TONE_{it}$ is relatively low at 0.374 on average across commodities, by contrast with the persistence exhibited in the traditional signals – e.g., an average first-order autocorrelation in the basis and momentum signals at 0.886 and 0.982, respectively. However, the key question is whether the increased TO of the tone-overlay portfolios wipes out their performance improvement vis-à-vis the corresponding traditional portfolios.

To address this question, we calculate the time *t* net return of the long-short portfolio *P* as

$$r_{P,t+1} = \sum_{i=1}^{N} w_{i,t+1} r_{i,t+1} - TC_{i,t}\sum_{i=1}^{N}\left|w_{i,t+1} - w_{i,t^+}\right| \quad (8)$$

using transaction costs estimated according to the model of Szakmary et al. (2010) which assumes a fixed brokerage fee of \$10 per contract, and a bid-ask spread equal to one tick, as

$$TC_{i,t} = \frac{\$10 + Tick\ size_i \times CM_i}{f_{i,t} \times CM_i} \quad (9)$$

where $Tick\ size_i$ is the minimum tick size of the commodity, CM_i the contract multiplier, and f_{it} the settlement price of the nearby futures contract. As Table A.7 shows, the transaction costs are heterogeneous across commodity futures markets reflecting their different liquidity level. There is also notable time-variation in trading costs with a long-run downward trend; the average

$TC_{i,t}$ across commodities over the first and second half of the sample stand at 12.7 bp and 7.3 bp, respectively. The full-sample average $TC_{i,t}$ is not far from the 8.6 bp suggested by Marshall et al. (2012) for commodity futures. The net Sharpe ratios presented in Panel B of Figure 6 suggest that the performance gains of the tone-overlay strategy are not eroded by transaction costs.

5.4. Holding period of the tone-overlay portfolios

Thus far we have implemented the tone-overlay strategy through sequential portfolios that are maintained for one week before a new portfolio is constructed. Now we appraise their sequential performance from portfolio time t to $t+h$ with $h=\{4,8,12\}$ weeks. Table A.8 shows for each of the tone-overlay portfolios the premium captured (mean excess return), Sharpe ratio and Sharpe ratio gain vis-à-vis the corresponding traditional portfolio. Panel A neglects trading costs, while Panel B embeds the above $TC_{i,t}$ estimates. The sizeable gross and net premia and Sharpe ratios obtained for $h=1$ lessen monotonically as the holding period h is increased; the largest drop is clearly observed from $h=1$ to $h=4$. For instance, the average net premium and Sharpe ratio of 7.51% p.a. and 0.8755 ($h=1$) are almost halved to 4.20% p.a. and 0.4879 ($h=4$), dropping a bit further to 3.34% and 0.3987 ($h=8$) and 3.02% and 0.3622 ($h=12$).

For completeness, we also deployed the traditional and standalone-tone portfolios for various holding periods as presented in Table A.9. The standalone-tone portfolio worsens monotonically with h. A particularly large drop is observed as h increases from 1 to 4 weeks which further confirms that the predictive ability of newswire tone for the cross-section of commodity futures returns captures a short-term mispricing. By contrast, the performance of traditional portfolios is similar for $h=1$ and $h=4$ but net of trading costs the latter is superior. This aligns with a commodity risk premia literature that typically adopts monthly rebalancing; see Boons and Prado (2019), Fernandez-Perez et al. (2018, 2019), and Gu et al. (2023) inter alia.

6. Conclusions

This paper investigates the usefulness of embedding the tone of commodity-specific newswires into traditional commodity characteristics for tactical allocation. For this purpose, we put forward a flexible tone-overlay method that tilts the traditional allocation signals up or down according to the salient optimistic or pessimistic newswire tone. We implement the tone-overlay allocation strategy on 26 commodities using various traditional signals – basis, momentum, hedging pressure, convexity, skewness, basis-momentum and liquidity – to probe its efficacy.

Overlaying the newswire tone signal upon traditional allocation signals bears fruition by increasing the premium captured, shrinking the downside risks, and more than doubling the risk-adjusted returns. The salience of newswires matters as borne out by more pronounced profitability gains vis-à-vis the traditional allocations when the tone overlay focuses on the most salient optimistic or pessimistic newswires. The efficacy of the tone-overlay strategy is confirmed by a placebo test and remains sizeable net of trading costs. Given that commodity futures traders are mainly institutional, the added premium earned by embedding the newswire tone into traditional allocation signals represents indirect evidence that institutional investors are swayed by sentiment.

The benefits generated by the tone-overlay strategy are greater during recessions and in stressed financial markets. On the one hand, this evidence is aligned with the Keynes (1936) contention that investors' decision-making is more likely to be swayed by sentiment (the "animal spirits") in periods of anxiety and fear. On the other hand, the evidence confirms that the newswire tone-induced mispricing is more difficult to arbitrage when funding liquidity dries out.

Among the practical lessons, the tone-overlay provides portfolio managers with an opportunity to extract additional alpha net of transaction costs by jointly exploiting traditional commodity characteristics and the commodity-specific newswire tone. An exploration of alternative tone-overlay parameterizations reveals that this novel tactical allocation works best when deployed in a "managed" way to account for financial market conditions.

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Figure 1. Commodity-specific newswire tone and broad market sentiment

The figure presents box-and-whisker plots of the correlation between each of the broad market sentiment proxies – Baker and Wurgler (2007) index orthogonalized with respect to macro variables, Federal Reserve Bank of San Francisco news sentiment index, and CBOE's VIX index – and the commodity-specific newswires tone index, $TONE_{i,t}$ from Equation (4). The sample period is January 3, 2000 to May 31, 2020.

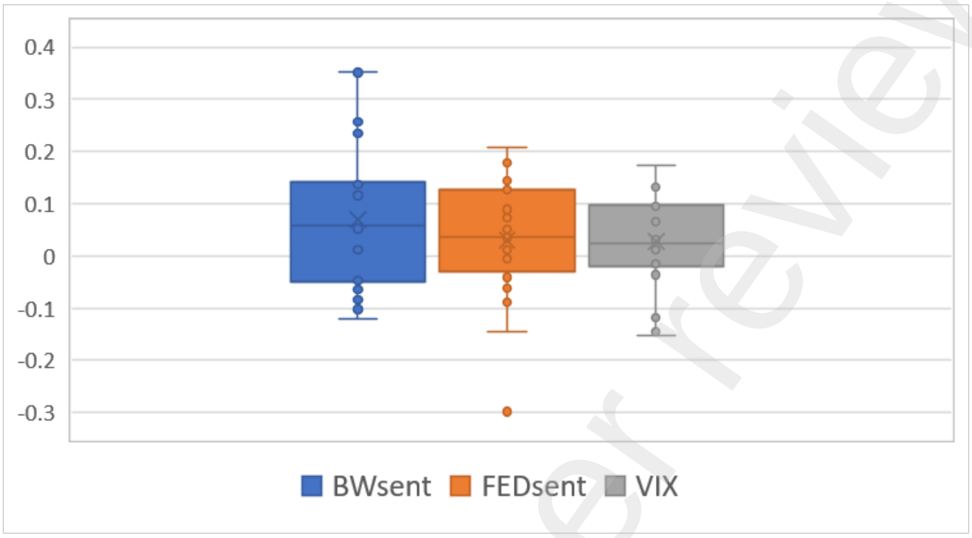


Figure 2. Cumulative Sharpe ratio of tone-overlay and traditional allocation strategies.

The figure plots the Sharpe ratio gain of tone-overlay portfolios versus traditional portfolios $\Delta SR = SR_{overlay} - SR_{trad}$. The first Sharpe ratio plotted is based on an initial 260-week returns window which is recursively expanded forward by one week. The tone-overlay Equation (2) is deployed with tilting parameter $\tau_{i,t} = \tau = 0.9$, salience parameter $\pi = 0.10$, observation window $L = 260$ weeks, pessimism/optimism weight parameters $\delta_t^+ = \delta_t^- = 1$. The news tone measure, Equation (4), is calculated using daily news impact-decay parameter $\gamma = 0.9$ and within-day novelty score $\phi_{d(k)} = 1/K_d$. The first available excess return for the tone-overlay portfolio pertains to the first week January 2005 due to the L weeks window. The sample period is January 3, 2000 to May 31, 2020.

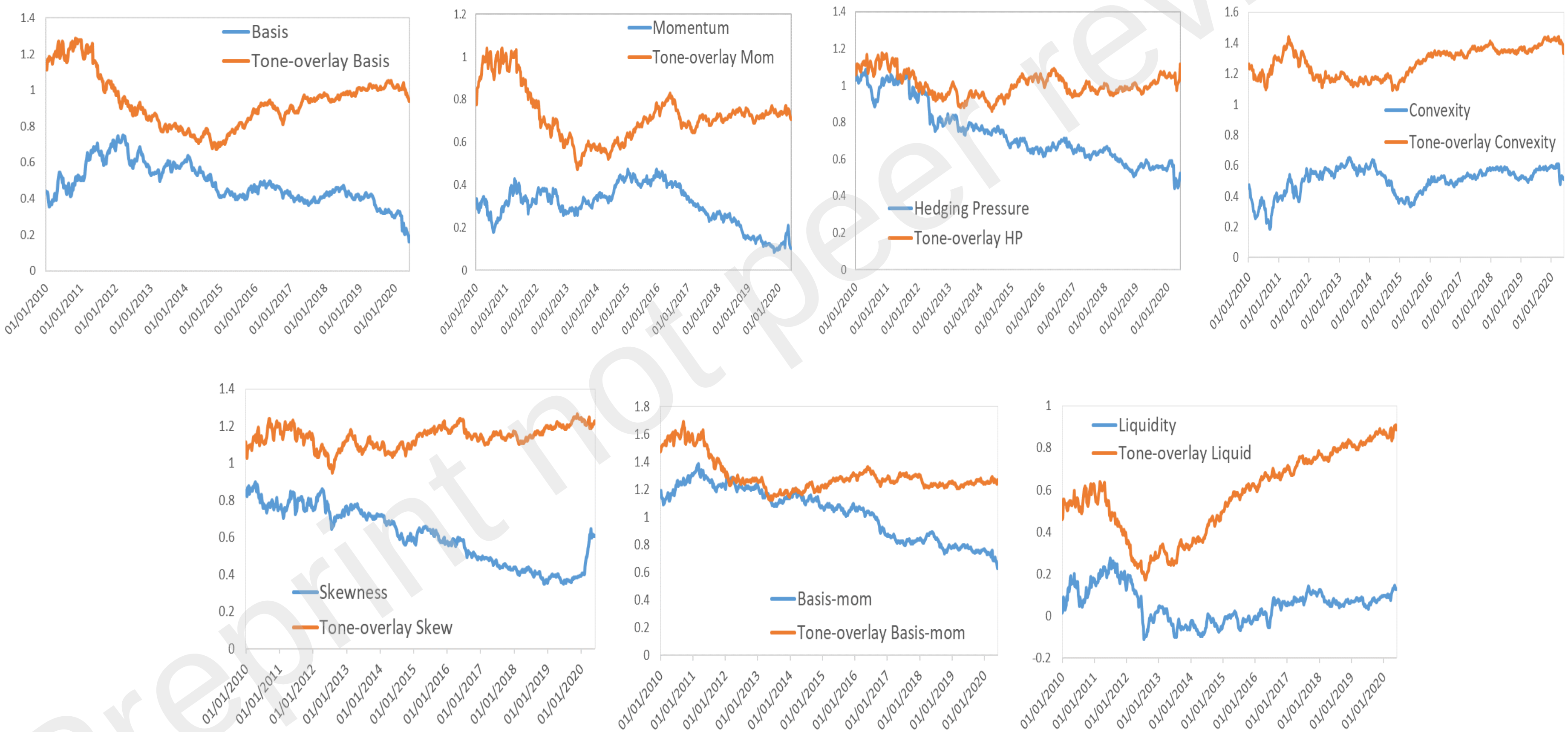


Figure 3. Cumulative post-formation excess returns.

The figure plots the cumulative post-formation excess returns of the long-short commodity allocation strategy based on $TONE_{i,t}$ from Equation (4) as a standalone signal, and the long-short allocation traditional basis, momentum, hedging pressure (HP), convexity, basis-momentum, skewness and liquidity strategies. The horizontal axis shows event time from week 1 to week 104 after portfolio formation time (day 0). The sample for the analysis covers the period January 3, 2000 to May 31, 2020.

