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COMMODITY INSIGHTS DIGEST
Vol. 1, No. 1: Summer 2023
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The *CID* acknowledges the central importance and role of knowledge-exchange and engagement between academia and industry. Accordingly, the *CID*'s mission is to disseminate cutting-edge academic research along with industry insights that are based on hands-on experience in the commodity markets.

The themes of interest include commodity pricing and trading strategies, risk modeling and forecasting methods, as well as debates and challenges associated with climate change, geopolitical risks, and biodiversity.

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In this paper, the authors develop a framework to quantify the convenience yield risk (CYR) inherent in each commodity futures market. Implementing the paper's approach, the authors document that their novel CYR measure is informative about future commodity returns. In panel regressions, the CYR predicts future returns with a positive sign. Economically, a strategy that opens long positions in commodity markets with a higher than median CYR signal and sells the remaining commodities yields an average return of 6.93% per year. The performance of the CYR strategy cannot be explained by exposure to existing commodity strategies or other variables that capture changes in the investment opportunity set.

Prime Money Market Funds Regulation, Global Liquidity, and the Crude Oil Market 14
By Miruna-Daniela Ivan, Ph.D, Policy Analyst in the Financial Stability Strategy and Risk Directorate, Bank of England, U.K.; Chiara Banti, Ph.D., Associate Professor of Finance, Essex Business School, University of Essex, U.K.; and Neil Kellard, Ph.D., Professor of Finance, Essex Business School, University of Essex, U.K.

This paper explores how the 2016 U.S. Prime Money Market Funds (PMMFs) regulation affected the crude oil market. This reform led to an increase in short-term dollar borrowing costs and the oil sector became particularly susceptible to disruptions in the global funding market due to a post-financial crisis debt expansion which far outpaced other commodity industries. Building on the global crude oil market structural vector autoregression (SVAR) model pioneered by Kilian and Murphy (2014), the authors find that tighter PMMFs funding conditions have a lagged negative effect on the real price of crude oil and a lagged positive effect on oil production. The authors show that these responses are driven primarily by a fall in certificates of deposits issued by global banks. Lastly, the authors evidence that the U.S. nominal effective exchange rate acts as a transmission channel for the negative funding shock to the real price of oil.

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Revisiting The Silver Crisis **19**
By Don Bredin, Ph.D., Full Professor of Finance, University College Dublin, Ireland; Enrique Salvador, Ph.D., Associate Professor in Accounting and Finance, Universitat Jaume I, Spain; and Valerio Potì, Ph.D., Professor of Finance, University College Dublin, Ireland

In August 1988, the Hunt Brothers were found guilty by a jury of conspiracy, manipulation, monopolization, racketeering and fraud. Using a behavioral model, the authors aim to quantify the extent of manipulation in the silver market during the 1970s and the 1980s, with a specific focus on the period leading up to the Silver Crisis. The authors' behavioral model takes account of the role of fundamentals, manipulation and speculation. The authors' results indicate very little evidence of manipulation in the silver market in the run up to the Silver Crisis. Both fundamentals and speculation dominate the silver market during our sample, with speculation particularly important in the latter half of the 1970s.

Commodity Premiums Under Financialization **25**
By Loïc Maréchal, Ph.D., Research Fellow, HEC Lausanne (University of Lausanne) - Cyber-Defence Campus, armasuisse Science and Technology, Switzerland

This paper examines the effects of financialization on commodity markets in terms of pricing. It investigates whether commodity index traders affect weekly returns and turnover during roll periods and the effect of commodity index traders' market share on returns. Risk adjustments are tested to see if they alter liquidity and insurance premiums and how financialization affects liquidity and insurance premiums. Finally, an alternative method is used to test how liquidity and insurance premiums determine commodity returns.

The Role of Storage in Commodity Markets: Indirect Inference Based on Grains Data **31**
By Christophe Gouel, Ph.D., Senior Research Fellow, Paris-Saclay Applied Economics, National Research Institute for Agriculture, Food and the Environment (INRAE), France and Scientific Advisor, Center for International Prospective Research and Data (CEPII), France and Nicolas Legrand, Ph.D., Research Fellow, Structures and Markets in Agriculture, Resources and Territories (SMART), INRAE, France

The quantitative contribution of speculative storage to commodity price dynamics remains an open question. This research provides an answer by developing a rich model of competitive storage and a new structural estimation approach exploiting the joint dynamics of prices and quantities, and carries it on global grain market data. The results show that the extended storage model explains most of the moments in the data, including the high price autocorrelation, and that, although supply shocks are the main driver of grain market dynamics, demand shocks are important with a standard deviation of more than three-fifth of that of total supply shocks.

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The Lead-lag Relations in the Commodity Futures Returns:
A Machine Learning Approach **37**

By Yufeng Han, Ph.D., Professor of Finance, Belk College of Business, University of North Carolina at Charlotte, U.S.A. and Lingfei Kong, Ph.D., Postdoctoral Research Associate in Finance, Olin School of Business, Washington University in St. Louis, U.S.A.

This paper uses machine learning tools to study the lead-lag relations in commodity futures returns. The authors use LASSO (Least Absolute Shrinkage and Selection Operator) to select the predictors because the number of predictors is large relative to the number of observations. They find significant full-sample and out-of-sample predictability. The out-of-sample forecasts based on LASSO generate statistically and economically large gains. When the authors use more complex machine learning models such as regression trees and neural networks to forecast commodity futures returns, the out-of-sample performance is worse than LASSO portfolios, suggesting that nonlinearities and interactions do not appear substantial in the data. Finally, the authors find that index trading due to financialization has been associated with excess comovement among commodity futures.

Currency and Commodity Return Relationship under Extreme Geopolitical Risks: Evidence from the Invasion of Ukraine **43**

By Olga Dodd, Ph.D., Auckland University of Technology, New Zealand; Adrian Fernandez-Perez, Ph.D., Auckland University of Technology, New Zealand and Editorial Board Member, Commodity Insights Digest; and Simon Sosvilla-Rivero, Ph.D., Universidad Complutense de Madrid, Spain

This study examines the relationship dynamic between currency and commodity returns around the Russian invasion of Ukraine in February 2022. In regular times, in line with previous research, there is a positive relationship between currency and commodity returns; that is, an increase in commodity prices is associated with an increase in foreign currency values relative to the U.S. dollar. However, this positive relationship reverses and becomes negative during the period when the invasion of Ukraine was highly probable (from January 20, 2022) and remains negative during the outset of the war (February 24 – March 11, 2022). The results suggest that the war's anticipation and subsequent start changed the sign of the relationship between commodity and currency prices. In other words, during this period of heightened geopolitical risks, the observed increase in commodity prices was associated with a decrease in the value of foreign currencies relative to the U.S. dollar. This study also examines whether the exposure to geopolitical risk around the invasion of Ukraine affects currency returns. The study reports that geographic distance to the war significantly affects currency returns during the period of anticipation and the outset of
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the war; that is, the further away the country is from the war, the higher the country's currency return. Overall, the results indicate that a war between two major commodity-exporting countries significantly affects global currency pricing.

Staking: Implications for Token Valuation, Yield Framing, and Carry Trades **52**
By Lin William Cong, Ph.D., SC Johnson College of Business, Cornell University and National Bureau of Economic Research (NBER), U.S.A.; Zhiheng He, Institute of Economics, Tsinghua University, China; and Ke Tang, Ph.D., Institute of Economics, Tsinghua University, China

Tokens in the recent phenomenon of the staking economy offer transaction convenience in digital networks and are frequently staked for base-layer consensus generation or incentivizing platform development (consequently earning staking rewards), thereby generating both currency-like and commodity-like properties as hybrid assets. This paper builds a theoretical model where heterogeneous agents dynamically allocate their wealth over staking, on-chain transaction, and off-chain consumption. Model implications and empirical findings from stakable tokens corroborate the predictions: (i) the staking ratio positively correlates with reward rates; (ii) higher staking ratios predict greater excess returns; and (iii) uncovered interest-rate parity is violated, generating significant crypto carry premia.

Practitioner Insights

Managing Asymmetric Risk: Six Episodes in Crude Oil **58**
By Blu Putnam, Ph.D., Managing Director, Chief Economist, CME Group, U.S.A.; John Wiesner, Director, Options Solutions Financial Engineer, CME Group, U.S.A.; and Arthur Yu, Manager, Data Science & Economics, CME Group, U.S.A.

In their research, the authors use the crude oil market in a case study that introduces a method of assessing whether there is meaningful price-risk asymmetry reflected in options pricing. Specifically, they use CVOL, an implied volatility calculation from the CME Group, to look into whether there are important differences between the upside price risk reflected in out-of-the-money call options compared to the downside price risk reflected in out-of-the-money put options. The authors pay particular attention to how risk-management approaches might need to be adjusted when price-risk sentiment is significantly asymmetric.

Digital Assets Regulation in 2023: Is a New Regulatory Framework Finally Emerging? **69**
By Deanna Reitman, Of Counsel, DLA Piper, U.S.A. and Editorial Board Member, Commodity Insights Digest; Elizabeth S. M. Caires, Senior Attorney, DLA Piper, U.S.A.; Michael Mapp, Associate, DLA Piper, U.S.A.; Eric Forni, Partner, DLA Piper, U.S.A.; and Evan North, Of Counsel, DLA Piper, U.S.A.

The authors note that as the potential U.S. regulatory framework begins to take shape, participants in the space should prepare for significant change. To understand what may come next, these market participants can look to rules and regulations put in place by the U.S. Commodity Futures Trading
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Commission (CFTC) for participants in the swaps, options, and futures marketplaces. However, even if the CFTC does gain regulatory jurisdiction over digital assets through legislation, token issuers should be aware that the U.S. Securities and Exchange Commission will retain some authority due to case law and the Howey Test for investment contracts.

Managing the U.S. Strategic Petroleum Reserve in the Face of Uncertainty **75**
Based on testimony by Ilia Bouchouev, Ph.D., to a subcommittee of the U.S. House Committee on Oversight and Accountability, specifically the U.S. House Subcommittee on Economic Growth, Energy Policy, and Regulatory Affairs. Dr. Bouchouev is a Member of the Commodity Insights Digest Editorial Board.

The U.S. Strategic Petroleum Reserve (SPR), "the world's largest supply of emergency crude oil was established primarily to reduce the impact of disruptions in supplies of petroleum products and to carry out obligations of the United States under the international energy program," notes the U.S. Department of Energy. Dr. Ilia Bouchouev is an expert on the U.S. SPR, and as such provided testimony on March 8, 2023, regarding this topic to a subcommittee of the U.S. House Committee on Oversight and Accountability, specifically the U.S. House Subcommittee on Economic Growth, Energy Policy, and Regulatory Affairs. The *CID* is republishing Dr. Bouchouev's well-thought-out testimony.

Commodity Markets Begin to Price Carbon Risk **79**
By Peter Sainsbury, Founder, Carbon Risk, U.K.

The rise of carbon markets and the increased cost of compliance is forcing commodity markets to respond. The carbon risk facing commodity markets is acute, including (a) the emissions associated with the extraction, refining and combustion of fossil fuels, (b) the energy required to dig and process ore into metal, and (c) the risk of deforestation and high emissions associated with carbon intensive agriculture. In addition to the increased regulatory burden, companies are having to face up to much greater scrutiny as to the provenance and the emissions associated with their products. But as this *CID* article also demonstrates, the commodity industry is not sitting idly by. Companies across various commodity industries have a rich capacity to innovate in the face of these new and emerging pressures.

Interview

Interview with Julie Lerner, Founder and CEO, PanXchange **86**
Interview by Hilary Till, Managing Co-Editor, Commodity Insights Digest, Honorary Senior Visiting Fellow, Bayes Business School - City, University of London, U.K. and Principal, Chicago-based Premia Research LLC, U.S.A.

We are delighted to interview Julie Lerner, Founder and CEO of U.S.-based PanXchange, a web-based trading and price-discovery platform for physical commodities. Lerner is a regular contributor to media outlets such as the *Wall Street Journal*, the *Financial Times* and Bloomberg TV. She has also been endorsed as a Futures Industry Association
(Continued on the next page.)

Interview
(Continued)

Innovator. In addition, she has been recognized both in the Forbes 50>50 in Finance and in the *Denver Business Journal*'s most admired CEO's. In this interview we learn how her career evolved, and how PanXchange was founded.

Convenience Yield Risk

Marcel Prokopczuk, Ph.D.
Professor of Finance and Commodity Markets, School of Economics and Management, Leibniz University Hannover, Germany

Lazaros Symeonidis, Ph.D.
Senior Lecturer in Finance, Essex Business School, University of Essex, U.K.

Chardin Wese Simen, Ph.D.
Professor of Finance, Management School, University of Liverpool, U.K.

Robert Wichmann, Ph.D.
Senior Associate, UniCredit Bank AG, Germany

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In this paper, the authors develop a framework to quantify the convenience yield risk (CYR) inherent to each commodity futures market. Implementing our approach, we document that our novel CYR measure is informative about future commodity returns. In panel regressions, the CYR predicts future returns with a positive sign. Economically, a strategy that opens long positions in commodity markets with a higher than median CYR signal and sells the remaining commodities yields an average return of 6.93% per year. The performance of the CYR strategy cannot be explained by exposure to existing commodity strategies or other variables that capture changes in the investment opportunity set.

Introduction

The convenience yield, defined as the benefit that accrues to the holder of the physical commodity, plays a central role in commodity markets (Kaldor, 1939; Working, 1949; Brennan, 1958; Telser, 1958). Several studies in the extant literature have analyzed the information content of the convenience yield (*e.g.*, Gorton *et al.*, 2013). A common theme across these papers is that they focus on the level of the convenience yield. Naturally, one may wonder: what is the information content of the other moments of the convenience yield? In their paper, the authors focus on the second moment of the convenience yield and explore its information content.

The authors propose a simple, novel and model-free measure of convenience yield risk. For each of the 27 commodity markets, they compute the convenience yield implied by (i) the first and second nearby futures contracts as well as (ii) the second and third nearby futures contracts. At the end of each month, they use all daily data pertaining to the month to compute the monthly volatility of each of the two convenience yield series. Finally, they obtain the CYR signal as the trailing 12-month average of the difference between the monthly volatility estimates of the first and second convenience yield series.

This digest article was contributed by Lazaros Symeonidis, Ph.D., Associate Professor in Finance at the University of Essex (U.K.) and Associate Editor of the Journal of Commodity Markets.

The paper documents that the CYR is a highly significant predictor of commodity futures returns, even after controlling for several prominent commodity return predictors. To further explore the economic value of the predictive power of the CYR, the authors implement a simple trading strategy. At the end of each month, they sort all commodities by their CYR signal. They then open long and short positions in the commodities with a CYR signal higher and lower than the median CYR signal, respectively. The strategy generates a positive and significant annualized average return of 6.93% (t-stat = 3.24) and an annualized Sharpe ratio of 0.46. Further analysis reveals that the performance of the CYR strategy cannot be explained by exposure to existing commodity strategies or other variables that capture changes in the investment opportunity set. Moreover, the CYR strategy remains profitable after accounting for transaction costs.

Why is the Paper Research Agenda Important?

So far, research has extensively focused on the level of the convenience yield. However, the volatility of the convenience yield has not been explored yet. The authors fill this gap in the literature. Their results have important implications for various commodity market participants. First, it can help investors gain a better understanding of the drivers of commodity risk premia and thus build more profitable investment strategies. Second, it can motivate market participants to pay attention not only to the level of the convenience yield but also its volatility. The present study is also important for academics as it (i) adds to the literature that employs information from the term structure of commodity futures to build profitable trading strategies, and (ii) it contributes to the broader literature on commodity risk premia.

Summary of the Methodology

The authors start by computing the daily implied convenience yield using the cost-of-carry relationship. For the i^{th} and j^{th} nearby futures contracts, it holds that:

$$f_t^{(j)} = f_t^{(i)} + \left(rf_t^{(i,j)} - y_t^{(i,j)}\right)\frac{M_t^{(j)} - M_t^{(i)}}{365} \quad (1)$$

where $f_t^{(j)}$ and $f_t^{(i)}$ are the logarithmic prices of the j^{th} and i^{th} nearby futures contracts on day t (with $j > i$), respectively. $rf_t^{(i,j)}$ is the annualized risk-free rate on day t for the period starting at i and ending at j. $y_t^{(i,j)}$ is the annualized convenience yield on day t referring to the period between the expiration dates of the i^{th} and j^{th} futures contracts. $M_t^{(j)}$ and $M_t^{(i)}$ are the days to expiry of the above futures contracts ($M_t^{(j)} > M_t^{(i)}$). The authors then compute the convenience yield by rearranging Equation (1). This methodology is deliberately non-parametric as opposed to approaches which model convenience yield as a continuous-time stochastic process.

The next step is to compute the monthly volatility of the convenience yield as follows:

$$\sigma_t\left(y^{(i,j)}\right) = \sqrt{\frac{1}{N_t - 1}\sum_{\tau=1}^{N_t}\left(y_\tau^{(i,j)} - \overline{y_\tau^{(i,j)}}\right)^2} \tag{2}$$

where $\sigma_t\left(y^{(i,j)}\right)$ denotes the month *t* volatility of the convenience yield associated with nearby contracts i and j, respectively. N_t is the number of daily observations in month t, $y_\tau^{(i,j)}$ is the convenience yield on day τ of month t for the pair of nearby contracts i and j, and $\overline{y_\tau^{(i,j)}}$ is the average of $y^{(i,j)}$ during month t. The *convenience yield risk* (CYR) is then defined as follows:

$$CYR_t = \frac{1}{12}\sum_{i=1}^{12}\left[\sigma_{t-i}\left(y^{(1,2)}\right) - \sigma_{t-i}\left(y^{(2,3)}\right)\right] \tag{3}$$

where CYR_t is the convenience yield risk at time t. $\sigma_{t-i}\left(y^{(1,2)}\right)$ and $\sigma_{t-i}\left(y^{(2,3)}\right)$ are the monthly volatilities of the first and second nearest convenience yields of month $t - i$, respectively.

Several factors motivate the computation of the CYR. First, the computation of the monthly volatility of the convenience yield (see Equation (2)) captures the monthly time-variation in the convenience yield. Second, the difference between the monthly volatility of the first two convenience yield series aims to remove any market-specific effect. This approach is akin to that of Gu *et al*. (2019). Third, the use of a 12-month measurement period was used to (i) address the issue of seasonality in both the level and volatility of the convenience yield series and (ii) alleviate concerns about measurement errors. The use of a 12-month trailing window is consistent with the standard formation period used in benchmark trading strategies (Moskowitz *et al.*, 2012; Boons and Prado, 2019). Fourth, the proposed CYR measure in Equation (3) relies on data pertaining to the first three nearest futures contracts, which are typically the most liquid ones.

Key Results

The authors consider daily price and trading volume data on 27 commodity markets spanning six sectors: energy, grains, livestock, metals, oilseeds, and softs. The period considered is July 7, 1959, to December 31, 2018. To explore the predictive ability of the CYR for excess commodity futures returns, the authors estimate a predictive panel regression using several established predictors of commodity returns as controls, such as the basis, momentum (Miffre and Rallis, 2007), basis-momentum (Boons and Prado, 2019), skewness (Fernandez-Perez *et al*., 2018), among others. The CYR predicts future commodity returns with a positive sign and a highly significant t-statistic.

To shed further light on the economic significance of documented predictability, the authors implement a simple trading strategy. At the end of each month, they sort the 27 commodities on their CYR signal and then build a "High" portfolio containing all commodities with a CYR above the median and a "Low"

portfolio containing the remaining commodities. They then compute the equal-weighted return of the "High-Low" portfolio for the month ahead as the difference between the 1-month returns of the "High" and "Low" portfolios. The above steps are repeated each month. The CYR strategy generates a significant annualized average return of about 7%, and a Sharpe ratio of 0.46 as shown in Table 1.

Table 1
Performance of the Convenience Yield Risk (CYR) Strategy

	High	Low	High–Low
Av. Return	7.11	0.19	6.93
(t-stat)	(3.31)	(0.23)	(3.40)
Sharpe Ratio	0.46	0.01	0.46

Notes: This table reports the average return of the CYR strategy (and its components). We report in parentheses the Newey and West (1987) standard errors (computed using 6 lags). The last row presents the annualized Sharpe ratio for portfolios sorted on convenience yield risk. We sort the 27 commodities by their CYR at the end of each month and form a "High" portfolio containing the commodities associated with a CYR greater than the median CYR and a "Low" portfolio containing the remaining commodities. We also report the average return on the "High-Low" spread portfolio. The commodities in each portfolio are equally-weighted. The sample period is from July 1959 to December 2018.

Importantly, the CYR strategy has low correlation with other commodity strategies, such as carry, momentum, basis-momentum, relative basis, and skewness, providing good diversification opportunities. The authors perform spanning tests to further explore whether the return of the CYR strategy can be explained by exposure to established commodity risk factors. All regressions yield positive and significant alphas (intercepts), meaning that the CYR strategy cannot be explained by passive exposure to other commodity strategies (see Table 2 on the next page).

Moreover, the authors examine the potential link between the CYR and a broad range of macroeconomic variables that capture changes in the investment opportunity set. The performance of the CYR strategy cannot be explained by any of these variables. The authors perform additional checks to assess the robustness of their findings. They show that the CYR strategy remains profitable when (i) rank- instead of equal-weights are employed, when (ii) alternative formation periods are considered for the computation of the trading signal, and (iii) a delay of one month is introduced between the computation of the trading signal and the implementation of the strategy. Also, the performance of the CYR strategy is robust to transaction costs and is stronger during volatile periods.

Table 2
Spanning Regressions

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
α	6.68	6.27	6.37	5.04	6.92	6.91	6.69	6.93	7.71	7.76	4.60	6.46
	(3.40)	(2.86)	(3.24)	(2.21)	(3.26)	(3.26)	(3.02)	(3.09)	(3.20)	(3.18)	(2.09)	(2.87)
MRKT	0.07										0.05	0.01
	(0.74)										(0.53)	(0.16)
BAS		0.09									0.06	0.16
		(1.58)									(0.92)	(2.01)
MOM			0.06								0.00	-0.01
			(0.87)								(0.00)	(-0.11)
BASMOM				0.13							0.11	-0.03
				(2.12)							(1.51)	(-0.31)
IVOL					0.01						-0.17	-2.05
					(0.36)						(-0.32)	(-2.11)
TVOL						0.01					0.18	2.13
						(0.39)					(0.34)	(2.26)
SKEW							0.03				0.03	0.16
							(0.75)				(0.72)	(2.71)
RELBAS								0.00			-0.04	-0.08
								(0.03)			(-0.57)	(-0.88)
SP									-0.02			0.02
									(-0.35)			(0.20)
HP										-0.02		-0.01
										(-0.47)		(-0.09)
R^2	0.00	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04
Obs	713	713	713	713	713	713	713	713	395	395	713	395

Notes: This table reports the results from spanning regressions of the CYR strategy returns on the returns of an equally-weighted commodity market portfolio (MRKT), and the returns of the strategies based on the basis (BAS), momentum (MOM), basis-momentum (BASMOM), idiosyncratic volatility (IVOL), total volatility (TVOL), skewness (SKEW), relative basis (RELBAS), speculative pressure (SP), and hedging pressure (HP), respectively. The sample covers the period from July 1959 to December 2018. Returns are annualized and expressed in percentage points. t-statistics using Newey and West (1987) standard errors (using 6 lags) are reported in parentheses below the estimated coefficients.

Conclusions

In this paper, the authors quantify the convenience yield risk associated with individual commodity markets. They analyze the information content of the convenience yield risk for future returns. The convenience yield risk predicts future commodity returns with a positive and statistically significant coefficient. The authors implement a simple trading strategy to shed light on the economic value of the predictability. This strategy delivers a significant annualized average return of 6.93% and an annualized Sharpe ratio close of 0.46. Pursuing the analysis, they find that existing commodity factors, e.g., carry, momentum, and basis-momentum, and prominent macroeconomic variables do not fully explain the performance of the convenience yield risk strategy. Moreover, the profitability of the strategy is robust to transaction costs and survives a battery of robustness checks.

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Keywords

Commodity risk factors, convenience yield, futures curve, return predictability.

Author Biographies

MARCEL PROKOPCZUK, Ph.D.
Professor of Finance and Commodity Markets, School of Economics and Management, Leibniz University Hannover, Germany

Dr. Prokopczuk is a Professor of Finance and Commodity Markets at Leibniz University Hannover. His research interests are asset pricing, commodity markets, risk management, derivatives, and household finance. He is a founding editor of the *Journal of Commodity Markets*. His research has been published in world-leading journals, such as the *Review of Economic Studies*, *Management Science*, *Journal of Financial and Quantitative Analysis*, and the *Review of Asset Pricing Studies*. He has received funding for his research from the German Research Foundation and the British Academy and is a regular speaker at top-level conferences.

LAZAROS SYMEONIDIS, Ph.D.
Essex Business School, University of Essex, U.K.

Dr. Lazaros Symeonidis is a Senior Lecturer in Finance at Essex Business School, University of Essex. His research interests lie in the areas of financial econometrics, asset pricing, and commodities. His work has been published in internationally

recognized academic journals, such as the *Journal of Financial Markets*, *Journal of Banking & Finance*, *Journal of International Money and Finance*, *Journal of Futures Markets*, and the *Energy Journal*. His research has attracted funding from the British Academy and the ESCP. Professor Symeonidis is an associate editor in the *Journal of Commodity Markets*. He also regularly acts as reviewer for several peer-reviewed academic journals.

CHARDIN WESE SIMEN, Ph.D.
Management School, University of Liverpool, U.K.

Dr. Wese Simen is a Professor of Finance at the Liverpool University Management School. His main research interests include asset pricing, commodity markets, derivatives, and financial econometrics. Professor Wese Simen has published his research in world-leading journals, including the *Journal of Econometrics*, the *Journal of Financial and Quantitative Analysis*, *Management Science*, and the *Journal of Money, Credit and Banking*. His research has attracted awards and funding from national and international institutions, including the British Academy. He has presented his research at several U.K. and international universities, as well as leading academic conferences, such as the meetings of the American Finance Association (AFA) and the Western Finance Association (WFA). He is a member of the editorial boards of the *European Journal of Finance* and the *Journal of Commodity Markets* and regularly serves as a reviewer for leading journals.

