Stop Orders in Select Futures Markets

by

Nicholas Fett, and Lihong McPhail

This version: August, 2017

OCE Staff Papers and Reports, Number 2017-009

Office of the Chief Economist
Commodity Futures Trading Commission

Stop Orders in Select Futures Markets*

Nicholas Fett† and Lihong McPhail‡

August 29, 2017

Abstract

This paper analyzes trade and order book audit trail data to provide a detailed summary of the use of stop orders in select futures markets; specifically E-mini S&P 500 Futures, Ten Year Treasury Note Futures, and WTI Crude Oil Futures. Recent flash rallies and the ever increasing speed of futures markets have called into question the appropriateness of traditional stop order strategies. By utilizing metrics related to both placement of and execution of stop orders, we show that stop orders are being used in these futures contracts with varying frequency and the strategy of stop order placement varies greatly by participant. As expected, trades involving stop orders are found to be highly correlated with intraday price volatility. Existence of stop orders is generally unknown to market participants as stop orders are not visible in the orderbook but must be triggered by a trade in the market at the corresponding price. More importantly, our analysis indicates that many traders are not only using stop orders for hedging purposes but also using them for latency reduction strategies. We provide a background on the usage and depth associated with stop orders in selected futures markets.

1 Introduction

Stop orders are orders to buy or sell an asset when the price of that asset rises or falls past a specified price. They are traditionally used as a strategy to prevent loss due to substantial price movements, without having to constantly follow the position. Stop orders can be stop buy orders (buy if price rises above a certain point) or stop sell orders (sell if price falls below a certain point) and then can either be placed as limit orders (stop limit) or market orders (stop loss). By buying when the price rises or selling when the price falls, both order types can be useful for protecting/ limiting exposure as well as for various trend following or mean reversion strategies.

*The research presented in this paper was co-authored by Nicholas Fett and Lihong McPhail, who are both CFTC employees, in their official capacities with the CFTC. The Office of the Chief Economist and CFTC economists produce original research on a broad range of topics relevant to the CFTC's mandate to regulate commodity futures markets, commodity options markets, and the expanded mandate to regulate the swaps markets pursuant to the Dodd-Frank Wall Street Reform and Consumer Protection Act. These papers are often presented at conferences and many of these papers are later published by peer-review and other scholarly outlets. The analyses and conclusions expressed in this paper are those of the authors and do not reflect the views of other members of the Office of Chief Economist, other Commission staff, or the Commission itself.

†Research Economist, nfett@cftc.gov.

‡Research Economist, lmcphail@cftc.gov.

This paper focuses on identifying the usage of stop orders and some of the common characteristics of stop orders in three very liquid futures products: E-mini S&P 500 Futures, Ten Year Treasury Note Futures, and WTI Crude Oil Futures. By utilizing metrics related to both placement of and execution of stop orders, we show that stop orders are being used in these futures contracts with varying frequency and the strategy of stop order placement varies greatly by participant. As expected, trades involving stop orders are found to be highly correlated with intraday price volatility. More importantly, our analysis indicates that many traders are not only using stop orders for hedging purposes but also using them for latency reduction strategies. Existence of stop orders is generally unknown to market participants as stop orders are not visible in the orderbook but must be triggered by a trade in the market at the corresponding price. We observe that average rest times for executed stop loss orders have decreased over the past few years. Additionally, slippage values for stop market trades can sometimes be significant, but limited due to the protection levels set by the exchange.

The rest of paper is organized as follows: Section 2 provides background on stop loss orders, Section 3 decribes the data and classification methods we use for our analysis, Section 4 presents our findings, and Section 5 concludes.

2 Background

We analyze stop orders using transactions and the Globex orderbook information from the Chicago Mercantile Exchange (CME). CME Globex supports two types of stop orders: stop-limit and stop market orders, known in this paper as stop loss orders. Stop-limit orders are orders that get entered in the order book as limit orders when the trigger price associated with that stop-limit order is traded in the market. At the time of a stop-limit order entry, the trigger price for a bid order must be higher than the last traded price, while the trigger price for a sell order must be lower than the last traded price. Table 1 presents a simplified version of E-mini S&P 500 futures (ES for short) order book. If the last trade price for ES was 2384.5, the trigger price for a bid order must be set at 2384.75 or higher, and the trigger price for a sell order must be set at 2384.25 or lower. After the trigger price is traded in the market (e.g. a sell stop placed at 2384 followed by a trade at 2384), the order enters the order book as a limit order at the order limit price (e.g. 2384.25 limit order sell or a market order which will fill against the best available bid). Stop loss orders can usually work as intended in normal market conditions. However, in a fast market when price gaps down, stop loss orders will be triggered but executed at the next available market price, which could lead to losses much higher than intended.