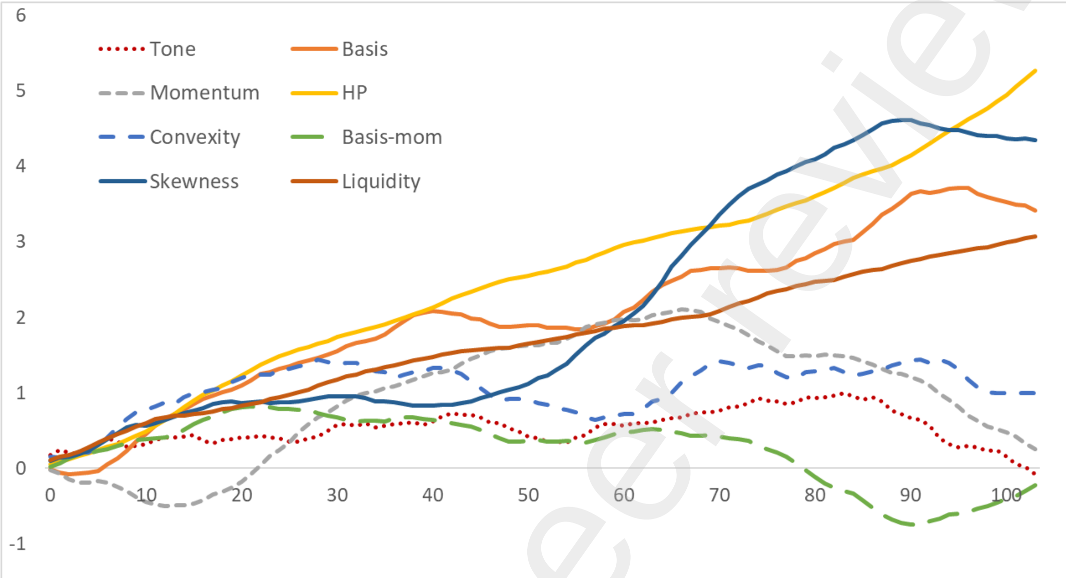


Figure 4. Daily news-impact decay and tone-overlay effectiveness.

The graph plots in the vertical axis the Sharpe ratio gain of the long-short tone-overlay portfolios versus the corresponding traditional portfolios. The horizontal axis is the daily-news decay parameter $\gamma = \{0.1, \ldots, 0.9, 1\}$ in the $TONE_{i,t}$ measure, Equation (4). The value $\gamma = 1$ represents the no-decay case where $TONE_{i,t}$ is an equally-weighted average of the sentiment scores of news stories in the 7 prior days.

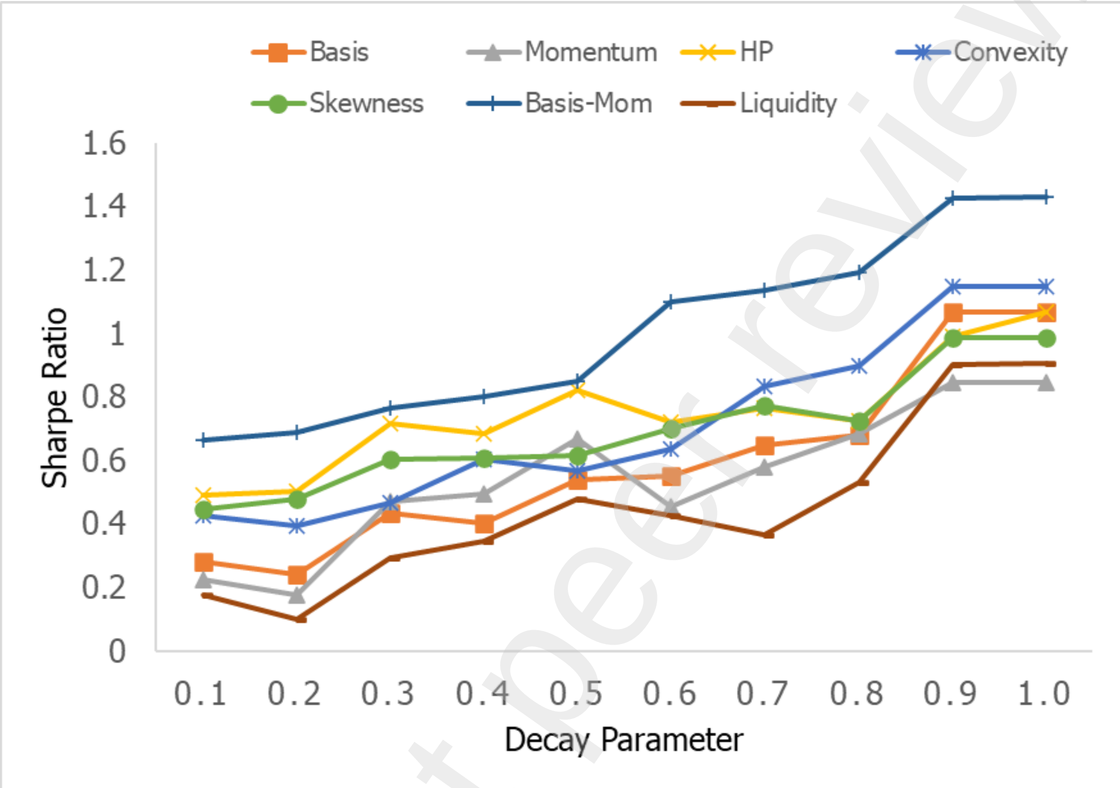


Figure 5. Dynamic correlations between commodity portfolios and the equity market portfolio.

The graphs report L=260 week rolling correlations between the premium captured by traditional commodity allocations and the equity market premium (blue line), and between the tone-overlay premium and the equity market premium (red line). The equity market portfolio is proxied by the S&P500 index. The black dotted line is the Aruoba, Diebold and Scotti (2009; ADS) gauge of US macroeconomic activity. The sample period is from January 3, 2020 to May 31, 2020.

Panel A: Commodity-equity return correlations and macroeconomic conditions.

(*Cont.*)

Figure 5. Correlation between commodity portfolios and the equity market portfolio.

Panel B: Commodity-equity return correlations and TED spread.

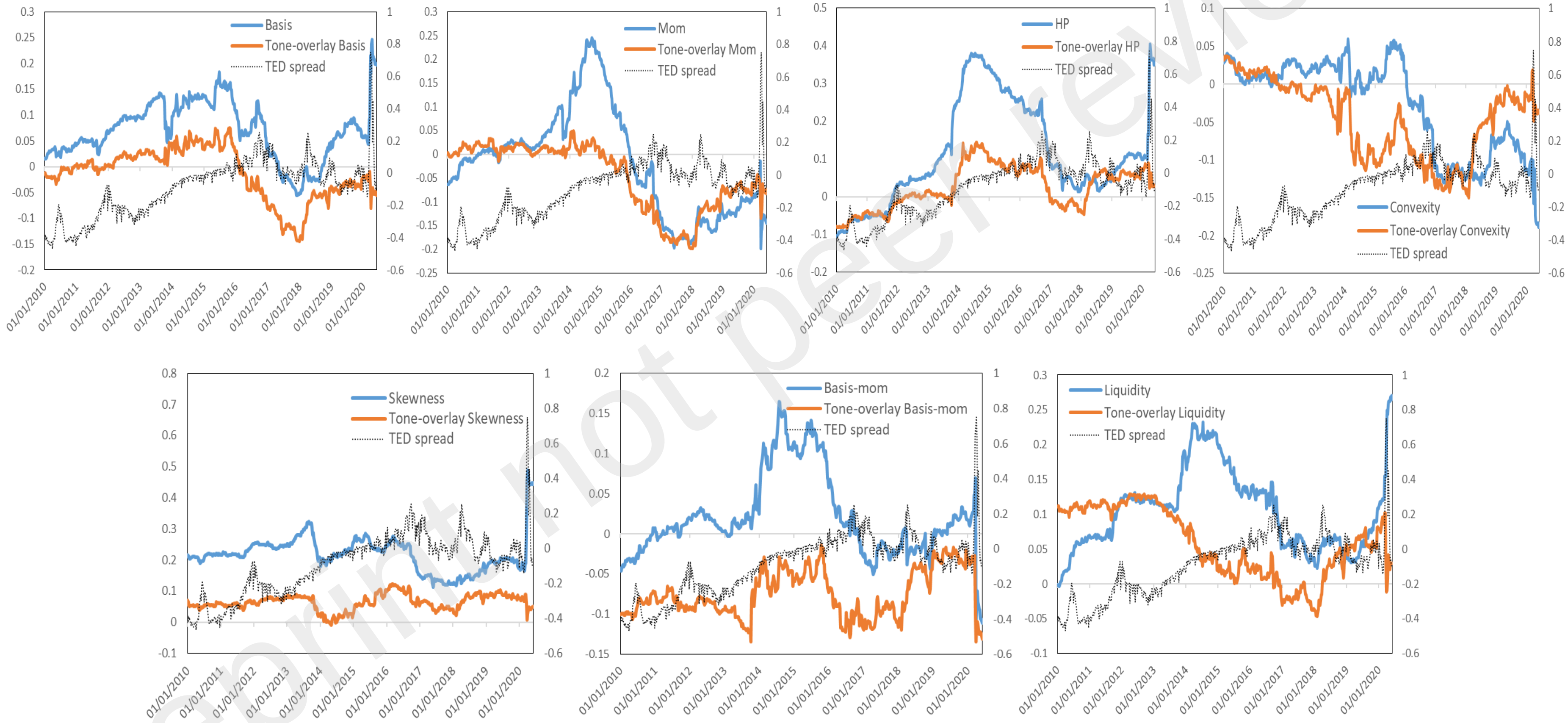
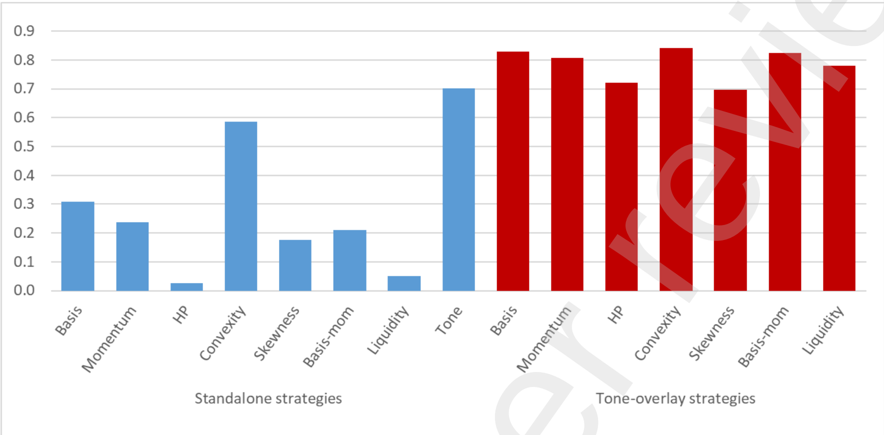


Figure 6. Turnover and net Sharpe ratio.

The figure plots in Panel A the turnover (TO) of standalone traditional- and tone-signal portfolios (blue bars) and the tone-overlay portfolios (red bars), and in Panel B the net Sharpe ratio (SR) based on the commodity-heterogeneous and time-varying transaction cost estimates $TC_{i,t}$ derived from the model of Szakmary et al. (2010). The data covers the period January 3, 2000 to May 31, 2020.

Panel A: Average TO



Panel B: Net Sharpe ratio

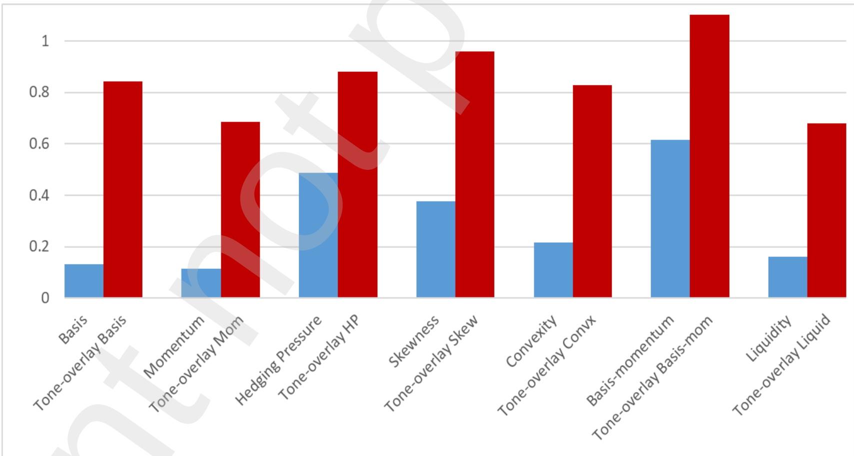


Table 1. Summary statistics for commodity futures excess returns and news tone.