ROBERT WICHMANN, Ph.D.
Senior Associate, UniCredit Bank AG, Germany

Robert Wichmann is a Senior Associate at UniCredit Bank AG. He is part of the Financial Risk Methodologies & Infrastructure Team in Munich (Germany) as well as the Market Data & Valuation Team (Equity & Commodity) in Milan (Italy). He was awarded his Ph.D. in 2020 under the supervision of Professors Chardin Wese Simen and Marcel Prokopczuk, focusing on Empirical Asset Pricing in Commodity Markets. His research has been published in the *Energy Journal*, *Journal of Futures Markets*, and *Energy Economics*.

Prime Money Market Funds Regulation, Global Liquidity, and the Crude Oil Market

Miruna-Daniela Ivan, Ph.D.
Policy Analyst in the Financial Stability Strategy and Risk Directorate, Bank of England, U.K.

Chiara Banti, Ph.D.
Associate Professor of Finance, Essex Business School, University of Essex, U.K.

Neil Kellard, Ph.D.
Professor of Finance, Essex Business School, University of Essex, U.K.

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This paper explores how the 2016 U.S. Prime Money Market Funds (PMMFs) regulation affected the crude oil market. This reform led to an increase in short-term dollar borrowing costs and the oil sector became particularly susceptible to disruptions in the global funding market due to a post-financial crisis debt expansion which far outpaced other commodity industries. Building on the global crude oil market SVAR model pioneered by Kilian and Murphy (2014), we find that tighter PMMFs funding conditions have a lagged negative effect on the real price of crude oil and a lagged positive effect on oil production. We show that these responses are driven primarily by a fall in certificates of deposits issued by global banks. Lastly, we evidence that the U.S. nominal effective exchange rate acts as a transmission channel for the negative funding shock to the real price of oil.

Introduction

U.S. Prime Money Market Funds, hereafter PMMFs, are a primary funding source of short-term liquidity, offering financial institutions and non-financial corporations access to wholesale U.S. dollar funding. Given that the U.S. dollar is the foremost funding and investment currency in the international monetary and financial system, the resilience of global economic and financial activity is conditional on the continuous flow of U.S. dollar funding (CGFS, 2020). Consequently, the vital role played by PMMFs in global dollar funding provision during crisis episodes such as the 2007–2009 Global Financial Crisis (GFC), the Eurozone crisis, and the March 2020 "dash-for-cash," has positioned PMMFs at the center of international policy debate (IMF, 2021).

In 2016, a set of regulatory reforms for PMMFs were introduced to address the vulnerabilities which emerged during the GFC. These regulatory reforms represented an important shift in the intermediation of wholesale bank funding as they increased short-term dollar borrowing costs (BIS, 2016). Oil companies are particularly susceptible to sudden disruptions in the global dollar funding market, given the post-GFC debt expansion in the oil sector, which far outpaced other commodity sectors (Domanski *et al*., 2015). Specifically, following the GFC, oil companies have borrowed heavily in U.S. dollars from banks as well as in international bond markets.

In this respect, the authors propose two channels through which disruptions in the short-term funding of PMMFs can be transmitted to oil companies which borrow in U.S. dollars: an indirect channel through cross-border bank flows based on the cross-border bank lending model of Bruno and Shin (2015), and a direct channel through PMMFs. The latter channel suggests that disruption in the short-term wholesale

funding, driven by the reforms, affects oil companies which borrow directly from PMMFs by issuing commercial papers.

Relevance of the Research Question

The relevance of this paper to the global economic outlook lies in the persistent vulnerabilities posed by PMMFs (*i.e.*, via liquidity mismatch). These vulnerabilities are a significant source of risk to global financial stability, and hence, a major source of concern for policymakers. For example, deteriorating global dollar funding conditions, during the acute Covid-related stress period of March 2020, were driven by runs on PMMFs. This episode represents a further reminder of the high reliance of global banks and corporations on the short-term unsecured funding of PMMFs.

Moreover, this is the first study to show that global liquidity matters for the crude oil spot market. In particular, the authors show that strains on U.S. dollar funding from PMMFs affect the price and global production of crude oil. Through the empirical approach employed, they capture not only major disruptions from the introduction of the 2016 regulatory reforms, but also other funding shocks.

This paper contributes to the extant literature on global liquidity and the crude oil market, by introducing novel measures capturing the short-term component of private global liquidity, namely, the U.S. PMMFs investment holdings by global issuance, and by instrument. Through these global liquidity proxies, the authors are able to capture the post-GFC shift in U.S. dollar funding intermediation, referred in the literature as "the second phase of global liquidity." Specifically, post-GFC, global dollar funding intermediation in advanced economies has moved away from the traditional deposit-based funding towards international debt securities, and non-bank financial institutions have increased their dominance in driving global liquidity (Shin, 2014; Turner, 2014; Aldasoro and Ehlers, 2018; Avdjiev *et al*., 2020).

Further, the paper explores the effect of global liquidity movements on crude oil prices, channeled through the activity of oil companies rather than the activity of financial investors and commodity consumers, which has been the focus of other empirical studies on the oil market (Ratti and Vespignani, 2013; Beckmann *et al*., 2014, among others).

Data and Methodology

The empirical analysis builds on Kilian and Murphy's (2014) pioneering global crude oil market structural VAR (SVAR) model. Structural shocks are identified using Uhlig's (2005) pure-sign restriction approach. Notably, sign restrictions have become increasingly popular in the empirical literature that explores oil markets (Baumeister and Peersman, 2013a, 2013b; Kilian and Murphy, 2012, 2014).

The authors use monthly data for global crude oil production, global real economic activity, global crude oil inventories and the real price of crude oil, variables employed by Kilian and Murphy (2014), to which they add two novel global liquidity measures: PMMFs investment holdings by global issuance, and by instrument. Certificates of deposits and commercial paper are investment instruments held by PMMFs and introduced in the model to capture the two proposed transmission channels of PMMFs funding shocks

to oil companies. Notably, certificates of deposits became the most important unsecured wholesale funding source for banks following the GFC, and a barometer for bank funding conditions (Eren *et al*., 2020), while commercial paper represents the primary financing source used to balance short-term liquidity requirements by major oil companies.

The price of crude oil can be exposed to fluctuations in the value of the U.S. dollar via oil supply, oil demand and financial markets (Breitenfellner and Cuaresma, 2008). The authors account for an appreciation in the value of the U.S. dollar against other major currencies driven by lower dollar supply from U.S. PMMFs, by employing the U.S. nominal effective exchange rate in their modeling approach.

Main Results

This study shows that tighter U.S. dollar funding conditions, driven by the 2016 regulatory reform for U.S. PMMFs, have an impact on the crude oil market. The authors find compelling evidence of a lagged negative effect of tighter funding conditions on the real crude oil spot price, measured by the U.S. refiners' acquisition cost for imported crude oil, and of a lagged positive effect on oil production. Furthermore, the paper finds that the effect of PMMFs funding disruption on the crude oil market is driven by a fall in certificates of deposits. This highlights the importance of cross-border bank flows in the transmission of liquidity shocks to the crude oil market.

Their empirical results confirm the theoretical predictions of Domanski *et al*. (2015) who argue that, in response to higher short-term dollar funding costs, oil producers seek to increase their output levels to raise short-term cash flow. Sustaining the continuity of short-term cash flows is needed for oil producers to meet obligations and to avoid suppressing market demand in the long run.

Lastly, the authors show that the U.S. nominal effective exchange rate acts as a complementary transmission channel of PMMFs funding disruptions to oil companies – an appreciation of U.S. dollar driven by lower U.S. dollar supply coming from PMMFs, leads to a decline in the real crude oil price via oil production, oil demand and the hedging activity of oil producers.

Conclusions

PMMFs represent a vital source of U.S. dollar funding for non-U.S. financial institutions and non-financial corporations, especially during crisis episodes. In 2016, regulatory reforms for U.S. PMMFs introduced to address the vulnerabilities which emerged during the GFC, have led to higher short-term U.S. dollar borrowing costs. The post-GFC expansion of debt in the oil sector made oil companies particularly vulnerable to sudden disruptions in short-term dollar funding markets.

Augmenting the global crude oil market model of Kilian and Murphy (2014), this study is the first to show that tighter short-term U.S. dollar funding conditions driven by the 2016 U.S. PMMFs reforms affect the crude oil market. The authors find that following a negative funding shock, oil production increases and in turn, the real price of oil declines. The authors suggest that the positive response of the oil production to tighter short-term U.S. dollar funding conditions can be explained by oil companies increasing output

levels to raise short-term cash flows, which enable them to remain liquid and meet dividend payments or to stabilize the purchasing power value of their export revenues in dollars.

Further, the paper finds that the effect of the PMMFs funding disruption on the crude oil market is driven by a fall in certificates of deposits, which constitute the most important unsecured wholesale funding for global banks. Hence, the U.S. dollar funding disruption triggered by the PMMFs reform is transmitted indirectly from PMMFs to oil companies, through cross-border bank flows.

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Prime money market funds, global liquidity, the real crude oil price, sign-identified structural VAR models, cross-border flows.

Author Biographies

MIRUNA-DANIELA IVAN, Ph.D.
Policy Analyst in the Financial Stability Strategy and Risk Directorate, Bank of England, U.K.

Dr. Miruna-Daniela Ivan is a Policy Analyst in the Financial Stability Strategy and Risk Directorate at the Bank of England. Her research explores the links between commodity markets, monetary policy, liquidity, and non-bank financial institutions. Her articles have been published in the *Journal of International Money and Finance* and in *Studies in Higher Education*.

CHIARA BANTI, Ph.D.
Associate Professor of Finance, Essex Business School, University of Essex, U.K.

Dr. Chiara Banti is an Associate Professor of Finance at Essex Business School, University of Essex, and a Fellow of the Emerging Markets Group at Bayes Business School (formerly Cass). Her research is in the fields of international finance and FX market microstructure, and she studies the implications of the global movement of large pools of liquidity on recipient economies, in terms of their credit, currency and financial market dynamics and development. Her work has been published in the *Journal of International Money and Finance*, *Journal of Financial Stability*, and *Journal of Financial Research*, among others.

NEIL KELLARD, Ph.D.
Professor of Finance, Essex Business School, University of Essex, U.K.

Dr. Neil Kellard is a Professor of Finance at Essex Business School, University of Essex and also an Academic Fellow at Centre for Responsible Banking and Finance, University of St Andrews. His research examines the linkages between commodity prices, environmental finance, regulation, efficiency, risk measurement, health, and inequality. Professor Kellard's articles have been published in the *Review of Economics and Statistics*, the *British Journal of Management*, *Social Science and Medicine*, *Journal of International Money and Finance*, the *Journal of Development Economics*, the *European Journal of Finance*, the *Journal of Empirical Finance*, and the *Journal of Futures Markets*, among others.

Revisiting The Silver Crisis

Don Bredin, Ph.D.
Full Professor of Finance, University College Dublin, Ireland

Enrique Salvador, Ph.D.
Associate Professor in Accounting and Finance, Universitat Jaume I, Spain

Valerio Potì, Ph.D.
Professor of Finance, University College Dublin, Ireland

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In August 1988, the Hunt Brothers were found guilty by a jury of conspiracy, manipulation, monopolization, racketeering and fraud. Using a behavioral model, we aim to quantify the extent of manipulation in the silver market during the 1970s and the 1980s, with a specific focus on the period leading up to the Silver Crisis. Our behavioral model takes account of the role of fundamentals, manipulation and speculation. Our results indicate very little evidence of manipulation in the silver market in the run up to the Silver Crisis. Both fundamentals and speculation dominate the silver market during our sample, with speculation particularly important in the latter half of the 1970s.

Introduction

Our aim in this study is to quantify the extent of manipulation in the silver market, with a specific focus on the period leading up to the Silver Crisis, where prices rose from $8 (per troy ounce) to highs of $50 on January 21, 1980 (see Williams, 1995). The Hunt Brothers were found guilty, along with a number of their associates, of manipulating the price of silver during late 1979 and into early 1980.[1] In addition to our quantification of manipulation versus speculation, we also address whether the manipulation was an isolated incident or whether manipulation became pervasive into the 1980s. In order to quantify the role of manipulation in the silver market, we examine the role of a combined set of actors or investors, using a behavioral finance model.[2]

We distinguish between long-term investors, namely those focusing on fundamentals, and short-term investors. We focus on two types of short-term investors, Speculators and Manipulators. Both Speculators and Manipulators have a short-term investment horizon, however the Speculators act rationally, while the Manipulators take a contrarian position. We also examine the case of agents that are only interested in long-run fundamentals (Fundamentalists). Rather than examining each case separately, we simultaneously combine all three agents in relation to silver price movements.

Our results provide consistent evidence that the price of silver was not driven by manipulation in the latter half of the 1970s, the early 1980s or at any point during our 1970/1980 sample. While Manipulators were present, their role in influencing silver prices was small and was always less than that played by Speculators. During the 1970s and the subsequent Silver Crisis, we find that speculation played a dominant role, relative to manipulation, in the determination of silver prices. Our results indicate that

peak speculative activity occurred in 1978 and 1979, in advance of the period price highs (January 21, 1980 - $50). Our results also emphasize the role of speculation during the mid-to-late 1970s and the limited role of manipulative activity during this particular period.

Hypothesis Test

We examine the dominance of manipulation during the second half of the 1970s into the early 1980s and across our overall 1970/1980s sample. We examine whether manipulation dominated, as would be consistent given the trial outcome, during the Silver Crisis. Using our behavioral model, we can formally determine the dominance of rational focused agents (Speculators and Fundamentalists) versus irrational agents (Manipulators).

Hypothesis 1: Manipulation was the dominant strategy in advance and during the Silver Crisis

H1a: Manipulators dominated the combined role played by Fundamentalists and Speculators

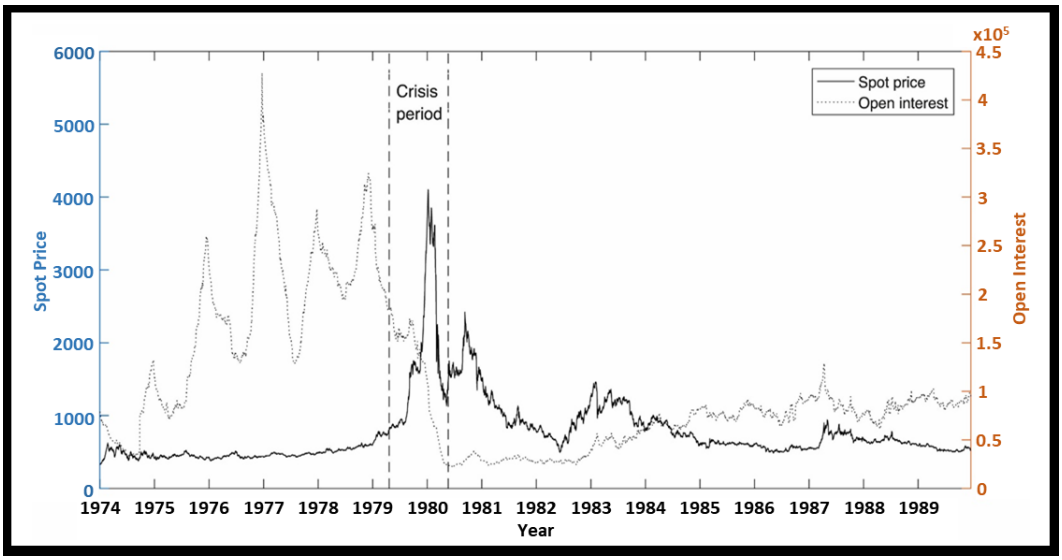
Behavioral Model and Data

In order to quantify the role of manipulation in the silver market, we examine the role of a combined set of actors or investors, using a behavioral finance model.[3] We distinguish between long-term investors, namely those focusing on fundamentals, and short-term investors. We focus on two types of short-term investors, Speculators and Manipulators. We consider the case of short-term investors operating on legitimate grounds, who attempt to benefit from price changes (Speculators) and those that actively engage in pushing prices away from their fundamental value (Manipulators). Gorton and Rouwenhorst (2006) have highlighted that commodity futures allow producers to hedge their exposure to uncertain price movements in the future. In return for providing this insurance, the investors (or Speculators) in commodity futures are paid compensation for bearing this risk. This transfer of risk from producers to Speculators reflects the socially beneficial role being played by Speculators. However, with Manipulators pushing prices away from their fundamental value, prices do not reflect the proper information signal to consumers and producers. We also examine the case of agents that are only interested in long-run fundamentals (Fundamentalists). Rather than examining each case separately, we simultaneously combine all three agents in relation to silver price movements.

Our study examines the market for silver during the 1970s and the 1980s. The market prices for silver trading on the COMEX exchange, with delivery months in January, February, March, April, May, July, September, and December are considered. Data is monthly and sourced via the Commodity Research Bureau (CRB), which in turn is now owned by Barchart.[4] The proxy for the spot price (Pt) is the spot (front month) futures contract, *i.e.*, the contract expiring in month *t*. The proxy for the futures price (Ft) will then be the next-to-expire futures contract. Thus, the spot and futures prices represent the exact same good and the time intervals between the two delivery dates is known. Silver prices (solid line) and open interest (broken line), representing gross positions, are reported in Figure 1 on the next page. The Silver Crisis period is defined as May 1979 to April 1980. The figure clearly displays a distinct difference in open

interest in the 1970s versus the 1980s. The series of spikes in open interest are large and peak prior to 1979, with a considerable stabilization occurring from 1981 onward.

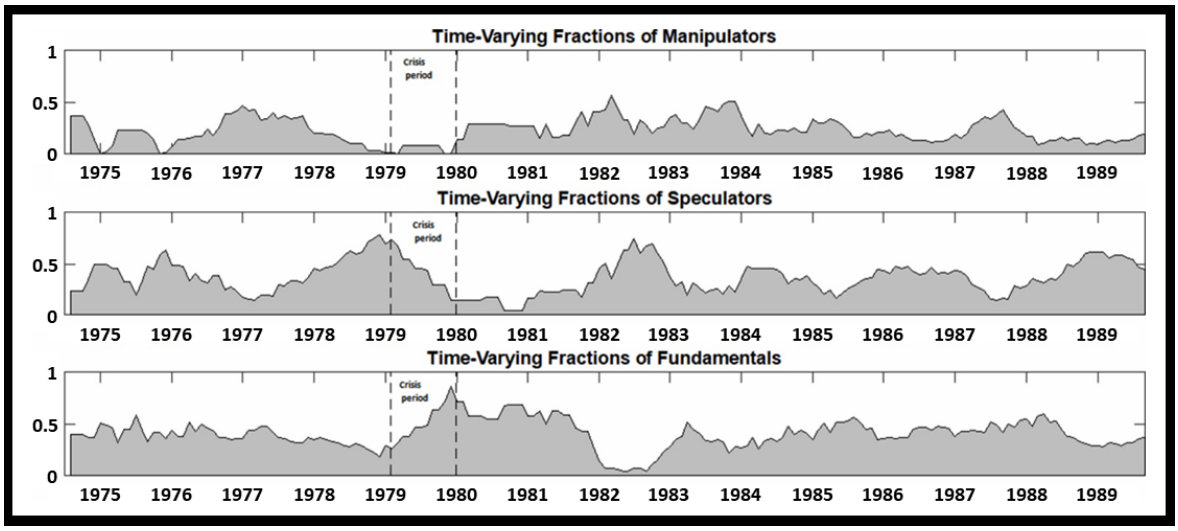
Figure 1



Results

The results presented in Figure 2 indicate a significant and consistent role for both speculation and fundamentals. Our graphical results are very much at odds with the trial outcome, but perfectly consistent within the narrative of the relatively limited literature on the Silver Crisis.[5] A steady rise in speculation is observed during the second half of the 1970s. During this period, levels associated with manipulation declined and were certainly always dominated by both speculation and fundamentals.

Figure 2



To shed further light on this, we formally test our hypothesis that Manipulators dominates the combined role of Speculators and Fundamentalists. We test our hypothesis on the full sample of data, as well as a series of sub-samples including the Silver Crisis and both the pre and post crisis. Table 1 reports consistent evidence that the share associated with Manipulators does not dominate the combined role of Speculators and Fundamentalists. Importantly this includes an analysis for both the crisis and the pre-crisis, as well as the post crisis 1980s. Irrespective of the chosen sample, we consistently reject the hypothesis that Manipulators dominate the combined role of Speculators and Fundamentalists.

Table 1
Test Equality Means for Different Subsample Periods

Statistic	Period Pre-	May 1979-	Period Post-	Full sample excluding	Full sample
(p-value)	May 1979	April 1980	April 1980	May 1979–April 1980	
H_{1a} : $\mu_M >$ $\mu_{F\&S}$	−22.3148**	−47.9984**	−36.7307**	−42.2852**	−43.7268**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

The distinction between manipulation and speculation, in terms of risk sharing and rationality, is key from an academic perspective, but more importantly from a policy and regulatory point of view. Our behavioral model provides very consistent evidence of the small role being played by manipulation during the Silver Crisis. As can be seen from Figure 2, a far greater role is being played by speculators from the mid-1970s.

Conclusions

Using a behavioral finance model, and for the first time (to the best of our knowledge), we formally examine the role of manipulation in the silver market, including the Silver Crisis period. We distinguish between long-term investors, namely those focusing on fundamentals, and short-term investors. Our specification of short-term investors, Speculators and Manipulators, are most relevant for the Silver Crisis period. In particular, Speculators in our behavioral model act in a fully rational manner and make no attempt to push prices away from their fundamental value.

On the contrary, Manipulators behave in an irrational manner and actively engage in pushing prices away from their fundamental value. Besides being consistent with economic theory, our interpretation of Speculators and Manipulators in our behavior model is very much in the spirit of the discussions during the course of the Hunt trial. Our results provide consistent evidence that the price of silver was not driven by manipulation in the latter half of the 1970s, the early 1980s or at any point during our 1970/1980 sample. While we do find evidence of the presence of Manipulators, their role in the run-up and during the Silver Crisis was small.

How relevant is the Silver Crisis of over 40 years ago? We would argue extremely relevant. The flood of funds into commodities, via commodity futures, which has been referred to as the financialization of commodities, is the primary reason. What happens in commodity markets is critical for the stability of our financial system. The financialization process represents a structural change in commodity market participation and, combined with the price increase during the commodity super cycle, leads to concerns over the potential role of speculation and manipulation.

Endnotes

Professor Potì presented on this topic at the Annual Meeting of the Commodity & Energy Markets Association (CEMA) on June 21, 2022 in Chicago.

1 Williams (1995) provides a detailed and forensic account of the trial and the approaches adopted by both the plaintiff and the defense.

2 See Pirrong (2017) for an excellent recent survey of manipulation in commodity markets.

3 The behavioral model is described in detail in Bredin *et al*. (2018). An application to food price movements is further developed in Bredin *et al*. (2022).

4 See Barchart (2019).

5 For example, Williams (1995) indicates that the "... lack of any identification of the Hunts' alleged manipulation profoundly affected the trial, especially the experts' testimony" (see page 96). For such a noteworthy event, the extent of the academic literature addressing the Silver Crisis is quite limited and as far as the authors are aware, there is no formal empirical identification of manipulation for the Silver Crisis in the literature. In his survey, Pirrong (2017) raises doubts on the existence of manipulation, and Kleit (2018) draws similar conclusions.

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Author Biographies

DON BREDIN, Ph.D.
Full Professor of Finance, University College Dublin, Ireland

Dr. Don Bredin is a Full Professor of Finance at the UCD College of Business as well as the College of Business Associate Dean International (Vice Principal for Internationalization and Global Engagement). His main research interests are in the economics and finance of commodities.

ENRIQUE SALVADOR, Ph.D.
Associate Professor in Accounting and Finance, Universitat Jaume I, Spain

Dr. Enrique Salvador is an Associate Professor in Accounting and Finance, Universitat Jaume I. He obtained an M.Sc. in Banking and Quantitative Finance from an inter-university programme organized by University of Valencia, University of Basque Country, University Castilla-la-Mancha and University Complutense Madrid with distinction (2009) and a Ph.D. in Finance (2012) from University of Valencia. His main research interests are in asset pricing, hedging strategies, risk management and financial Econometrics.

VALERIO POTÌ, Ph.D.
Professor of Finance, University College Dublin, Ireland

Dr. Valerio Potì is a Professor of Finance in the Business School of University College Dublin, where he is the Director of the UCD Smurfit Centre for Doctoral Research. He is also a Visiting Professor of Econometrics in the University of Bari in Italy. His research interests include asset pricing, performance attribution, market efficiency, behavioral finance, financial econometrics, corporate finance and small-to-medium-sized-enterprise (SME) financing and, more recently, digital finance and financial data science.

Commodity Premiums Under Financialization

Loïc Maréchal, Ph.D.
Research Fellow, HEC Lausanne (University of Lausanne) - Cyber-Defence Campus, armasuisse Science and Technology, Switzerland

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This paper examines the effects of financialization on commodity markets in terms of pricing. It investigates whether commodity index traders affect weekly returns and turnover during roll periods and the effect of commodity index traders' market share on returns. Risk adjustments are tested to see if they alter liquidity and insurance premiums and how financialization affects liquidity and insurance premiums. Finally, an alternative method is used to test how liquidity and insurance premiums determine commodity returns.

Introduction

This paper aims to check the robustness of two risk premiums in commodity returns identified by Kang, Rouwenhorst, and Tang (2020, hereafter KRT) under different scenarios, considering the influence of commodity index traders (CITs). It is hypothesized that these investors reduce the insurance premium and increase the liquidity premium on nearby contracts. The net effect of CITs on contract demand is similar to that of processors and users, but the causes of this demand differ.

Testing for risk premiums in commodity futures markets is a long-standing challenge due to the small number of contracts available, their heterogeneity, lack of integration with traditional asset classes, and the lack of (readily available) spot prices. Theoretically, Black (1976) denies the existence of a commodity risk premium, and the empirical literature largely supports this view when additional commodity market peculiarities are not controlled properly. There is weak evidence concerning a significant risk premium, and empirical tests based on characteristics such as "normal backwardation" or storage do not provide convincing results. However, characteristics underlying risk premiums could be used as control variables in the setting of KRT, in which control for potential confounding effects is not fully examined.

The comprehensive paper studies the effects of financialization on commodity premiums. With a Bayesian asset pricing method, the paper selects an optimal subset among several factors known to predict commodity futures returns and construct portfolios based on these factors. Next, the paper studies the impact of days during which CITs roll their positions from the nearby to the first deferred contract on commodity returns and turnover. Those roll days are associated with a significant increase in turnover. The paper then replicates the KRT analysis of the relationship between insurance and liquidity premiums and commodity returns and finds that these premiums are robust to the inclusion of additional variables related to financialization.