Table 1. E-mini S&P 500 Sample Futures Orderbook			
Bid		Ask	
Quantity	Price	Price	Quantity
		2385.5	5
		2385.25	10
		2385	5
		2384.75	2
4	2384.25		
6	2384		
8	2383.75		
7	2383.5		

It is worth noting that all stop loss orders are automatically entered with protection points set by the CME, which prevent stop loss orders from being executed at extreme prices. A stop loss order with protection is activated when the market trades at or through the stop trigger price and can only be executed within the protection price range limit. For example, protection points for E-mini S&P 500 Futures are 3 index points (12 ticks). So, when a market participant sends in a new stop loss offer (with trigger price 2384), the order is activated at price 2384 and protection price limit is 2381. This way, the market participant will be protected from selling any contracts at a price lower than 2381. Protection points for WTI crude oil futures is \$0.5 (50 ticks) while protection point for 10-Year U.S. Treasury Note Futures is 0.25 points (about 16 ticks).

3 Data Overview

In this study, our analysis is based on two proprietary data sets provided by the CME Group. The analysis uses the complete transaction audit trail for the select futures products from the beginning of 2014 until the end of 2016 and a sample set of dates (the first Tuesday and Thursday of each month) from a subset of this time frame for calculating orderbook related metrics.[1] In our study, any analysis utilizing executed stop orders make use of the former data set. Measures of depth and placement in the orderbook are calculated using the latter dataset.

The transaction audit trail is a trade-by-trade record of all executions on the CME's trading platform. This data set provides a number of details related to each trade, including product information, the customer accounts and traders on the buy and sell sides of the transaction, trade prices and quantities, information on the submission and execution of the order (algorithmic vs manual, aggressive vs passive), along with other relevant information. In our

[1]This period of time was chosen due to underlying data limitations. Though this time frame allows for some comparisons across time and across different market conditions, the time frame does not allow for comparisons to liquidity levels prior to the financial crisis or prior to implementation of some regulatory efforts, like Dodd-Frank.

analysis, we focus only on outright trades (not spreads) associated with the most active futures contract for that date.

The latter data set is based on order messages submitted to the CME by market participants. We use this order audit trail to track, at the level of individual messages, the actions of market participants. This data set includes information about the firm and account sending the message, the message type, and the price, quantity and timestamp associated to the message. Trades included in this audit trail match the trades in the first data set, however, for transaction-level analysis we use the trade audit trail as the date range covered is larger.

For our participant-level analysis, we classify firms into four different participant categories: Bank/Dealers, Asset Managers, Principal Trading Firms (PTFs), and Non-Bank FCMs (i.e. non-bank intermediaries).[2] The Asset Manager category is perhaps the broadest, including traditional asset managers, hedge funds, pension funds, sovereign wealth funds and similar buy-side institutions. Expanding on the work in the Joint Report[3], classifications in this paper cover active accounts across all futures products traded on the CME futures platform. Using reference information for trading accounts, market participants are assigned to the parent firm associated to the account. Each parent firm is then assigned to one of the six categories using registration information and publicly available information about the firm; the classification is based on the firm's primary activity. Firms that did not fit into the major categories, or were unknown, are placed into the 'Other' category.

4 Analysis

4.1 How Frequently are Stop Orders Used?

Using transaction level data, Table 2 illustrates that stop orders account for a small, but significant portion of all outright transactions (0.3% to 2%) over the sample period range from 2014 to 2016. Stop orders are most frequently used by market participants in the WTI crude oil futures, followed by E-mini S&P 500 futures, and then followed by 10 Year US Treasury Note futures. Specifically, for WTI crude oil futures, total trade volume from 2014 to 2016 was 607.6 million, of which 2% of volume (13.6 million contracts) was transacted using stop orders. For E-mini S&P 500 Futures, total trade volume was about 2.5 billion contracts, of which 0.9% of trades (about 22.8 million contracts) were placed using stop orders. For 10 Year US Treasury Note futures, total trade volume was 1.8 billion, of which 0.3% of trades (about 5.4 million contracts) were placed using stop orders.

Table 2 also reports the average 30 day volatility for each market. Given that stop orders are designed to execute at price levels different than the last transaction price, it is not surprising that the market with the highest volatility is also the one experiencing the highest rate of stop orders.

