

Sharp Price Movements in Commodity Futures Markets

A Report by Staff of the Market Intelligence Branch

Division of Market Oversight

U.S. Commodity Futures Trading Commission

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Executive Summary

The staff of the Market Intelligence Branch in the Division of Market Oversight (“DMO”) conducted research on sharp, intraday price movements in the commodity futures markets. DMO staff analyzed 2.2 billion transactions from 16 of the most actively traded futures contracts in all major market sectors using data from 2012 through 2017.

The research produced the following 3 main findings:

1. Neither the frequency nor intensity of sharp price movements appear to be consistently increasing over time;
2. Sharp price movements are linked to volatility, market fundamentals, and news and data releases; and, significantly, this research does not show signs of weakness or fragility in the futures markets causing disruptive price movements; and
3. Most importantly, the U.S. commodity futures markets are very efficient, incorporate new information quickly, and continue to be the premier price discovery mechanism for global commodity markets.

Flash Crashes and Why They Matter to the CFTC

The term “flash crash” is almost a decade old. The equity market crash that coined the phrase occurred on May 6, 2010 and, while this was not the first large intra-day drop ever witnessed in the financial markets, the speed of price movements observed that day made it clear the market had entered into a new, modern era of trading.

Recent Flash Crash Events

There is some debate over exactly which events get labeled as a flash crash. The Wall Street Journal reported at least twelve major flash crashes occurred between the passage of the Dodd-Frank Act in 2010 and 2016.¹ Other major outlets have different counts. Despite the controversy over exactly which events get labeled as a flash crash, there are a handful of events in the last decade that consistently appear in articles and discussions of this topic. These events are listed in Exhibit 1 with some contextual notes.

Exhibit 1: Noteworthy Flash Crash Events

Event	Date	Notes
Equity Market Crash	May 6, 2010	<ul style="list-style-type: none">• The DJIA dropped over 600 points in about 5 minutes, then somewhat rebounded in approximately the next 30 minutes• Note: Relevant, available data begins in 2012, so the 2010 event is not included in this analysis
Equity Market “Twitter Flash Crash”	Apr. 23, 2013	<ul style="list-style-type: none">• The DJIA dropped 1% within a few minutes then rebounded completely• The market reacted to a fake tweet sent from a hacked Associated Press Twitter account
10-Year T-Note Price Spike/Yield Crash	Oct. 15, 2014	<ul style="list-style-type: none">• Yield fell 34 basis points from 2.2% to 1.86% then immediately rebounded• Entire event only lasted a few minutes and although the move was small in percentage terms, it was 7 standard deviations away from the daily norm
Swiss Franc FX Ceiling Removal	Jan. 15, 2015	<ul style="list-style-type: none">• Swiss National Bank removed upper limit in the Franc’s exchange rate against the Euro and the Swiss Franc rose 39% against Euro and U.S. Dollar
British Pound Flash Crash	Oct. 6, 2016	<ul style="list-style-type: none">• GBP fell 6% in 2 minutes then rebounded somewhat in subsequent 30 minutes

The CFTC’s mission is to “foster open, transparent, competitive, and financially sound markets” so it is our charge to investigate potential vulnerabilities in the derivatives markets. Large price

¹ Max Colchester and Alistair MacDonald, *A Short History of Sudden Market Moves*, The Wall Street Journal, Oct. 6, 2016, <https://www.wsj.com/articles/a-short-history-of-sudden-currency-moves-1475837735?mg=com-wsj>.

swings and excessive volatility can be a symptom of market instability. Given the small number of observed flash crashes and the subjective selection criteria used to identify them, DMO staff casted a wider net to better understand and contextualize these events. As a result, DMO staff defined a clear, quantitative metric to identify “sharp price movements” in our data and the following results are based off that analysis.

Key Questions and Answers

This research effort started with a clear set of questions. Each question is listed below along with the corresponding conclusion DMO staff reached through its analysis.

1. Is the frequency of sharp price movements increasing over time?

- There is no clear evidence of a widespread increase in the frequency of sharp price movements.

2. Are sharp price movements related to market volatility?

- Sharp price movements occur more often during periods of elevated volatility and there is no clear evidence of a widespread increase in the intensity of such movements.

3. Are news and market data releases a factor in sharp price movements?

- News and market data releases are large drivers of sharp price movements in many contracts studied; so much so that news events and data releases are a topic worthy of further study as well as something to be filtered out of future analyses.