Data and Methodology

The daily closing prices of 26 commodity futures nearby and first deferred contracts, among which 18 are S&P GSCI components, are downloaded from Thomson Reuters. The sample starts in January 1994 and ends in January 2020. The study computes the Tuesday-to-Tuesday weekly arithmetic excess returns for each maturity. To mitigate the effect of thinly traded contracts as they approach maturity, the study follows KRT. The study defines the nearby contract as the actual nearby for the weeks ending with a Tuesday before the seventh calendar day of the month. The study also defines the nearby contract as the first deferred if it matures in the current month and if the return calculation's week-ending day is on a Tuesday on or after the seventh day of the month. All contracts are under U.S. Commodity Futures Trading Commission (CFTC) supervision. The CFTC releases the Commitments of Traders' weekly report (COT) on Fridays with data as of the previous Tuesday; U.S. holidays may delay the release by a day or two. The COT includes the long and short positions of the "commercials" and the long, short, and spreading positions of the "non-commercials" categories for every U.S. futures contract.

In 2006, the CFTC revised the compositions of these groups and added the "disaggregated" COT report (DCOT), which splits "commercials" and "non-commercials" trades into "Producer / Merchant / Processor / User," "Money managers," "Swap dealers," and "Other reportables." From the CFTC, the following three contract characteristics are computed: (i) the net trading of the "commercials" category (intensity with which commercials provide short-term liquidity), (ii) the average hedging pressure (demand for insurance), (iii) the "crowding" (intensity with which speculators are involved). Next, the paper computes the following four characteristics: (i) the basis, (ii) the momentum, (iii) the β, and (iv) the basis-momentum (see Boons and Prado, 2019).

The study computes the weekly returns of several portfolios. It uses eight defined characteristics and sorts the portfolios into five quantiles based on those characteristics. The study uses the Bayesian approach of Barillas and Shanken (2018) to determine the optimal set of factors. The likelihood ratio of the unrestricted and restricted time series regressions is used to determine the marginal contribution of the factors. The study uses relative and absolute tests, leaving out factors related to liquidity and insurance from the selection process.

The paper uses dummy variables to capture the individual effects of five S&P GSCI roll days on 18 contracts. The dummy variables are set to 1 when the contract includes a particular roll day and 0 otherwise. The effects of the roll days on the factors are determined by regressing the return on each factor on five dummy variables set to 1 when the factor includes a roll day. These regressions allow controlling for systematic roll-day effects on the factors without making assumptions about whether individual contracts experience a roll.

To make the results easy to compare with KRT, the study uses Fama-MacBeth regressions to replicate and extend the tests on the forecasting power of liquidity and insurance characteristics. The study uses cross-sectional estimation on week t and includes variables for returns on the nearby contract, insurance and liquidity characteristics of the contract, pressure from index investment, and controls for risk. Alternatively, the study includes the factors selected in the previous section. These regressions enable

comparing these results with those of KRT and further test the forecasting power of liquidity and insurance characteristics.

Factor Performance

The annualized weekly returns of the quantile (equally weighted) portfolios are constructed from eight characteristics. Five of eight portfolio sorts show a monotonic increase in returns across quintiles. The long-short portfolio sorted on the rolling Beta alone does not deliver a performance that is statistically different from zero. The performance of the long-short strategy for the full period and the pre-and post-financialization sub-periods is reported. (The pre-financialization period is defined as 1994 to 2003, and the post-financialization period is defined as 2004 to 2017.) The liquidity factor delivers the highest mean weekly returns, followed by the crowding and basis factors. The average annualized weekly returns of the liquidity, basis, momentum, basis-momentum and crowding factors are statistically different from 0 at the 1% level. However, the momentum and crowding factors display noticeable changes across sub-periods. The crowding (momentum) strategy is not significant at the usual levels in the first (second) period and significant at the 1% level in the second (first) period.

An Optimal Subset of Factors

To test the effect of roll days on commodity returns, the paper estimates a panel data regression for the 26 contracts simultaneously, controlling for contract fixed effects and clustering the variance at the contract level. To capture the effect of the roll days on the factors individually, the paper regresses each factor's time series on five dummy variables. These regressions allow controlling for systematic roll-day effects on the factors, with no assumptions on whether the individual contracts experience a roll or not.

Roll Days Effects

The results indicate that there is no systematic effect on commodity prices that can be attributed to the roll of the major index. The roll-day coefficients are not significant and do not show a consistent pattern across periods. However, the results show an effect on market functioning and risk-sharing structure, with CITs trading significantly more than traditional traders during the roll. The adjusted R2 is also higher when considering turnover. These results support the view that financialization has not affected the two characteristics of interest: average hedging pressure and liquidity.

Performance of Liquidity and Insurance Premiums

The results of Fama-MacBeth regressions are in Table 1 on the next page. The results show that the size of the coefficients of average hedging pressure and liquidity decreases slightly when the optimal set of factors is used. The average hedging pressure coefficient is statistically significant only at the 10% level, while the liquidity factor coefficient is robust to this risk adjustment and remains statistically significant at the 1% level. The risk adjustment increases the average (adjusted) R2 by about five (two) percentage points. The results indicate that the roll affects the predictability of the liquidity factor but not through the CIT inclusion. Overall, the results point to a modification of the risk-sharing structure in commodity

markets with major changes related to the insurance (hedging pressure) but not to the liquidity component. There is no evidence that financialization has affected the liquidity premium paid by speculators based on an examination of outright futures contract returns.

Table 1
Performance of the Liquidity and Insurance Premiums

	KRT		Opt. risk	3+	18-CIT	26-CIT	Pre	Post	1994–2020
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$AHP_{c,t-1}$	0.51	0.43	0.34	0.55	0.31	0.38	0.25	0.43	0.41
	(3.35)	(2.67)	(1.93)	(1.98)	(1.18)	(2.04)	(0.92)	(1.84)	(2.33)
$Q_{c,t-1}$		4.66	3.80	2.32	3.78	3.70	2.63	4.82	3.20
		(5.97)	(4.91)	(1.88)	(3.38)	(4.63)	(3.10)	(3.91)	(2.49)
$CIT_{c,t-1}$					-0.14	-0.25			
					(-0.11)	(-0.29)			
$B_{c,t-1} \times 10^2$	-1.38	-1.39	-0.53	-2.70	-0.21	-0.49	0.42	-1.38	1.35
	(-2.52)	(-2.52)	(-0.85)	(-2.09)	(-0.25)	(-0.76)	(0.50)	(-1.55)	(0.65)
$S_{c,t-1} \times 10^{-2}$	-0.21	-0.16							
	(-1.72)	(-1.30)							
R_{t-1}	0.01	0.03							
	(1.19)	(3.14)							
$M_{c,t-1}$			0.11	0.12	0.09	0.09	0.21	0.01	0.03
			(0.67)	(0.42)	(0.39)	(0.54)	(0.88)	(0.06)	(0.16)
$BM_{c,t-1}$			1.52	0.86	1.38	1.51	0.62	2.27	2.32
			(3.06)	(0.88)	(1.95)	(2.98)	(0.97)	(3.09)	(2.32)
$CR_{c,t-1}$			-0.96	-1.05	-0.74	-0.96	-0.15	-1.65	-0.63
			(-3.45)	(-2.03)	(-2.09)	(-3.33)	(-0.59)	(-3.59)	(-1.78)
Intercept	0.05	0.06	0.05	-0.01	-0.01	0.03	0.05	0.05	0.01
	(0.89)	(1.11)	(0.90)	(-0.10)	(-0.10)	(0.42)	(0.79)	(0.60)	(0.15)
Avg. R^2 (%)	25.66	30.02	35.78	35.17	52.92	39.18	36.65	35.02	36.52
Avg. Adj. R^2 (%)	11.06	11.95	13.73	12.81	18.52	13.88	13.65	13.78	14.44

Note: This table reports the statistics of Fama-MacBeth regressions of commodity returns onto lagged characteristics: (i) AHP and (ii) Q are the KRT characteristics for insurance and liquidity, respectively, (iii) CIT is the share of S&P GSCI interest in the total open interest, (iv) B is the basis and S is the 52-week trailing regression residuals of commodity returns on the S&P 500 returns, (v) R_t−1 is the lagged weekly return, and (vi) M, (vii) BM, and (viii) CR, are the momentum, basis-momentum, and crowding characteristics, respectively. Columns KRT are the specifications of Kang *et al.* (2020). Column "18-CIT" restricts the estimations to the 18 contracts of the sample that belongs to the S&P GSCI. Column "3+" restricts the sample to the weeks with at least three days under which the S&P GSCI rolls. The columns "Pre" and "Post" restrict the sample before and after financialization (*i.e.*, 1994-to-2003 and 2004-to-2017, respectively.) Finally, "1994-2020" extends the sample until December 2020. The t-statistics computed with Newey-West standard errors with four lags are reported in parenthesis.

Robustness Tests

The study uses the Generalized Portfolio Sorts method of Hoechle *et al*. (2020) to examine the impact of financialization on the risk-sharing structure of commodity markets. The study finds that financialization has modified the risk-sharing structure from the "commercials" perspective and decreased, in particular, the price of insurance. A one standard deviation change in insurance during the pre- (post-) financialization period translates into an 8.33 (5.12) bps change in weekly returns. For liquidity, a one standard deviation change implies a 15.91 and 13.05 bps change in returns for the pre- and post-financialization periods, respectively.

The paper also uses the CFTC's DCOT report to refine the measurement of the commercials category. The results show that the coefficient of average hedging pressure is not significant at the 10% level and turns negative. In contrast, the coefficient for liquidity remains statistically significant at the 1% level and is similar to the COT/post-financialization setting. The coefficient for an alternative proxy for CITs does not show any economic or statistical significance at the usual levels. A Chow test does not reject the null hypothesis of stable coefficients over the pre-and post-financialization periods (particularly for the average hedging pressure.) Still, when the coefficients of the post-financialization period are replaced by those of the 2007-2020 period in the DCOT setting, the test does reject the null for the average hedging pressure, indicating a drastic reduction in the insurance premium paid by hedgers.

Conclusion

This paper examines the robustness of the commodity futures risk premiums uncovered by Kang *et al.* (2020) in light of financialization and optimal risk adjustment. The latter consists of four factors: (i) the basis, (ii) basis-momentum, (iii) momentum, and (iv) "crowding."

Whereas this study identifies that roll-days of popular indices are significant predictors of turnover, with an increased effect in the post-financialization period, there is no evidence that the roll affects returns on commodities or commodity factors either before or after financialization. This contributes to the view that financialization has not influenced prices but plays a role in the reorganization of futures markets as an insurance market. To find support for this hypothesis, this study uses the aforementioned uncovered four-factor model to optimally adjust the specification of Kang *et al.* (2020) for risk and provide the results of Fama-MacBeth and panel data tests (Hoechle *et al*., 2020) aiming to disentangle financialization effects on this market organization. Kang *et al*. (2020) findings are robust to i) risk adjustment, ii) index funds pressure, and iii) roll periods. Finally, the insurance premium varies across periods, but not that of liquidity, which supports the view of a market reorganization, in which the index traders supply insurance to producers, thereby decreasing its price. Conversely, this market reorganization does not affect the premium captured by producers in providing liquidity to speculators. Given these results, financialization would benefit the producers both ways.

Endnote

Dr. Maréchal presented on this topic at the J.P. Morgan Center for Commodities' 5th Annual International Symposium at the University of Colorado Denver Business School on August 16, 2022.

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Author Biography

LOÏC MARÉCHAL, Ph.D.
Research Fellow, HEC Lausanne (University of Lausanne) – Cyber-Defence Campus, armasuisse Science and Technology, Switzerland

Dr. Loïc Maréchal is a Research Fellow at HEC Lausanne and the Cyber-Defence Campus, armasuisse Science and Technology (Switzerland). He focuses on commodity markets and private equity investments through asset pricing and risk management. He has worked for both consulting and trading companies in commodity market analysis. His additional interests include machine learning and market microstructure. Dr. Maréchal has a Master's degree with Honors in Banking, Money, and Markets from Université Paris Nanterre (France) and a Ph.D. in Finance from Université de Neuchâtel (Switzerland).

The Role of Storage in Commodity Markets: Indirect Inference Based on Grains Data

Christophe Gouel, Ph.D.
Senior Research Fellow, Paris-Saclay Applied Economics, National Research Institute for Agriculture, Food and the Environment (INRAE), France; and Scientific Advisor, Center for International Prospective Research and Data (CEPII), France

Nicolas Legrand, Ph.D.
Research Fellow, Structures and Markets in Agriculture, Resources and Territories (SMART), INRAE, France

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The quantitative contribution of speculative storage to commodity price dynamics remains an open question. This research provides an answer by developing a rich model of competitive storage and a new structural estimation approach exploiting the joint dynamics of prices and quantities, and carries it on global grain market data. The results show that the extended storage model explains most of the moments in the data, including the high price autocorrelation, and that, although supply shocks are the main driver of grain market dynamics, demand shocks are important with a standard deviation of more than three-fifth of that of total supply shocks.

Introduction

The dynamics of global commodity prices are characterized by periods of low and stable prices interrupted by sharp price spikes. These booms are then generally followed by times of higher and more volatile prices. In this context, a major issue for economic agents is the tendency of commodity prices to stay at low or high levels for prolonged periods of time. This is, indeed, today a key question: will the current high global commodity prices last and if so for how long? So far, much of the economic analysis of commodity markets has relied on the rational expectations storage model. In this model, storage is the crucial mechanism for explaining commodity price persistence and dynamics. Unfortunately, it is far from being empirically validated. Its first estimations by Deaton and Laroque (1992) show that the model is able to account qualitatively for many of the stylized facts. However, Deaton and Laroque (1996) found that the storage model, while able to generate autocorrelation in prices, is not able to match the level observed in the data.

Subsequent work offered some solutions to raise the persistence induced by the model and better match this central feature of the data (Cafiero *et al*., 2011, 2015; Gouel and Legrand, 2017), but all these studies build on Deaton and Laroque's approach where the model is estimated only on prices, which requires restrictive identifying assumptions and prevents estimation of all the model parameters. This approach seriously limits the model's usefulness (a) in studying how price fluctuations are driven by the underlying shifts in supply and demand, (b) in assessing the respective importance of these supply and demand shocks, and (c) in using this structural model to run counterfactual and welfare analyses for policy purposes.

This paper proposes a credible solution to the old autocorrelation puzzle grounded on a full empirical test of the storage model that is needed to get a comprehensive picture of how production, consumption and

prices are connected by storage decisions. This research is done in three steps. The first consists of developing a new storage model with rich dynamic features able to capture the richness of the price and quantity data. The second is to provide a new empirical methodology to carry the structural estimation of the model. It is based on the econometrics method of indirect inference, and it exploits the information contained in the joint dynamics of quantity and price to identify all the structural parameters of the model. The third is to take the richer storage model to the data. These include five key time series of the global grains market, represented by an aggregate index of the world's most important basic food products. In particular, the results show that, once fully-specified, the microfounded storage model is able to fit quite well the main characteristics of the global food market, and in particular its empirical persistence.

The Model

The rational expectations storage model is a basic supply and demand dynamic equilibrium model in which storage plays a central role. Intuitively, when there are stocks, prices tend to be low and stable. When little or no inventories are carried, forward prices are higher and more volatile. The demand for storage puts a floor under prices preventing them from collapsing[1], but whenever stocks are empty, the price can peak nonetheless. Finally, by buying low and selling high, the speculators are linking together current and expected prices and so induce autocorrelation in prices.

More formally, the original setting consists of a commodity market populated by three representative agents. On the supply side are rational and profit-maximizing producers. They make their production decisions and pay for inputs a period before knowing the selling price and bringing their final output to the market. On the demand side there is the final consumer, which is represented by a downward sloping demand function of current price. Between producers and final consumers, there are forward-looking speculators who maximize profit by storing at a cost a commodity. Their arbitrage decision is dictated by the difference between the expected price and the current price. Another important note is that because storage cannot be negative, there is a nonnegativity constraint on inventories. In this simple setup, the source of variability only comes from unexpected supply shocks. As is usually done in the estimation of macroeconomic models, this initial simple framework needs to be more complex to make it more realistic and sufficiently rich to be able to capture the overall time series properties of the data on both prices and quantities.

The resulting extended model nests a number of extensions which have been previously suggested in the storage literature but introduced in isolation only and rarely empirically tested. The newly developed model features: (i) a supply response (Wright and Williams, 1982), (ii) long-run trends in prices and quantities (Dvir and Rogoff, 2014), (iii) a persistent demand shock (Chambers and Bailey, 1996; Deaton and Laroque, 1996; Routledge *et al.*, 2000), and (iv) three supply shocks with different timings (Osborne, 2004). The key difference with the existing literature is that thanks to the new empirical methodology based on the information in prices and quantities, now it is possible to empirically assess the overall consistency of these combined theoretical developments of the model. In particular, for three of these dimensions—the persistence of the demand shock, the supply elasticity, and the size and cross-correlation of the supply shocks—the dynamics of quantities play a critical role because price data alone cannot identify any of them.

Data and Econometric Strategy

From an econometric viewpoint, both the parameters of the model and those of the stochastic processes governing the structural shocks are estimated using the dataset used by Roberts and Schlenker (2013), which is extended by ten years to cover the period 1961–2017. This dataset consists of five key time series representing the world market of grains, and includes: the current price, the expected price, production, consumption, and the aggregate yield shock.

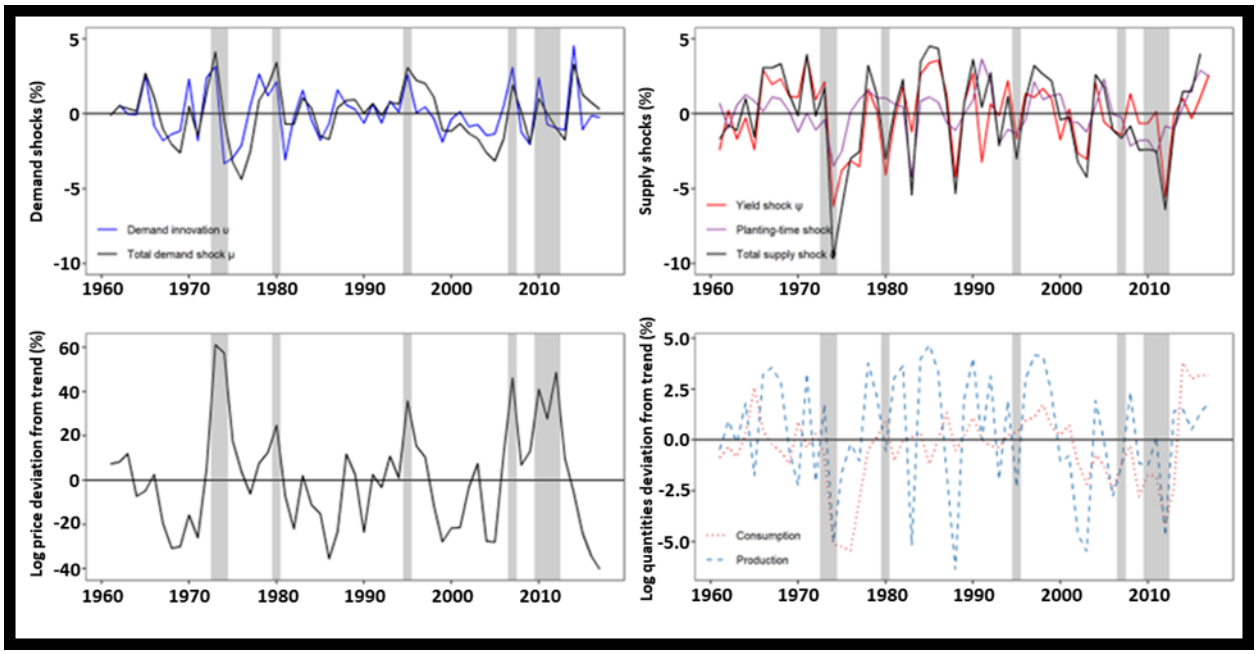
The structural estimation of the model involves the same empirical challenges that are typical of estimations of such nonlinear dynamic stochastic equilibrium models. The approach developed follows the common practice in empirical macroeconomics and uses the simulation method of indirect inference. The key in this empirical approach is to find an appropriate auxiliary model that captures all the key moments needed to recover the parameters of the model structural equations. In practice, the indirect inference estimator chooses the values of the structural parameters so that the parameters of this auxiliary model, estimated using both observed data and data simulated from the structural model, are as close as possible. In the context of this project, a good choice for the auxiliary model is the Instrumental Variable model proposed by Roberts and Schlenker (2013). However, unlike these authors, rather than indirectly using the storage model to motivate the choice of instruments, here it is the overall consistency of the structural storage model that is directly tested. Concretely, the auxiliary model consists of five linear equations and fifteen auxiliary parameters to be matched both on observed data and on data simulated from the model.

This auxiliary model has three important advantages. First, since it involves only linear regressions, it is trivial to estimate, and so avoids burdening the indirect inference procedure with a computationally costly auxiliary model. Second, it is quite transparent regarding the relationships between the auxiliary model and the storage model parameters. Third, while Roberts and Schlenker estimate only a subset of the structural parameters, by using the same dataset their strategy provides a good benchmark for comparing the estimates obtained by indirect inference.

Empirical Results and Applications

The purpose of the estimation is threefold. The first is to provide a plausible solution to the autocorrelation puzzle by accounting for sufficient features of the grains market. Using the benchmark estimations, it is found that approximately forty percent of the observed one-year autocorrelation can be explained by storage, a third by a trend in prices, a fifth by autocorrelated demand shocks, and the final five percent by the shocks on supply. The second objective is to use the estimated model to analyze the sources of commodity price movements in the global market of grains. As a complement to the standard use of vector autoregressive models for these purposes, this empirical methodology offers a fully structural approach that has not been used before in the commodity price literature. In particular, the structural approach makes it easier to identify the various shocks in a theoretically consistent way (see Figure 1 on the next page).

Figure 1
Historical Decomposition of the World Price, Production and Consumption of Grains into the Various Shocks



Note: Gray areas denote price spike periods defined as log deviations from the trend greater than one standard deviation, 23.6%.

The resulting decomposition reveals that total supply shocks are twice as large as demand shocks, but that all price spikes (over the past six decades) have been associated with large positive demand shocks. The fact that several large supply shocks are not associated with price spikes demonstrates the importance of storage to buffer against supply shortages.

The third objective of the estimation is to evaluate the ability of the richer storage model to capture the empirical processes in both price and quantity data. As is typically done following the estimation of dynamic equilibrium models, the performance of the estimated storage model is assessed by comparing the variances and covariances based on model simulations and those based on observations. Generally, the covariances are similar for simulations and observations, suggesting that the model is actually able to mimic the cross-covariances in the data. However, the model underestimates the negative correlation between current price and quantities.

Conclusion

This paper proposes a new empirical strategy to estimate the rational expectations storage model. It requires five observables and reliance on a simple linear supply and demand model as the auxiliary model in an indirect inference approach. The results show that the long-standing price autocorrelation puzzle can be solved convincingly by accounting for sufficient features of the market for grains. The estimated model can then be used for different purposes like quantifying the relative size and contribution of the

various structural disturbances to the boom-and-bust episodes recorded over the past sixty years. While the present paper focuses on the grains market, the empirical methodology provided is fully applicable to the oil market or to any other storable commodity as long as there is an observable demand or supply shock (*e.g.*, a demand shock based on freight rates as suggested by Kilian, 2009).

Endnotes

Dr. Legrand presented on this topic at the Annual Meeting of the Commodity & Energy Markets Association (CEMA) on June 21, 2022 in Chicago.

1 Outside of grains, there are some commodities for which insufficient storage can emerge, at which point prices can become negative. One signature example is WTI crude oil markets experiencing negative prices on April 20, 2020.

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Commodity price dynamics, indirect inference, storage, grains.

Author Biographies

CHRISTOPHE GOUEL, Ph.D.
Senior Research Fellow, Paris-Saclay Applied Economics, INRAE, France; and Scientific Advisor, CEPII, France

Dr. Christophe Gouel is a senior research fellow at INRAE, Paris-Saclay Applied Economics (France) and a scientific advisor at CEPII (France). He is an agricultural economist working on international markets for agricultural products. He analyzes agricultural markets through two perspectives: the short-run and the long-run. For the short-run perspective, his research focuses on the economics of storable commodities, food price volatility, and food policies to limit price volatility. For the long-run perspective, his research focuses on climate change and its effects on agriculture, international trade of agricultural products and its economic modeling.

NICOLAS LEGRAND, Ph.D.
Research Fellow, SMART, INRAE, France

Dr. Nicolas Legrand is a research fellow at SMART, INRAE (France) and a visiting research scholar at Georgetown University (U.S.A.). He is an economist specialized in the dynamics of global commodity markets. His research lies at the intersection of agricultural economics, empirical macroeconomics and international finance, with a focus on the analysis of commodity markets. He develops and uses economic models to identify and measure the relative contribution of the most important factors to the observed commodity price instability on both the global spot and futures markets.

The Lead-lag Relations in the Commodity Futures Returns: A Machine Learning Approach

Yufeng Han, Ph.D.
Professor of Finance, Belk College of Business, University of North Carolina at Charlotte

Lingfei Kong, Ph.D.
Postdoctoral Research Associate in Finance, Olin School of Business, Washington University in St. Louis

Available at SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3536046

This paper uses machine learning tools to study the lead-lag relations in commodity futures returns. We use LASSO (Least Absolute Shrinkage and Selection Operator) to select the predictors because the number of predictors is large relative to the number of observations. We find significant full-sample and out-of-sample predictability. In the full sample, we find that LASSO can identify a sparse set of predictors that either come from economically linked commodities or from factors that are coincident with the period of "financialization" in the commodity markets. The out-of-sample forecasts based on LASSO generate statistically and economically large gains. When we use more complex machine learning models such as regression trees and neural networks to forecast commodity futures returns, the out-of-sample performance is worse than LASSO portfolios, suggesting that nonlinearities and interactions do not appear substantial in the data. Finally, we find that index trading due to financialization has been associated with excess comovement among commodity futures.