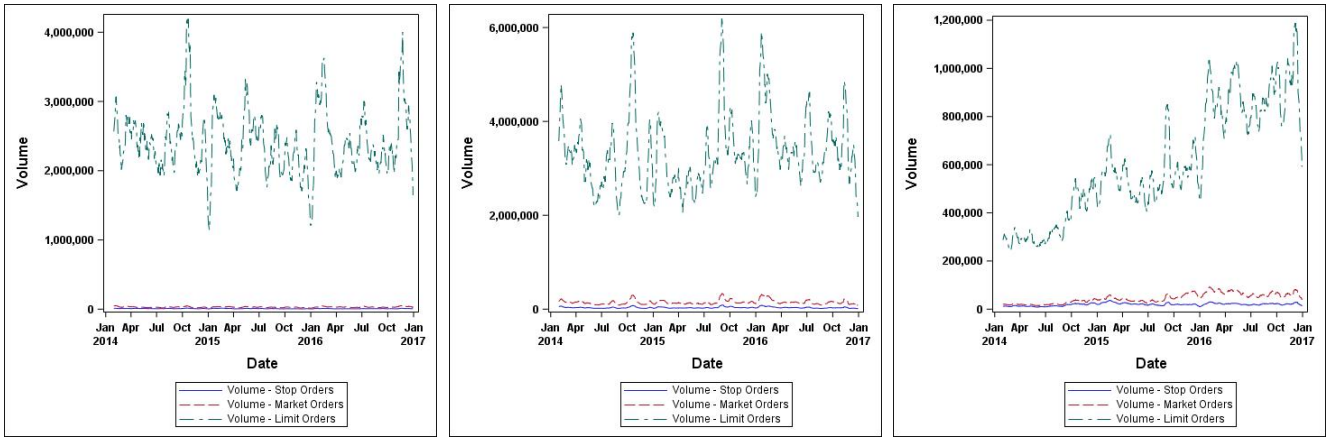
[2]Other categories are available, but due to confidentiality constraints are not published. See Fett and Haynes, "The Future Trading Landscape" for more detail on participant classifications.

[3]The classification was based on a similar, but less extensive, trader classification initially done for the Joint Report on the events of October 15, 2014.

Table 2 - Total Volume - Executed Stop Orders - 2014 to 2016					
Commodity Name	**Percent Stop**	**Total Volume**	**Volatility (30 day)**	**Total Stop Volume**	**Stop Order to Trade Ratio**
E-mini S&P 500 Futures (ES)	0.9%	2,483,400,538	0.35	22,789,175	28%
WTI Crude Oil Futures (CL)	2%	607,631,144	0.02	13,571,340	37%
10 Year US Treasury Note Futures (21)	0.3%	1,800,758,392	0.00	5,410,656	24%

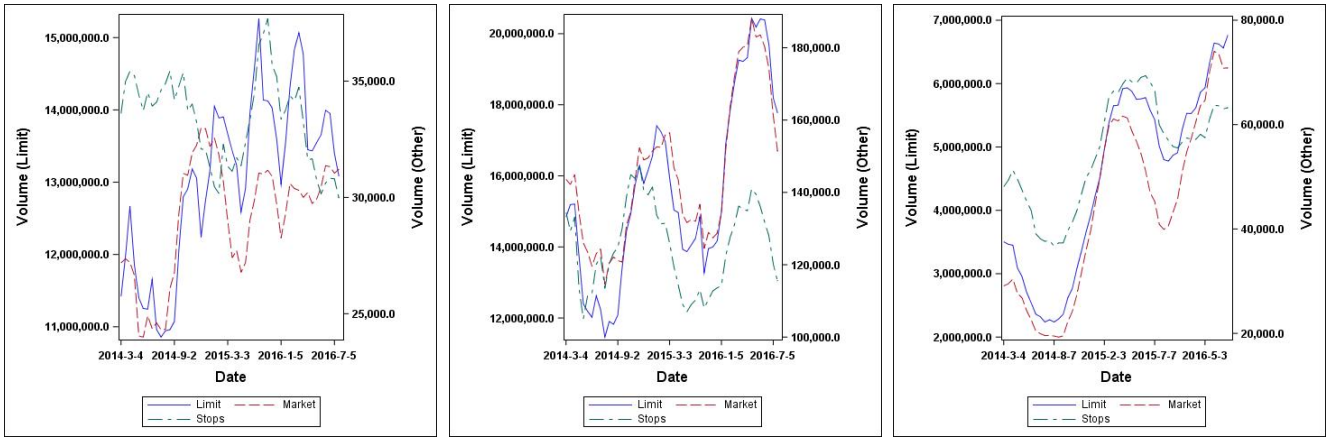
It is worth noting that in the markets we analyze, almost all stop orders are stop limit orders. Specifically, for 10 Year Treasury Note Futures, 95% of executed stop orders are stop limit; for E-mini S&P 500 Futures, 98% of executed stop orders are stop limit; and for WTI futures, 99% of executed stop orders are stop limit. One of the reasons for this is that when a stop price is hit, a stop loss order will execute as a market order. If the market price is falling rapidly, a market order can execute far below the trigger price. Due to the possible risk of a stop loss order executing at price levels quite different than the trigger price, they are not used very frequently.