The table reports summary statistics for the weekly excess returns and media tone, $TONE_{i,t}$, from Equation (4), and news coverage for each individual commodity organized per sector. Mean and standard deviation (StDev) of excess returns have been annualized. AC1 is the first-order autocorrelation coefficient. The first column reports the exchange in which the commodity trades: NYMEX (New York Mercantile Exchange), CME (Chicago Mercantile Exchange), CBOT (Chicago Board of Trade), COMEX (Commodity Exchange), and ICE (Intercontinental Exchange). The sample period is January 3, 2000 to May 31, 2020.

Sector	Commodity	Exchange (ticker)	First obs YYYYMMDD	Last obs YYYYMMDD	Excess return Mean	Excess return StDev	Excess return AC1	#New items	Relevance > 90 #New items	Relevance > 90 #News per week	TONE Mean	TONE StDev	TONE Min	TONE Max	TONE AC1
Energy	Heating oil	NYMEX (HO)	20000103	20200531	-0.021	0.322	0.043	60,059	2,917	2.74	50.632	14.176	28	76	0.582
	Natural gas	NYMEX (NG)	20000103	20200531	-0.353	0.448	0.009	1,104,993	65,150	61.17	49.550	7.938	12	76	0.225
	RBOB gasoline	CME (RB)	20051010	20200531	-0.048	0.357	0.098	413,420	55,426	52.04	52.640	11.338	13	100	0.593
	Unleaded gasoline	CME (RB)	20000103	20070102	0.193	0.360	-0.040	342,414	8,510	7.99	56.188	16.053	12	100	0.558
	WTI crude oil	NYMEX (CL)	20000103	20200531	-0.060	0.367	0.063	3,607,532	681,766	640.16	50.592	5.329	28	66	0.204
Grains	Corn	CBOT (C)	20000103	20200531	-0.086	0.279	-0.021	266,862	20,581	19.32	53.103	9.029	29	93	0.380
	Oats	CBOT (O)	20000103	20200531	0.049	0.334	-0.024	23,260	242	0.23	56.273	12.088	35	91	0.919
	Rough rice	CBOT (RR)	20000103	20200531	-0.075	0.251	0.060	93,685	5,856	5.50	51.157	13.141	4	88	0.496
	Wheat CBT	CBOT (W)	20000103	20200531	-0.097	0.297	0.004	341,922	16,371	15.37	52.689	8.969	31	94	0.463
Livestock	Feeder cattle	CME (FC)	20000103	20200531	0.016	0.170	-0.077	75,570	527	0.49	57.994	11.900	30	68	0.875
	Lean hogs	CME (LH)	20000103	20200531	-0.086	0.298	-0.010	125,672	5,948	5.58	54.363	9.127	33	70	0.365
	Live cattle	CME (LC)	20000103	20200531	0.010	0.169	-0.050	50,137	3,549	3.33	51.601	12.372	19	93	0.563
	Frozen pork bellies	CME (PB)	20000103	20110705	0.048	0.289	0.032	15,097	924	0.87	48.311	13.159	22	68	0.677
Metals	Copper (High Grade)	COMEX (HG)	20000103	20200531	0.056	0.265	-0.030	440,461	61,988	58.20	51.742	8.507	13	86	0.212
	Gold 100oz (CMX)	COMEX (GC)	20000103	20200531	0.075	0.176	-0.040	1,226,862	194,225	182.37	50.367	7.308	25	79	0.092
	Palladium	NYMEX (PA)	20000103	20200531	0.020	0.360	0.029	77,566	3,878	3.64	50.948	18.138	7	92	0.668
	Platinum	NYMEX (PL)	20000103	20200531	0.019	0.234	0.039	83,455	4,004	3.76	51.636	16.693	8	93	0.624
	Silver 5000 oz	COMEX (SI)	20000103	20200531	0.049	0.312	0.005	195,706	16,483	15.48	46.179	13.560	6	91	0.559
Oilseeds	Soybeans	CBOT (S)	20000103	20200531	0.048	0.239	0.024	231,815	20,413	19.17	53.546	12.874	18	95	0.531
	Soybean meal	CBOT (SM)	20000103	20200531	0.102	0.274	0.030	65,147	2,476	2.32	52.769	11.470	16	94	0.451
	Soybean oil	CBOT (BO)	20000103	20200531	-0.017	0.231	0.048	131,914	8,734	8.20	48.712	15.399	7	93	0.691
Softs	Cocoa	ICE (CC)	20000103	20200531	0.067	0.307	0.021	148,220	11,164	10.48	53.351	12.498	10	99	0.446
	Coffee C	ICE (KC)	20000103	20200531	-0.089	0.302	0.025	250,937	21,134	19.84	53.875	9.772	26	96	0.411
	Cotton no.2	ICE (CT)	20000103	20200531	-0.060	0.282	0.011	173,669	9,747	9.15	52.303	10.731	19	94	0.495
	Frozen Orange juice	ICE (OJ)	20000103	20200531	-0.009	0.323	0.027	15,282	2,222	2.09	52.297	13.685	13	77	0.796
	Lumber	CME (LB)	20000103	20200531	-0.105	0.319	0.017	38,341	1,862	1.75	56.036	11.643	33	91	0.597

Table 2. Performance of tone-overlay portfolios versus traditional portfolios.

The table summarizes the traditional portfolios formed according to basis, momentum, hedging pressure, relative basis or convexity, skewness, basis-momentum, and liquidity signals, standalone-tone portfolios formed according to $TONE_{i,t}$ and $\Delta TONE_{i,t}$ signals, and the tone-overlay portfolios. Mean excess returns and standard deviation (StDev) are annualized. Newey-West robust *t*-statistics are shown in parentheses. ΔSR is the Sharpe ratio gain of the tone-overlay (vs. corresponding traditional) portfolios and ΔCER the certainty equivalent return gain based on power utility with coefficient of relative risk aversion $\nu = 5$. The Ledoit and Wolf (2008) test is deployed for the hypotheses $H_0{:}\,\Delta SR_j \leq 0$ versus $H_A{:}\,\Delta SR_j > 0$, with $\Delta SR = SR_{overlay,j} - SR_{trad,j}$. The GMM test of Anderson and Cheng (2016) tests for the differences in CER, i.e., $H_0{:}\,\Delta CER_j = 0$ vs $H_A{:}\,\Delta CER_j \neq 0$ with $\Delta CER_j = CER_{overlay,j} - CER_{trad,j}$. The last rows report the factor-adjusted excess returns (α) and beta (β) from a regression of the tone-overlay portfolio excess returns on the excess returns of the underlying traditional portfolio. The tone-overlay Equation (2) is deployed with tilting parameter $\tau_{i,t} = \tau = 0.9$, salience parameter $\pi = 0.10$, observation window $L = 260$ weeks, pessimism/optimism weight parameters $\delta_t^+ = \delta_t^- = 1$. The news tone measure, Equation (4), is calculated using daily news impact-decay parameter $\gamma = 0.9$ and within-day novelty score $\phi_{d(k)} = 1/K_d$. The portfolios are implemented on data from January 2, 2000 to May 31, 2020.

	Traditional portfolios							Tone portfolios		Tone-overlay portfolios						
	Basis	Mom	Hedging pressure	Convexity	Skewness	Basis-Mom	Liquidity	Tone	ΔTone	Basis	Mom	Hedging pressure	Convexity	Skewness	Basis-Mom	Liquidity
Mean return	0.0169	0.0120	0.0563	0.0474	0.0391	0.0608	0.0135	0.0571	0.0636	0.0860	0.0756	0.0811	0.1077	0.0896	0.1233	0.0791
	(0.84)	(0.68)	(2.27)	(2.04)	(1.09)	(2.79)	(0.64)	(4.09)	(3.94)	(4.16)	(4.23)	(4.57)	(5.05)	(3.66)	(6.34)	(3.77)
StDev	0.1040	0.1170	0.1077	0.0924	0.0645	0.0961	0.1050	0.0838	0.0908	0.0913	0.1069	0.0727	0.0809	0.0731	0.0971	0.0893
Skewness	-0.5764	-0.0773	-0.3723	-0.1747	-0.3319	-0.0849	-0.1901	0.2000	0.1349	-0.0391	-0.1912	0.0270	0.1240	0.1454	0.0395	0.1923
Excess Kurtosis	4.2565	2.0250	2.2347	3.4514	2.6704	2.8458	0.5988	2.2986	1.4534	0.5314	0.7669	2.6500	0.7369	1.7944	0.5615	2.8154
Semi-deviation	0.0568	0.0532	0.0692	0.0589	0.0425	0.0612	0.0533	2.9867	2.3822	0.0565	0.0584	0.0524	0.0549	0.0557	0.0540	0.0549
1% VaR	-0.0331	-0.0374	-0.0336	-0.0288	-0.0200	-0.0298	-0.0335	-0.0205	-0.0186	-0.0272	-0.0274	-0.0251	-0.0269	-0.0269	-0.0259	-0.0269
Max drawdown	-0.2819	-0.3881	-0.1756	-0.2479	-0.3453	-0.2440	-0.3538	-0.1239	-0.0711	-0.1392	-0.2165	-0.0904	-0.1291	-0.1595	-0.1226	-0.2311
Sharpe ratio	0.1624	0.1024	0.5234	0.5129	0.6053	0.6323	0.1285	0.6811	0.7001	0.9415	0.7071	1.1149	1.3312	1.2269	1.2698	0.8859
$\Delta SR = SR_{overlay} - SR_{trad}$										0.7791	0.6047	0.5915	0.8182	0.6216	0.6375	0.7575
Ledoit-Wolf test *p*-value										*0.0049*	*0.0059*	*0.0074*	*0.0121*	*0.0115*	*0.0068*	*0.0055*
Sortino ratio	0.2975	0.2253	0.8137	0.8045	0.9189	0.9930	0.2533	1.3692	1.6550	1.5213	1.2951	1.5485	1.9609	1.6106	2.2823	1.4404
Omega ratio	1.0795	1.0603	1.2304	1.2217	1.2601	1.2764	1.0669	1.4103	1.4596	1.4069	1.3594	1.4297	1.5346	1.4456	1.6302	1.3979
CER	0.0164	0.0138	0.0454	0.0455	0.0232	0.0604	0.0135	0.0562	0.0622	0.0838	0.6210	0.0872	0.1172	0.0861	0.1065	0.0792
$\Delta CER = CER_{overlay} - CER_{trad}$										0.0674	0.0483	0.0418	0.0717	0.0629	0.0460	0.0657
GMM test *p*-value										*0.0115*	*0.0124*	*0.0254*	*0.0288*	*0.0248*	*0.0201*	*0.0129*
α (traditional factor-adjusted return)										0.0778	0.0689	0.0612	0.0871	0.0725	0.0980	0.0730
										(4.05)	(4.23)	(3.83)	(4.37)	(3.71)	(5.03)	(3.96)
β (traditional factor beta)										0.3662	0.3557	0.3284	0.4063	0.5889	0.3971	0.3200
										(9.89)	(10.79)	(8.82)	(9.65)	(23.17)	(12.63)	(10.34)

Table 3. Placebo test for tone-overlay efficacy.

The table summarizes the performance of "placebo" tone-overlay portfolios where commodity *i* at portfolio formation time *t* is assigned the newswire tone of a randomly drawn commodity from another sector. Excess returns are annualized. The data covers the period January 3, 2000 to May 31, 2020.