Introduction

Commodity futures contracts are agreements to buy or sell a predetermined quantity of a commodity at a specified price on a particular date in the future. Historically, commodity futures were primarily used by farmers, producers, and commodity merchandisers to lock in the price and reduce the risk of financial losses from price changes. Over the past two decades, financial institutions such as hedge funds, swap dealers, and mutual funds have dramatically increased their exposure to commodities. The advent of commodity futures Exchange-Traded Funds (ETFs) and Exchange-Traded Notes (ETNs) also gives individual investors easy access to commodity futures. According to BarclayHedge, the assets under management for managed futures have grown from $95.7 billion to $318.4 billion from 2003 to 2019; managed futures programs, in turn, include the trading of both financial futures and physical commodity futures (Gupta and Wilkens, 2007). The phenomenon of investor participation in physical commodity futures trading is called "financialization" by researchers (*e.g.*, Tang and Xiong, 2012; Basak and Pavlova, 2016), and has received extensive attention from researchers and practitioners.

This paper examines the predictability of commodity futures returns. Specifically, we examine the lead-lag relations in the commodity futures returns by predicting commodity futures returns with the commodity futures' own lagged returns as well as other commodity futures' lagged returns. We focus on the post-financialization period (2004-2019) when commodity futures became a popular investment asset class, and futures markets became more liquid than before. The inclusion of the broad set of lagged returns is motivated by the following arguments. First, many futures have economic links that can drive the lead-lag relations among futures returns. For instance, (a) heating oil is refined from crude oil so via the crack spreads, the lagged returns of crude oil futures would be tied to the returns of heating oil futures; (b) corn and soybean meal are the primary feeds for livestock such as pigs and cows, thus via the feed margins, the returns of corn and soybean futures would plausibly impact the returns of lean hogs and live

cattle futures at some stage of the production; and (c) crops such as corn and soybeans are used to produce biofuels, which are substitutes for fossil fuels such as crude oil, so crude oil futures prices would be expected to be related to grain futures prices. Mensi *et al*. (2014) find significant spillovers among grain and energy commodity prices by studying the lead-lag relations of the returns and volatilities of these commodities. Second, the increased trading activities by financial institutions and retail investors can either weaken or strengthen these effects, or even introduce new relations that are not driven by any economic links; for example, Till (2008) describes how seemingly unrelated commodities and financial instruments became (temporarily) very correlated during "risk off" episodes. Unlike producers/merchants who use futures contracts to lock in the price of their products or inputs, these traders generally do not have physical exposure to the commodities but use commodity futures as investment tools, and thus are non-commercial traders.

Some researchers have concluded that the proliferation of non-commercial trading may have caused price distortion and excessive price comovement, depending on the frequency of observation. For example, Tang and Xiong (2012) find that since 2004 when financial institutions significantly increased their positions on commodity futures, the prices of non-energy commodity futures have become increasingly correlated with oil futures, and the correlations are stronger for commodities that are included in the broadly traded commodity indices than for non-indexed commodities.

To provide an even balance of views, one must also note that there may be other explanations besides the proliferation of non-commercial futures traders for the increased correlations of oil futures with non-energy commodity futures, which would include a broad-based increase in commodity demand from emerging economies (Cevik and Sedik, 2011). Further, IEA (2011) states that "[a] … comparison of the non-exchange-traded commodity price index, as well as [the] crude oil price series, supports the notion that, starting in 2003 and more strongly after 2004, a demand shock pushed upward the price of most commodities." In addition, based on an examination of crude oil, natural gas, and corn futures markets, Brunetti *et al.* (2015) "find little evidence that speculators destabilize … markets."

Relevance of the Research Question

This paper contributes to the existing literature in the following ways. First, the majority of the literature, after financialization, studies the comovement among commodity futures in the context of contemporaneous relations rather than lead-lag relations. Moreover, most papers regarding return predictability in commodity futures focus on the futures' own past returns or other characteristics but ignore the cross-serial correlations. As far as we can tell, this paper is the first to analyze the predictability of the lagged futures returns that allows each individual commodity futures' return to respond to the lagged returns for all commodity futures, thereby accommodating a large dimension of commodity links, both direct and indirect. Second, we use machine learning techniques to overcome the potential overfitting problem. With a large number of predictors, OLS (ordinary least squares) estimation is subject to overfitting. Third, we find that incorporating the lagged returns of commodity futures can help to forecast the returns for individual commodity futures and construct profitable trading strategies. The performance of the long-only futures indices has been lackluster in the last decade. By contrast, the

actively constructed single-sort or timing strategies based on LASSO generate both statistically and economically large out-of-sample returns.

Data and Methodology

We study 27 commodity futures that are traded actively in the U.S. The data are collected from Bloomberg. The 27 commodity futures cover five main sectors, namely, grains, softs, livestock, energy, and metals. There are 8 grains futures, 7 softs futures, 3 livestock futures, 4 energy futures, and 5 metals futures in the sample. The sample period is from January 2004 to December 2019.

The main methodology used to forecast commodity futures returns is LASSO (Least Absolute Shrinkage and Selection Operator), as proposed by Tibshirani (1996). The reason why we use LASSO is that the number of predictors is large compared with the number of observations used to fit the model. With a large number of predictors, OLS model causes overfitting, which means it reduces the in-sample mean squared error but often results in a large out-of-sample mean squared error. LASSO selects a subset of predictors and thus reduces overfitting. We use the corrected Akaike information criterion (AICC) to select the shrinkage parameter in LASSO. We use OLS to estimate the coefficients for the predictors selected by LASSO (OLS post-LASSO) since LASSO can overshrink the magnitudes of the coefficients for the selected predictors (Efron *et al*., 2004). Our main benchmark forecast models are OLS that include all the lagged returns as predictors and prevailing mean, which is the moving average of the commodity futures returns during the estimation window.

In the in-sample analysis, we use the full sample to estimate the OLS post-LASSO regression. In the out-of-sample analysis, we run a 60-month rolling LASSO regression and calculate the one-step ahead out-of-sample return forecast. To evaluate the out-of-sample forecast performance, we construct two trading strategies, one is a single-sort portfolio, in which we form equally-weighted portfolios using the five commodities with the highest forecasted returns and the five commodity futures with the lowest forecasted returns. We then calculate the return differences between the two portfolios. The other strategy is a moving-average timing portfolio; that is, we establish a long position if its forecasted return is positive and a short position if its forecasted return is negative, then form an equally-weighted portfolio of all the positions. There are two versions of LASSO models in the out-of-sample analyses: they are LASSO that excludes any futures that do not have any lagged returns selected by the LASSO, and LASSO (All) that includes all contracts including those without any predictors.

To test whether financialization has been associated with the excess comovement among commodity futures, we have both in-sample tests and out-of-sample tests. In the in-sample test, we create a dummy variable that is equal to 1 when the commodity futures are members of indices and when the date is after the inception of three ETF or ETN products (September 2006) that track the returns of the Bloomberg Commodity Index (BCOM) or the S&P Goldman Sachs Commodity Index (GSCI); otherwise, the dummy variable is set to 0. We then add the dummy as well as its interaction with all the lagged returns as the additional predictors and run the OLS post-LASSO regression using the full sample. In the out-of-sample test, we classify the commodity futures included in both the BCOM and GSCI as indexed futures, and those included neither in the BCOM nor GSCI index as non-indexed futures. There are 16 indexed futures and 7

non-indexed futures. We then reconstruct the single sort and timing portfolios using the 16 indexed futures or the 7 non-indexed futures. We also test the lead-lag relations and construct single-sort and timing portfolios using data during 1970-2003, which is before the financialization period.

Main Results

The LASSO single-sort portfolio has an annualized mean return of 15.15%, which is more than eight times the mean return of the prevailing mean portfolio (1.78%). The annualized Sharpe ratio of this LASSO portfolio is also much higher than those of the two benchmark portfolios, 0.93 versus 0.10 (prevailing mean) and -0.21 (OLS). The LASSO timing portfolio yields an average excess return of 6.15% per year and a Sharpe ratio of 0.72. In contrast, the prevailing mean timing portfolio generates an annual return of only 1.80%, and the OLS timing portfolio generates an even smaller average return that is less than 1%. Overall, the results show that lagged returns contain predictability for the cross-section of commodity futures returns and LASSO helps to identify important predictors. The above results are robust to transaction costs, an alternative number of lagged returns, seasonality, and different machine learning models such as elastic net.

When we interact the ETF inception dummy with lagged returns for the whole sample, at least one lagged commodity futures return is selected for 14 of the 16 indexed futures. In addition, 10 out of the 14 futures have interactions of the ETF inception dummy with lagged returns as selected effects, and the hypothesis that the interactions are all equal to 0 is rejected for all the 10 futures. When we use indexed-only futures to run the lead-lag predictive regressions and construct portfolios, the LASSO portfolio generates economically and statistically significant out-of-sample returns in both the single-sort and timing strategies. However, when we use the non-indexed futures to run the lead-lag predictive regressions, the LASSO portfolio no longer generates any significant out-of-sample returns. In addition, when we examine the lead lag relations from 1970-2003, the two LASSO portfolios do not generate significant out-of-sample returns.

Conclusions

In this paper, we exploit the lead-lag relations in the commodity futures returns via machine learning tools (mainly LASSO) to analyze return predictability in commodity futures markets. The portfolio analysis reveals that the LASSO strategies outperform the well-known OLS and historical moving average by generating statistically and economically larger excess returns. We find that LASSO strategies perform well after the financialization period but not before financialization. When we separate the indexed futures from the non-indexed futures, we find that LASSO strategies only work in the basket of indexed futures. Moreover, the lead-lag relations are stronger after the advent of ETFs or ETNs that track the broad futures indices such as the GSCI and BCOM indices. Overall, our results suggest that lagged returns contain valuable information to predict futures returns and that machine learning is a useful and effective tool to increase out-of-sample predictability.

Endnote

Dr. Kong presented on this topic at the J.P. Morgan Center for Commodities' 5th Annual International Symposium at the University of Colorado Denver Business School on August 15, 2022.

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Keywords

Commodity futures, LASSO, machine learning, predictability, lead-lag relations, financialization, comovement.

Author Biographies

YUFENG HAN, Ph.D.
Professor of Finance, Belk College of Business, University of North Carolina at Charlotte

Dr. Yufeng Han joined the Belk College faculty as an Associate Professor of Finance in 2016. Prior to joining UNC Charlotte, he served as a faculty member at the University of Colorado Denver and Tulane University. Dr. Han's primary research interests are empirical asset pricing, investment, mutual funds, and econometrics. He has published in the *Review of Financial Studies, Journal of Financial Economics, Journal of Financial and Quantitative Analysis, Journal of Banking and Finance, Real Estate Economics* and many other finance and economics journals. Dr. Han received a Bachelor's degree from Tsinghua University (China) and a Ph.D. from Washington University in St. Louis.

The Lead-lag Relations in the Commodity Futures Returns: A Machine Learning Approach

LINGFEI KONG, Ph.D.
Postdoctoral Research Associate in Finance, Olin School of Business, Washington University in St. Louis

Dr. Lingfei Kong is a Postdoctoral Research Associate in Finance at the Olin School of Business, Washington University in St. Louis. Dr. Kong received her Ph.D. in Finance from the University of North Carolina at Charlotte. Her research focuses on empirical asset pricing, return predictability, big data analytics, commodity futures, corporate finance, and product innovation.

Currency and Commodity Return Relationship under Extreme Geopolitical Risks: Evidence from the Invasion of Ukraine

Olga Dodd, Ph.D.
Senior Lecturer, Department of Finance and a Fellow of the Auckland Centre for Financial Research, Auckland University of Technology, New Zealand

Adrian Fernandez-Perez, Ph.D.
Director of the Auckland Centre for Financial Research, Auckland University of Technology, New Zealand

Simon Sosvilla-Rivero, Ph.D.
Professor of Economics at the Complutense University of Madrid, Spain

Available at SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4089030

This study examines the relationship dynamic between currency and commodity returns around the Russian invasion of Ukraine in February 2022. In regular times, in line with previous research, there is a positive relationship between currency and commodity returns; that is, an increase in commodity prices is associated with an increase in foreign currency values relative to the U.S. dollar. However, this positive relationship reverses and becomes negative during the period when the invasion of Ukraine was highly probable (from January 20, 2022) and remains negative during the outset of the war (February 24 – March 11, 2022). The results suggest that the war's anticipation and subsequent start changed the sign of the relationship between commodity and currency prices. In other words, during this period of heightened geopolitical risks, the observed increase in commodity prices was associated with a decrease in the value of foreign currencies relative to the U.S. dollar. This study also examines whether the exposure to geopolitical risk around the invasion of Ukraine affects currency returns. The study reports that geographic distance to the war significantly affects currency returns during the period of anticipation and the outset of the war; that is, the further away the country is from the war, the higher the country's currency return. Overall, the results indicate that a war between two major commodity-exporting countries significantly affects global currency pricing.

Introduction

The Russian invasion of Ukraine on February 24, 2022, was Europe's most extensive military operation since World War II. Although there were signs that an invasion could occur, it largely came as a shock to global financial markets. The heightened geopolitical and economic risks associated with the invasion of Ukraine triggered a sharp increase in commodity prices, already impacted by COVID-19-related supply chain disruptions and an appreciation of the U.S. dollar due to a flight-to-safety or hedge motive. This paper examines whether a war between two major commodity-exporting countries impacts the relationship between currency and commodity markets.

Relevance of the Research Question

The financialization of commodity markets has increased co-movements among commodities (Tang and Xiong, 2012) and across asset classes (Natoli, 2021). Existing literature documents a positive contemporaneous relationship between currency (relative to the U.S. dollar) and commodity returns, particularly in commodity-exporting economies (Chen *et al*., 2010; Chan *et al*., 2011; Liu *et al*., 2020), and

accordingly, a negative relationship between commodity and the U.S. dollar returns (Erb and Harvey, 2006).

The previous literature links currency and commodity prices through a variety of channels (*e.g.*, Beckmann *et al*., 2020). The terms of trade channel focuses on real commodity prices and exchange rates (Ayres *et al*., 2020). The portfolio and wealth channels link the nominal exchange rate to the nominal commodity price effect (Krugman, 1983). Finally, the expectations channel allows for nominal causalities in both directions (Chen *et al*., 2010). Furthermore, several studies (*e.g.*, Zhang *et al*., 2016; Belasen and Demirer, 2019) document a causal link between currency and commodity prices.

The open question is how extreme geopolitical risks affect the pricing relationship between currency and commodity markets. In general, uncertainty impacts foreign currency (Bartsch, 2019; Chen *et al*., 2020) and commodity prices (Joëts *et al*., 2017; Bakas and Triantafyllou, 2018). Recently, uncertainty associated with geopolitical risks is increasingly attracting attention. Qin *et al*. (2020) show that geopolitical concerns have asymmetric effects on energy returns and volatility under various market conditions. Filippou *et al*. (2018) demonstrate that political risk is priced in the cross-section of currency momentum, which provides information not contained in other risk indicators.

This study contributes to the literature on the relationship between commodity and currency prices and the impact of geopolitical risks by analyzing the relationship between currency and commodity returns around the Russian invasion of Ukraine in 2022.

Data and Methodology

This study examines free-floating or floating currencies based on the International Monetary Fund (IMF) classification with available data, excluding the currencies of the countries directly affected by the war (Ukraine, Russia, and Belarus). The sample includes 31 currencies[1] and spans from January 1, 2012, to March 2022. The focus is on two subperiods: (1) before the war from January 20 to February 23, 2022 (the anticipation of the period), and (2) the outset of the war from February 24 to March 11, 2022 (the war period.) The "before" or the anticipation period comprises the time of a heightened possibility of war when many observers reportedly predicted that Russia would invade Ukraine.[2]

To measure the performance of currencies and commodities, the authors calculate daily currency and commodity log returns using WM/Refinitiv foreign exchange rates (expressed as the U.S. dollar price) and the S&P GSCI commodity futures index and energy, precious metals, agriculture, and industrial metals subindices data from Refinitiv Datastream.

The degree of geopolitical risk is captured with measures of political exposure (the Eastern Bloc heritage, NATO membership, and being included in the list of Russia's "unfriendly" countries), geographical distance to the war (the distance in kilometers (km) between Kyiv, the capital of Ukraine, and the country's capital), and the economic proximity to the war (a country's bilateral trade with Russia, measured by the share of the Russian exports and imports in the country's total exports and imports using data from the IMF's Direction of Trade Statistics.)

Other potential determinants of currency returns included in the analysis as control variables are the News Sentiment Index of the Federal Reserve Bank of San Francisco, which captures U.S. economic uncertainty, local stock market returns (in local currency) calculated using MSCI stock market indices' prices obtained from Refinitiv Datastream, and local interest rates measured with overnight interbank interest rates from Refinitiv Datastream.

The authors employ panel fixed effects regressions to evaluate the relationship between currency and commodity returns. To isolate the impact of the determinants before and at the start of the war, they include interaction terms of the explanatory variables with the dummy variables that capture these two subperiods. First, the relationship between currency and commodity returns is estimated without evaluating the role of country-level variables:

$$\begin{aligned} r_fx_{i,t} = \alpha + \left(\beta_1 + \beta_1^{bef} \times 1_bef_t + \beta_1^{war} \times 1_war_t\right) \times r_commo_t + \\ + \left(\beta_2 + \beta_2^{bef} \times 1_bef_t + \beta_2^{war} \times 1_war_t\right) \times news_s_t + \\ + \left(\beta_3 + \beta_3^{bef} \times 1_bef_t + \beta_3^{war} \times 1_war_t\right) \times r_mkt_{i.t} + \\ + \left(\beta_4 + \beta_4^{bef} \times 1_bef_t + \beta_4^{war} \times 1_war_t\right) \times r_f_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (1)$$

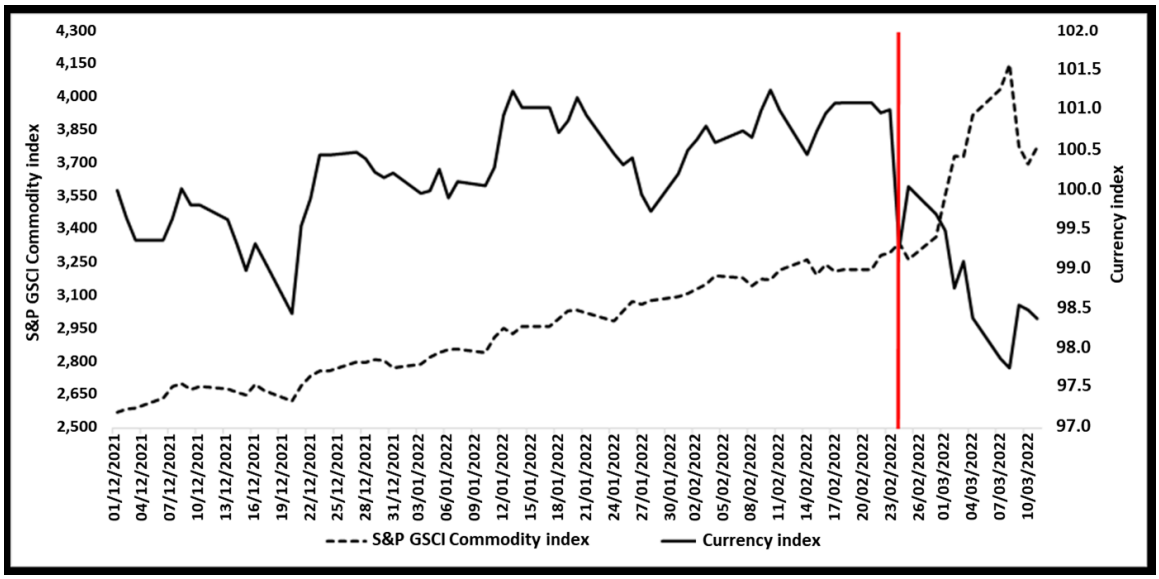
where $r_fx_{i,t}$ is the return of currency *i* at day *t*, 1_bef_t and 1_war_t are dummy variables equal to one from January 20 to February 23, 2022 and from February 24 to March 11, 2022, respectively, and zero otherwise; r_commo_t is the commodity index return; $news_s_t$ is the news sentiment index; $r_mkt_{i,t}$ is the local stock market return; $r_f_{i,t}$ is the local overnight interest rate; and $\varepsilon_{i,t}$ is the residual. This model is estimated as an Ordinary Least Squares (OLS) regression and includes currency and month-year fixed effects. The inferences are based on White *t*-statistics with double-clustered standards errors by currency and day-year. It is an unbalanced panel with a total number of observations of 74,581 ($T = \sum_{i=1}^{31} T_i = 74{,}581$ where T_i is the number of observations for the currency *i* with *i*=1, …, 31).

Second, the above equation is estimated with country-level variables that capture a country's exposure to the war (instead of currency-fixed effects). This analysis evaluates the relationship between currency and commodity returns and whether a country-level exposure to the war can explain currency returns before and during the war.

Results

The uncertainty and extreme geopolitical risks associated with the anticipation and the start of the war sent commodity (natural gas, oil, industrial metals, and agricultural products) prices rising and many currencies, especially European currencies, depreciating against the U.S. dollar. Figure 1 on the following page plots the S&P GSCI commodity index and the equally weighted index of the sample currencies from December 1, 2021, to March 11, 2022. It depicts the changes in the trends in both commodity prices and exchange rates around the invasion date of February 24, 2022.

Figure 1
Commodity Price Index and Currency Index Since December 1, 2021



During the anticipation of the war period from (January 20 - February 23, 2022), 61% of the sample currencies suffered losses. From the war's outset (February 24 - March 11, 2022), this number increased to 71%, with the currencies of Kazakhstan, Hungary, and Poland having the lowest returns and currencies of Colombia, Jamaica, and Peru having the highest returns. The authors note significant heterogeneity in responses to the war across currencies.

The regression analysis in Table 1 on the next page corroborates a significant depreciation of the sample currencies against the U.S. dollar over the sample period, especially from the war's outset. As documented in previous studies, the regression analysis also confirms the positive relationship between currency and commodity returns in regular times (over the sample period from 2012), including global commodity, energy, precious metals, agricultural, and industrial metals commodity index returns.

However, the relationship between currency returns and commodity indices returns turns negative before and during the war, indicating that the relationship between currency and commodity returns reverses around the start of the war. The negative relationship is statistically significant for the global commodity index and energy and agricultural commodities subindices before the war and for all commodity indices during the war. These findings align with other studies highlighting the asymmetric risk-return relationship in financial markets (Bekiros *et al*., 2018) and the reversal of causal linkages in the main commodity markets (Lahmiri, 2017).

The main findings hold when we perform several robustness tests, including estimating the model with an additional explanatory variable - the USD index returns, to control for the changes in the U.S. dollar value, particularly the appreciation of the U.S. dollar as a result of flight-to-safety.[3]

Currency and Commodity Return Relationship under Extreme Geopolitical Risks: Evidence from the Invasion of Ukraine

Table 1

The Relationship Between Currency and Commodity Returns (Explanatory notes on next page)

	Panel A. Currency and various commodity returns						Panel B. Country-level exposure to the war					
Dep.: r_fx (%)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Constant	-0.016***	0.178*	0.178*	0.085	0.161	0.138	0.185*	0.187*	0.184*	0.174*	0.186*	0.192*
	(-6.76)	(1.82)	(1.78)	(0.94)	(1.63)	(1.63)	(1.89)	(1.90)	(1.88)	(1.69)	(1.90)	(1.87)
l_bef	0.017	-0.051	-0.084	-0.074	-0.073	-0.088	-0.048	-0.039	-0.016	-0.335	-0.051	-0.518**
	(0.72)	(-0.24)	(-0.39)	(-0.37)	(-0.34)	(-0.53)	(-0.22)	(-0.18)	(-0.07)	(-1.10)	(-0.24)	(-2.00)
l_war	-0.200***	-0.482	-0.509	-0.805	-0.737	-0.314	-0.446	-0.416	-0.335	-1.808	-0.473	-1.090
	(-5.94)	(-0.65)	(-0.68)	(-1.14)	(-1.18)	(-0.38)	(-0.59)	(-0.58)	(-0.48)	(-1.49)	(-0.62)	(-1.58)
r_commo		0.065***					0.065***	0.065***	0.065***	0.065***	0.065***	0.065***
		(5.72)					(5.71)	(5.71)	(5.71)	(5.71)	(5.71)	(5.71)
r_commo × l_bef		-0.087*					-0.086*	-0.086*	-0.086*	-0.086*	-0.086*	-0.085*
		(-1.86)					(-1.85)	(-1.85)	(-1.81)	(-1.84)	(-1.84)	(-1.78)
r_commo × l_war		-0.139***					-0.141***	-0.139***	-0.140***	-0.140***	-0.141***	-0.141***
		(-4.71)					(-4.77)	(-4.61)	(-4.52)	(-4.44)	(-4.68)	(-4.47)
r_energy			0.029***									
			(4.56)									
r_energy × l_bef			-0.056*									
			(-1.75)									
r_energy × l_war			-0.080***									
			(-4.19)									
r_prec_metals				0.115***								
				(6.94)								
r_prec_metals × l_bef				-0.060								
				(-0.70)								
r_prec_metals × l_war				-0.252***								
				(-3.61)								
r_agr					0.054***							
					(6.09)							
r_agr × l_bef					-0.080**							
					(-2.12)							
r_agr × l_war					-0.150***							
					(-3.17)							
r_ind_metals						0.110***						
						(7.74)						
r_ind_metals × l_bef						-0.020						
						(-0.81)						
r_ind_metals × l_war						-0.221***						
						(-3.00)						
Eastern Bloc							-0.001					0.011*
							(-0.21)					(1.78)
Eastern × l_bef							-0.008					0.028
							(-0.14)					(0.43)
Eastern × l_war							-0.488**					-0.209
							(-2.04)					(-0.63)
NATO								-0.004				-0.011
								(-0.72)				(-1.64)
NATO × l_bef								-0.035				0.060
								(-0.64)				(1.11)
NATO × l_war								-0.217				0.010
								(-1.31)				(0.17)
Unfriendly									0.001			0.004
									(0.24)			(0.61)
Unfriendly × l_bef									-0.055			-0.042
									(-0.90)			(-0.69)
Unfriendly × l_war									-0.235			-0.077
									(-1.30)			(-0.40)
Distance to Kyiv										0.001		-0.001
										(0.43)		(-0.23)
Distance × l_bef										0.034		0.056**
										(1.20)		(2.18)
Distance × l_war										0.156**		0.079***
										(1.97)		(2.63)
Econ. prox to Russia											-0.091**	-0.141***
											(-2.42)	(-3.19)
Econ. prox × l_bef											0.303	0.570
											(0.44)	(0.66)
Econ. prox × l_war											-3.866***	-2.247
											(-2.94)	(-0.70)
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month-year fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Currency fixed effects	No	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No
R-squared (%)	0.05	6.87	6.2	8.59	6.08	8.21	6.87	6.85	6.85	6.87	6.87	6.89
N. observations	74,581	74,581	74,581	74,581	74,581	74,581	74,581	74,581	74,581	74,581	74,581	74,581

Notes for Table 1: This table reports the estimation results of Equation (1). The dependent variable is daily currency returns. Panel A (models 1 to 6) reports estimations between currency and commodity returns. Panel B (models 7 to 12) reports estimations with country-level variables to capture country-level heterogeneity. Distance to Kyiv (km) is in logs. Unless otherwise stated, all models include month-year and currency-fixed effects. The sample period is from January 1, 2012, to March 11, 2022. White *t*-statistics with standard errors clustered by currency and day-year (except for Model 1, where standard *t*-statistics are used) are reported in parenthesis. ***, **, and * denote significance at the 1%, 5% and 10% level, respectively.