Figure 1 displays the time series of the amount of volume executed by each basic order type (market orders, limit orders, and stop orders). Of note is the rising number of orders in the crude oil market as well as the seasonality present in the E-mini for limit orders. Figure 2 shows the time series of daily order placement by each type. Limit orders (left axis) make up the vast majority of orders and trades, however market orders and stop orders (right axis) still play a large role in the markets today. Table 2 shows the average order-to-trade ratio for our timeframe for each product and is roughly 1/4 to 1/3 of all stop orders. This ratio is very volatile depending on the day, since the volatility of the number of stop orders executed each day is also very high.



(a) 10 Year Treasuries (b) E-Mini S&P 500 (c) Crude Oil

Figure 1: Daily Volume by Type - 10 Day Moving Average

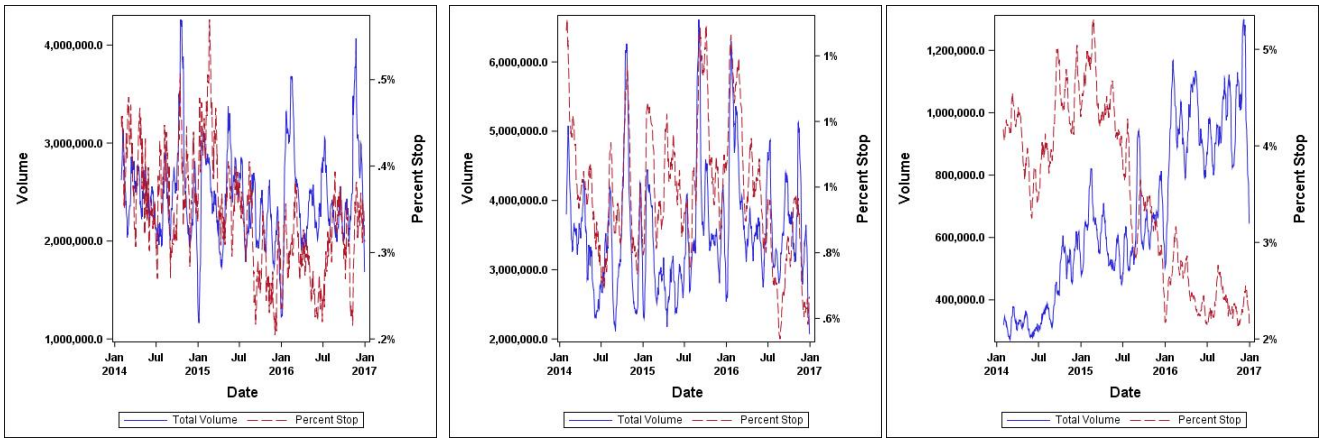


(a) 10 Year Treasuries (b) E-Mini S&P 500 (c) Crude Oil

Figure 2: Daily Orders by Type - 10 Day Moving Average

Another trend revealed in our analysis is the effect of rolls on stop limit orders. Over our sample frame, stop loss orders accounted for only 5 percent of 10 Year treasury stop volume, and only 1 percent of both E-mini and Crude Oil total stop volume. Although all data here is for only outright trades, E-mini and 10 Year treasury data show indications of volumes spiking during the roll periods (quarterly). In Crude Oil, contracts are monthly, so the effect of rolls is more subdued. Also of note is the lack of volatility in the stop loss orders. With very few being executed on most days, the volume of stop loss orders in our products do not portray the same cyclicality or volatility as stop limit orders.