4. When are the sharp price movements occurring (day/night)?

- Some contracts see sharp price movements in overnight trading, but not a disproportionate amount when compared to volume traded during day/night.

Methodology Overview

DMO staff analyzed 2.2 billion transactions from January 2012 through December 2017. The data included 16 different futures contracts from all four major commodity market sectors: agricultural, energy, financial, and metals products. DMO staff sourced all data used for this project internally from the trade data provided to us by our exchanges.

The primary metric used in this analysis was the 100 largest price movements in each contract – these are what we identified as “sharp price movements.” DMO staff identified the top 100 price movements by calculating the largest percentage price movements in a rolling 3-minute window, using the volume-weighted average price in each minute. Once we calculated those

values, we ranked them from largest to smallest and retained the 100 largest movements for further analysis.

DMO staff chose the 3-minute time window to capture the sharpest price movements in a relatively short period of time. We focused on fast movements that both human traders and automated trading algorithms could react to. We evaluated a range of time periods from 2 to 15 minutes and the 3-minute interval worked the best for this analysis. DMO staff purposefully excluded time periods longer than 15 minutes to focus on sharp price movements that occurred in short periods of time.

DMO staff chose the top 100 price movements to focus on the most extreme observed changes in each contract. Many analyses like this begin by setting a high threshold based on the distribution seen in the data, usually something like the 99th percentile. This effort started there as well, but DMO staff found that the 99th percentile actually was not high enough for this analysis. Since the dataset was so large, there were still over 1 million data points in each contract above the 99th percentile. DMO staff evaluated several thresholds and determined that the top 100 was the most useful for this analysis to focus on the most extreme observed changes in each contract. The key benefit to this approach is the ability to uniformly apply these metrics across a wide variety of contracts and compare the results.

This is a bit of a departure from previous work, most of which used different metrics, allowed longer time periods, and focused on fewer contracts. Many studies have also analyzed specific flash events. That is not what DMO staff set out to do in this analysis. The work was primarily designed to determine what sharp price movements can reveal about the healthy functioning of exchange traded futures markets.

Range of Top 100 Price Movements by Contract

Exhibit 2 below is a high-level summary of the largest price movements DMO staff observed in the data in the 3-minute window, including the threshold for the top 100 and the highest observed change for each contract. The top 100 cutoff column shows the 100th largest price move for each contract so all other price changes in our sample are above that cutoff. For example, the first row is the corn futures contract. Its 100th largest price movement was 0.78% and its largest observed price movement was over 6.5%. The table also shows some other thresholds DMO staff evaluated (the 99th percentile and the top 500) before we settled on the top 100 as the most useful threshold.

The top 100 threshold is less than 1% in all but 3 of the 16 contracts studied. Natural gas, crude oil, and silver were the only contracts with a top 100 threshold above 1%. As far as the largest observed price movements, corn and silver were the only contracts that moved more than 6% in the 3-minute window, but more than half of the contracts had movements of 2% or more for their highest values.

DMO staff found a significant difference between the top 100 threshold and the highest observed movement. This means the extreme upper tail of the distribution still contains a significant amount of variation, making it an interesting sample for study.

Exhibit 2: Key Price Ranges by Contract

Sector	Contract	Median	99 th Percentile	Top 500 Cutoff	Top 100 Cutoff	Max Change
Ags and Softs	Corn	0.05%	0.27%	0.49%	0.78%	6.57%
	Live Cattle	0.04%	0.25%	0.38%	0.57%	1.80%
	Sugar	0.06%	0.35%	0.63%	0.95%	2.58%
	Wheat-SRW	0.05%	0.32%	0.57%	0.90%	3.89%
Energy	Crude Oil, Light Sweet	0.03%	0.28%	0.69%	1.04%	2.39%
	Natural Gas	0.06%	0.39%	0.83%	1.58%	5.45%
Financials	10-Year U.S. T-Note	0.01%	0.04%	0.10%	0.22%	0.91%
	British Pound Sterling	0.01%	0.07%	0.19%	0.35%	3.26%
	E-Mini S&P 500	0.01%	0.11%	0.24%	0.37%	1.34%
	Euro FX	0.01%	0.07%	0.19%	0.35%	1.18%
	Japanese Yen	0.01%	0.08%	0.21%	0.39%	2.66%
Metals	Copper	0.03%	0.18%	0.42%	0.63%	1.91%
	Gold	0.02%	0.13%	0.37%	0.63%	1.94%
	Palladium	0.07%	0.40%	0.60%	0.90%	2.72%
	Platinum	0.04%	0.22%	0.39%	0.60%	1.59%
	Silver	0.04%	0.25%	0.61%	1.07%	6.24%

There are 2 key points to take away from this table:

1. Financial products have the lowest price movements of all the sectors, which reflect their generally tighter trading ranges when compared to the agricultural, energy, and metals contracts.
2. All price moves occurred in a 3-minute window so even though these intraday moves are the largest observed for each contract, they're naturally smaller than the price swings observed over hours or a full day's trading session.