The second part of the analysis employs the model with country-level variables that capture a country's exposure to the war (instead of currency-fixed effects) to evaluate whether a country-level exposure to the war can explain currency returns before and during the war. This analysis confirms the reversal in the relationship between currency and commodity returns around the time of the war in Ukraine, as documented in the first part of the analysis.

Regarding the country-level variables, the currencies of former Eastern Bloc members depreciated more from the war's outset. Currencies of countries that are more geographically distant from the war have higher returns during the war. Countries with significant economic ties to Russia have currencies that underperform during the sample period and even more so from the war's outset.

The estimation results of the model that includes all country-level variables show that currencies of former Eastern Bloc countries marginally outperform and currencies of countries with economic ties to Russia strongly underperform over the sample period. However, before and during the war, the only significant country-level determinant of currency returns is the geographic distance to the war; that is, the further away from the war, the higher the currency return. This result is in line with the "proximity penalty" documented by Federle *et al*. (2022) when examining stock market reactions to the invasion of Ukraine and the evidence of spillover effects via information transmission from the directly affected markets to the rest (Ehrmann *et al*. 2011). The results highlight the importance of geopolitical factors in explaining currency returns when geopolitical risks are heightened.

In the additional analysis, the study distinguishes between commodity currencies (Chen and Rogoff, 2003; Norland, 2020) and non-commodity currencies. The main result is observed in both subsamples, but the effect is more substantial for commodity currencies.

Conclusions

This study analyzes the relationship between currency (in terms of the U.S. dollar) and commodity returns during heightened geopolitical risks in February-March 2022 when Russia invaded Ukraine. While there is a positive association between currency and commodity returns in regular times, this relationship reverses and becomes negative around the invasion. Furthermore, the study documents that geopolitical factors, notably the distance to the war, have a considerable impact on currency returns. The findings show that heightened geopolitical risks associated with a war between two large commodity-exporting countries significantly impact the currency and commodity price relationship. Further research is called to investigate potential explanations of the observed change in the currency-commodity return relationship under extreme uncertainty and geopolitical risks.

Endnotes

1 Our sample includes 31 currencies from the following countries: Australia, Brazil, Canada, Chile, Colombia, Czech Republic, Eurozone (Germany), Ghana, Hungary, Iceland, India, Indonesia, Israel, Jamaica, Japan, Kazakhstan, Korea, Malaysia, Mauritius, Mexico, New Zealand, Norway, Peru, Philippines, Poland, South Africa, Sweden, Switzerland, Thailand, Turkey, and the United Kingdom.

2 On January 20, 2022, the Atlantic Council (2022) issued a report confirming that Russia had deployed critical combat capabilities to the border with Ukraine (and the U.S. President reportedly predicted that Russia would move into Ukraine, according to Sanger (2022) on January 19, 2022.)

3 The main results also hold when the sample excludes Kazakhstan as a potential outlier when the model includes the daily geopolitical risk index of Caldara and Iacoviello (2022) or local stock market return in U.S. dollars (instead of local currency) as control variables.

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Foreign exchange rates, currency return, commodity returns, Ukraine-Russia war, geographic distance.

Author Biographies

OLGA DODD, Ph.D.
Senior Lecturer, Department of Finance and a Fellow of the Auckland Centre for Financial Research, Auckland University of Technology, New Zealand

Dr. Olga Dodd is a Senior Lecturer at the Department of Finance and a Fellow of the Auckland Centre for Financial Research at Auckland University of Technology, New Zealand. She is also an Associate Editor of the *International Review of Financial Analysis* and *Journal of Climate Finance* journals. Her research interests include international financial markets, culture and finance, corporate governance, corporate financial risk management, and corporate social responsibility. She has publications in leading international peer-reviewed journals, including the *Journal of Corporate Finance*, *European Financial Management*, *International Review of Financial Analysis*, and *Financial Review*. Her research has been featured in media and other outlets, including Columbia Law School's *Blue Sky Blog* and *The Conversation*.

ADRIAN FERNANDEZ-PEREZ, Ph.D.
Director of the Auckland Centre for Financial Research, Auckland University of Technology, New Zealand

Dr. Adrian Fernandez-Perez is the Director of the Auckland Centre for Financial Research, Auckland University of Technology, New Zealand. His research focuses on the pricing of commodities and behavioral finance. Dr. Fernandez-Perez has published articles in leading academic journals such as the *Journal of Financial Economics*, *Review of Finance*, and *Journal of Banking and Finance*, among others. His research has been featured in media and practitioners' journals (*Wall Street Journal*, *Bloomberg*, and *Harvard Business Review*), and he has received awards and grants from INQUIRE UK or BA/Leverhulme Trust. He is an Associate Editor of both the *Journal of Commodity Markets* and the *Commodity Insights Digest* (*CID*).

SIMON SOSVILLA-RIVERO, Ph.D.
Professor of Economics at the Complutense University of Madrid, Spain

Dr. Simon Sosvilla-Rivero is a Professor of Economics at the Complutense University of Madrid and also both a Senior Research Fellow at the Complutense Institute for Economic Analysis (ICAE) and a Research Fellow at Research Group of Risk in Insurance and Finance, University of Barcelona, Spain. Dr. Sosvilla-Rivero is also an Associate Editor of the *SN Business & Economics* and *Applied Finance Letters* journals. His research interests include international financial markets, time series analysis, macroeconometric modeling, the welfare state, and European integration. His articles have been published in the *North American Journal of Economics and Finance*, *European Economic Review, Empirical Economics*, *The World Economy*, *International Journal of Forecasting*, *Journal of International Money and Finance*, *Economic Modelling*, *Journal of International Financial Markets*, *Institutions and Money*, *International Journal of Finance and Economics*, and *The Quarterly Review of Economics and Finance*, among others.

Staking: Implications for Token Valuation, Yield Framing, and Carry Trades

Lin William Cong, Ph.D.
Rudd Family Professor of Management and Professor of Finance, SC Johnson College of Business, Cornell University; and Research Associate, National Bureau of Economic Research (NBER)

Zhiheng He
Economics Doctoral Candidate, Institute of Economics, Tsinghua University, China

Ke Tang, Ph.D.
Professor and Director of the Institute of Economics, Institute of Economics, Tsinghua University, China

Available at SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4059460

Tokens in the recent phenomenon of the staking economy offer transaction convenience in digital networks and are frequently staked for base-layer consensus generation or incentivizing platform development (consequently earning staking rewards), thereby generating both currency-like and commodity-like properties as hybrid assets. This paper builds a theoretical model where heterogeneous agents dynamically allocate their wealth over staking, on-chain transaction, and off-chain consumption. Model implications and empirical findings from stakable tokens corroborate the predictions: (i) the staking ratio positively correlates with reward rates; (ii) higher staking ratios predict greater excess returns; and (iii) uncovered interest-rate parity is violated, generating significant crypto carry premia.

The past decade witnessed an explosive growth in cryptocurrencies and rising interest in Decentralized Finance (Harvey *et al*., 2021), which totaled 2.5 trillion USD and over 130 billion USD respectively as of February 2022. The world is also just starting to understand the categorization of tokens and valuations of digital assets (*e.g.*, Cong *et al*., 2021; Cong and Xiao, 2021). The recent phenomena of token staking, value locking, and yield farming for higher-layer Decentralized Finance (DeFi) innovations as well as for base-layer consensus formation calls for a better understanding of tokens as transaction media, investment assets, and deposit-like or collateral instruments for earning rewards and deriving utilities.

To this end, this paper offers the first study relating various utility-based functions that crypto-tokens provide to users (*e.g.*, transaction convenience via medium of exchange and rewards via staking) from both theoretical and empirical angles. In brief, agents' utility in holding tokens comes either from transactions, which naturally relate to currency-like properties or from value lock-up staking, which is closely related to the phenomenon of commodities as collateral (Tang and Zhu, 2016), thus making crypto-tokens in the staking economy a hybrid asset.

The present work constructs a continuous-time model of an economy with token-based digital networks, where agents heterogeneous in wealth optimally solve consumption-portfolio problems and interact with each other through their staking decisions. The framework portrays the structure and economic activities of the staking economy and endogenously explains token pricing. In particular, the staking ratio plays an important role in both platform development and linking the staking reward rate to price appreciation. The latter naturally relates to the classical puzzle in the foreign-exchange market, *i.e.*, the violation of the uncovered interest-rate parity (UIP) in practice, where the staking reward rate corresponds to the deposit

rate, while the price appreciation corresponds to the exchange-rate changes. Precisely, higher reward rates attract greater future staking, increasing an individual's staking allocation and the staking ratio in aggregate, which in turn predicts positive excess returns.

The comprehensive article empirically corroborates the model predictions. Furthermore, since the UIP is violated, investors have the opportunity to earn both a higher staking reward rate and price appreciation. The article also discusses a potential investment strategy based off this research, which at least historically has had high risk-adjusted returns.

Relevance of the Research Question

This research is crucial not only for constructing a unified framework for studying the phenomena of staking and yield farming, but also for connecting utility tokens as financial technology (FinTech) innovations to traditional assets, such as currencies and commodities.[1] It adds to the framework of tokenomics and serves as a basis for the Commodities Futures Trading Commission (CFTC) to treat cryptocurrencies as commodities.[2] This research also relates to a sizable international finance literature on UIP and the carry trade.

Model and Implications

The theoretical model captures the following two distinguishing features of Proof-of-Stake (PoS) consensus protocols and higher-layer stakable projects. First, such tokens are used on platforms that support specific economic transactions or broader use in on-chain-based projects. This generates utility flows in, *e.g.*, transaction convenience. Second, the rate of staking rewards that an agent earns is influenced by other agents' behavior in aggregate, but individuals take it as given when making decisions.

Agents in the economy derive utilities from consumption over an infinite horizon with a time discount. They allocate and adjust their holdings of staked tokens, tradable tokens, and numeraire under a budget constraint, trading off staking rewards, transaction convenience, and numeraire convenience for offline (off-chain or off-platform) consumption. The resulting equilibrium is characterized by a Master Equation in the mean-field-games (MFGs) framework, which captures the value function that is related to individual states and also influenced by the system states with systematic shocks. The staking reward rate is determined by a fixed point problem. Token price dynamics are fully endogenous and are described by a partial differential equation akin to the Black-Merton-Scholes formula.

There are three main model implications. First, the staking reward is positively related to the staking ratio in the cross-section. While more staking reduces the reward rate for any given reward quantity, more tokens-as-rewards increase the staking yield, which naturally attracts more staking, creating a higher staking ratio in aggregate and for individual agents. Second, the expected price appreciation increases with the aggregate staking ratio. In equilibrium, agents stake more when the platform productivity is low, yet that is exactly the time that more wealth can be potentially allocated to the platform in the future. Third, there are generally predictable excess returns to staking over holding the numeraire, arising as compensation for the losses in transaction and consumption convenience. This is particularly interesting

when relating stakable tokens to traditional assets such as currencies. The token price can be treated as an exchange rate against a numeraire (such as USD), whereas the reward rate can be viewed as a deposit interest rate of the token. Then the model implies that the classical UIP fails.

Data and Empirical Results

The empirical analysis utilizes staking reward rates, staking ratios, and token prices from Stakingrewards.com. Our sample covers daily observations of 66 stakable tokens with the largest market capitalization and longest time span, including both base-layer pan-PoS protocols and higher-layer DeFi platform tokens. The sample period covers July 2018 through November 2022, which includes the initial birth and rapid growth of "staking," as well as bear markets.

The empirical findings support the model predictions. First, we document that a higher reward ratio for staking significantly and positively relates to a higher staking ratio. As the aggregate reward (relative to the total amount of tokens) increases by 0.1 units, the corresponding staking ratio increases by 7.9%. Moreover, the reward rate has a predictable effect on changes in the staking ratio both in the cross-section and in the time series. On average, a 1% increase in reward rate in the previous week increases the staking ratio in the following week by about 0.024%. This property is robust to adding both two-way fixed effect and control variables including market capitalization and volatility. However, its significance decreases with longer time intervals, reflecting to some extent the mechanical downward adjustment of the reward rate when more tokens are staked (because the same staking rewards have to be divided among more staked tokens) and the fact that in practice, tokens are locked for a prolonged time.

Second, a larger staking ratio predicts greater price appreciation in subsequent weeks. When the staking ratio increases by 1%, the corresponding token price appreciates by 0.066% in the following week. Considering that the variation of the staking ratio is often large, especially in the cross-section, this effect is relevant for investment decisions. Crypto market return and size factors do not explain the predictive power of the staking ratio, which is closely related to market liquidity and depth and reflects the fact that tokens can be commodity-like.

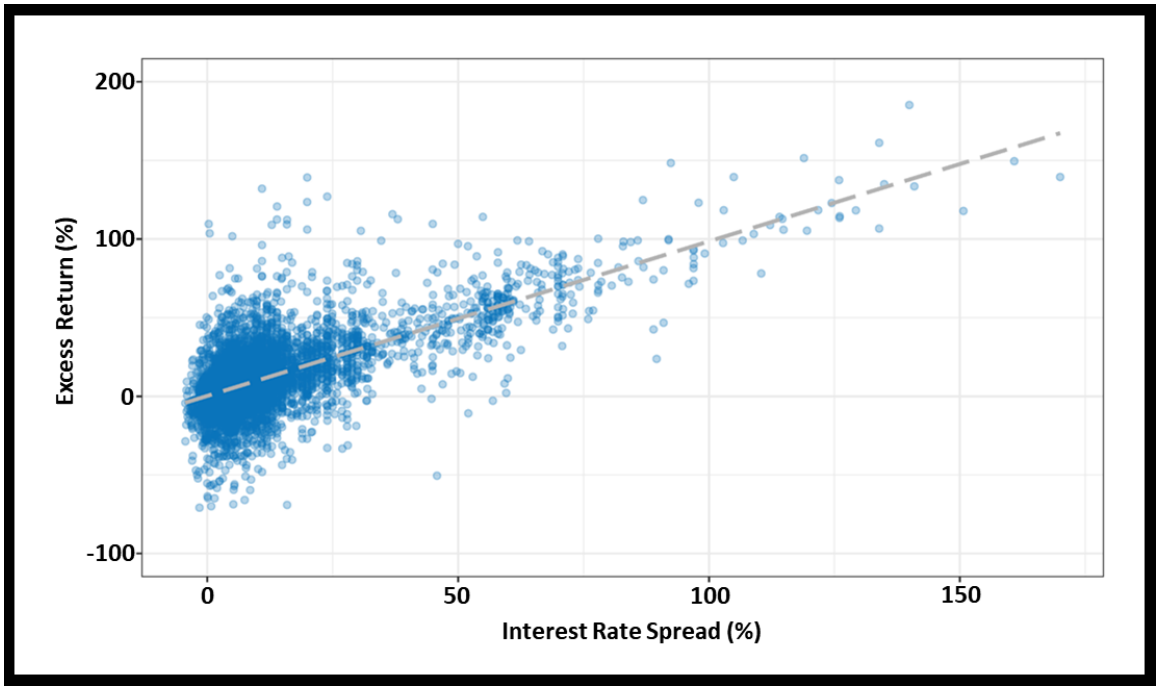
Finally, to test for violations of UIP, we follow Fama (1984)'s method and obtain that the estimated coefficient of the interest-rate spread significantly deviates from zero (where the coefficient should be zero under UIP.) Figure 1 on the next page includes an illustration of UIP violation in the cryptocurrency market over our sample period.

As a corollary of UIP violation, there exists a crypto carry premium. We construct a carry trade strategy that goes long the top 50% high-carry crypto assets and shorts the low-carry assets, yielding a Sharpe ratio of 1.60, which is due to assets with higher carry generating greater returns.[3]

Panel regressions further show that crypto carry predicts excess returns almost one-for-one in the cross-section, with a reduced albeit significant effect in the time series. This does not appear in currencies but does in commodities (Koijen *et al*., 2018). When a commodity has a high spot price relative to its futures price, implying a high carry, the spot price tends to depreciate on average, thus lowering the realized

return on average below the carry. For stakable tokens, however, a different mechanism may be responsible for this phenomenon. In the model, while a high reward rate leads to a high staking ratio and thus a higher price appreciation, there is a downward adjustment effect of the reward rate in the time series. As the sum of carry (approximately equal to the reward rate) and the price appreciation, the excess return is then influenced by the adjustment.

Figure 1
UIP Violation in Cryptocurrency Markets



Note: This figure depicts the violation of uncovered interest-rate parity (UIP) in the cryptocurrency market based on the data sample. The U.S. dollar is treated as local currency and the 1-Year Treasury interest rate is the local interest rate. Each point in the figure indicates a weekly data point for a particular in-sample token. The staking reward rate (annualized) is used as the foreign interest rate, and the x-axis, the interest-rate spread, is calculated as the foreign interest rate minus the local interest rate. The y-axis is the excess return in the next week, including the interest-rate spread and the price appreciation. Since the tokens are priced in U.S. dollars, the price change is the change in foreign exchange rates. The grey line shows a linear trend of the scatter points. If UIP held, the grey line's slope should be close to zero.

Conclusions

This paper relates stakable crypto-tokens to other major asset classes such as currencies and commodities and verifies model implications in our data analysis. In particular, the staking ratio resembles liquidity and market depth since a high staking ratio leads to a lower amount of available tokens available for trade. The staking ratio is proportional to the reward rates in the cross-section but negatively correlated to reward rates in the time series; it positively predicts the price appreciation.

Furthermore, the theoretical framework rationalizes violations of the uncovered interest-rate parity and a significant crypto carry premia that we empirically document. As a corollary in investment applications, a strategy of buying high-carry tokens and shorting low-carry tokens yields a Sharpe ratio of 1.6, which can be attributed to transaction convenience in certain digital networks. Meanwhile, we also indicate and rationalize the impact of the reward adjustment due to the staking mechanism on carry trade returns.

Endnotes

Professor Cong presented on this topic at the Annual Meeting of the Commodity & Energy Markets Association (CEMA) on June 22, 2022 in Chicago.

1 Staking in general involves two broad categories of activities: those related to pan-PoS consensus protocols and those in higher-layer DeFi applications. Under pan-PoS, agents who stake native tokens have opportunities to append blocks and earn block rewards and fees as compensation. This also contributes to contract execution and platform development. In DeFi applications, staking is popular for incentivizing desirable behavior and guarding against misbehavior, which also increases the security level of the platform. Users on DeFi platforms receive staking rewards as a form of interest payment from their staked token balance.

2 The Commodities Futures Trading Commission (CFTC) regards cryptocurrencies as commodities; see, *e.g.*, CFTC (2019).

3 The performance of the long-short carry trade strategy relies on investors' ability to easily short crypto-tokens. But in practice, short selling may be difficult. Therefore, we alternatively have tested long-only strategies. Separate results show that the benchmark, *i.e.*, equal weighting of all stakable tokens, yields a Sharpe ratio of 0.20, while the portfolio that consists of equal weighting the top 50% of high-carry tokens yields a Sharpe ratio of 0.61. We conclude that this indicates the existence of a carry premium.

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Keywords

Blockchain, DeFi, proof-of-stake, yield farming, tokenomics.

Author Biographies

LIN WILLIAM CONG, Ph.D.
Rudd Family Professor of Management and Professor of Finance, SC Johnson College of Business, Cornell University; and Research Associate, National Bureau of Economic Research (NBER)

Professor Cong is the Rudd Family Professor of Management, a tenured Professor of Finance, and the founding director of the FinTech Initiative at Cornell. He is also a Finance editor at *Management Science*, Research Associate at the NBER, cofounder of two international research forums (ABFR and CBER), and was formerly a Kauffman Junior Fellow, Poets & Quants World Best Business School Professor, George P. Shultz Scholar, and Lieberman Fellow. He taught at the University of Chicago after earning his Finance Ph.D. and M.S. in Statistics from Stanford, and an A.M. in Physics jointly with an A.B. in Mathematics and Physics from Harvard. He studies applied theory, asset pricing, corporate finance, and information economics, including novel applications of information design in financial markets. Since 2014, he pioneered interdisciplinary research on tokenomics, crypto asset pricing, Artificial Intelligence (AI) for finance, blockchain forensics and design, and how digitization and big data interact with competition, growth, and entrepreneurship. His work has been recognized with numerous best paper prizes and grants and has been widely circulated and adopted in the industry. A highly sought-after keynote speaker at various international conferences and world forums, he advises leading FinTech firms and quant funds, as well as government and regulatory agencies around the globe.

ZHIHENG HE
Economics Doctoral Candidate, Institute of Economics, Tsinghua University, China

Zhiheng He is an Economics Ph.D. candidate in the Institute of Economics, School of Social Science, Tsinghua University, China. He received his Bachelor of Economics from Tsinghua University in 2019. His research interests include crypto market, stock market, and FinTech innovations. He is also a student fellow at the Cornell FinTech Initiative.

KE TANG, Ph.D.
Professor and Director of the Institute of Economics, Tsinghua University, China

Ke Tang is a Professor and Director of the Institute of Economics, School of Social Science, Tsinghua University, China, where he teaches courses in economics and finance. He received his B.A. in Engineering from Tsinghua University in 2000, Master of Financial Engineering from University of California, Berkley in 2004, and his Ph.D. in Finance from Cambridge University in 2008. His research has covered such topics as the commodity markets, crypto markets, big data and AI in economics. He has published many papers including in the *Journal of Finance*, *Review of Financial Studies*, *Management Science*, *PNAS*, and the *Annual Review of Financial Economics*. He is also a frequent participant in various policy-related conferences held by institutions such as the United Nations, the Organization for Economic Co-operation and Development, and the Food and Agriculture Organization. He currently serves as a managing editor of *Quantitative Finance* and as an associate editor of the *Journal of Commodity Markets*.

Managing Asymmetric Risk: Six Episodes in Crude Oil

Blu Putnam, Ph.D.
Managing Director, Chief Economist, CME Group

John Wiesner
Director, Options Solutions Financial Engineer, CME Group

Arthur Yu
Manager, Data Science & Economics, CME Group

Introduction

Market sentiment is often assumed to be symmetric, or balanced in terms of the risk of potential price moves to the upside or downside. While this sentiment may well be in line with a bell-shaped probability distribution most of the time, our perspective is that risk managers need to be especially aware of market conditions in which significant variability in risk perceptions may be present. For example, if the behavior of market participants suggests that an abrupt and large upside price move has some reasonable probability while prices are expected to grind lower gradually, then one may well see this asymmetry reflected in the prices of options and trading volumes and need to adjust risk-management approaches accordingly.

In this research we use the crude oil market as our case study, and we introduce a method of assessing whether there is meaningful price-risk asymmetry reflected in options pricing. Specifically, we use CVOL, an implied volatility calculation from the CME Group, to look into whether there are important differences between the upside price risk reflected in out-of-the-money call options compared to the downside price risk reflected in out-of-the-money put options.

Our research is divided into three sections. First, we briefly describe CVOL and touch on why this method of calculating implied volatility has some distinct advantages relative to implied volatility measures derived from Black-Scholes-Merton types of option valuation models. Second, we apply our analysis to the crude oil market over the last several years, identifying periods when risk asymmetry was important. And the last section provides a summary of our findings, with particular attention to how risk-management approaches might need to be adjusted when price-risk sentiment is significantly asymmetric.

CVOL and Identifying Periods of Asymmetric Risk Perceptions

CVOL is a technique to measure implied expected volatility and is especially useful for identifying market environments where a distinct asymmetry appears to exist in the form of a large expected price move in one direction versus more moderate moves in the other direction. That is, we want to know more than a single metric of expected volatility; we also want to know when risk sentiment is skewed in one direction or the other. While there are many ways to get at this question of identifying asymmetry in expectations or skewness, they are typically quite complex to implement and often require considerably more

information than is needed for CVOL. This excess information may unnecessarily complicate the analysis. And the underlying or embedded assumptions in these alternative techniques can be inappropriate to understanding market price-risk asymmetry when it exists. Specifically, we note the following advantages of CVOL:

- It is a straightforward method to calculate expected or implied volatilities from options prices.
- CVOL's calculation does *not* assume either a normal or log-normal probability distribution (*i.e.*, the CVOL method is independent of the underlying probability distribution).
- Price gaps are incorporated (*i.e.*, discontinuity is allowed, and so the calculation does *not* assume or require smooth price continuity as prices abruptly move up or down).
- The technique provides separate basic measures for upside and downside risk expectations in an intuitive manner (*i.e.*, there is no need to calculate the whole volatility surface or create the options "smile," strike by strike, to assess convexity or skewness).