Figure 3 shows total volume of trades (left axis) and the percentage of executed orders that were originally stop orders (right axis). For WTI Crude Oil futures, total volume of contracts were generally increasing over the sample period, however, the percent of trades that were placed using stop loss orders spiked in January 2015, and afterwards sharply decreased. By contrast, for 10 Year Treasuries and E-mini S&P 500 futures, total volume of contracts and the percent of executed orders that were originally stop orders were stable.



(a) 10 Year Treasuries (b) E-Mini S&P 500 (c) Crude Oil

Figure 3: Total Volume and Percent of Trades Stop Orders - 10 Day Moving Average

4.2 Who Trades Stop Orders?

Figure 4 shows the percentage of total volume that corresponds to stop loss orders, by participant grouping. In terms of percentages, stop loss order usage in WTI futures seems much more prevalent compared to other markets. However, looking across all three markets, stop loss order usage by Non-bank Future Commission Mechants (FCMs) makes up a significant percentage of total volume. These findings suggest that stop loss order usage might be motivated by hedging goals, mainly by Non-Bank FCM participants.

Figure 4: Percent of Volume as Stop Loss Orders by Participant Type

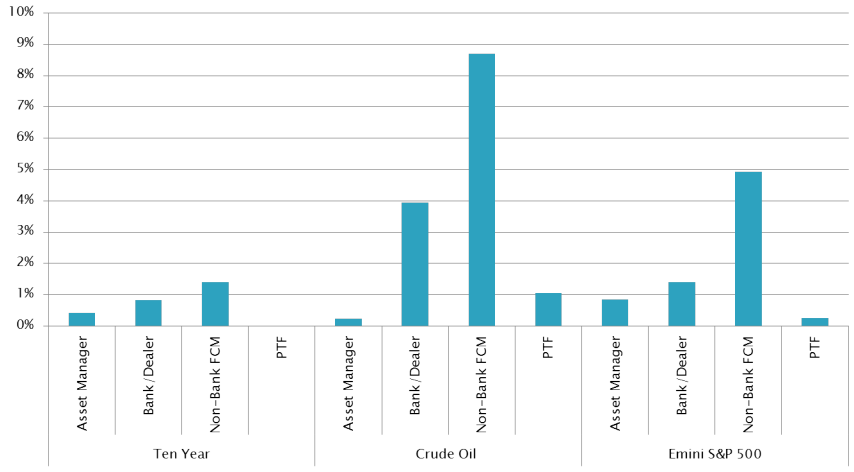
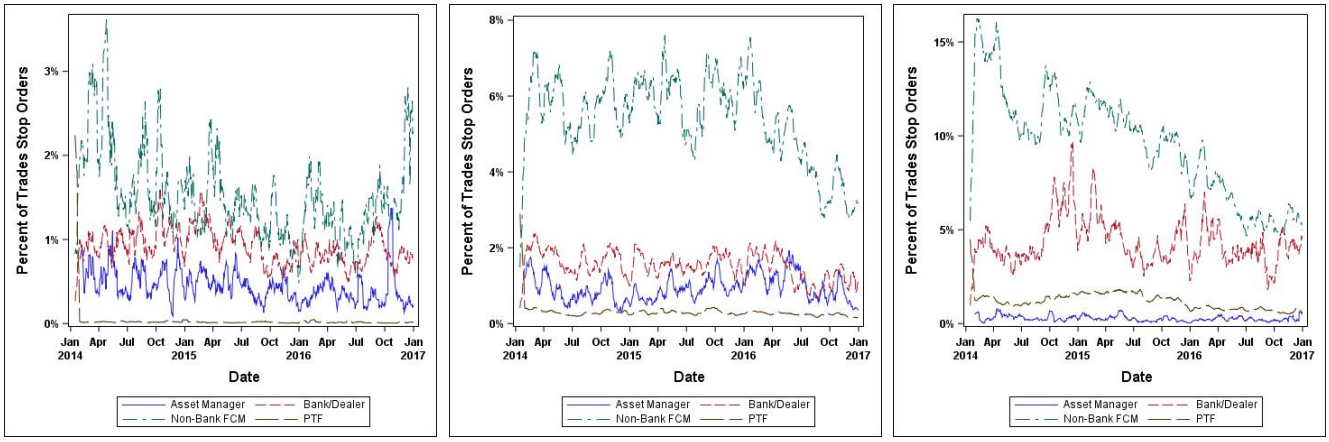