	Tone portfolios		Tone-overlay portfolios						
	Tone	ΔTone	Basis	Mom	Hedging pressure	Convexity	Skewness	Basis-Mom	Liquidity
Mean	-0.0065	0.0059	0.0073	0.0012	0.0165	0.0051	-0.0070	0.0307	-0.0318
	-0.18038	0.39244	(0.41)	(0.22)	(0.84)	(0.34)	(-0.08)	(1.26)	(-1.00)
StDev	0.0773	0.0820	0.0930	0.1010	0.0873	0.0951	0.0967	0.0997	0.0959
Skewness	-0.2378	0.2643	-0.0918	0.0259	-0.1367	-0.0411	-0.2712	0.0146	-0.1991
Excess Kurtosis	1.5007	2.5670	0.5183	1.8671	0.7270	2.4455	1.5753	0.6770	1.2953
Semi-deviation	0.0526	0.0508	0.0609	0.0671	0.0573	0.0630	0.0664	0.0615	0.0663
1% VaR	-0.0250	-0.0263	-0.0298	-0.0325	-0.0278	-0.0305	-0.0312	-0.0315	-0.0315
Max drawdown	-0.3328	-0.3133	-0.3421	-0.3554	-0.2699	-0.2989	-0.2950	-0.3450	-0.4306
Sharpe ratio	-0.0841	0.0713	0.0781	0.0121	0.1889	0.0536	-0.0726	0.3083	-0.3322
$\Delta SR=SR_{overlay}-SR_{trad}$			-0.0843	-0.0903	-0.3345	-0.4593	-0.6779	-0.3240	-0.4607
Ledoit-Wolf test *p*-val			*0.4565*	*0.6092*	*0.8843*	*0.9062*	*0.9602*	*0.8396*	*0.9230*
Sortino ratio	-0.1236	0.1151	0.1192	0.0182	0.2881	0.0809	-0.1058	0.4996	-0.4802
Omega ratio	0.9835	1.0420	1.0459	1.0231	1.0870	1.0382	0.9911	1.1331	0.8987
ΔCER			0.0250	0.0166	0.0630	0.0520	0.0176	0.0922	-0.0175
$\Delta CER=CER_{overlay}-CER_{trad}$	-0.0056	0.0069	0.0086	0.0028	0.0175	0.0065	-0.0056	0.0318	-0.0309
GMM test *p*-value			*0.1932*	*0.3749*	*0.1665*	*0.2464*	*0.8004*	*0.1173*	*0.9099*

Table 4. Multifactor explanation of standalone-tone portfolio premium.

The table reports estimation results from spanning regressions of the weekly excess returns of the long-short portfolio based on $TONE_{i,t}$, Equation (4), as a standalone allocation signal, on a widely-used set of risk factors in commodity pricing: excess returns of a long-only equally-weighted portfolio of the 26 commodities (MKT), excess returns of long-short basis, momentum, hedging pressure, convexity, skewness, basis-momentum, and liquidity portfolios (see Appendix Table A.1 for a description of the sorting signals). The alpha is annualized. Newey-West heteroskedasticity and autocorrelation adjusted *t*-statistics are shown in parentheses. The portfolios are constructed from data covering the period January 3, 2000 to May 31, 2020.

	Standalone-tone portfolio excess returns								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
α	0.0583	0.0594	0.0573	0.0583	0.0599	0.0542	0.0573	0.0583	0.0552
	(4.02)	(4.04)	(3.96)	(3.98)	(4.05)	(3.72)	(3.84)	(4.01)	(3.79)
β_{MKT}	-0.0107								0.0010
	(-0.69)								(0.06)
β_{Basis}		-0.0414							-0.0690
		(-1.09)							(-1.62)
$\beta_{Momentum}$			0.0516						0.0374
			(1.39)						(1.05)
β_{HP}				0.0155					-0.0056
				(0.48)					(-0.16)
$\beta_{Convexity}$					-0.0256				-0.0033
					(-0.85)				(-0.09)
$\beta_{Skewness}$						0.0716			0.0618
						(1.94)			(1.71)
$\beta_{Basis\text{-}Mom}$							0.0845		0.0588
							(1.89)		(1.31)
$\beta_{Liquidity}$								-0.0154	0.0038
								(-0.54)	(0.11)
Adj. R^2	0.0011	0.0031	0.0053	0.0006	0.0014	0.0087	0.0112	0.0005	0.0241

Table 5. Conditionality of the tone-overlay performance gains.

The table reports the Sharpe ratio of each tone-overlay portfolio and underlying plain-vanilla traditional portfolio, and the corresponding Sharpe ratio gain ($\Delta SR = SR_{overlay} - SR_{trad}$) in different macroeconomic conditions – NBER recession versus expansion, low versus high U.S. economic activity as captured by the Aruoba, Diebold and Scotti (2009; ADS) index – and funding liquidity conditions – high versus low TED spread – in Panels A and B, respectively. The ADS index and TED spread regimes are defined using the median value of each variable. The last row of each section reports the Ledoit and Wolf (2008) test p-value for the significance of the Sharpe ratio gain $H_0: \Delta SR \leq 0$ vs $H_A: \Delta SR > 0$ with $\Delta SR = SR_{overlay} - SR_{trad}$. The tone-overlay method is deployed using Equation (2) with $(\tau, \pi, L, \delta) = (0.9, 0.10, 260, (1,1))$ and Equation (4) with $(\gamma, \phi) = \left(0.9, \frac{1}{K}\right)$. The portfolios are implemented on data from January 2, 2000 to May 31, 2020.

			Tone-overlay portfolios							
			Basis	Momentum	HP	Convexity	Skewness	Basis-mom	Liquidity	*Average*
Panel A: Macroeconomic conditions										
NBER cycle	Recess.	*SR_overlay*	2.1764	1.7228	1.7989	1.6014	2.2377	1.9666	1.3560	*1.8371*
		SR_trad	0.2489	0.1010	0.6774	-0.2059	0.0880	0.5022	-0.1318	*0.1828*
		ΔSR	1.9275	1.6218	1.1215	1.8074	2.1496	1.4644	1.4878	*1.6543*
		p-value	0.0036	0.0025	0.0042	0.0017	0.0009	0.0039	0.0051	
	Expans.	*SR_overlay*	0.7628	0.9558	0.9739	1.0623	0.5590	1.2592	0.7575	*0.9044*
		SR_trad	0.2111	0.1782	0.5463	0.7195	0.3331	0.7060	0.2331	*0.4182*
		ΔSR	0.5517	0.7776	0.4276	0.3427	0.2259	0.5532	0.5245	*0.4862*
		p-value	0.0339	0.0180	0.0422	0.1341	0.2593	0.0338	0.0348	
Business act. (ADS)	Low	*SR_overlay*	1.4817	1.3271	1.4016	1.4685	1.2371	1.5974	1.0041	*1.3597*
		SR_trad	0.5613	-0.0401	0.5090	0.6597	0.2175	0.7811	-0.0390	*0.3785*
		ΔSR	0.9205	1.3672	0.8926	0.8088	1.0197	0.8163	1.0431	*0.9812*
		p-value	0.0012	0.0003	0.0101	0.0065	0.0011	0.0184	0.0015	
	High	*SR_overlay*	0.3961	0.7763	0.7351	0.7424	0.3737	1.0889	0.6651	*0.6825*
		SR_trad	-0.2235	0.4343	0.6345	0.4206	0.3334	0.5283	0.4261	*0.3648*
		ΔSR	0.6196	0.3420	0.1006	0.3217	0.0403	0.5606	0.2391	*0.3177*
		p-value	0.0185	0.1423	0.2473	0.1783	0.2776	0.0281	0.1079	
Panel B: Funding liquidity conditions										
TED spread	High	*SR_overlay*	0.8783	0.9645	0.8708	0.9807	0.9429	1.3512	0.5103	*0.9284*
		SR_trad	-0.0068	0.0044	0.4433	-0.3615	0.3123	0.5944	-0.1324	*0.1220*
		ΔSR	0.8851	0.9601	0.4275	1.3421	0.6305	0.7568	0.6426	*0.8064*
		p-value	0.0032	0.0010	0.0289	0.0018	0.0196	0.0100	0.0162	
	Low	*SR_overlay*	1.0936	1.2077	1.4035	1.3390	0.6956	1.3825	1.2836	*1.2008*
		SR_trad	0.4838	0.3690	0.7406	0.7867	0.2138	0.7480	0.5533	*0.5564*
		ΔSR	0.6098	0.8388	0.6629	0.5523	0.4817	0.6345	0.7303	*0.6443*
		p-value	0.0170	0.0023	0.0107	0.0266	0.0328	0.0137	0.0154	

Table 6. Alternative parameterizations of the tone-overlay.

The table reports the Sharpe ratio gain of tone-overlay portfolios deployed with various specifications of Equations (2) and (4). One parameter is altered in each specification and the remaining parameters are maintained at the baseline case: tilting parameter $\tau = 0.9$, extreme deciles (π, 1-π) = (0.10, 0.90) of the commodity-specific historical tone distribution $\{TONE_{i,t-L+1}, \dots, TONE_{i,t-1}, TONE_{i,t}\}$ to define salient tone, lookback window length (in weeks) to define salient tone and measure the dispersion of the traditional signal $L = 260$, optimism vs pessimism asymmetry parameter $\boldsymbol{\delta}=(\delta^+, \delta^-) = (1, 1)$, daily news impact decay $\gamma = 0.9$, within-day news novelty score, $\phi_{k(d)} = \frac{1}{K_d}$. In Panel A, $\widetilde{TONE}_{i,t}$ denotes the cross-sectionally standardized tone. To facilitate comparison, within Panel E all the risk-adjusted return gains are based on returns starting from Jan 2011 as dictated by the longest *L*= 520 considered. The *p*-value of the Ledoit and Wolf (2008) test for $H_0: \Delta SR \leq 0$ versus $H_A: \Delta SR > 0$ with $\Delta SR = SR_{overlay} - SR_{trad}$ is in parentheses. Bold fonts in the first and last columns indicate the baseline parameterization and resulting average ΔSR. The highest Sharpe ratio gain in each panel is shaded.

	Tone-overlay portfolios							
	Basis	Mom	Hedging pressure	Convexity	Skewness	Basis-Mom	Liquidity	*Average*
Panel A: Tone-tilting intensity parameter (τ)								
τ = 0.4	0.4189	0.5119	0.5967	0.6724	0.3215	0.4533	0.3747	*0.4785*
	(0.063)	(0.016)	(0.014)	(0.006)	(0.156)	(0.011)	(0.039)	
τ = 0.6	0.6739	0.6458	0.5665	0.7292	0.3545	0.5607	0.4768	*0.5725*
	(0.009)	(0.007)	(0.029)	(0.005)	(0.153)	(0.044)	(0.015)	
τ = 0.8	0.7300	0.6525	0.5972	0.7310	0.4766	0.6116	0.4933	*0.6132*
	(0.007)	(0.011)	(0.025)	(0.005)	(0.085)	(0.033)	(0.015)	
τ = 0.9	0.7791	0.6047	0.5915	0.8182	0.6216	0.6375	0.7575	***0.6871***
	(0.005)	(0.006)	(0.007)	(0.012)	(0.015)	(0.007)	(0.005)	
τ = 1	0.8535	0.6937	0.5644	0.7340	0.6492	0.7595	0.7318	*0.7123*
	(0.002)	(0.001)	(0.044)	(0.006)	(0.012)	(0.001)	(0.003)	
τ = 1.2	0.8419	0.6849	0.5019	0.7058	0.6395	0.7199	0.7265	*0.6886*
	(0.003)	(0.008)	(0.059)	(0.007)	(0.014)	(0.008)	(0.003)	
τ = 1.5	0.6308	0.6884	0.4105	0.5757	0.4867	0.6614	0.4578	*0.5588*
	(0.006)	(0.001)	(0.008)	(0.009)	(0.018)	(0.002)	(0.009)	
$\tau_{it} = \lvert\widetilde{TONE}_{it}\rvert$	0.8695	0.7841	0.4882	0.6059	0.4252	0.8170	0.7608	*0.6787*
	(0.003)	(0.004)	(0.010)	(0.020)	(0.017)	(0.003)	(0.007)	
$\tau_{it} = \lvert\Delta\widetilde{TONE}_{it}\rvert$	0.9402	0.7875	0.6135	0.7062	0.8848	0.8043	0.8365	*0.7962*
	(0.004)	(0.004)	(0.009)	(0.016)	(0.004)	(0.007)	(0.009)	
Panel B: Tone-salience parameter (π, 1-π)								
0.01 - 0.99	0.3246	0.3880	0.2964	0.3564	0.3687	0.5288	0.1141	*0.3396*
	(0.226)	(0.106)	(0.313)	(0.128)	(0.118)	(0.054)	(0.421)	
0.05 - 0.95	0.8088	0.7986	0.5989	0.8814	0.7411	0.6955	0.7854	*0.7585*
	(0.003)	(0.002)	(0.020)	(0.004)	(0.002)	(0.002)	(0.002)	
0.10 - 0.90	0.7791	0.6047	0.5915	0.8182	0.6216	0.6375	0.7575	***0.6871***
	(0.005)	(0.006)	(0.007)	(0.012)	(0.012)	(0.007)	(0.005)	
0.15 - 0.85	0.6971	0.5650	0.5773	0.5935	0.7456	0.5432	0.7987	*0.6458*
	(0.032)	(0.036)	(0.021)	(0.028)	(0.013)	(0.021)	(0.007)	
0.20 - 0.80	0.5998	0.5756	0.4439	0.3746	0.7096	0.3955	0.6475	*0.5352*
	(0.035)	(0.037)	(0.031)	(0.157)	(0.018)	(0.240)	(0.030)	
0.25 - 0.75	0.4954	0.4031	0.2871	0.3820	0.4481	0.6509	0.3999	*0.4381*
	(0.047)	(0.046)	(0.280)	(0.154)	(0.039)	(0.037)	(0.150)	