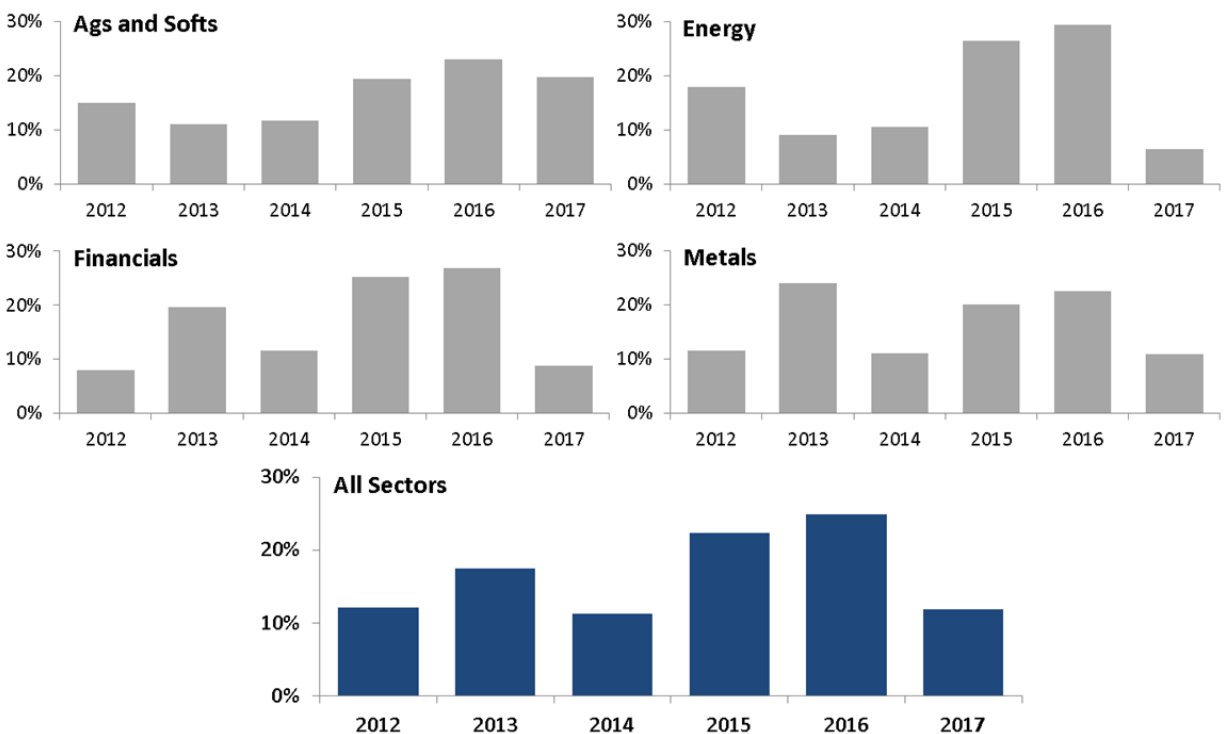
Frequency of Sharp Price Movements

The first major finding is that there is no clear evidence of a widespread increase in the frequency of sharp price movements across sectors. The charts in Exhibit 3 below show the percentage of top 100 price movements that occurred in each year by sector and all sectors combined. For example, in the chart on the top left for the Ags and Softs sector, about 15% of the top 100 price movements occurred in the year 2012.

If sharp price movements were increasing in frequency over time, meaning each year had more big moves than the year before it, one would expect the bars to get steadily larger from left to right, however that is not the case. Instead, the charts show significant variation in each year, but no consistent buildup or up-trend. Some contracts have seen more large moves in recent years, but there is not an across the board increase.