Figure 5 presents how the percentage of stop loss trades changes across time for each type of market participants separately for each market. We observe clear differences across participant types. For E-mini S&P 500 futures, the percentage of trading volume done via stop orders seems to be pretty small for all groups during our sample period. For 10 year treasury note futures, one can also observe that the ratio of stop orders to total trading volume seem to be diminshing for non-bank FCMs towards the end of our sample. For crude oil futures, percentages are much higher comprared to other markets analyzed. In terms of comparing participant types within crude oil, asset managers and Proprietary Trading Firms (PTFs) seem to rank at the bottom, while non-bank FCMs rank at top. During our sample, Asset Managers seem to increase their usage of stop orders especially between mid-2014 until mid-2015. Clearly, this also corresponds to a volatile time in crude oil prices and it is not surprising that more stop orders are executed when prices movements are highly volatile.



(a) 10 Year Treasuries (b) E-Mini S&P 500 (c) Crude Oil

Figure 5: Percent of Trades Stop Orders by Participant Type - 10 Day Moving Average

Table 3 displays more information about the number and type of participants using stop orders. When comparing the number of firms and accounts across products, note that the ten year treasury futures market is an institutional investor market with the least number of firms and accounts. WTI and the E-mini SP 500 futures markets have more participants, but since the numbers presented in table 3 are averages, and with volatility and number of stop orders hit positively correlated, some very flat days see far fewer accounts/firms hit.

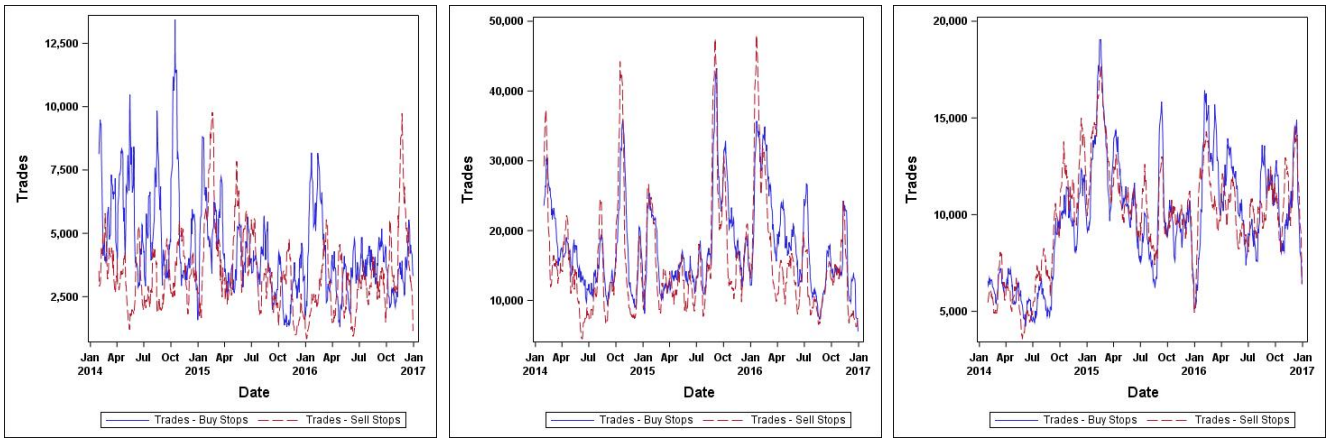
In addition, the vast majority of stop orders are entered manually and for customers. This corresponds closely with the particpant type analysis and lends credence to the traditional view of manually entered stop orders by customers looking for protection. Although the correlation is not perfect, customer stop orders tend to be placed manually while stop orders for house (prop) accounts are more automatic. Execution of stop orders is also much more systematic with little volatility for the automatic orders, while manual orders tend to hit more sporadically, often corresponding with roll periods and volatile market days.

Table 3 - Participant Characteristics - Daily Averages

Commodity Name	Firms	Accounts	Percent Manual	Percent House
E-mini S&P 500 Futures (ES)	63	1,375	92%	20%
WTI Crude Oil Futures (CL)	46	1,021	94%	14%
10 Year US Treasury Note Futures (21)	37	125	90%	23%

The number of transactions (irrespective of quantity), shows a similar trend as stop order volume. Figure 6 shows the total number of buy and sell stops over time. Buy stops can be used to limit loss by participants to offset short positions in the futures. The number of buy and sell stop transactions seem to experience volatile periods throughout our sample and this volatility does not seem to change much across time or product. Over our sample period, for E-mini S&P 500 futures and Ten Year Treasury Futures, there are slightly more buys than sells as

the price trend is upward in general. In contrast, for crude oil, there are slightly more sell than buy, because the downward price trend over our sample period.