(*Cont.*) Table 6. Alternative parameterizations of the tone-overlay

	Tone-overlay portfolios							
	Basis	Mom	Hedging pressure	Convexity	Skewness	Basis-Mom	Liquidity	*Average*
Panel C: Optimism vs pessimism weighting parameter δ = (δ^+, δ^-)								
(0, 1)	0.4764	0.4045	0.3219	0.3852	0.6028	0.6943	0.6671	*0.5074*
	(0.008)	(0.023)	(0.042)	(0.043)	(0.002)	(0.010)	(0.014)	
(0.2, 1)	0.6555	0.7619	0.5874	0.5871	0.7299	0.7505	0.8235	*0.6994*
	(0.006)	(0.000)	(0.001)	(0.007)	(0.001)	(0.003)	(0.000)	
(0.4, 1)	0.7775	0.7641	0.6783	0.6774	0.8527	0.8090	0.9387	*0.7854*
	(0.003)	(0.002)	(0.001)	(0.010)	(0.000)	(0.001)	(0.000)	
(0.6, 1)	0.8865	0.6970	0.6886	0.7319	0.7380	0.7287	0.8994	*0.7672*
	(0.007)	(0.002)	(0.010)	(0.001)	(0.002)	(0.001)	(0.000)	
(0.8, 1)	0.8384	0.6576	0.5234	0.7485	0.7166	0.6943	0.8292	*0.7154*
	(0.003)	(0.010)	(0.048)	(0.006)	(0.002)	(0.001)	(0.003)	
(1, 1)	0.7791	0.6047	0.5915	0.8182	0.6216	0.6375	0.7575	***0.6871***
	(0.005)	(0.006)	(0.007)	(0.012)	(0.012)	(0.007)	(0.005)	
(0, 1) high TED	0.7249	0.6745	0.6803	0.7212	0.6243	0.7953	0.6899	*0.7015*
(1, 0) low TED	(0.004)	(0.039)	(0.014)	(0.009)	(0.010)	(0.008)	(0.002)	
(0, 1) high TED	0.8251	0.7420	0.7447	0.7979	0.8673	0.7942	0.9447	*0.8166*
(1, 0.4) low TED	(0.002)	(0.012)	(0.014)	(0.014)	(0.005)	(0.010)	(0.005)	
(0.4, 1) high TED	0.7628	0.6965	0.7155	0.7633	0.7643	0.7528	0.8811	*0.7623*
(1, 0) low TED	(0.003)	(0.014)	(0.012)	(0.018)	(0.002)	(0.005)	(0.001)	
(0.4, 1) high TED	0.8616	0.7910	0.7469	0.7978	0.8924	0.8193	0.9699	*0.8398*
(1, 0.4) low TED	(0.003)	(0.003)	(0.003)	(0.004)	(0.001)	(0.001)	(0.000)	
(0.4, 1) high TED	0.8549	0.7695	0.7446	0.7820	0.8860	0.8185	0.9624	*0.8311*
(1, 0.8) low TED	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.001)	(0.000)	
(0.4, 1) high TED	0.8326	0.7684	0.7322	0.7783	0.8810	0.8171	0.9693	*0.8256*
(1, 1) low TED	(0.003)	(0.003)	(0.003)	(0.004)	(0.001)	(0.002)	(0.000)	
(1, 1) high TED	0.8360	0.7485	0.7216	0.7851	0.8497	0.7976	0.9415	*0.8114*
(1, 0.4) low TED	(0.003)	(0.003)	(0.004)	(0.002)	(0.002)	(0.006)	(0.000)	
Panel D: Dispersion of traditional signal distribution (σ)								
$\hat{\boldsymbol{\sigma}}_{\boldsymbol{it}}$	0.7791	0.6047	0.5915	0.8182	0.6216	0.6375	0.7575	***0.6871***
	(0.005)	(0.006)	(0.007)	(0.012)	(0.012)	(0.007)	(0.005)	
σ_{it}=1	0.5156	0.5445	0.1623	0.4880	0.3513	0.3585	0.7308	0.4501
	(0.048)	(0.036)	(0.248)	(0.051)	(0.068)	(0.119)	(0.008)	
Panel E: Lookback window for signal distribution (L weeks)								
L = 52	0.5810	0.5829	0.2668	0.6457	0.4598	0.4039	0.5064	*0.4923*
	(0.022)	(0.017)	(0.187)	(0.008)	(0.056)	(0.067)	(0.039)	
L = 104	0.6972	0.6262	0.3604	0.7064	0.5450	0.5846	0.5861	*0.5866*
	(0.006)	(0.013)	(0.122)	(0.024)	(0.017)	(0.017)	(0.022)	
L = 208	0.8280	0.7920	0.8082	0.7437	0.6982	0.6553	0.8696	*0.7707*
	(0.002)	(0.002)	(0.020)	(0.005)	(0.003)	(0.009)	(0.001)	
L = 260	0.8577	0.7948	0.9410	0.8248	0.9401	1.0925	0.8994	*0.9072*
	(0.009)	(0.012)	(0.018)	(0.017)	(0.001)	(0.003)	(0.006)	
L = 520	0.7508	0.7433	0.8494	0.2494	0.8310	0.8273	0.5123	*0.6805*
	(0.015)	(0.013)	(0.007)	(0.237)	(0.020)	(0.008)	(0.032)	
Panel F: Within-day news novelty parameter (ϕ)								
□$_{\boldsymbol{k(d)}}\boldsymbol{=1/K}$	0.7791	0.6047	0.5915	0.8182	0.6216	0.6375	0.7575	***0.6871***
	(0.005)	(0.006)	(0.007)	(0.012)	(0.012)	(0.007)	(0.005)	
$\phi_{k(d)} = \widehat{ENS}_{k(d)}$	0.4822	0.4728	0.3910	0.5845	0.5604	0.4645	0.4151	*0.4815*
	(0.027)	(0.037)	(0.023)	(0.020)	(0.014)	(0.021)	(0.023)	

Table 7. Tone-overlay strategy versus EWI and double-sorting as alternative strategies to embed newswire tone.

The table compares the tone-overlay strategy with two alternative strategies to embed newswire tone: i) the equal-weight integration (EWI) strategy of Fernandez-Perez et al. (2019) deployed for each traditional signal and $TONE_{i,t}$ signal in Panel |A, and ii) the double-sorting (first, by the traditional signal, and, second, by the $TONE_{i,t}$ signal) in Panel B. The tone-overlay strategy is deployed with the baseline specification for Equation (2) using $(\tau, \pi, L, \delta) = \left(0.9, 0.10, 260, (1,1)\right)$ and Equation (4) using $(\gamma, \phi) = \left(0.9, \frac{1}{K}\right)$. All the strategies allocate with equal weights the commodities in the top (long) quintile and bottom (short) quintile. ΔSR is the Sharpe ratio gain of the tone-overlay portfolio and ΔCER is the certainty equivalent return gain based on power utility with relative risk aversion parameter $\nu = 5$. The portfolios are implemented on data from January 2, 2000 to May 31, 2020 period. The first available return for the tone-overlay portfolios pertains to the first week of January 2005 and hence, for comparability, the EWI and double-sort portfolios are appraised over the same weeks.

Panel A: EWI strategy versus Tone-overlay strategy

	EWI strategy							Tone-overlay strategy						
	Basis	Mom	Hedging pressure	Convexity	Skewness	Basis-Mom	Liquidity	Basis	Mom	Hedging pressure	Convexity	Skewness	Basis-Mom	Liquidity
Mean	0.0294	0.0250	0.0554	0.0468	0.0107	0.0835	0.0348	0.0860	0.0756	0.0811	0.1077	0.0896	0.1233	0.0791
	(1.30)	(1.10)	(2.25)	(1.93)	(0.60)	(3.96)	(1.62)	(4.16)	(4.23)	(4.57)	(5.05)	(3.66)	(6.34)	(3.77)
StDev	0.0873	0.0930	0.0982	0.0859	0.0699	0.0961	0.0825	0.0913	0.1069	0.0727	0.0809	0.0731	0.0971	0.0893
Skewness	-0.3439	-0.0222	-0.8463	-0.0514	-0.6322	0.2885	0.0226	-0.0391	-0.1912	0.0270	0.1240	0.1454	0.0395	0.1923
Excess Kurtosis	2.2784	1.9885	5.4616	3.5573	4.2285	7.5512	1.2882	0.5314	0.7669	2.6500	0.7369	1.7944	0.5615	2.8154
Semi-deviation	0.0613	0.0651	0.0702	0.0574	0.0507	0.0612	0.0560	0.0565	0.0584	0.0524	0.0549	0.0557	0.0540	0.0549
1% VaR	-0.0320	-0.0373	-0.0329	-0.0286	-0.0343	-0.0299	-0.0286	-0.0272	-0.0274	-0.0251	-0.0269	-0.0269	-0.0259	-0.0269
Max drawdown	-0.2651	-0.3686	-0.1802	-0.2412	-0.3229	-0.1247	-0.2092	-0.1392	-0.2165	-0.0904	-0.1291	-0.1595	-0.1226	-0.2311
Sharpe ratio	0.3369	0.2688	0.5643	0.5440	0.1535	0.8686	0.4215	0.9415	0.7071	1.1149	1.3312	1.2269	1.2698	0.8859
$\Delta SR = SR_{overlay} - SR_{EWI}$								0.6045	0.4383	0.5506	0.7872	1.0733	0.4011	0.4645
Ledoit-Wolf test *p*-value								*0.0056*	*0.0210*	*0.0362*	*0.0122*	*0.0005*	*0.0238*	*0.0420*
Sortino ratio	0.4801	0.3840	0.7897	0.8149	0.2115	1.3642	0.6207	1.5213	1.2951	1.5485	1.9609	1.6106	2.2823	1.4404
Omega ratio	1.1278	1.1030	1.2357	1.2230	1.0590	1.3851	1.1643	1.4069	1.3594	1.4297	1.5346	1.4456	1.6302	1.3979
CER	0.0306	0.0268	0.0557	0.0470	0.0125	0.0817	0.0355	0.0838	0.0742	0.0791	0.1036	0.0871	0.1176	0.0774
$\Delta CER = CER_{overlay} - CER_{EWI}$								0.0532	0.0474	0.0233	0.0566	0.0747	0.0359	0.0419
GMM test *p*-value								*0.0132*	*0.0248*	*0.0447*	*0.0192*	*0.0016*	*0.0278*	*0.0275*

(*Cont.*) Table 7. Tone-overlay strategy versus EWI and double-sorting as alternative strategies to embed newswire tone.