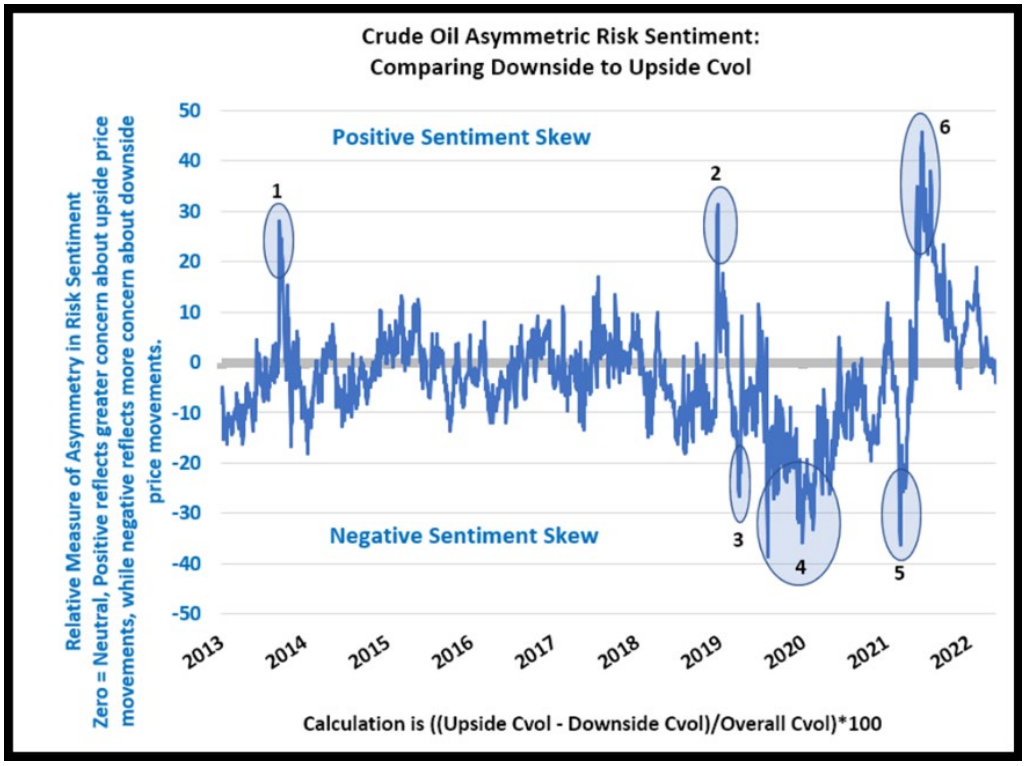
One can observe from typical options volatility curves that out-of-the-money options imply higher volatility than at-the-money options for the same underlying asset with the same maturity. Since every strike on the options volatility curve potentially has a different implied volatility level, the calculation of CVOL, which utilizes all the options strike prices for a given maturity, makes the result unambiguous. Specifically, out-of-the-money put options are used to calculate downside price risk, and out-of-the-money call options are used to calculate upside price risk. For a single measure of implied volatility, we combine the out-of-the-money options volatility metrics for both puts and calls. To assess asymmetry in risk sentiment or skewness, we look at the difference in the upside and downside implied volatility metrics. For a mathematical description of both CVOL and its "Derivative Indicators," one may consult CME Group (2023) as well as refer to the Appendix for this article.

There are several things to note about CVOL compared to more traditional Black-Scholes-Merton style implied volatility calculations. First, the shape of the distribution is determined by the market and the forced assumption of either a normal or log-normal distribution is not required. Second, since CVOL uses all the strike prices and since out-of-the-money implied volatilities are generally higher than the at-the-money, CVOL will generally produce a slightly higher implied volatility measure than an implied volatility taken only from the at-the-money call and put options. This means CVOL is able to capture the effect of the "volatility smile" in providing a more realistic expectation of future volatility. All in all, CVOL's lack of unrealistic assumptions embedded in traditional Black-Scholes-Merton style implied volatility calculations very much appeals to us. And, as our goal in this research is to explore the potential for asymmetric risk sentiment, we can use differences in the downside put implied CVOL relative to the upside call implied CVOL. With these observations in mind, we can now move to our case study of the WTI crude oil market, which, in turn, explains the relevance for risk management of comparing downside and upside implied volatilities.

Crude Oil and Periods of Asymmetric Risk

Our examination of the WTI crude oil options market provides us with an interesting perspective on how to use the upside (call) and downside (put) price risk implied by our CVOL calculations to explore the cases where distinct asymmetry was present. Since 2013, there are six episodes where the asymmetry was noticeably extreme in the crude oil market: three to the upside and three to the downside. See Figure 1. We will take a brief look at each episode. Since there are only six episodes, please avoid jumping to any generalized conclusions. Nevertheless, there are definitely a few insights we can gain from examining each of the six episodes.

Figure 1
Identifying Asymmetric Risk Sentiment in the Crude Oil Market



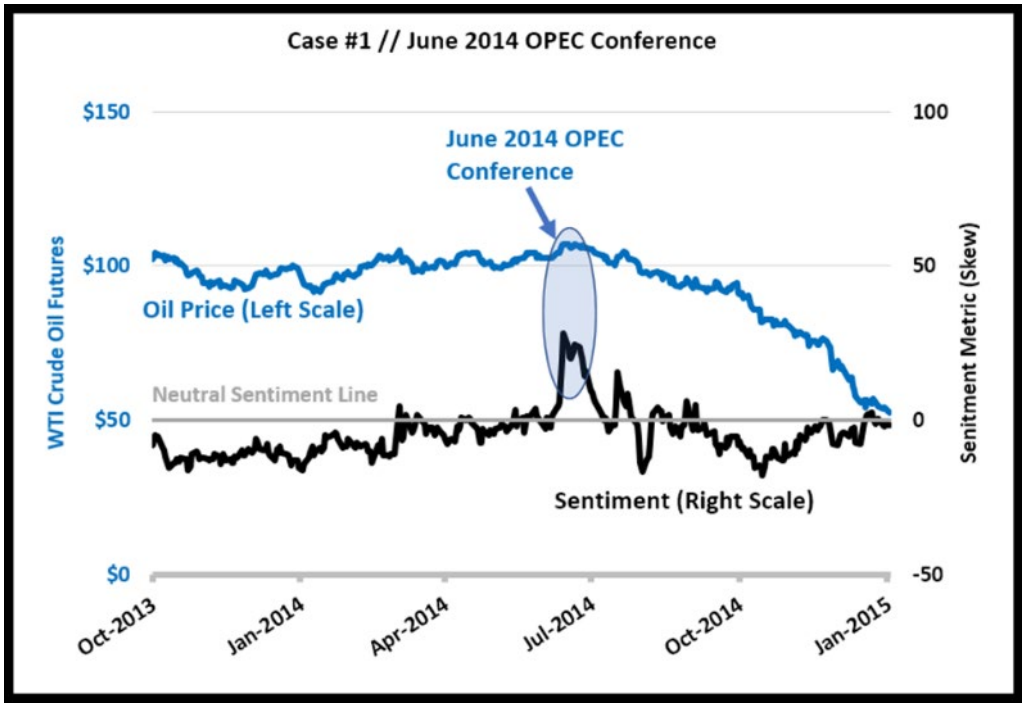
Source: CME Group.

Also, the time frequency matters. In this case study, we are always using a one-month CVOL, estimated from the option contracts expiring in just less than one month combined with the options contracts expiring shortly beyond one month to give us a representative 30-day option CVOL. To identify periods of distinct asymmetry between the upside and downside implied volatilities from CVOL, we standardize by taking the difference in the upside and downside volatilities divided by overall CVOL for each day since the beginning of 2013. When this asymmetry sentiment risk metric is above zero, it indicates a bias toward upside potential price moves. A reading below zero implies a bias toward downside potential price moves. A reading of zero (or close to zero) implies a balance in the sentiment risk.

Case #1: June 12 – June 25, 2014: Upside Price Risk (OPEC)

WTI crude oil prices had been hovering around $100/barrel (nearby futures price) or just above $100 for the first five months of 2014. The June OPEC conference that year (technically the 165th session of the OPEC conference) was very much on the minds of oil market participants.

Figure 2
WTI Crude Oil Prices & Risk Sentiment, October 2013 – December 2014



Source: Bloomberg Professional for oil prices (CL) and CME Group CVOL sentiment (skew) metric.

Economic growth was moderate to relatively robust from the U.S. to Europe to China. OPEC had held discussions in Moscow about coordination with Russia earlier in 2014. Our reading of the overall consensus of market participants at the time was that OPEC would not announce any production cuts or increases. That said, some oil market participants were afraid of any signs that OPEC might want to constrain production and try to push market prices well above $100/barrel. Because of the relatively positive picture on global economic growth, concerns about a sharp fall in the price of oil were relatively minimal. Hence, there was a skew to the upside in price-risk sentiment.

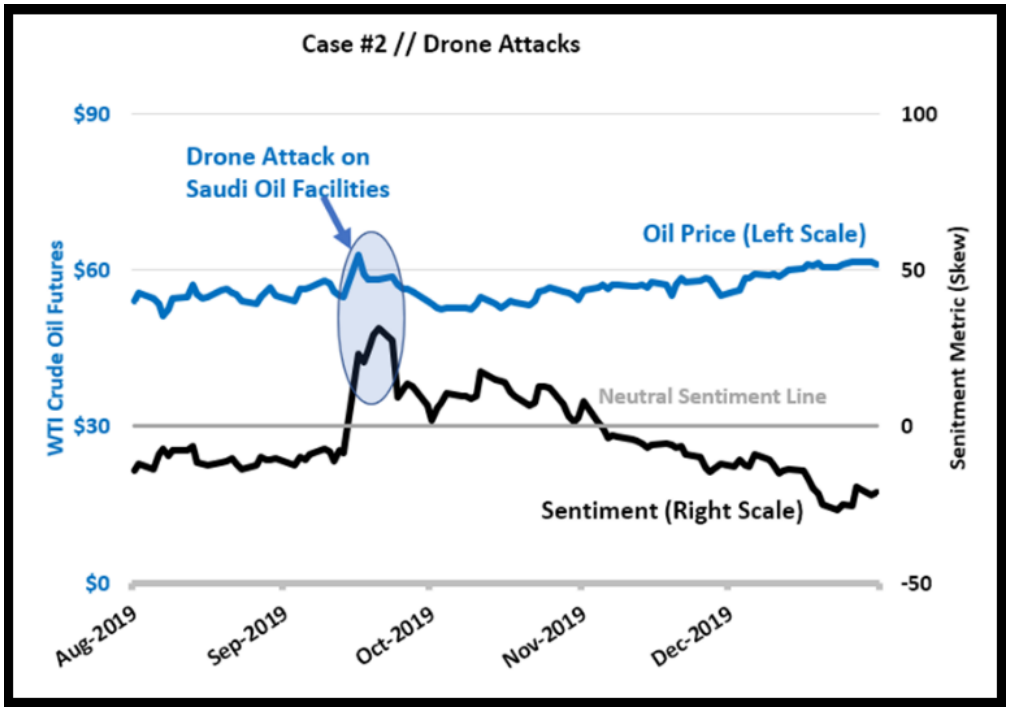
Worth noting is that the WTI crude oil futures maturity curve was in severe backwardation. During the time of the OPEC meeting in June 2014, the nearby futures contract was trading about $15/barrel higher than the 24-month out futures contract. Once the short-term concerns of some market participants were removed by OPEC doing nothing on production at its meeting, oil prices started to trend lower for the rest of 2014. In this case, and please avoid generalizing this scenario as already advised, once the upside price

fears were removed, the market commenced a steady trend toward lower prices. See Figure 2 on the previous page.

Case #2: September 16 – September 23, 2019: Upside Price Risk (Drone Attack on Saudi Arabia)

The upside price concerns evident in the CVOL metrics for September 2019 were directly related to the attacks on crude oil production, which was down 1,318,000 barrels per day in September compared to the previous month. The oil production decline was due to the drone attack on the Saudi oil complexes at Abqaiq and Khurais, which occurred on September 14, 2019. There were fears among many market participants of further attacks causing additional production losses and sharply higher prices. Those fears quickly proved unfounded, as Saudi Arabia brought oil production back to normal in a very rapid process. See Figure 3.

Figure 3
WTI Crude Oil Prices & Risk Sentiment, August 2019 – December 2019



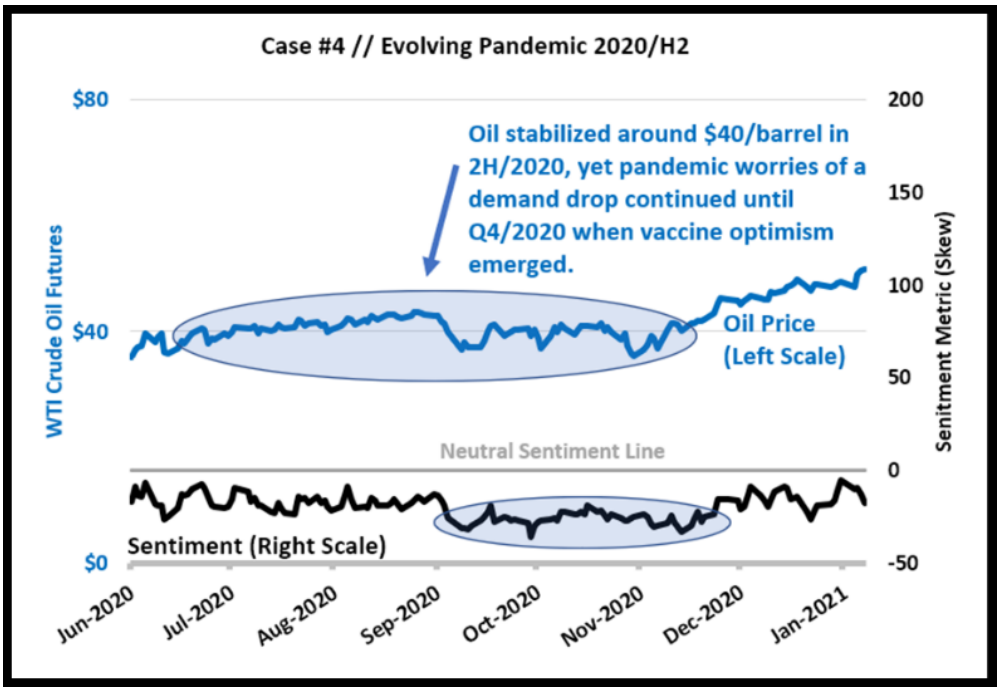
Source: Bloomberg Professional for oil prices (CL) and CME Group CVOL sentiment (skew) metric.

Case #3: April 23 – May 8, 2020: Downside Price Risk (Start of the Pandemic)

The concerns about a large downside price movement in late April 2020 were triggered by the spread of the COVID-19 virus and the partial shutdown of the service sector all over the world, dramatically reducing the demand for refined petroleum products for transportation, especially air travel but also for moving people and goods by trains, trucks, buses, and cars. The unanticipated sharp decline in oil demand resulted in a rapid build of oil stocks in storage facilities around the world, with attention focused on the

build-up at Cushing, Oklahoma, due to its role as a delivery point for WTI crude oil futures contracts if held to expiration. An extremely small percentage of futures contracts are held to expiration and require the short-side of the market to deliver oil to the long-side, as over 90% of all futures contracts are closed or rolled into the next maturity before expiration and entering the delivery period. Even so, in this event, the nearby WTI crude oil futures price actually turned negative at expiration for one day. Futures participants quickly rolled positions out an extra month to avoid any delivery risk, and at the same time the inventory backlog was spread across other storage facilities, including oil shipping tankers. The downside price fears quickly abated, and prices commenced an upward price pattern. See Figure 4.

Figure 4
WTI Crude Oil Prices, 2020/H2 and the Evolving Pandemic



Source: Bloomberg Professional for oil prices (CL) and CME Group CVOL sentiment (skew) metric.

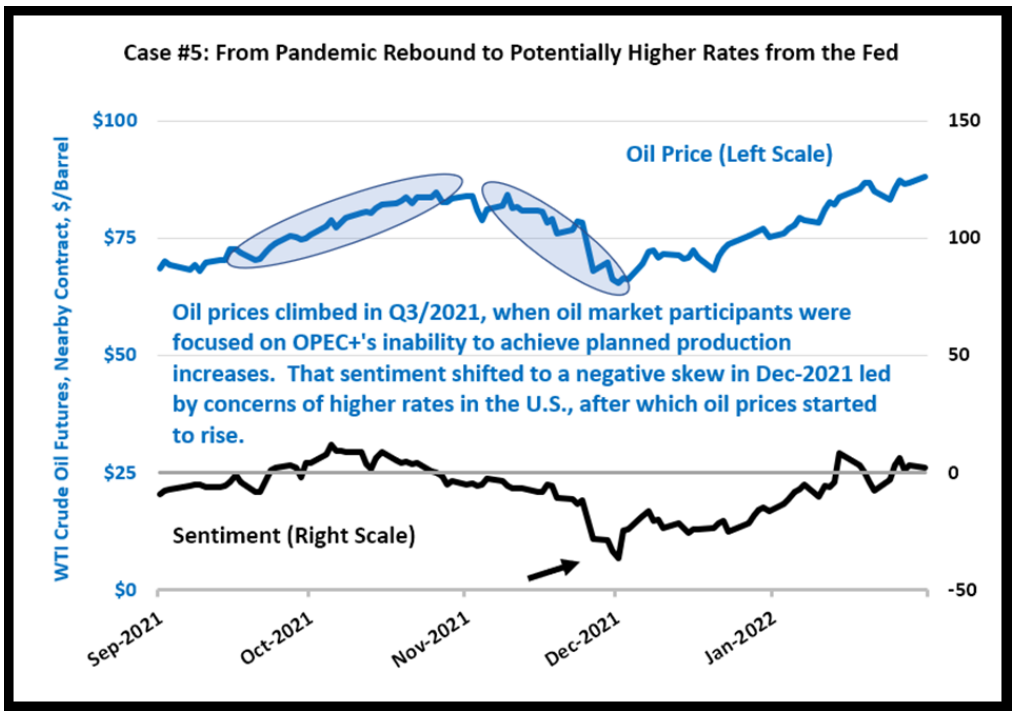
Case #4: June 25 – November 23, 2020: Downside Price Risk (Pandemic Fatigue)

For many months after the negative oil price shock of late April 2020, the uncertainties related to the unfolding of the pandemic, the lack of vaccinations, and general worries over the extent of economic deterioration that might impact oil prices to the downside were factors in causing persistent asymmetry in oil market price-risk sentiment. The downside price worries remained elevated even though the nearby futures oil price stabilized in the $40/barrel territory from June through October 2020. The imminent arrival of effective vaccines toward the end of 2020 removed the fears of demand falling and created an atmosphere of general optimism that economic growth would resume. Greater symmetry returned to oil price-risk sentiment and a pattern of price rises followed as well. See, again, Figure 4.

Case #5: November 26 – December 28, 2021: Downside Price Risk (From OPEC+ to Higher U.S. Interest Rates)

Oil prices climbed from August 2021 through October 2021. During that period, oil market participants were focused on OPEC+, and its inability to achieve planned production increases. The positive sentiment abruptly shifted to negative sentiment and downside price concerns led by expectations of higher rates in the U.S. and weaker economic activity globally. The negative sentiment was short-lived. Sentiment returned to a neutral state as oil prices started to rise in early 2022, even before the Russian invasion of Ukraine. See Figure 5.

Figure 5
WTI Crude Oil Prices, 2021

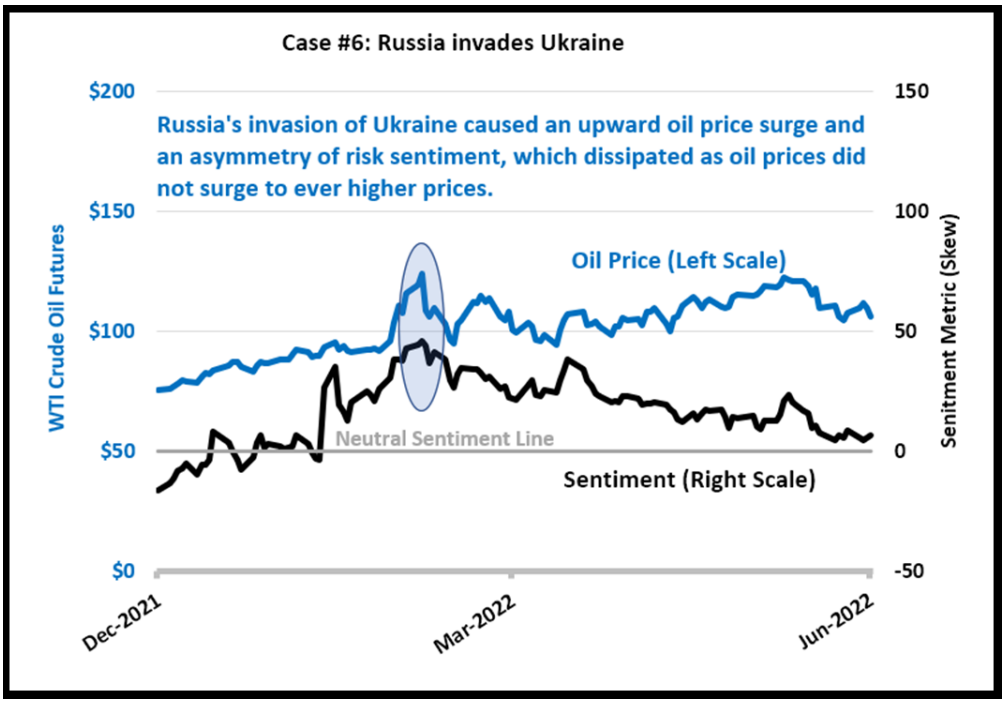


Source: Bloomberg Professional for oil prices (CL) and CME Group CVOL sentiment (skew) metric.

Case #6: February 11 – May 9, 2022: Upside Price Risk (Russia Invades Ukraine)

Russia's invasion of Ukraine in February 2022 set in motion an emphasis on the risk of a sharp upside price move if Russia were to abruptly cut off the flow of oil and natural gas to western Europe. Natural gas prices in Europe, already rising before the Russian invasion, shot skyward. Oil and wheat prices also surged due to the invasion. With the U.S. and European Union imposing sanctions on Russia, concerns about an oil price surge were elevated. By the summer, though, oil market participants realized that the worst-case scenario of an oil price surge was increasingly unlikely, and as the price pattern shifted to a downward trend, market sentiment came back into balance. See Figure 6 on the next page.

Figure 6
WTI Crude Oil Prices 2022



Source: Bloomberg Professional for oil prices (CL) and CME Group CVOL sentiment (skew) metric.

Risk Management During Periods of Asymmetric Risk

We have studied only the six episodes of distinct oil price-risk sentiment asymmetry that have occurred since 2013. With this limited data set, we caution against making any confident assessments of what might happen when these periods develop. Nevertheless, as shown in a straightforward manner through our use of CVOL to analyze market sentiment, periods of heightened asymmetry in oil price-risk sentiment do seem to suggest an elevated probability of a change in the previous price trend. Either the risk about which many market participants are concerned materializes, or it does not. That is, the appearance of distinct asymmetry in CVOL-calculated upside and downside implied volatility from the options market, looking across the full spectrum of strike prices for the same maturity, can be an important signal of event risk. In our interpretation, the event risk is characterized by two scenarios, both with meaningful probabilities and yet, over time, only one scenario can prevail. Once one scenario or the other prevails, then the market generally reverts to a more balanced price-risk sentiment, and often a new price trend.

What this means for risk management is that there are heightened probabilities for an abrupt change in prices, up or down, and/or a new price trend developing. The potential for an elevated probability of price gaps makes some risk-management approaches less viable, such as delta hedging. Our conclusion is that risk managers need to be on high alert during these periods of asymmetric price-risk sentiment, carefully studying the underlying causes. In each of our six cases, the underlying causes were strikingly different, from an OPEC meeting to the pandemic and the Russian invasion of Ukraine. So, the emphasis for risk

management is to develop a scenario-based approach that takes into consideration the distinctly different possible outcomes when event risk is present.

Appendix: Calculating CVOL

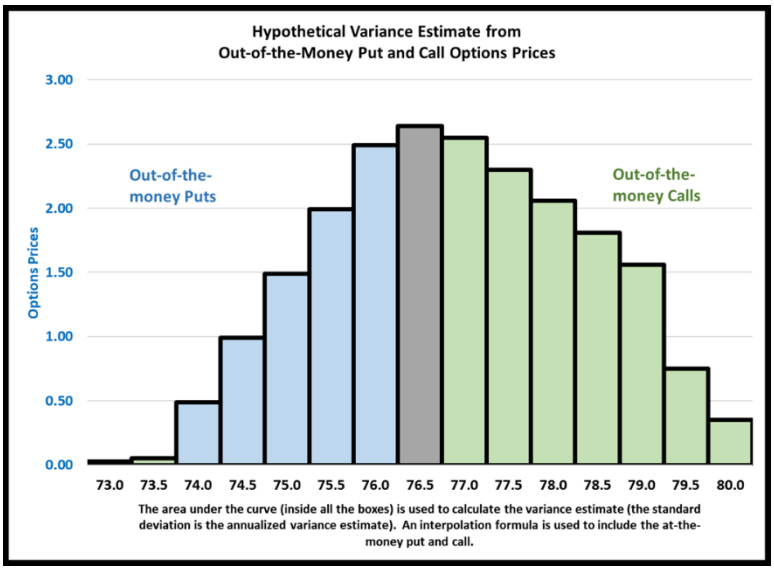
The CVOL calculation method is known as a variance estimate. Start with a hypothetical table of out-of-the-money put and call options prices for one specific maturity or expiration date. See Figure 7 below. Then, consider a chart with the options prices on the vertical axis with the different strike prices arranged along the horizontal axis. See Figure 8 on the next page. The area inside all the boxes, representing the distance between strike prices multiplied by the option price, is used to calculate the estimated variance, which can then be adjusted to provide a standard deviation estimate and annualized. As can be observed in this example, the shape of the probability distribution is determined by the market prices for the different available strike prices and does not embed heroic or unrealistic assumptions about the shape of the probability distribution as is done with Black-Scholes-Merton type estimates for implied volatility. We also point out that with the CVOL method, one easily can do a calculation of the estimated variance just using the downside (puts) and the upside (calls). As a quick note, the at-the-money price used is an interpolation of the closest put and call prices to the underlying asset price.

Figure 7
Table of Prices and Strikes

Hypothetical Options Strikes and Prices				
At-the-Money equals 76.5				
Put Options Prices	Strike		Call Options Prices	Strike
2.73	76.50		0.35	80.00
2.49	76.00		0.75	79.50
1.99	75.50		1.31	79.00
1.49	75.00		1.56	78.50
0.99	74.50		1.81	78.00
0.49	74.00		2.06	77.50
0.05	73.50		2.30	77.00
0.03	73.00		2.55	76.50

Source: CME Group. For a more comprehensive explanation, see:
https://www.cmegroup.com/education/courses/introduction-to-cvol/understanding-the-cvol-index.html.