There is also a distinct drop in the frequency of sharp price moves in 2017, which was a low volatility year for most sectors. The key point to note is that nothing structural changed in the futures markets during the sample time period. Therefore, the variation in frequency observed from year-to-year appears to be driven largely by market fundamentals and volatility, not by market weakness or fragility.

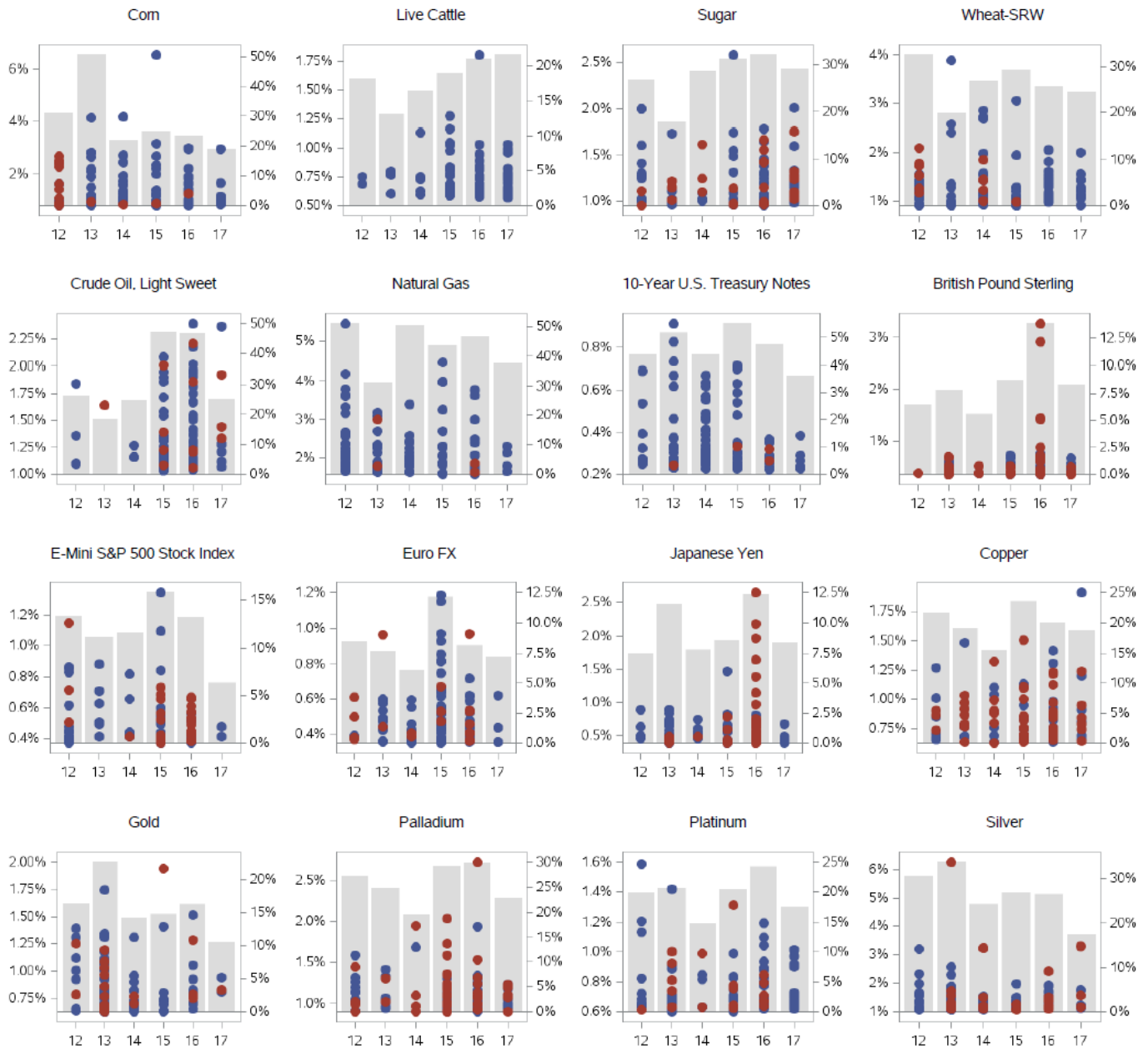
Exhibit 3: Frequency of Top 100 Price Movements by Year



Sharp Price Movements and Volatility

The second major finding is that sharp price movements occur more often during periods of elevated volatility and there is no clear evidence of a widespread increase in the intensity of such movements. The charts in Exhibit 4 show the relationship between the top 100 price movements and volatility in each year.