Panel B: Double-sorting strategy versus Tone-overlay strategy

	Double-sorting strategy							Tone-overlay strategy						
	Basis	Mom	Hedging pressure	Convexity	Skewness	Basis-Mom	Liquidity	Basis	Mom	Hedging pressure	Convexity	Skewness	Basis-Mom	Liquidity
Mean	0.0351	0.0285	0.0488	0.0199	0.0476	0.0603	0.0206	0.0860	0.0756	0.0811	0.1077	0.0896	0.1233	0.0791
	(2.38)	(2.01)	(2.93)	(1.34)	(3.01)	(3.95)	(1.48)	(4.16)	(4.23)	(4.57)	(5.05)	(3.66)	(6.34)	(3.77)
StDev	0.0690	0.0709	0.0697	0.0684	0.0714	0.0678	0.0627	0.0913	0.1069	0.0727	0.0809	0.0731	0.0971	0.0893
Skewness	-0.1396	0.0517	-0.1904	-0.0811	-0.2485	0.2685	0.0361	-0.0391	-0.1912	0.0270	0.1240	0.1454	0.0395	0.1923
Excess Kurtosis	2.3927	2.0155	2.6019	2.6141	2.9293	3.6564	1.5407	0.5314	0.7669	2.6500	0.7369	1.7944	0.5615	2.8154
Semi-deviation	0.0493	0.0498	0.0502	0.0486	0.0512	0.0456	0.0436	0.0565	0.0584	0.0524	0.0549	0.0557	0.0540	0.0549
1% VaR	-0.0215	-0.0223	-0.0215	-0.0216	-0.0221	-0.0207	-0.0198	-0.0272	-0.0274	-0.0251	-0.0269	-0.0269	-0.0259	-0.0269
Max drawdown	-0.1633	-0.1395	-0.1422	-0.1858	-0.1463	-0.1329	-0.1807	-0.1392	-0.2165	-0.0904	-0.1291	-0.1595	-0.1226	-0.2311
Sharpe ratio	0.5089	0.4015	0.7004	0.2909	0.6665	0.8887	0.3280	0.9415	0.7071	1.1149	1.3312	1.2269	1.2698	0.8859
$\Delta SR=SR_{overlay} - SR_{double\text{-}sort}$								0.4326	0.3057	0.4145	1.0402	0.5604	0.3811	0.5579
Ledoit-Wolf test *p* -value								*0.0418*	*0.0532*	*0.0460*	*0.0014*	*0.0109*	*0.0510*	*0.0124*
Sortino ratio	0.7122	0.5711	0.9728	0.4093	0.9298	1.3211	0.4712	1.5213	1.2951	1.5485	1.9609	1.6106	2.2823	1.4404
Omega ratio	1.2476	1.1934	1.3499	1.1432	1.3288	1.4614	1.1578	1.4069	1.3594	1.4297	1.5346	1.4456	1.6302	1.3979
Certainty equivalent	0.0352	0.0288	0.0484	0.0204	0.0473	0.0593	0.0210	0.0838	0.0742	0.0791	0.1036	0.0871	0.1176	0.0774
$\Delta CER=CER_{overlay} - CER_{double\text{-}sort}$								0.0485	0.0453	0.0306	0.0832	0.0398	0.0583	0.0564
GMM test *p* -value								*0.0313*	*0.0304*	*0.0376*	*0.0126*	*0.0362*	*0.0084*	*0.0043*

APPENDIX

Newswire Tone-Overlay Commodity Portfolios

Table A.1. Traditional signals for tactical commodity allocations and news tone signal.

The table formalizes the traditional signals used to construct the long-short portfolios alongside the commodity-specific newswire tone signal presented in the manuscript as Equation (4). For the commodity allocations, all signals are uniformly defined and cross-sectionally standardized so that the largest or most positive signal values correspond with the commodity futures contracts that are expected to appreciate the most and hence, assigned the long leg (top quintile Q1); the smallest or most negative signal values correspond with the commodity futures contracts that are expected to depreciate the most (or depreciate the least) and hence, assigned to the short leg (bottom quintile Q5). The long-short portfolios are constructed at Monday-end of each sample week.

Allocation signal (commodity futures characteristic)			Measurement window	Key references
Basis	Difference in log prices of the nearest and second-nearest futures contracts with maturity times T_1 and T_2, respectively. Also known as *roll-yield* or *carry* signal.	$ln(f_{i,t}^{T_1}) - ln(f_{i,t}^{T_2})$	Observations at time *t*	Gorton et al. (2013), Szymanowska et al. (2014)
Momentum	Average past weekly excess return of the commodity (w=1,…,*W* weeks in the prior year).	$\frac{1}{W}\sum_{w=0}^{W-1} R_{i,t-w}$	Observations over 52 weeks preceding *t*	Erb and Harvey (2006), Miffre and Rallis (2007)
Hedging pressure	Standardized weekly net open interest of hedgers (short positions minus long positions over total positions) on average over the prior year.	$\frac{1}{W}\sum_{w=0}^{W-1} \frac{H_{i,t-w}^{short} - H_{i,t-w}^{long}}{H_{i,t-w}^{short} + H_{i,t-w}^{long}}$	Observations over the 52 weeks preceding *t*	Basu and Miffre (2013)
Relative basis / Convexity	Difference between front and further-into-the-curve basis scaled by the difference in maturity time. Also known as *relative basis* signal.	$\frac{ln(f_{i,t}^{T_1}/f_{i,t}^{T_2})}{T_2 - T_1} - \frac{ln(F_{i,t}^{T_2}/F_{i,t}^{T_3})}{T_3 - T_2}$	Observations at time *t*	Gu et al. (2023)
Skewness	Negative of coefficient of skewness of distribution of daily returns (*d* =1,…, *D* trading days in the prior year).	$-\frac{\sum_{d=1}^{D}(R_{i,d}-\mu_i)^3/D}{\sigma_i^3}$	*D* = Number of days in the year preceding t	Fernandez-Perez et al. (2018)
Basis momentum	Difference in momentum of front contract and second-nearest contract based on weekly data over the prior year.	$Mom_{i,t}^{T_1} - Mom_{i,t}^{T_2}$	Observations in the 52 weeks preceding t	Boons and Prado (2019)
Iliquidity (Amihud)	Daily price change per dollar volume on average over d=1,…, *D2* trading days in the two months preceding *t* .	$\frac{1}{D}\sum_{d=0}^{D2-1} \frac{\lvert R_{i,t-d}\rvert}{\$Volume_{i,t-d}}$	D = Number of days in the 2 months preceding *t*	Szymanowska et al. (2014), Fernandez-Perez et al. (2019)
TONE	Exponentially weighted average of Event Sentiment Scores (ESS) over the prior week (with daily news impact decay γ^{t-d} and within-day news novelty score $\phi_{d(k)}$).	$\frac{\sum_{d=t}^{t-D+1}\gamma^{t-d}(\sum_{k=1}^{K_d}\phi_{d(k)}ESS_{d(k)})}{\sum_{d=t}^{t-D+1}\gamma^{t-d}}$	*D* = Number of days in week prior to time *t* ; K_d = Number of news items on day *d* ; $\phi_{d(k)}$ = Within-day news novelty score.	

Table A.2. Within- and cross-commodity sector correlations.

The table illustrates the commodity dependence structure within the same sector (grey shaded area) and across sectors. The left-hand section reports average pairwise correlations of weekly commodity log excess returns. The right-hand section of the table reports average pairwise correlations of the weekly news tone measure, $TONE_{i,t}$, as formalized in Equation (4) with parameters $\gamma = 0.9$ and $\phi_{k(d)} = \frac{1}{K_d}$, that quantifies the tone of news published in the last five days.

Sector	Commodity	Excess return						Media tone					
		Energy	Grains	Livestock	Metals	Oilseeds	Softs	Energy	Grains	Livestock	Metals	Oilseeds	Softs
Energy	Heating oil	0.6917	0.1337	0.0591	0.2860	0.2171	0.1238	0.2536	-0.0106	0.0048	0.0311	-0.0120	0.0013
	Natural gas	0.4095	0.0967	0.0366	0.0956	0.1160	0.0674	0.2639	-0.0125	0.0219	0.0235	0.0136	0.0482
	RBOB gasoline	0.5363	0.1517	0.0974	0.3284	0.2253	0.1273	0.4718	0.0349	0.0147	0.0154	0.0084	0.0049
	Unleaded gasoline	0.4696	-0.0080	0.0008	0.0778	0.0382	0.0263	0.4718	0.0349	0.0147	0.0154	0.0084	0.0049
	WTI crude oil	0.6692	0.1305	0.0543	0.2957	0.2072	0.1182	0.3187	0.0542	-0.0206	0.0909	0.0389	0.0355
	Average	*0.5553*	*0.1009*	*0.0497*	*0.2167*	*0.1607*	*0.0926*	*0.3560*	*0.0202*	*0.0071*	*0.0353*	*0.0114*	*0.0190*
Grains	Corn	0.1542	0.5861	-0.0086	0.2074	0.4719	0.1392	0.0198	0.3712	-0.0037	-0.0140	0.1007	0.0487
	Oats	0.0894	0.5039	0.0210	0.1280	0.3180	0.1175	0.0425	0.3669	-0.0227	-0.0249	0.1298	0.1047
	Rough rice	0.0687	0.3966	-0.0036	0.1212	0.1904	0.0813	0.0045	0.3017	0.0360	-0.0221	0.0084	0.0226
	Wheat CBT	0.0914	0.5502	0.0173	0.1661	0.3452	0.1163	0.0140	0.3523	0.0559	-0.0407	0.1543	0.0649
	Average	*0.1009*	*0.5092*	*0.0065*	*0.1557*	*0.3314*	*0.1136*	*0.0202*	*0.3480*	*0.0164*	*-0.0254*	*0.0983*	*0.0602*
Livestock	Feeder cattle	0.1039	-0.0626	0.5455	0.0787	0.0268	0.0737	-0.0125	0.0256	0.2680	-0.0172	0.0103	0.0262
	Lean hogs	-0.0075	0.0138	0.4577	0.0251	0.0314	-0.0023	0.0554	0.0190	0.2801	-0.0022	0.0021	0.0344
	Live cattle	0.0986	0.0603	0.5461	0.0781	0.0942	0.0866	0.0051	0.0618	0.2876	0.0068	0.1169	0.0146
	Frozen pork bellies	0.0036	0.0147	0.3998	0.0133	0.0119	0.0198	-0.0196	-0.0410	0.2681	-0.0474	0.0418	0.0086
	Average	*0.0497*	*0.0065*	*0.4872*	0.0488	0.0411	0.0444	*0.0071*	*0.0164*	*0.2760*	*-0.0150*	*0.0428*	*0.0210*

(*Cont.*) Table A.2. Within- and cross-commodity sector correlations.

Sector	Commodity	Excess return						Media tone					
		Energy	Grains	Livestock	Metals	Oilseeds	Softs	Energy	Grains	Livestock	Metals	Oilseeds	Softs
Metals	Copper (High Grade)	0.2577	0.1900	0.0755	0.5014	0.2740	0.1579	0.0674	0.0938	-0.0029	0.2379	0.0218	0.0401
	Gold 100oz (CMX)	0.1615	0.1347	0.0028	0.6077	0.1472	0.1181	0.0325	-0.0066	-0.0312	0.2768	-0.0084	0.0193
	Palladium	0.1929	0.1293	0.0895	0.5789	0.2036	0.1456	0.0175	-0.0288	0.0107	0.2323	-0.0448	0.0241
	Platinum	0.2514	0.1473	0.0556	0.6397	0.2053	0.1607	0.0162	-0.0724	-0.0189	0.2128	-0.1246	0.0009
	Silver 5000 oz	0.2202	0.1770	0.0207	0.6619	0.1989	0.1606	0.0426	-0.1131	-0.0328	0.2815	-0.0184	0.0180
	Average	*0.2167*	*0.1557*	*0.0488*	*0.5979*	*0.2058*	*0.1486*	*0.0353*	*-0.0254*	*-0.0150*	*0.2483*	*-0.0349*	*0.0205*
Oilseeds	Soybeans	0.1798	0.4210	0.0455	0.2215	0.7196	0.1467	0.0181	0.0949	0.0362	-0.0374	0.3303	0.0333
	Soybean meal	0.0979	0.3568	0.0137	0.1271	0.6254	0.1046	0.0035	0.0964	0.0695	-0.0568	0.3436	0.0293
	Soybean oil	0.2384	0.3558	0.0591	0.2885	0.5994	0.1693	0.0018	0.1296	0.0240	-0.0460	0.3728	0.0599
	Average	*0.1720*	*0.3779*	*0.0394*	*0.2124*	*0.6481*	*0.1402*	*0.0078*	*0.1070*	*0.0433*	*-0.0467*	*0.3489*	*0.0408*
Softs	Cocoa	0.1536	0.1234	0.0608	0.2277	0.1466	0.3160	0.0014	0.1093	-0.0038	-0.0160	0.1322	0.2593
	Coffee C	0.1114	0.1761	0.0375	0.1867	0.1990	0.3438	0.0406	0.0583	0.0223	0.0338	0.0688	0.2599
	Cotton no.2	0.1269	0.1918	0.0461	0.1860	0.1369	0.4543	0.0224	0.0722	0.0413	0.0008	0.0677	0.3665
	Frozen Orange juice	0.0228	0.0681	0.0250	0.0908	0.0975	0.3003	0.0364	-0.0067	0.0650	0.0411	-0.0778	0.1977
	Lumber	0.0825	0.0868	0.0545	0.0890	0.1142	0.2922	-0.0025	0.0799	0.0003	0.0231	0.0669	0.2513
	Average	*0.0994*	*0.1292*	*0.0448*	*0.1561*	*0.1388*	*0.3413*	*0.0197*	*0.0626*	*0.0250*	*0.0166*	*0.0516*	*0.2670*

Table A.3. Correlations between tone strategies and traditional strategies.