Figure 8
Probability Distribution for Variance Estimate Calculation



Source: CME Group.

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Author Biographies

BLUFORD PUTNAM, Ph.D.
Chief Economist, CME Group

Dr. Bluford Putnam is a Managing Director and Chief Economist of CME Group. As Chief Economist, Dr. Putnam is responsible for leading the economic analysis on global financial markets by identifying emerging trends, evaluating economic factors and forecasting their impact on CME Group and the company's business strategy. He also serves as CME Group's spokesperson on global economic conditions and manages external research initiatives.

Prior to joining CME Group, Dr. Putnam gained experience in the financial services industry with concentrations in central banking, investment research and portfolio management. He also has served as President of CDC Investment Management Corporation and was Managing Director and Chief Investment Officer for Equities and Asset Allocation at the Bankers Trust Company in New York. His background also includes economist positions with Kleinwort Benson, Ltd., Morgan Stanley & Company, Chase Manhattan Bank and the Federal Reserve Bank of New York. Dr. Putnam holds a Bachelor's degree from Florida Presbyterian College (later renamed Eckerd College) and a Ph.D. in Economics from Tulane University.

Dr. Putnam has authored five books on international finance, as well as many articles that have been published in academic journals, including the *American Economic Review*, *Journal of Finance*, and *Review of Financial Economics* among others. His latest book, Economics Gone Astray, is available from World Scientific (WS) Professional.

JOHN WIESNER
Director, Options Solutions Financial Engineer, CME Group

John Wiesner is a Director and Options Solutions Financial Engineer at the CME Group. Amongst his prior professional roles, Wiesner served as a Senior Financial Engineer at Numerix and as a Risk Management Strategist at the CBOE. He has an M.B.A. from the University of Chicago in Finance, Econometrics, and Statistics and a B.A. in Philosophy from Thomas Aquinas College.

ARTHUR YU
Manager, Data Science & Economics, CME Group

Arthur Yu is a Manager for Data Science in the Economics Department of the CME Group. He has a Master's in Analytics from the University of Chicago and is currently enrolled in the Master's in Computer and Information Technology program at the University of Pennsylvania.

He is also the president of the board of directors of Nankai University's American Alumni Association of Finance, a group of over 200 financial professionals and executives in the U.S. that provides collaborative opportunities in academics and business to students and faculties at the university. In his role as president, Mr. Yu is heavily involved in providing essential career guidance and informational services on important events to alumni to help establish themselves in the U.S.

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Digital Assets Regulation in 2023: Is a New Regulatory Framework Finally Emerging?

Deanna Reitman
Of Counsel, DLA Piper; and Editorial Board Member, *Commodity Insights Digest*

Elizabeth S. M. Caires
Senior Attorney, DLA Piper

Michael Mapp
Associate, DLA Piper

Eric Forni
Partner, DLA Piper

Evan North
Of Counsel, DLA Piper

Introduction

A redefined regulatory framework is on the horizon for the digital asset marketplace. In this article, we look at the current state of U.S. regulatory authority over digital assets and explore potential changes in the regulation of digital assets.

Background

On December 1, 2022, in the wake of the downfall of cryptocurrency exchange FTX Trading Ltd., Rostin Behnam, the chairman of the U.S. Commodity Futures Trading Commission (CFTC), urged the U.S. Congress to create a new regulatory framework for digital assets.

Behnam stated that digital assets need to be overseen by a single federal regulator, replacing the current paradigm of overlapping CFTC and U.S. Securities and Exchange Commission (SEC) authority. He noted that the current regulatory situation has undermined the CFTC's investigation into the FTX debacle; for example, the agency is (a) unable to register cash market exchanges, (b) does not have legal authority to examine any of FTX's other entities, and (c) has no visibility into the operations of those FTX subsidiaries.

CFTC and SEC – Current Statutory Authority

Both the CFTC and the SEC have claimed primary authority to regulate digital assets. The CFTC says that digital assets are commodities, while the SEC says most digital asset offerings are investment contracts subject to its jurisdiction.

The CFTC has authority over "commodities" as defined in the U.S. Commodities Exchange Act (CEA). This authority includes derivatives, over-the-counter swaps, futures contracts, options contracts, and enforcement fraud and misconduct penalties relating to derivatives and commodities.

The CFTC first defined digital currencies as commodities under the CEA in settlement of the enforcement action *In the Matter of Coinflip, Inc, d/b/a Derivabit, and Francisco Riordan, CFTC Docket No. 15-29*. In *Coinflip*, the CFTC stated that the definition of a "commodity" is broad and "bitcoin and other virtual currencies are encompassed in the definition and [are] properly defined as commodities." Thus, the CFTC concluded it has clear authority to regulate cryptocurrencies. However, even with this expansion of CFTC authority, the CFTC has little to no power to regulate spot markets for commodities - even if the commodities are digital currencies.

The SEC has authority over "securities" as defined in the U.S. Securities Act of 1933, the Securities Exchange Act of 1934, and the Investment Company Act of 1940, as well as authority over virtually any instrument that might be sold as an investment. The SEC also has more expertise in overseeing the securities markets.

The SEC considers an investment contract as all offerings of an asset in a manner described under the test in *SEC v. W.J. Howey*. The Howey Test states that an investment contract exists where there is a monetary investment into a common enterprise with the reasonable expectation of profits due to the efforts of others. As a result, the SEC considers digital assets that fall under the Howey Test to be "investment contracts" in the form of securities similar to stock in publicly traded companies. The SEC has released guidance providing a framework for whether a digital asset is a security, stating that persons and entities engaged in the marketing, offer, sale, resale, or distribution of any digital asset must determine if the federal securities laws apply to such action using the Howey Test.

CFTC and SEC – Current Regulatory Authority Arising from Case Law

The two federal agencies are jockeying for pole position in the regulation of digital assets, but courts have affirmed the authority of both agencies over certain digital assets in different contexts.

Courts have affirmed the CFTC's authority to regulate digital assets in cases involving fraud and Ponzi schemes. These courts have further stated that the CEA's text supports the CFTC's assertion of authority due to the CEA defining "commodities" broadly. The courts therefore conclude that the CFTC taking a broad position in its anti-fraud jurisdiction over digital assets is still aligned with congressional intent to strengthen federal regulations of commodity futures trading.

Courts have also supported the SEC's authority over digital assets, notably in the context of initial coin offerings (ICOs).

In *SEC v. LBRY*, the court examined the economic realities surrounding an offering of a digital asset that would lead investors to have a reasonable expectation of profits to be derived from the entrepreneurial

or managerial efforts of others along with whether the offeror of the digital assets was aware of the digital assets' potential value as an investment.

Additionally, in cases such as *In the Matter of Steven Seagal and SEC v. Balina*, the SEC has initiated enforcement actions against individuals and entities for promotion of ICOs with a lack of or inadequate disclosure of material relationships.

Defining a New Regulatory Framework

Several bills have been introduced in Congress to define a new regulatory framework for digital assets. Among the bills introduced in the Senate are the Responsible Financial Innovation Act, introduced in June 2022, and the Digital Commodities Consumer Protection Act of 2022, introduced in August 2022, which would establish a regulatory framework that would set clear standards and define appropriate jurisdictional boundaries while offering greater protections for customers.

Both of these bills aim to give the CFTC more extensive jurisdiction to regulate digital commodity trading. While Congress may grant such jurisdiction to the CFTC, it would not limit the SEC's ability to regulate digital commodities that are offered as securities. Indeed, U.S. Senator Debbie Stabenow (D-MI), the sponsor of the Digital Commodities Consumer Protection Act of 2022, stated that the bill would not take authority away from financial regulators and that the bill recognizes that other financial agencies play some role in the regulation of digital assets that are not commodities, for example, securities. Moreover, the Responsible Financial Innovation Act distinguishes between digital assets that are securities regulated by the SEC and those that are commodities subject to CFTC oversight, in addition to giving the CFTC authority over digital asset spot markets.

In December 2022, the Digital Asset Anti-Money Laundering Act was introduced in the Senate, aiming to bring know-your-customer rules to digital asset participants, including wallet providers and miners. The bill would prohibit financial institutions from transacting with digital assets mixers that obscure the origin of funds of parties. While the bill does not grant specific jurisdiction to one agency over the other, it does direct both the CFTC and the SEC to establish risk-focused examinations and to review the adequacy of anti-money laundering programs and reporting obligations.

Each of these bipartisan bills designate the CFTC as the regulatory agency in the spot crypto space. This is partially because the CFTC has brought enforcement actions against several individuals and entities operating in digital asset spot markets using the current CEA and its rules.

In 2022, the CFTC brought over 80 enforcement actions. More than 20 percent of those were brought against entities engaging in the digital asset marketplace, including some of its major participants.

Moreover, crypto platforms globally have combined the trading of spot digital assets with derivatives of such assets. Because of this amalgamation, and the CFTC's existing authority over derivatives trading involving digital currencies, many of those contemplating a new regulatory framework think that it would be more efficient to allocate authority over spot trading of digital assets to the CFTC.

FTX and Regulatory Control

After the fall of FTX, both the CFTC and the SEC charged Sam Bankman-Fried, his companies, several FTX executives and Alameda Research LLC with criminal activity related to the downfall of FTX.

The CFTC alleges fraud and material misrepresentations in connection with the sale of the FTX exchange digital tokens, FTT, as digital commodities in interstate commerce resulting in the loss of over $8 billion in customer deposits. The CFTC further alleges that FTX did not segregate from FTX's own assets customer funds, which were accepted and held by Alameda. Moreover, FTX had features in its code allowing Alameda to essentially maintain an unlimited line of credit on FTX.

The SEC alleges FTX had concealed diversion of customers' funds to Alameda while raising more than $1.8 billion from investors. In its fraud, FTX and Bankman-Fried attempted to conceal from FTX investors the undisclosed diversion of FTX customer funds to Alameda, the undisclosed special treatment of Alameda on the FTX platform, and undisclosed risk stemming from FTX's exposure to Alameda's significant holdings of overvalued illiquid assets such as FTX-affiliated tokens. The SEC contends that the former executives of Alameda and FTX had engaged in market manipulation of the FTT token at the direction of Bankman-Fried. To underscore that these are security violations, the SEC further contends that FTT is a security because it was "offered and sold as an investment contract."

The results of these cases may succeed in clarifying some ambiguities as to whether digital assets are commodities or securities, or both – possibly before any defining legislation can pass both the U.S. House of Representatives and the Senate. More importantly, these cases, brought simultaneously and cooperatively by the CFTC and SEC, could be a sign of things to come: the CFTC receiving more explicit tools and authority from Congress to regulate the space than any other agency, while the door remains open for the CFTC and the SEC to work together on prosecuting fraud on digital assets, which also are securities under the Howey Test.

CFTC Recommendations

The CFTC has put forth a set of recommendations for a to-be-implemented regulatory framework. These recommendations are based on the current regulatory framework implemented by the CFTC for designated contract markets, swap execution facilities, and intermediary entities required to register with the CFTC. Its recommendations include:

- Oversight of spot digital assets to be placed in the hands of a single agency, the CFTC, to reduce regulatory fragmentation. This concentration would include creating a fully fleshed out regulatory structure for these assets.

- A registration requirement for digital currency exchanges.

- Regulatory power to compel participants in the digital assets space to (a) outline their separation and protection of customer funds, (b) prove they are maintaining sufficient capital to operate, and (c) provide public disclosures backed by independent accounting.

- Lastly, Congress should bridge the gap between CFTC and SEC regulation of the space by properly defining the difference in commodities versus securities.

Conclusion

The CFTC appears poised to retain and perhaps even expand significant regulatory authority over digital assets. Indeed, on October 14, 2022, SEC Chair Gensler recommended that Congress grant the CFTC explicit jurisdiction over at least those digital assets consisting of stablecoins and the stablecoin exchanges.

As the potential regulatory framework begins to take shape, participants in the space should prepare for significant change. To understand what may come next, these market participants can look to rules and regulations put in place by the CFTC for participants in the swaps, options, and futures marketplaces. However, even if the CFTC does gain regulatory jurisdiction over digital assets through legislation, token issuers should be aware that the SEC will retain some authority due to case law and the Howey Test for investment contracts.

Endnotes

For additional information on this and related subjects, one may contact DLA Piper's Commodities team at DLAPiperCommodities@us.dlapiper.com.

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Author Biographies

DEANNA REITMAN
Of Counsel, DLA Piper and Editorial Board Member, *Commodity Insights Digest*

Deanna Reitman has over 20 years of experience working in commodity markets and more than 18 years of senior management experience. Her background encompasses legal, regulatory and business experience in commodities, with a particular focus on energy. She has extensive global energy commodity legal and regulatory experience. Reitman is a skilled communicator and team manager with a record of success in achieving complicated objectives. Her core competency is in legal and regulatory global commodity marketing and trading, in both physical and financial markets. At DLA Piper, Reitman draws upon her experience as an in-house counsel for energy commodities marketing and trading firms to advise on the structuring of transactions and provide regulatory and commercial advice to energy clients.

ELIZABETH S. M. CAIRES
Senior Attorney, DLA Piper

Elizabeth Caires is a technology compliance attorney, with over 15 years' experience advising on the adoption of fully digital transactions and processes, including the practical application of law to technology platforms used for electronic signatures, in person and remote electronic notarization, and creation and vaulting of digital assets. Caires advises both technology platform providers and commercial enterprises across various industries with respect to compliance with laws, regulations and industry standards related to electronic signatures and records. Represented industries include technology companies in the electronic contracting or electronic and remote notarization space, as well as commercial entities purchasing such services, such as entities in financial services, FinTech, equipment leasing, mortgage, and other industry sectors.

MICHAEL MAPP
Associate, DLA Piper

Michael Mapp focuses his practice on corporate commodities and representing entities conducting a variety of transactions including mergers and acquisitions and debt finance. He primarily has experience in advising entities operating in the energy sector and entities in the trade of emissions reduction credits in navigating complexities of the Dodd-Frank Act and CFTC regulation. He has further experience representing businesses in the energy sector including renewable energy companies, liquid natural gas companies, and coal companies.

ERIC FORNI
Partner, DLA Piper

Eric Forni is an experienced investigator, federal securities laws advisor, civil litigator, and trial attorney who represents clients in connection with Securities and Exchange Commission (SEC), Department of Justice (DOJ), Commodity Futures Trading Commission (CFTC), and Financial Industry Regulatory Authority (FINRA) inquiries or investigations; internal investigations; and a variety of federal securities laws compliance-related matters, including those related to digital assets, insider trading policies and procedures, broker-dealer anti-money laundering (AML) policies and procedures, auditor independence rules, and the marketing rule applicable to investment advisers. Before joining DLA Piper, Forni served as a senior trial and enforcement attorney with the SEC for 15 years, where he developed a deep understanding of the SEC and the laws it enforces, as well as knowledge in such areas as digital asset-related securities registration rules and life science company disclosure obligations.

At the SEC, Forni coordinated parallel investigations with such agencies as the Federal Bureau of Investigation and worked on matters with the assistance of FINRA. Additionally, he was a member of the SEC's Market Abuse Unit, focusing on matters related to complex insider trading, broker-dealer and hedge fund conduct and market manipulation. Forni previously worked as a Special Assistant United States Attorney for the District of Massachusetts, where he conducted federal jury trials in cases concerning conspiracy; securities, mail and wire fraud; witness tampering; false statements; and structuring. He also worked on all aspects of criminal prosecutions, including grand jury investigations and plea negotiations. Forni is a recipient of the Paul R. Carey Award, a national award conferred by the SEC to recognize individuals with exceptional personal commitment and effectiveness, unquestioned integrity, unlimited enthusiasm, and unwavering dedication to the protection of the individual investor.

EVAN NORTH
Of Counsel, DLA Piper

Evan North is a litigator with broad experience handling complex government investigations and related civil and criminal litigation. North focuses his practice on handling inquiries by government authorities. He regularly counsels companies in responding to subpoenas issued by grand juries and regulators and has managed real-time responses to unannounced government inspections. North has successfully resolved high-risk regulatory and criminal inquiries brought by federal and state authorities, both in early negotiations and at trial. In his litigation practice, North has successfully resolved white-collar matters for individual and corporate clients and a variety of complicated civil matters. He has experience in an array of industries, including technology, health care, and banking.

Managing the U.S. Strategic Petroleum Reserve in the Face of Uncertainty

The U.S. Strategic Petroleum Reserve (SPR), "the world's largest supply of emergency crude oil was established primarily to reduce the impact of disruptions in supplies of petroleum products and to carry out obligations of the United States under the international energy program," notes the U.S. Department of Energy.[1] Dr. Ilia Bouchouev is an expert on the U.S. SPR, and as such provided testimony on March 8, 2023, regarding this topic to a subcommittee of the U.S. House Committee on Oversight and Accountability, specifically the U.S. House Subcommittee on Economic Growth, Energy Policy, and Regulatory Affairs. Dr. Bouchouev is a Managing Partner at Pentathlon LLC and is also an Editorial Board member of the Commodity Insights Digest (CID). The following is Dr. Bouchouev's testimony to the U.S. House Subcommittee; and of note, all views expressed in the CID are those of the individual authors or presenters and not necessarily those of its sponsors or donors.

Introduction

My name is Ilia Bouchouev. I'm an energy consultant and an educator. I'm an adjunct professor at New York University and a research associate at The Oxford Institute of Energy Studies. Prior to that, I spent over 20 years managing global derivatives trading business for Koch Supply & Trading.

In my testimony, I would like to focus on two principal points. One is how storage of limited resources, such as the U.S. Strategic Petroleum Reserve (SPR), must be managed in the presence of uncertainty, and second is how this uncertainty and the price of oil relate to global financial markets.

The SPR Strategy: Risk-Free Return or Return-Free Risk?

Any storage capability is an extremely valuable asset. Storage literally buys time. It allows supplies to be shifted from times of relative abundance to times of scarcity. The problem of optimal storage decisions goes back to the very beginnings of human civilization. It is a very difficult problem, as the decision today depends on what might happen tomorrow, which, of course, we don't know with certainty.

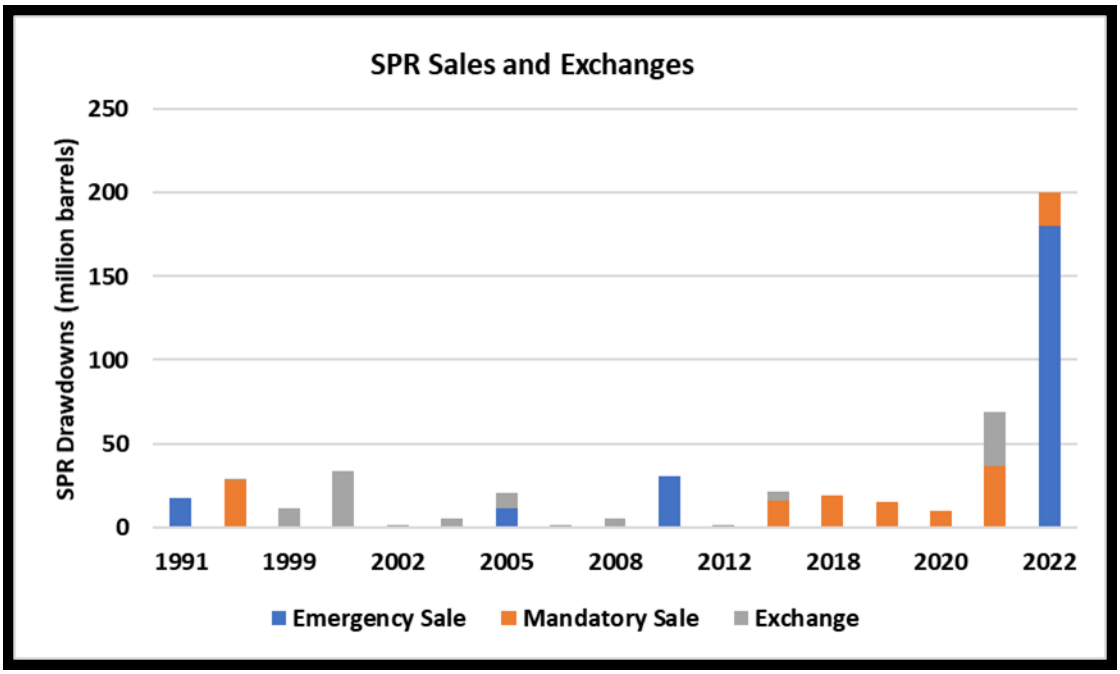
Let me illustrate it with an example of Robinson Crusoe, who lives on a remote island and has a limited supply of food. Every day, he needs to allocate between consuming some food today and keeping some for tomorrow, since he does not know how much more food (if anything) he might be able to find tomorrow. If he is very confident of being able to find more food tomorrow, then he can take his chances and consume the entire supply of food today. However, such a decision is not rational, as he would be taking too much risk with his life. At the same time, keeping the same supply of food always intact is not optimal either, as some food might get rotten like raw fish, or it can be eaten by animals. The optimal resource allocation between today and tomorrow is somewhere in between.

Conceptually, a similar problem arises in managing oil inventories, whether such inventories are commercial or government-owned. One naïve strategy would be to sell oil out of storage, when the price is high in the hope to replenish it later when the price drops. This strategy is highly speculative, as the price of oil is largely unpredictable. Such a decision is not rational, as the storage manager would be taking too much risk with his job. A more prudent strategy, which is what commercial traders do, is to lend oil to the market when the market needs it. This usually occurs when the spot price exceeds the futures price. For example, if today's oil price is 20% higher than forward price, then for every 100 barrels lent to

the market, one receives approximately 120 barrels back, essentially for free. In other words, this strategy generates a return with no risk.

By and large, the same two strategies are available for the management of the SPR. The President of the United States is authorized to sell oil in the case of emergency and to lend it to the market with more barrels to be returned at a later time. Last year the strategy of selling oil was utilized very aggressively. Its magnitude was truly unprecedented. To put things into perspective, the sale of SPR barrels was three times larger than all previous emergency sales combined over the past 40 years (Figure 1).

Figure 1
The History of SPR Sales and Exchanges



Source: U.S. Department of Energy, The Oxford Institute for Energy Studies, and Pentathlon Investments.

The loan strategy was also used in November 2021, but for a much smaller volume. This loan will generate approximately 9% guaranteed return to taxpayers essentially with no risk, when borrowed barrels are returned to the SPR next year. In contrast, the sale strategy with the hope to buy it back creates a lot of risk with a very limited return.

This brings me to my second point on why benefits of such an aggressive and risky strategy are very limited.[2]

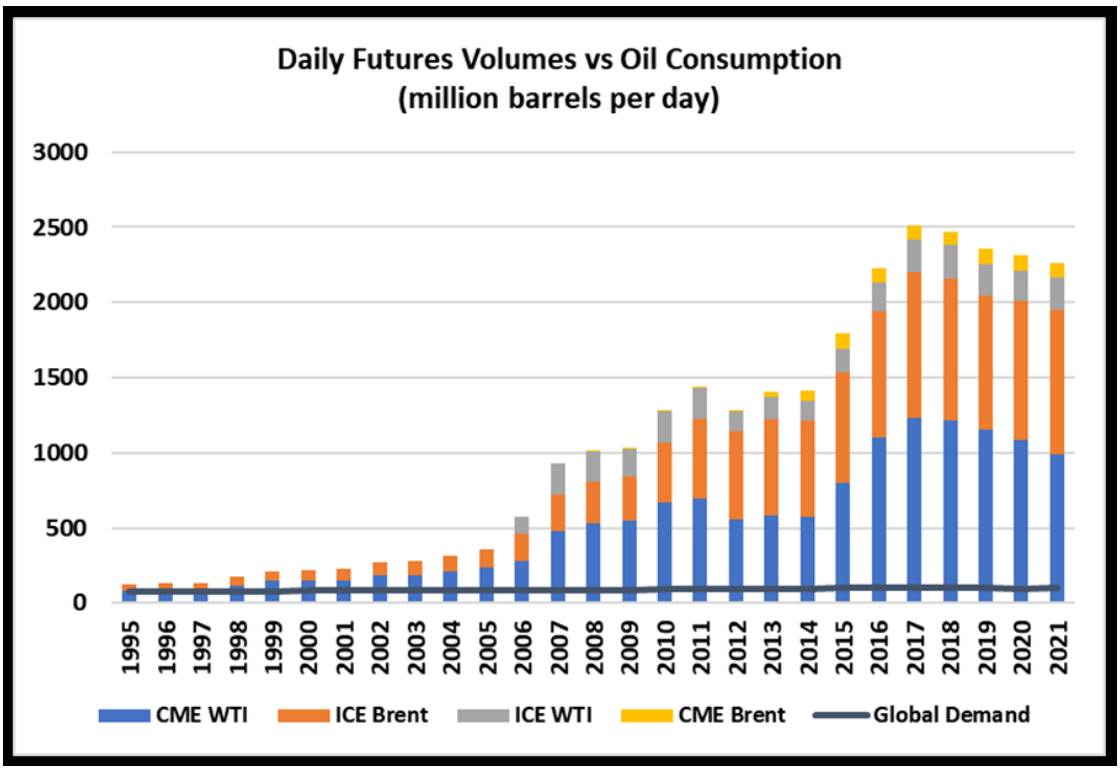
Oil and Financial Markets

I call the SPR sale strategy a return-free risk because, contrary to common beliefs, the price of a physical oil barrel is largely determined in the futures market. Unfortunately, many mistakenly believe that futures

are some sort of derivatives of physical oil prices. In reality, it is the other way around. The actual price of oil is determined in the futures market and physical oil transactions are priced as a differential to futures. In other words, in the oil market, the physical oil price can be viewed as a derivative of futures.

The problem is that the financial market for oil futures is substantially larger than the market for physical oil barrels. The world consumes approximately 100 million barrels of oil per day. At the same time, the daily trading volume of oil futures, options and over-the-counter derivatives is at least 5 billion barrels per day, i.e., 50 times larger (Figure 2). While daily volume is not the only metric that can be used to compare the relative sizes of two markets, financial oil markets are nevertheless much larger.

Figure 2
Average Daily WTI and Brent Futures Volume vs Global Oil Consumption



Note: Futures volumes are reported only for two primary oil contracts, WTI and Brent. They do not include options, futures on other petroleum contracts and over-the-counter swaps and options.

Source: CME, ICE, and Pentathlon Investments.