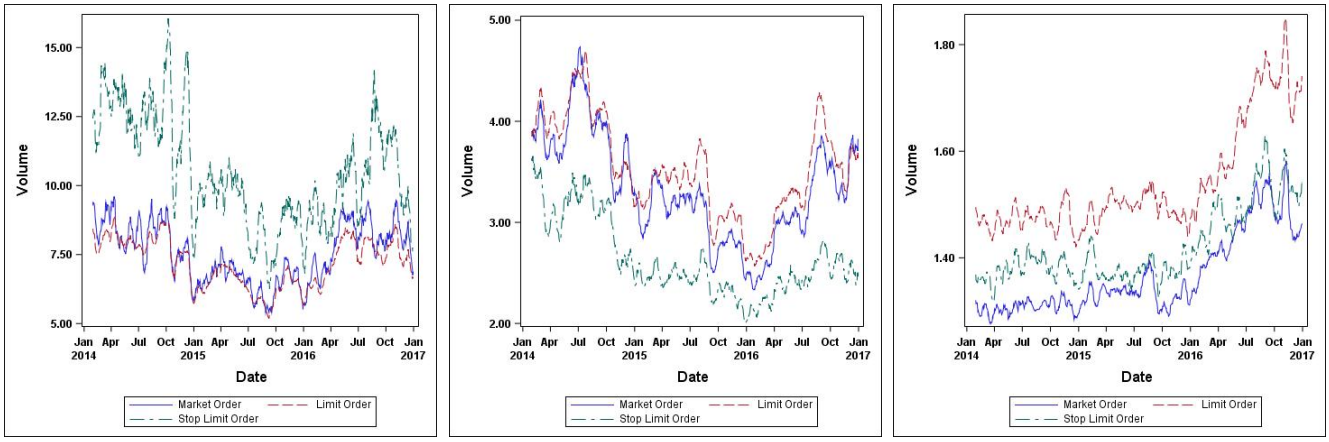


(a) 10 Year Treasuries (b) E-Mini S&P 500 (c) Crude Oil

Figure 6: Buy vs Sell Stop Transactions - 10 Day Moving Average

4.3 How are Stop Orders Different than Other Orders on the Orderbook?

While not used as often as limit orders, stop orders seem to be a preferred order type for some market participants. Figure 7 illustrates how the average trade size by order type changes across our sample and how the various order types compare. It appears that stop orders to do not follow a trend across products, as it is significantly larger in 10 Year treasuries, smaller in the E-mini futures contract and a similar size to market orders for Crude Oil. Comparing trade size across products, average size is the largest for Ten Year Treasury Futures and the smallest for WTI Crude Oil futures. Also note that the sample is not large enough or does not cover stop loss before 2015.

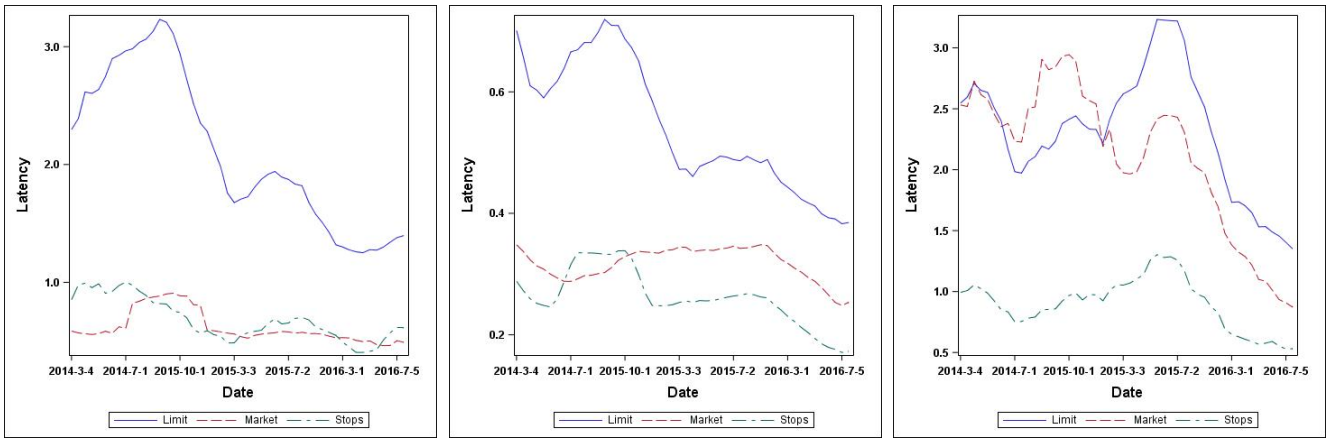


(a) 10 Year Treasuries (b) E-Mini S&P 500 (c) Crude Oil

Figure 7: Average Trade Size

Another interesting observation we make using orderbook data is how quickly the CME's Globex engine confirms