The table reports the full sample pairwise correlations between the excess returns of a long-only equally-weighted and weekly-rebalanced portfolio of the 26 commodities (MKT), the traditional long-short portfolios formed according to basis, momentum, hedging pressure, convexity, skewness, basis-momentum, and liquidity signals, and the long-short portfolio formed according to commodity-specific tone in levels, $TONE_{i,t}$, or shifts, $\Delta TONE_{i,t}$, as the standalone allocation signal. Significance p-values are shown in parentheses. The sample period is January 3, 2000 to May 31, 2020.

	Basis	Momentum	HP	Convexity	Skewness	Basis-Mom	Liquidity	Tone (standalone)	ΔTone (standalone)
MKT	0.0939	0.1000	0.1725	0.0217	0.1628	0.0599	0.1651	0.0106	0.0122
	(0.003)	(0.001)	(0.000)	(0.490)	(0.000)	(0.057)	(0.000)	(0.736)	(0.730)
Basis		0.4814	0.2648	0.3955	0.2492	0.3890	0.2127	0.0474	0.0370
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.132)	(0.194)
Momentum			0.2867	0.1308	0.0338	0.4456	-0.0071	0.0021	0.0034
			(0.000)	(0.000)	(0.282)	(0.000)	(0.822)	(0.947)	(0.841)
HP				0.0968	0.2424	0.2441	0.2550	0.0317	0.0403
				(0.002)	(0.000)	(0.000)	(0.000)	(0.314)	(0.487)
Convexity					0.0388	0.2965	-0.0045	0.0747	0.0634
					(0.217)	(0.000)	(0.886)	(0.067)	(0.070)
Skewness						0.0988	0.2427	-0.0562	-0.0410
						(0.002)	(0.000)	(0.074)	(0.065)
Basis-Mom							0.0726	0.0726	0.0669
							(0.021)	(0.041)	(0.084)
Liquidity								-0.0381	-0.0173
								(0.226)	(0.337)

Table A.4. Standalone-tone portfolio and market conditions.

The table reports the Sharpe ratio of the long leg (top quintile Q1), short leg (bottom quintile Q5), and long-short portfolio formed according to $TONE_{i,t}$, Equation (4), or its shifts, $\Delta TONE_{i,t}$, as a standalone allocation signal. The different states represent periods of economic expansion versus recession (NBER), low vs high economic activity (Aruoba-Diebold-Scotti index; ADS), and high vs low funding liquidity risk (TED spread). The ADS and TED regimes are defined using their median value. The sample period is January 3, 2000 to May 31, 2020.

Panel I: Newswire tone as standalone allocation signal ($TONE_{it}$)						
	Long (Q1)	Short (Q5)	Long - Short	Long (Q1)	Short (Q5)	Long - Short
	Panel A: Macroeconomic conditions					
	NBER recession			NBER expansion		
Mean return	-0.1732	-0.2744	0.0506	0.1066	-0.0193	0.0630
(*t*-stat)	(-1.37)	(-0.22)	(2.37)	(3.70)	(-0.88)	(4.27)
StDev	0.2710	0.1679	0.0376	0.1294	0.1033	0.0661
Sharpe ratio	-0.6392	-1.6342	1.3446	0.8239	-0.1870	0.9531
	Low economic activity (ADS)			High economic activity (ADS)		
Mean return	0.0278	-0.0933	0.0605	0.1068	-0.0117	0.0592
(*t*-stat)	(1.95)	(-1.35)	(2.91)	(0.54)	(-0.91)	(1.74)
StDev	0.1274	0.1353	0.0735	0.1672	0.1610	0.0789
Sharpe ratio	0.2181	-0.6894	0.8234	0.6383	-0.0724	0.7503
	Panel B: Funding liquidity conditions					
	High TED spread			Low TED spread		
Mean return	-0.1799	-0.2732	0.0466	0.0966	-0.0429	0.0698
(*t*-stat)	(-0.36)	(-1.40)	(2.27)	(3.03)	(-0.31)	(3.31)
StDev	0.2170	0.2396	0.0904	0.1354	0.1319	0.1450
Sharpe ratio	-0.8291	-1.1401	1.2689	0.7136	-0.3254	1.0399
Panel II: Newswire tone shift as standalone allocation signal ($\Delta TONE_{it}$)						
	Panel A: Macroeconomic conditions					
	NBER-dated recession			NBER-dated expansion		
Mean return	0.0014	-0.2164	0.1089	0.0302	-0.0203	0.0252
(t-stat)	(-1.12)	(-1.30)	(0.19)	(1.39)	(-2.20)	(3.10)
StDev	(0.28)	(0.30)	(0.10)	(0.14)	(0.15)	(0.08)
Sharpe ratio	0.0051	-0.7172	1.1211	0.2107	-0.1394	0.3163
	Low economic activity (ADS)			High economic activity (ADS)		
Mean return	0.0044	-0.1801	0.0922	0.0620	-0.0108	0.0364
(*t*-stat)	(0.09)	(-1.13)	(1.19)	(0.22)	(-2.16)	(2.42)
StDev	0.1432	0.1422	0.0804	0.1741	0.1825	0.0891
Sharpe ratio	0.0305	-1.2664	1.1471	0.3561	-0.0592	0.4084
	Panel B: Funding liquidity conditions					
	High TED spread			Low TED spread		
Mean return	-0.0063	-0.1738	0.0837	0.0778	-0.0110	0.0444
(*t*-stat)	(-0.24)	(-1.28)	(0.44)	(0.63)	(-2.39)	(2.77)
StDev	(0.22)	(0.24)	(0.10)	(0.15)	(0.15)	(0.08)
Sharpe ratio	-0.0292	-0.7300	0.8075	0.5255	-0.0744	0.5467

Table A.5. Tone-overlay strategy versus EWI for newswire tone shifts.

This table compares the tone-overlay strategy that embeds tone into traditional signals according to Equation (2) and the equally-weighted integration (EWI) strategy of Fernandez-Perez et al. (2019) applied in a bivariate fashion for each traditional signal and the newswire tone-shifts signal $\Delta TONE_{i,t}$. The tone-overlay Equation (2) is deployed with tilting parameter $\tau_{it} = \tau = 0.9$, top/bottom deciles of historical tone, $L = 260$ weeks, optimistic/pessimistic tone weights $(\delta^+, \delta^-) = (1, 1)$. The newswire tone signal, $TONE_{it}$ from Equation (4), is based on daily news impact-decay parameter $\gamma = 0.9$ and within-day news novelty score $\phi_{k(d)} = \frac{1}{K_d}$. ΔSR is the Sharpe ratio gain (tone-overlay minus traditional portfolio) and ΔCER is the certainty equivalent return differential based on power utility with coefficient of relative risk aversion $\nu = 5$. The portfolios are implemented on data from January 2, 2000 to May 31, 2020. The first available return for the tone-overlay portfolios pertains to the first week of January 2005; for comparability, the EWI portfolios are appraised over the same period.

	EWI strategy							Tone-overlay strategy						
	Basis	Mom	Hedging pressure	Convexity	Skewness	Basis-Mom	Liquidity	Basis	Mom	Hedging pressure	Convexity	Skewness	Basis-Mom	Liquidity
Mean	0.0433	0.0361	0.0595	0.0593	0.0438	0.0818	0.0450	0.0860	0.0756	0.0811	0.1077	0.0896	0.1233	0.0791
	(2.21)	(2.09)	(2.82)	(3.08)	(2.28)	(3.97)	(2.40)	(4.16)	(4.23)	(4.57)	(5.05)	(3.66)	(6.34)	(3.77)
StDev	0.0809	0.0836	0.0811	0.0759	0.0799	0.0851	0.0710	0.0913	0.1069	0.0727	0.0809	0.0731	0.0971	0.0893
Skewness	-0.4252	-0.0312	-0.5244	-0.0924	-0.4532	0.7588	-0.0128	-0.0391	-0.1912	0.0270	0.1240	0.1454	0.0395	0.1923
Excess Kurtosis	2.7660	1.3395	3.1443	10.0404	3.0346	7.3994	1.3607	0.5314	0.7669	2.6500	0.7369	1.7944	0.5615	2.8154
Semi-deviation	0.0563	0.0550	0.0592	0.0517	0.0573	0.0540	0.0466	0.0565	0.0584	0.0524	0.0549	0.0557	0.0540	0.0549
1% VaR	-0.0252	-0.0262	-0.0250	-0.0233	-0.0249	-0.0259	-0.0220	-0.0272	-0.0274	-0.0251	-0.0269	-0.0269	-0.0259	-0.0269
Max drawdown	-0.1291	-0.1712	-0.1479	-0.1488	-0.1527	-0.1556	-0.1477	-0.1392	-0.2165	-0.0904	-0.1291	-0.1595	-0.1226	-0.2311
Sharpe ratio	0.5351	0.4315	0.7338	0.7823	0.5478	0.9612	0.6340	0.9415	0.7071	1.1149	1.3312	1.2269	1.2698	0.8859
$\Delta SR = SR_{overlay} - SR_{EWI}$								0.4064	0.2756	0.3811	0.5489	0.6791	0.3086	0.2519
Ledoit-Wolf test *p*-value								*0.0355*	*0.0441*	*0.0399*	*0.0103*	*0.0014*	*0.0336*	*0.0451*
Sortino ratio	0.7694	0.6556	1.0055	1.1480	0.7643	1.5128	0.9662	1.5213	1.2951	1.5485	1.9609	1.6106	2.2823	1.4404
Omega ratio	1.2305	1.1847	1.3239	1.3507	1.2399	1.4456	1.2718	1.4069	1.3594	1.4297	1.5346	1.4456	1.6302	1.3979
CER	0.0434	0.0365	0.0589	0.0586	0.0438	0.0797	0.0449	0.0838	0.0742	0.0791	0.1036	0.0871	0.1176	0.0774
$\Delta CER = CER_{overlay} - CER_{EWI}$								0.0403	0.0376	0.0202	0.0450	0.0433	0.0378	0.0325
GMM test *p*-value								*0.0463*	*0.0532*	*0.0632*	*0.0404*	*0.0378*	*0.0528*	*0.0531*

Table A.6. Tone-overlay benefits in high versus low inflation periods.

This table reports the Sharpe ratio of the tone-overlay portfolios and traditional portfolios, and Sharpe ratio differential in high versus low inflation regimes. The regimes are defined by the median of the year-on-year changes in U.S. CPI. The Ledoit and Wolf (2008) test *p*-value for the significance in Sharpe ratio gains $H_0: \Delta SR \leq 0$ vs $H_A: \Delta SR > 0$ with $\Delta SR = SR_{overlay} - SR_{trad}$ is reported in the last row of each section. The tone-overlay portfolios are based on Equation (2) with $(\tau, \pi, L, \delta) = \left(0.9, 0.10, 260, (1,1)\right)$ and Equation (4) with $(\gamma, \phi) = \left(0.9, \frac{1}{K}\right)$. The portfolios are deployed on data from January 2, 2000 to May 31, 2020.

			Tone-overlay portfolios versus traditional portfolios							
			Basis	Momentum	HP	Convexity	Skewness	Basis-mom	Liquidity	*Average*
US CPI change	High	*SR_overlay*	1.3197	1.3335	1.2178	1.0998	1.1270	1.7761	1.1412	*1.2879*
		SR_trad	0.3558	0.0732	0.4087	0.8922	0.4179	0.4471	0.2256	*0.4029*
		ΔSR	0.9639	1.2603	0.8092	0.2076	0.7091	1.3290	0.9156	*0.8849*
		p-value	0.0142	0.0024	0.0180	0.1822	0.0337	0.0013	0.0119	
	Low	*SR_overlay*	0.6518	0.8337	0.9884	1.1682	0.5421	0.9499	0.5637	*0.8140*
		SR_trad	0.0957	0.2448	0.7091	0.2757	0.1508	0.8623	0.1412	*0.3542*
		ΔSR	0.5562	0.5889	0.2794	0.8924	0.3913	0.0877	0.4225	*0.4598*
		p-value	0.0275	0.0256	0.1293	0.0191	0.0616	0.1875	0.0456	

Table A.7. Summary statistics for transaction cost estimates.