Exhibit 4: Top 100 3-Minute Price Moves and Annual Volatility



Each chart shows the top 100 price movements overlaid on annual volatility for each contract from 2012 to 2017. Each dot is one of the top 100 price movements. The height of the dots is the percent change of the price movement, reflected on the left Y-axis. The color of the dots is when the change occurred, blue is daytime trading hours and red is overnight trading hours. The gray bars are annual volatility and their scale is the right Y-axis.

If the intensity was increasing over time, the charts would show a majority of the highest dots occurring in later years, or a cluster in an upward trend from left to right, but that is not the case in most contracts. DMO staff did not observe any trend in the data to suggest that some underlying mechanism might be causing larger and larger price movements over time. Instead, the data shows a clear link with volatility since big moves tend to occur more frequently in volatile years.

DMO staff also did not observe a large number of sharp price movements in periods of low volatility which could signal a structural issue. Large price movements during periods of market calm are generally more disruptive because they can catch more participants by surprise and margin requirements are lower. The data did not show a large number of these events, but there are some outliers and they are an area worthy of further study due to their potentially disproportionate market impact. The outliers observed so far are tied to market events. For example, corn's highest movement in 2015 occurred during a low volatility year and was in response to the monthly USDA crop production report.²

Volatility is often episodic and tied to market fundamentals so it is natural for volatility to escalate when there is uncertainty in the markets. Sharp price movements during these periods are an extension of this relationship. It is worth noting that trading volumes in futures markets have generally increased across all sectors over the last decade which strengthens the evidence that sharp price movements are not being driven by a structural weakness or liquidity problems in the markets.

Sensitivity of Sharp Price Movements to News and Data Releases

News and market data releases are heavily traded events in financial markets. Many participants plan strategies in advance and deploy them immediately following the release of information based on whether or not the news or data is in line with expectations. Therefore, the third major finding, as DMO staff expected, is that news and market data releases are large drivers of sharp price movements.

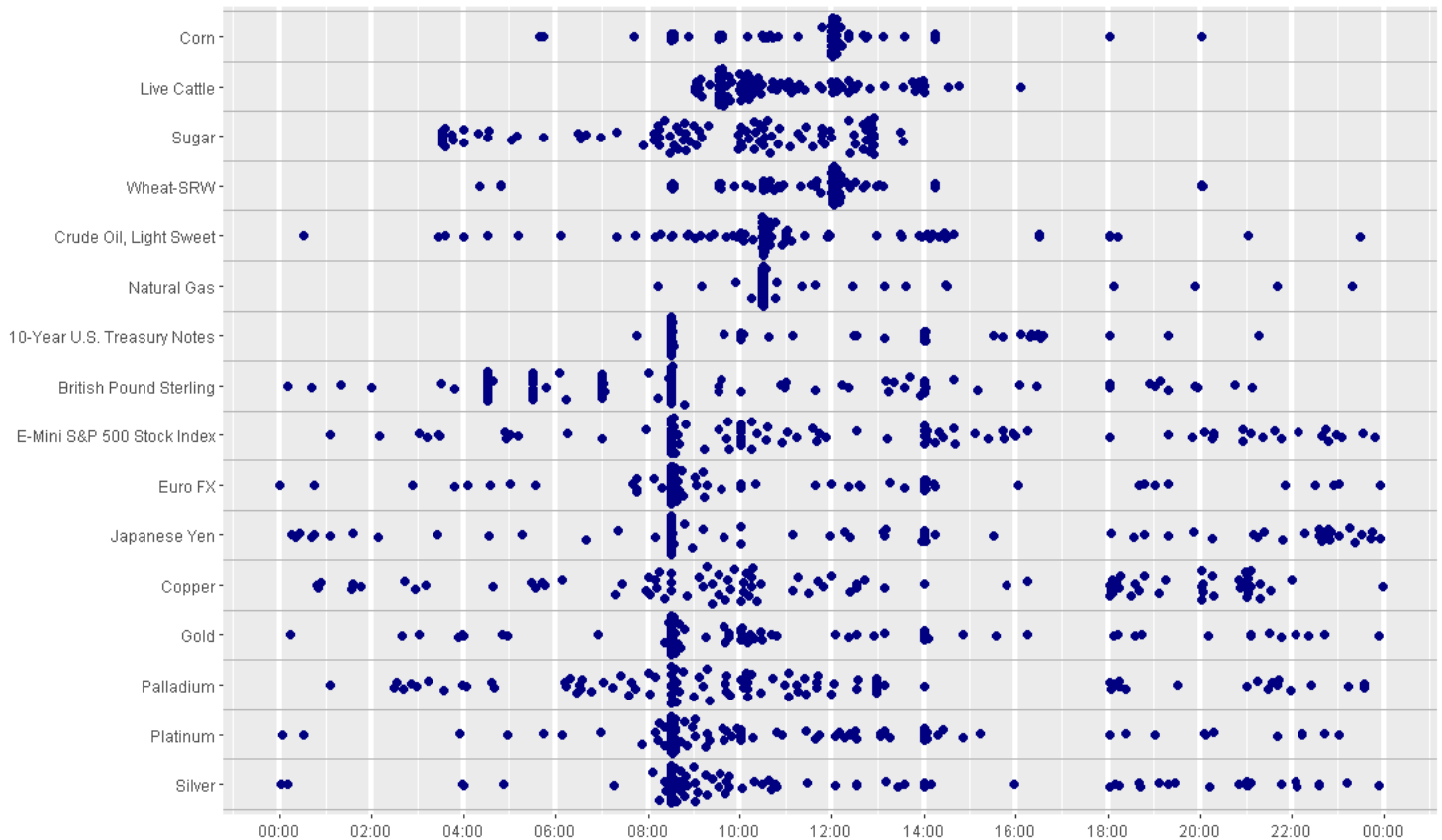
A large percentage of the top 100 price movements in many of the contracts studied were directly related to news and data events and Exhibit 5 below illustrates this relationship. The graph shows the time of day each of the top 100 price movements occurred by contract (ignoring dates). The x-axis is time from midnight to midnight and the position of the dots from left to right shows the time of day they occurred.