The SPR alone is unlikely to have any material impact on the price of oil because financial flows will always dominate the direction of price. For example, the primary drivers behind weaker prices in the second part of last year were not the SPR sales, but rather global macroeconomic factors, such as rising interest rates, increasing probability of recession, and Covid-related demand restrictions in China. The SPR has very little power to affect market prices of energy commodities, such as gasoline. This price will always be

determined by supply and demand and not only for physical barrels, but supply and demand for financial barrels as well.

Conclusion

To summarize, storage is a very valuable asset for the national security and must be managed prudently. Depleting it too aggressively could result in an economic waste with no return. Not managing it at all is also suboptimal, as its value, for example, can be eroded by inflation. One way to manage the SPR more effectively would be setting up a rigorous rule-based systematic program of oil loans that takes advantage of favorable market conditions and brings benefits to taxpayers with no risk. However, such a program can be created only after previous sales are bought back.

I view the current SPR strategy as a speculative oil trade. Fortunately, the SPR trade is currently in-the-money, but its ultimate outcome will not be known until the trade is closed, and barrels are repurchased before oil prices rise again. This should be done sooner rather than later, as risk always grows with time. Waiting much longer would be akin to Robinson Crusoe playing with the fire.

Endnotes

Dr. Bouchouev's testimony can be viewed at the following link: https://oversight.house.gov/hearing/burning-the-midnight-oil-why-depleting-the-strategic-petroleum-reserve-is-not-a-solution-to-americas-energy-problem-part-i/. Dr. Bouchouev is a frequent commentator on commodities on Twitter @IliaBouchouev and on LinkedIn.

1 The SPR is formally described at the following U.S. Department of Energy webpage, https://www.energy.gov/ceser/strategic-petroleum-reserve#:~:text=About%20the%20SPR,under%20the%20international%20energy%20program, as accessed on May 3, 2023.

2 A more detailed analysis of alternative SPR strategies is provided in Bouchouev (2022).

Reference

Bouchouev, I., 2022, "The Strategic Petroleum Reserve Strategies: Risk-Free Return or Return-Free Risk?", The Oxford Institute for Energy Studies. Accessed via website: https://www.oxfordenergy.org/publications/the-spr-strategies-risk-free-return-or-return-free-risk/.

Commodity Markets Begin to Price Carbon Risk

Peter Sainsbury
Founder, *Carbon Risk*[1]

The science of climate change argues that there is a limit to how much additional carbon dioxide that can be pumped into the atmosphere, known as the carbon budget. Go over this limit and it's likely that the negative impacts from climate change may accelerate, with each additional threshold leading to non-linear impacts.

In response to this threat, signatories to the 2015 Paris Agreement have backed a long-term target of limiting global average temperatures to "well below 2°C", requiring emissions to reach net zero by 2050.

The tragedy of the commons means that no single emitter is incentivized to cut their emissions. In the absence of a reason for markets to self-correct, the sensible solution is to price carbon emissions. A carbon price sends a signal to consumers about which goods and services are carbon-intensive; it signals to producers of products and services which inputs and activities they should switch towards to reduce their carbon costs; and it signals to innovators and entrepreneurs that demand for low carbon alternatives are likely to rise.

There are two ways in which governments can introduce a price on carbon: via a carbon tax, or by way of an emissions trading scheme (ETS). A carbon tax involves the government setting a price on the carbon emissions associated with the production and consumption of goods and services, raising the price relative to less carbon intensive alternatives. However, the government cannot be sure that the tax is set sufficiently high enough to be sure of cutting emissions. In contrast, an ETS typically involves the government or another institution imposing a cap on emissions. This is achieved through the issue of allowances denominated in tonnes of carbon. The emissions cap is typically reduced by a fixed percentage each year to move those covered by the scheme towards a long-term target of emissions cuts.

Almost one-quarter of global emissions are covered by some form of carbon pricing; 17% is covered via an ETS (often known as compliance markets, or cap-and-trade schemes) with some 6%-8% of greenhouse gas emissions covered through a carbon tax. Many countries, especially those in Europe combine both carbon taxes and cap-and-trade schemes, covering different sections of the economy (ICAP, 2023).

Although the price of carbon emission allowances in Europe (the oldest and most established ETS) have reached €80-€100 per tonne (equivalent to US$85-US$110), the price of allowances in other jurisdictions covered by an ETS tend to be substantially lower. Overall, the global ETS market-weighted average carbon price in 2021 was just US$28 per tonne. Outside of those countries with a tax or an ETS, the other three-quarters of global GHG emissions are effectively starting from zero cost of carbon. On a global basis this means the price of carbon is low, less than US$5 per tonne. Global carbon prices need to be well north of US$75 per tonne if the world is to decarbonize in the timescales set out by the 2015 Paris Agreement.

Capital markets have of course been taking things into their own hands, anticipating what climate policies are likely to mean, even in the absence of global transparency and coordination on carbon pricing. For example, the spread in the cost of capital between hydrocarbon and renewables widened by ten percentage points between 2015 and 2020, according to Goldman Sachs. The investment bank estimates that this is equivalent to a global carbon tax of US$80 per tonne CO2e (Goldman Sachs Research, 2021).

Nevertheless, the scope of global GHG emissions covered by carbon pricing is expected to grow substantially over the next decade. In a recent interview with S&P Global Commodity Insights, the president of the International Emissions Trading Association (IETA) estimated that 60%-70% of emissions are likely to be covered by an ETS by 2030. The price of carbon in other ETS's is also likely to increase as countries adopt aggressive emission reduction targets like Europe and look to avoid being subject to carbon border taxes on their carbon intensive exports (S&P Global, 2023).[2]

In the following, I discuss how carbon pricing is beginning to be felt across various commodities, including (a) the drive to cut emissions from the Canadian oil sands, (b) the growing demand for electric vehicles and the need to mine more nickel, (c) the role that agriculture can play in increasing the sequestration of carbon from the atmosphere, and (d) the impact carbon risk will have on the movement of commodities around the globe.

Underpinning all these examples is the growing need from other parts of the industrial supply chain for information on the provenance of commodities. The environmental performance of fossil fuel producers, metal miners and farmers are likely to become a key differentiator, with strong leadership on emissions reduction also likely to be rewarded by institutions allocating capital to the sectors. Across the various commodity industries discussed below, I also demonstrate how firms are responding to the price incentives, *i.e.*, investing in decarbonization and implementing more efficient practices.

Decarbonizing the Canadian Oil Sands

Canadian oil sands are far more emissions intensive to produce (*i.e.*, Scope 1 emissions) than most other fossil fuels. In 2020 the average emissions intensity of Canadian heavy oil projects was estimated to be ~70 kgs CO2e per barrel, compared with 15-50 kgs CO2e per barrel for most other crudes.

Canada is targeting a cut in its carbon emissions of at least 40% by 2030, before achieving net zero emissions by 2050. To do that the Canadian government is calling for the country's oil and gas sector (both upstream and downstream) to cut emissions by 42% (85 Mt CO2e), by 2030 compared with 2019 levels. Oil sands production will be required to share in that burden, cutting emissions by 34% (28 Mt CO2e) by 2030.

The Canadian government already has a national carbon tax. In November 2020, the Canadian Prime Minister announced that the carbon tax will increase by C$15 per tonne each year, rising from C$50 per tonne in 2022 (equivalent to US$37 per tonne) to C$170 (US$125) per tonne in 2030. The national carbon tax allows the governments of Canada's provinces and territories to set their own carbon taxation if it meets the minimum federal standard. The Canadian government is consulting on options to increase the

pressure on the fossil fuel sector through carbon pricing - either taking the form of an additional carbon tax imposed on the industry, or an industry cap-and-trade scheme.

Either way, the pressure on Canadian fossil fuel producers to cut emissions is only just getting started.

Today, crude price differentials typically reflect the value that the refiner expects to achieve from processing various grades of crude oil. The density of the crude, the sulphur content, its acidity, the cost of transportation and refining all influence the price that a refiner is willing to pay for a particular crude.

Under a carbon constrained world, high carbon intensity crudes will be at a big disadvantage compared with lower carbon intensity crudes. Crudes with relatively high carbon intensities could see their price discounts widen even further if they do not reduce their emissions intensity significantly.

For upstream oil producers in Canada, the introduction of carbon pricing should accelerate action to decarbonize their upstream operations. The top producers may be able to close the gap, or even overtake, their low carbon global competitors. Given the pressure that companies are under from governments, investors, and consumers, those producers that can demonstrate their low carbon credentials are likely to be rewarded by the market.

"Green" Nickel

Demand for commodities essential to the green energy transition are expected to rise fourfold by 2040 if we are to reach the goals of the Paris Agreement, *i.e.*, climate stabilization at "well below a 2°C global temperature rise." To achieve net-zero globally by 2050, six times more commodity inputs will be required by clean energy technology in 2040, according to the International Energy Agency (IEA).[3]

However, the average growth in commodity demand does a disservice to the growth requirements of certain niche metals essential to the energy transition. For example, demand for nickel, cobalt and graphite are all projected to grow 20-25 times under the IEA's Sustainable Development Scenario (SDS) by 2040. Despite delivering an overwhelmingly positive environmental outcome in the growth of electric vehicles, nickel cannot escape its own carbon footprint being scrutinized by manufacturers of power cells, automobile manufacturers and investors. Indeed, buyers are increasingly willing to pay a premium to ensure that the material has been secured sustainably.

Indonesia is in pole position to supply battery grade nickel to power the electrical vehicle (EV) transition. However, it has a carbon problem. Firstly, Indonesia's nickel reserves are primarily in the form of abundant laterite ore. Compared to the increasingly scarce sulphide ore found in Canada, Russia and Australia, laterite ore requires significantly more processing. That would be less of a problem if Indonesia's grid was powered by solar and wind, but instead thermal coal accounts for over half of Indonesia's electricity supply, and that means the power used by nickel miners and refiners is very carbon intensive. Overall, processing results in between 20 and 60 tonnes of CO2e per tonne of nickel, 2-6-times more than sulphide ore processing depending on the process used (IEA, 2022).

In February 2023, the Indonesia government launched the first phase of their emissions trading scheme covering coal powered electricity generators. At first only the largest coal facilities (those with a capacity of at least 100MW) will be covered by the scheme, before being rolled out to smaller coal and other fossil fuel power plants later. The energy ministry's own analysis indicates that the price of allowances is expected to be in the range of US$2-US$18 per tonne, much lower than that necessary to incentivize a switch away from thermal coal. Even if the ETS is successful in decarbonizing much of the nation's grid by 2030, it is still likely to be more carbon intensive than other nickel suppliers (*Reuters*, 2023).

Carbon Farming

Although governments and industry recognize that everything must be done to reduce emissions first, it is very unlikely that we will meet net zero without carbon removal. And so, carbon markets are not only putting a price on emissions, but they are also increasingly incentivizing the sequestration of carbon from the atmosphere too, via the carbon credit market. Carbon credits are a way for governments, corporations and even individuals to direct finance to where it can make the most difference to the climate.

Rewarding the sequestration of carbon into the soil via the carbon credit markets is becoming an increasingly attractive option. Soil carbon storage plays a vital role in regulating the amount of carbon dioxide that gets into the atmosphere. In addition, it improves soil fertility which enhances agricultural yields; it improves water storage and the supply of clean water; and finally, it also helps to maintain and enhance biodiversity.

Carbon sequestration practices include planting seeds without disturbing soil, spreading nutrient-rich compost over fields, and rotating where cattle graze. The role of soil carbon sequestration in cutting carbon emissions is gaining traction in the United States and in Australia in particular. In part this is due to supportive policies, but it is also due to the existence of large farm sizes in both countries, enabling carbon sequestration techniques to benefit from economies of scale.

For many parts of the world, however, carbon markets are being used to protect vast stores of carbon sequestered in tropical rainforests. Commodities are the primary driver of tropical deforestation, and typically involve the permanent conversion of forests to graze cattle, or to grow oilseeds such as soy and palm oil. When forests are cut down, vast quantities of carbon are released, while the carbon sequestration potential is lost. Halting deforestation is critical to meeting the 2050 net zero targets. Indeed, there is no pathway to limit global warming to 1.5°C without immediate action to halt deforestation (ETC, 2023).

Carbon credits go some way to offset the opportunity cost of deforestation faced by local landowners and other agents as they consider whether the forest is worth more to them alive, or more if they strip it bare and use it for agriculture. So called "Reducing Emissions from Deforestation and forest Degradation" (REDD+) credits help to finance activities that focus on the sustainable management and conservation of at-risk mature forests. Although they have typically been purchased by corporates in the past, governments with significant tropical forests on their land (*e.g.*, Guyana, Gabon) are increasingly looking

to issue sovereign REDD+ credits that protect their land from deforestation. A viable carbon credit market helps companies sourcing commodities from regions at risk of deforestation avoid their products being tainted by the perception that they have contributed to the destruction of the rainforest.

What Price Decarbonized Shipping?

Responsible for sending around 3% of global greenhouse gases into the atmosphere, the shipping sector emits more than the aviation industry, and about the same as the Japanese economy. Maritime emissions are forecast to increase over the next few decades as global trade in energy, commodities and goods continues to grow.

Given the shipping sector's major role in facilitating the global trade in commodities, climate related policies including carbon pricing are likely to have a major impact on commodity markets. First, by affecting the cost of moving resources around the globe, and secondly, by opening trade routes as new commodities seen vital to the energy transition (such as hydrogen produced using renewable energy, so-called "green hydrogen") are increasingly shipped to across the world.[4]

The International Marine Organization (IMO) sets regulations for the international shipping industry. IMO 2030 is designed to sharply reduce the shipping industry's carbon intensity and aim at forcing older, less-efficient ships off the market. However, beginning in 2024, the shipping sector will be subject to carbon pricing for the first time. Ships travelling within the EU (intra-EU voyages) will be required to pay for all their emissions, while for voyages to or from a non-EU destination, half of the emissions will be covered. Overall, some 10-15% of international shipping emissions are likely to be affected (Thomas, 2023).

The most straightforward way for ship owners to cut carbon emissions is to slow-steam - *i.e.*, deliberately sail at a reduced speed to cut fuel costs. Reducing the speed at which ships travel by 10% could reduce fuel usage by almost one-third. This will impact the availability of vessels in the region and lead to higher freight rates as charterers bid for the dwindling supply of vessels. Of course, there is a limit to how slow vessels can reduce their speed and continue to provide a reliable service.

In the longer term, ship owners must invest in decarbonizing their fleet. However, there is considerable uncertainty over what technological solution to pursue. For example, it is unclear whether hydrogen, ammonia or another candidate will provide the best low carbon option at an affordable cost. This could result in ship owners delaying placing orders, which might lead to a tightening in the supply of ships.

Pricing Carbon Risk

The rise of carbon markets and the increased cost of compliance is forcing commodity markets to respond. The carbon risk facing commodity markets is acute, including (a) the emissions associated with the extraction, refining and combustion of fossil fuels, (b) the energy required to dig and process ore into metal, and (c) the risk of deforestation and high emissions associated with carbon intensive agriculture.

In addition to the increased regulatory burden, companies are having to face up to much greater scrutiny as to the provenance and the emissions associated with their products.

But as this article also demonstrates, the commodity industry is not sitting idly by. Industry has a rich capacity to innovate in the face of these new and emerging pressures. Indeed, carbon markets and increased pressure from stakeholders has sparked a wave of innovation and new practices.

There is much more to be done, but commodity markets are now beginning to put a price on carbon risk.

Endnotes

All views expressed in *CID* articles are those of individual authors.

1 The *Carbon Risk* newsletter is available at https://carbonrisk.substack.com/.

2 The world's first levy on the importation of carbon intensive products is scheduled to be introduced in Europe. The levy, otherwise known as the Carbon Border Adjustment Mechanism (CBAM), seeks to address the problem of "carbon leakage." This is whereby firms located in the EU might lose market share to more carbon intensive products exported into the EU by firms located elsewhere in the world. Other jurisdictions including the United States, United Kingdom and Australia have discussed introducing similar carbon border taxes.

3 The IEA's Sustainable Development Scenario (SDS) is consistent with the goal of meeting the Paris Agreement, *i.e.*, climate stabilisation at "well below a 2°C global temperature rise."

4 Approximately one-third of the overall dry bulk trade (iron ore, coal, grains, and minor bulks such as fertilizer) and around 60% of the world's oil and products are transported by ship.

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Author Biography

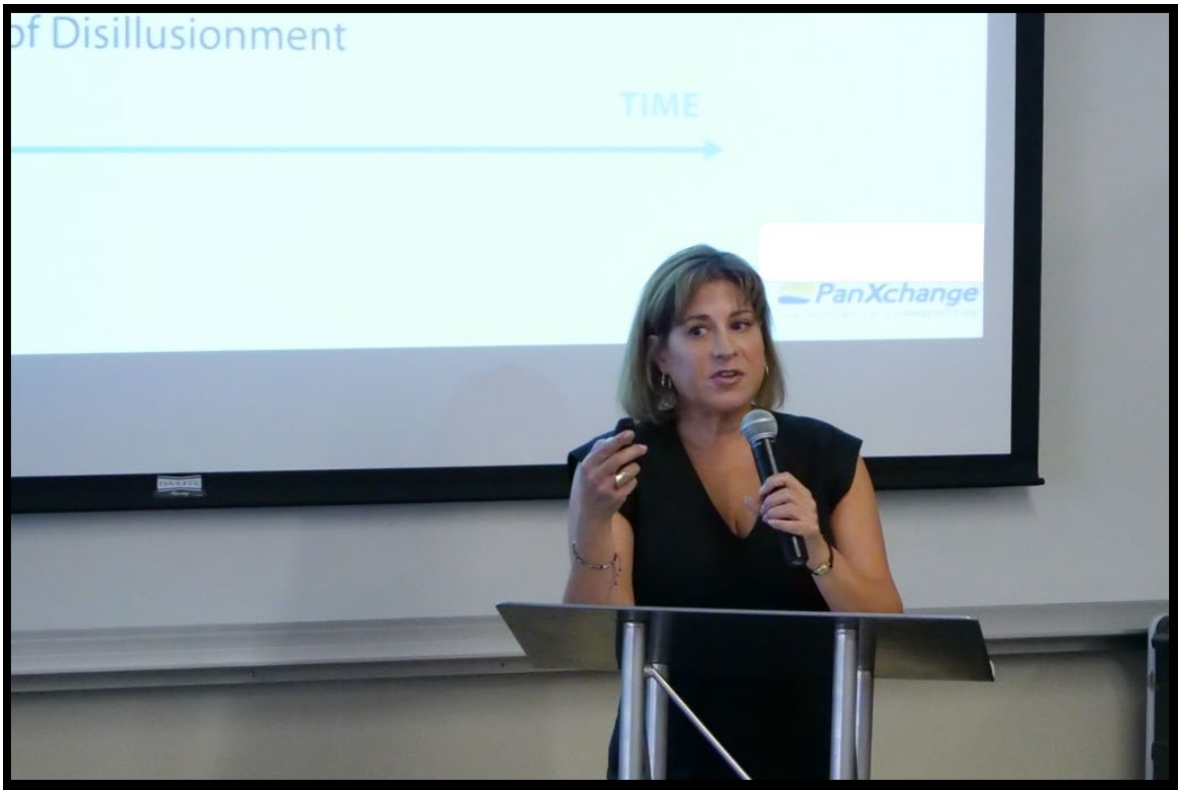
PETER SAINSBURY
Founder, *Carbon Risk*

Before launching *Carbon Risk* in November 2021, Peter Sainsbury was the Chief Economist for WRAP, a global environmental non-governmental organization (NGO). He is the author of four books including *Commodities: 50 Things You Really Need to Know* and has a B.Sc. in Economics with Honors from City, University of London, U.K.

Carbon Risk's mission is to help investors navigate "the currency of decarbonization."

Interview with Julie Lerner

Founder and CEO, PanXchange; and Editorial Board Member, *Commodity Insights Digest*



Julie Lerner, the Founder and CEO of PanXchange, is also an Editorial Board Member of the *Commodity Insights Digest*.

In the Summer 2023 issue of the *Commodity Insights Digest*, we are delighted to interview Julie Lerner, Founder and CEO of U.S.-based PanXchange, a web-based trading and price-discovery platform for physical commodities. In this interview we learn how her career evolved, and how PanXchange was founded. Lerner is a regular contributor to media outlets such as the *Wall Street Journal*, the *Financial Time*s and Bloomberg TV. She has also been endorsed as a Futures Industry Association Innovator. In addition, she has been recognized both in the *Forbes* 50>50 in Finance roster and in the *Denver Business Journal*'s most admired CEO's listing.

How did you become involved in commodities, and how has your career evolved?

I was always interested in a career in international business and envisioned that I would somehow be involved in import/export such as with fine wines and silks.

During my time in university, I was involved in AIESEC, a student organization that provided work visas (and so much more!) for a global exchange of interns. After my post-graduation internship in Geneva, Switzerland, I interviewed at Cargill. The interview process at Cargill was quite time-consuming, but the more I learned, the more I was determined to receive an offer from them. At one point, they thanked me

but said that they could not obtain a work permit for me. However, I had done so much work with AIESEC that I was able to secure another work permit within a week. That was so rare that they just had to hire me!

The rest, as they say, is history. I fell in love with the world of commodity trading, and there is no better classroom to learn commodity market fundamentals than at Cargill. I rose through the ranks to become their senior trader for Latin American Sugar and launched their first in-country warehouse operation in Peru; back then, outside of traditional grains, trade houses had much fewer assets like warehouses, port facilities, and processing facilities along the supply chain. During my stint at Cargill, the firm launched its now highly successful financial division, and the group taught me how to embed options into contracts (*e.g.*, we could offer a sugar grower a minimum price guarantee as long as we would not have to pay above a certain price for a cargo – a "zero cost collar.") I was fascinated by these innovative products, but unfortunately, there was an uphill battle to gain client acceptance of them. When electricity became deregulated in the U.S., I jumped at the rare chance to work on a "new" commodity market and signed with Sempra Energy Trading. My niche within commodities became an ability to embrace emerging product markets. I subsequently accepted an offer from XL Financial to help build an agricultural product line within their weather derivatives business, which was another new offering in commodities at that time.

Can you tell us about your firm, PanXchange, and how it started?

As one could infer from the first question, my passion within the commodity markets is a penchant for stirring up the *status quo*. I thought the inefficiencies involved in physical trading were ridiculous, especially given the technology that was emerging. I would spend the majority of the day on the phone trying to drum up profitable deals – calling the broker who specialized in Brazilian sugar, then the one focused on Thai sugar, then my direct contacts who might have sugar to sell, and finally calling my freight broker to see how much it would cost from those origins to Dubai. If all went well, I would put together the deal.

PanXchange started with the electronic platform that I designed to centralize the marketplace for price discovery and market access. Physical commodity trading is much different than stocks and commodity derivatives because every aspect of the trade – quantity, quality, location, type of transport, and type of payment – impacts price, and each aspect needs to be negotiated. I ended up with two U.S. patents on the system. After a successful pilot launch in world-market sugar, I realized that the market, though global, was too small. Only three companies moved more than 70% of the world's sugar, and the last thing they wanted was the transparency and efficiency that my company's system offered!

I was subsequently awarded a contract to test the program in Kenya for maize and wheat. That quickly expanded to Uganda and Tanzania and 30 different types of grains and beans. From there, we expanded into other markets, which has proved to be essential in preparation for the agricultural carbon markets that we are launching now.

What current trends in the commodity markets are impacting your business? And where are the opportunities?

It is all about Environmental, Social and Governance (ESG) today, but really the interest is just in the "E." It is urgent; it is chaotic; and it is changing daily. We are launching a program in the Voluntary Carbon Market with a focus on agriculture because we saw the need to create a program that was financially viable to the average farmer.

There are all kinds of motivations to be in this market. At one extreme, we have the purists, who focus far more on the accuracy of the science but often without regard to how cumbersome their programs are for businesses. At the other extreme, there are the financial-markets players seeing a different kind of green when they realize how many billions of dollars it would take for public companies to meet their carbon-neutral goals through purchasing carbon offsets (credits). If we want to successfully reduce GHG emissions, we need to meet in the middle with financially sustainable programs that incentivize everyone: farmers, manufacturers, energy companies, energy consumers and financiers. This will take a long time, but we must start somewhere.

In 2018 you wrote an article on "Blockchain for Physical Commodity Markets - A Realist's Perspective." What are your current views on this technology in the physical commodity markets?

I am so glad you asked this question. Back in 2018 when blockchain was the hottest fintech word, a colleague decided that I was "the Grim Reaper of Blockchain." Regarding physical commodities, especially agriculture, it is a badge I wore – and still wear – proudly. We are decades away from fixing issues like identity-preserving bulk commodities and standardizing the documentation. However, for digital commodities like carbon credits, distributed ledger technology (DLT) is essential. DLT allows PanXchange to build liquidity in the market. It offers an immutable record of essential aspects of the credit such as (a) where and how that credit was earned, (b) if the credit was even issued yet, (c) if it was retired to a carbon offsetter, and even (d) if the seller is trying to sell the same credit twice. With this particular use case, we are rapidly ramping up on the actual implementation of this technology in our trading platform.

What advice would you give those students and young professionals who are interested in pursuing a career that touches on the commodity markets?

Physical commodity markets feed and fuel the world, and it has never been a more interesting time to play a part in their evolution. We have some tough challenges to address such as where the metals come from to make electric vehicle (EV) batteries, and how we treat those countries and workers. At least in the U.S. energy market, no one is addressing the issue that our electricity grid cannot support a rapid conversion to EV vehicles, or what to do with solar panels when they degrade. Thus, we still need fossil fuels. In agriculture, we have food security issues, including a lack of crop diversity and geopolitical instability.

In all markets, whether they are in energy, metals or agriculture, we need to collaborate to find economically viable solutions to feed and fuel the world with less land and less damage to the planet,

especially reducing greenhouse gases. I encourage all students who are independent thinkers and quick thinkers to do at least a couple of internships at the major trade houses – such as at an energy firm then at an agricultural firm. Students might discover that trading is for them, but even if not, if one wants to be an effective part of the climate solution, I think it is essential to learn from these experts how the world really works.

Thank you, Julie Lerner, for the opportunity to interview you in the CID!

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BAYES BUSINESS SCHOOL
CITY, UNIVERSITY OF LONDON

Physical Address
Bayes Business School
106 Bunhill Row
London, EC1Y 8TZ
United Kingdom

Website
bayes-cid.com

Contact
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