This table describes the trading costs $TC_{i,t} = 100 \times (\$10 + Tick\_size_i \times CM_i)/(f_{i,t} \times CM_i)$ estimated according to the modelling approach of Szakmary et al. (2010). $TC_{i,t}$ denotes the transaction cost of commodity futures contract *i* at time (Monday-end) *t* expressed in percentage, $Tick\_size_i$ is the minimum tick size, CM_i is the contract multiplier, and $f_{i,t}$ is the settlement price of the front futures contract. We report the mean, standard deviation, maximum, minimum, and the number of observations. The observation period is January 3, 2000 to May 31, 2020.

Sector	Commodity	Mean			StDev	Max	Min	Obs
		full sample	1st half	2nd half				
Energy	Heating oil	0.0233	0.0299	0.0167	0.0126	0.0654	0.0082	1065
	Natural gas	0.0521	0.0386	0.0655	0.0215	0.1197	0.0139	1065
	RBOB gasoline	0.0177	0.0178	0.0176	0.0058	0.0551	0.0094	765
	Unleaded gasoline	0.0339	0.0339		0.0112	0.0662	0.0146	360
	WTI crude oil	0.0400	0.0483	0.0316	0.0196	0.1181	0.0137	1065
Grains	Corn	0.1383	0.1717	0.1048	0.0508	0.2575	0.0546	1065
	Oats	0.2091	0.2586	0.1597	0.0822	0.4651	0.0881	1065
	Rough rice	0.1090	0.1379	0.0655	0.0528	0.2801	0.0420	1065
	Wheat CBT	0.1018	0.1212	0.0823	0.0353	0.1901	0.0378	1065
Livestock	Feeder cattle	0.2329	0.2835	0.1824	0.0605	0.3696	0.1120	1065
	Lean hogs	0.4094	0.4514	0.3675	0.0869	0.8907	0.2090	1065
	Live cattle	0.0516	0.0615	0.0418	0.0120	0.0827	0.0293	1065
	Frozen pork bellies	0.0586	0.0601	0.0468	0.0095	0.0923	0.0395	599
Metals	Copper (High Grade)	0.0512	0.1057	0.0307	0.0350	0.1466	0.0512	1065
	Gold 100oz (CMX)	0.0304	0.0458	0.0149	0.0205	0.0775	0.0107	1065
	Palladium	0.1397	0.2019	0.0775	0.0850	0.3987	0.0230	1065
	Platinum	0.0319	0.0375	0.0263	0.0129	0.0758	0.0138	1065
	Silver 5000 oz	0.0681	0.0998	0.0364	0.0452	0.1735	0.0144	1065
Oilseeds	Soybeans	0.0557	0.0694	0.0421	0.0208	0.1064	0.0255	1065
	Soybean meal	0.0786	0.0986	0.0587	0.0274	0.1393	0.0366	1065
	Soybean oil	0.0930	0.1126	0.0735	0.0359	0.1842	0.0391	1065
Softs	Cocoa	0.1057	0.1329	0.0785	0.0468	0.2899	0.0541	1065
	Coffee C	0.0735	0.0920	0.0551	0.0316	0.1800	0.0256	1065
	Cotton no.2	0.0481	0.0570	0.0392	0.0135	0.1040	0.0141	1065
	Frozen Orange juice	0.2918	0.4996	0.0844	0.2996	1.0939	0.0529	1065
	Lumber	0.0350	0.0381	0.0318	0.0084	0.0684	0.0160	1065
	Average	0.0992	0.1271	0.0733	0.0440	0.2343	0.0403	1008

Table A.8. Tone-overlay portfolios for different holding periods.

The table reports the annualized mean of excess return from each portfolio formation time t (Monday-end) to $t+h$ and Sharpe ratio of the tone-overlay portfolios. ΔSR is the Sharpe ratio gain versus the corresponding traditional portfolios. The tone-overlay method is deployed using Equation (2) with $(\tau, \pi, L, \boldsymbol{\delta}) = \big(0.9, 0.10, 260, (1,1)\big)$ and Equation (4) with $(\gamma, \phi) = \left(0.9, \frac{1}{K}\right)$. Panel A reports performance measures before trading costs ($TC = 0$) and Panel B reports net performance with the TC_{it} estimated according to the Szakmary et al. (2010) model as discussed in Section 5 of the manuscript. The column labelled "Average" reports means across tone-overlay portfolios and grey shade denotes the best performance across holding periods. The portfolios are deployed on data from January 3, 2000 to May 31, 2020.

Holding period (weeks)		Tone-overlay portfolios: Basis	Mom	Hedging pressure	Convexity	Skewness	Basis-Mom	Liquidity	*Average*
Panel A. Performance before trading costs (TC = 0)									
h = 1	Mean	0.0860	0.0756	0.0811	0.1077	0.0896	0.1233	0.0791	0.0918
	Sharpe ratio	0.9415	0.7071	1.1149	1.3312	1.2269	1.2698	0.8859	1.0682
	$\Delta SR = SR_{overlay} - SR_{trad}$	0.7791	0.6047	0.5915	0.8182	0.6216	0.6375	0.7575	0.6871
	Ledoit-Wolf test *p*-value	*0.0049*	*0.0059*	*0.0074*	*0.0121*	*0.0115*	*0.0068*	*0.0055*	
h = 4	Mean	0.0425	0.0492	0.0437	0.0462	0.0460	0.0721	0.0288	0.0469
	Sharpe ratio	0.4851	0.5544	0.5270	0.5105	0.5708	0.8422	0.3276	0.5454
	$\Delta SR = SR_{overlay} - SR_{trad}$	0.1852	0.4586	0.0747	0.2329	0.1462	0.3104	0.1880	0.2280
	Ledoit-Wolf test *p*-value	*0.0709*	*0.0139*	*0.2953*	*0.0518*	*0.1555*	*0.1040*	*0.0648*	
h = 8	Mean	0.0304	0.0319	0.0358	0.0359	0.0395	0.0591	0.0186	0.0359
	Sharpe ratio	0.3623	0.3831	0.4400	0.3975	0.4906	0.7134	0.2094	0.4280
	$\Delta SR = SR_{overlay} - SR_{trad}$	0.1580	0.3110	0.0086	0.2074	0.1138	0.1868	0.0965	0.1546
	Ledoit-Wolf test *p*-value	*0.2021*	*0.0770*	*0.4733*	*0.0877*	*0.3110*	*0.2213*	*0.2824*	
h = 12	Mean	0.0297	0.0271	0.0310	0.0313	0.0368	0.0507	0.0175	0.0320
	Sharpe ratio	0.3581	0.3199	0.3963	0.3438	0.4555	0.6146	0.2029	0.3844
	$\Delta SR = SR_{overlay} - SR_{trad}$	0.1976	0.3182	-0.0185	0.1653	0.1345	0.1212	0.1297	0.1497
	Ledoit-Wolf test *p*-value	*0.3678*	*0.0411*	*0.6416*	*0.3306*	*0.4438*	*0.3073*	*0.3608*	
Panel B. Net performance after trading costs (commodity- and time-specific TC_{it})									
h = 1	Mean	0.0730	0.0621	0.0704	0.0826	0.0730	0.1082	0.0565	0.0751
	Sharpe ratio	0.8437	0.6849	0.8807	0.9577	0.8270	1.2543	0.6801	0.8755
	$\Delta SR = SR_{overlay} - SR_{trad}$	0.7120	0.5693	0.3935	0.5815	0.6107	0.6401	0.5192	0.5752
	Ledoit-Wolf test *p*-value	*0.0149*	*0.0324*	*0.0587*	*0.0327*	*0.0267*	*0.0162*	*0.0393*	
h = 4	Mean	0.0377	0.0445	0.0393	0.0400	0.0410	0.0670	0.0244	0.0420
	Sharpe ratio	0.4306	0.5012	0.4740	0.4426	0.5078	0.7817	0.2772	0.4879
	$\Delta SR = SR_{overlay} - SR_{trad}$	0.1400	0.4133	0.0303	0.1747	0.0925	0.2585	0.1460	0.1793
	Ledoit-Wolf test *p*-value	*0.3606*	*0.0229*	*0.4132*	*0.2543*	*0.3024*	*0.0538*	*0.4068*	
h = 8	Mean	0.0279	0.0296	0.0338	0.0326	0.0369	0.0564	0.0163	0.0334
	Sharpe ratio	0.3331	0.3560	0.4160	0.3622	0.4586	0.6803	0.1844	0.3987
	$\Delta SR = SR_{overlay} - SR_{trad}$	0.1403	0.2908	-0.0068	0.1831	0.0915	0.1622	0.0798	0.1344
	Ledoit-Wolf test *p*-value	*0.3683*	*0.0476*	*0.5387*	*0.0724*	*0.3044*	*0.2687*	*0.5967*	
h = 12	Mean	0.0278	0.0254	0.0296	0.0289	0.0350	0.0486	0.0158	0.0302
	Sharpe ratio	0.3318	0.2995	0.3784	0.3183	0.4335	0.5904	0.1835	0.3622
	$\Delta SR = SR_{overlay} - SR_{trad}$	0.1792	0.3040	-0.0265	0.1487	0.1196	0.1063	0.1186	0.1357
	Ledoit-Wolf test *p*-value	*0.3986*	*0.0317*	*0.7097*	*0.3183*	*0.5827*	*0.5920*	*0.5282*	

Table A.9. Traditional and standalone-tone portfolios for different holding periods.

The table reports the annualized mean excess return and Sharpe ratio of long-short allocations based on traditional signals and the individual $TONE_{i,t}$ signal. Panel A reports performance before trading costs and Panel B reports net performance using the commodity- and time-specific $TC_{i,t}$ estimated according to the Szakmary et al. (2010) model as discussed in Section 5 of the manuscript. The column labelled "Average" reports means across traditional portfolios and grey shade denotes the best performance across holding periods. The data covers the period is January 3, 2000 to May 31, 2020. Since the first available return of the tone-overlay portfolios (Table A.8) is for the first week of January 2005 due to the window length L in Equation (2), to facilitate comparisons the portfolios in this table are assessed over the same sample weeks.

Holding period (weeks)		Traditional portfolios								Tone (standalone) portfolio
		Basis	Mom	Hedging pressure	Convexity	Skewness	Basis-Mom	Liquidity	*Average*	
Panel A. Performance before trading costs (TC = 0)										
h = 1	Mean	0.0169	0.0120	0.0563	0.0474	0.0391	0.0608	0.0135	0.0351	0.0571
	Sharpe ratio	0.1624	0.1024	0.5234	0.5129	0.6053	0.6323	0.1285	0.3810	0.8611
h = 4	Mean	0.0284	0.0109	0.0445	0.0249	0.0419	0.0501	0.0149	0.0308	0.0251
	Sharpe ratio	0.2999	0.0958	0.4523	0.2775	0.4245	0.5317	0.1396	0.3174	0.3463
h = 8	Mean	0.0195	0.0082	0.0428	0.0180	0.0395	0.0506	0.0127	0.0273	0.0209
	Sharpe ratio	0.2043	0.0720	0.4314	0.1902	0.3767	0.5267	0.1128	0.2734	0.2859
h = 12	Mean	0.0165	0.0002	0.0430	0.0160	0.0340	0.0492	0.0083	0.0239	0.0107
	Sharpe ratio	0.1606	0.0016	0.4148	0.1785	0.3211	0.4934	0.0732	0.2347	0.1738
Panel B. Net performance after trading costs (commodity- and time-specific TC_{it})										
h = 1	Mean	0.0083	0.0067	0.0445	0.0309	0.0177	0.0559	0.0114	0.0251	0.0562
	Sharpe ratio	0.1317	0.1156	0.4872	0.3761	0.2163	0.6142	0.1609	0.3003	0.7711
h = 4	Mean	0.0275	0.0100	0.0437	0.0240	0.0410	0.0493	0.0140	0.0299	0.0200
	Sharpe ratio	0.2905	0.0879	0.4437	0.2680	0.4153	0.5232	0.1311	0.3085	0.2765
h = 8	Mean	0.0184	0.0074	0.0420	0.0170	0.0385	0.0498	0.0117	0.0264	0.0183
	Sharpe ratio	0.1929	0.0653	0.4228	0.1791	0.3671	0.5181	0.1046	0.2643	0.2512
h = 12	Mean	0.0156	-0.0005	0.0420	0.0152	0.0332	0.0483	0.0074	0.0230	0.0150
	Sharpe ratio	0.1527	-0.0045	0.4049	0.1696	0.3139	0.4841	0.0649	0.2265	0.2074