The large mass of activity around 8:30 a.m. is the monthly jobs report published on the first Friday of each month by the Bureau of Labor Statistics. We see similar clusters of activity in corn and wheat related to crop reports from the USDA (released at noon) and crude oil and natural gas related to the EIA's weekly storage reports (released at 10:30 a.m.).

² USDA Crop Production Reports and Analysis, <https://www.usda.gov/topics/farming/crop-production>.

Traders watching recurring news releases and other reports closely and planning trading strategies around them is nothing new. The difference now is the speed with which the new information is incorporated into the market. Trading around news releases is both a topic for further study and a behavior to filter out of future work.

Exhibit 5: Top 100 Price Movements and Time of Occurrence by Contract



Sharp Price Movements and Overnight Trading

The final major finding of this research is that some sharp price movements do occur in overnight trading sessions in most contracts, but they are proportional compared to overnight trading volumes. Exhibits 4 and 5 above show the contracts with more global interest and therefore more overnight trading tend to see more overnight sharp price movements. For the researched time period, DMO staff did not observe a disproportionate amount of sharp price movements overnight caused by thinner trading or lower liquidity.

The U.S. futures markets are active nearly 24 hours a day with participants trading from all over the world. Overnight trading is an interesting area of study and more work in this area is planned.

Conclusions and Takeaways

As stated earlier in the report, this research set out to provide context for flash crash events by analyzing sharp, intra-day price movements. The CFTC is responsible for a wide range of derivatives products and markets and this work focused on some of the most actively traded futures contracts available. The 16 contracts included in this study account for over 40% of all futures volume traded under the CFTC's authority from 2012 through 2017 so this analysis covers some of the deepest areas of liquidity available in U.S. futures markets.

The goal was to start with a large segment of the futures markets but more work is planned. Important concerns remain about satisfactory liquidity conditions and adequacy of market making outside of actively traded markets, asset classes, and centers of liquidity curves. However, this work appears to dispel at least one contemporary narrative: the notion that recent changes in market structure, particularly the growing presence of principal trading firms and high frequency trading, has in some way made markets less stable. DMO staff's research does not support this narrative. Not only has there not been any time trend toward more frequent short-term price swings, but many of the biggest price swings can be explained, not by the activities of principal traders, but by longer-term heightened market volatility and by the direct revelation of information and news events.

This analysis shows that today's U.S. commodity futures markets continue to function well, are able to digest information quickly, and readily accommodate heightened volatility. In short, U.S. futures markets remain the premier price discovery mechanism for the world.

Staff Contributors

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