stop orders[4]. Every order that gets sent to the order book needs to be confirmed by the engine before it can be processed and queued in the book. There is some latency associated with that process and Figure 8 examines daily average measures of this confirmation latency for limit, market and stop orders sent to Globex. For 10 Year Treasury Futures, we observe that market and stop orders have the shortest confirmation latency. While this observation also holds for E-Mini S&P 500, confirmation latency for all types of orders decreases towards the end of our sample. The biggest difference in terms of confirmation latency is observed in the Crude Oil Futures. Confirmation latency is the smallest for stop orders and the magnitude of difference between that of stop orders and other orders is sizable. However, it is also worth noting that, similar to what we observe in the E-Mini S&P 500 market, confirmation latency seems to be systemically decreasing for all order types towards the end of our sample in WTI Futures as well.



(a) 10 Year Treasuries (b) E-Mini S&P 500 (c) Crude Oil

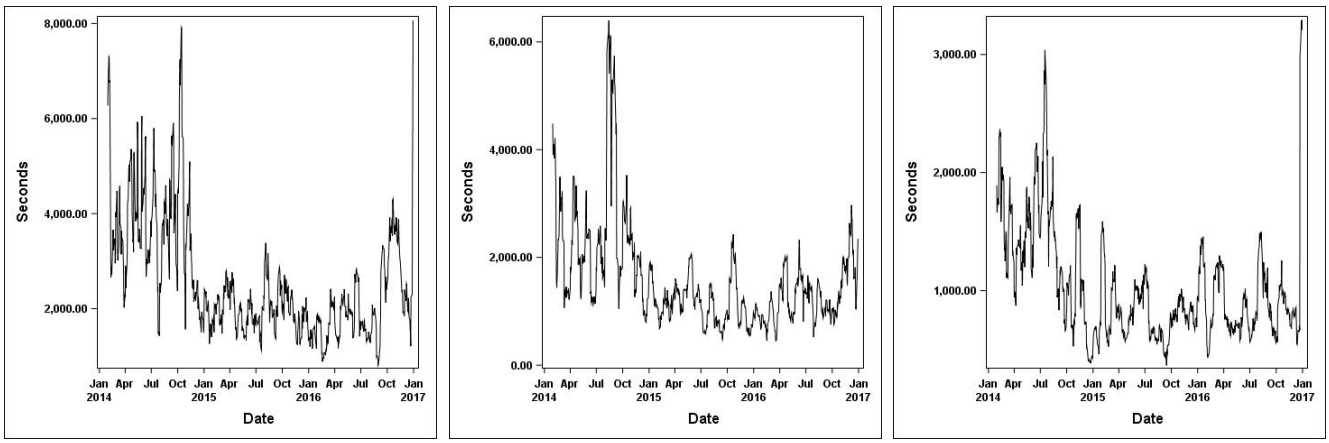
Figure 8: Latency

4.4 How long do stop orders sit on the book before execution?

Another statistic we investigate is resting time of executed stop loss orders. We observe the timestamp when the order enters the Globex and we also observe the timestamp when the order executes. By differencing those two timestamps, we can deduce how long the order sits on the book before execution, or resting time. This is an important number to know in order to figure out the strategic use of stop orders. If resting times are low, it indicates that participants are placing stop orders very close to the top of the book and or refreshing their orders at a higher frequency. Figure 9 shows daily average rest time for executed stop loss orders for three products. While average resting times for each product are different, they all drop significantly around January 2015. Specifically, daily average rest time for 10 Year Treasuries is about 42 minutes Daily average resting time for E-Mini S&P 500 is about 20 minutes. Daily average resting time over the sample period for WTI Futures is about 15 minutes. Contrary to the trend of decreasing average rest time for E-mini S&P 500, average rest time for WTI Futures and

[4]More information can be found at: https://www.cmegroup.com/confluence/display/EPICSANDBOX/Order+Types+for+Futures+and+Options

10 Year Treasuries has increased somewhat in the second half of 2016.

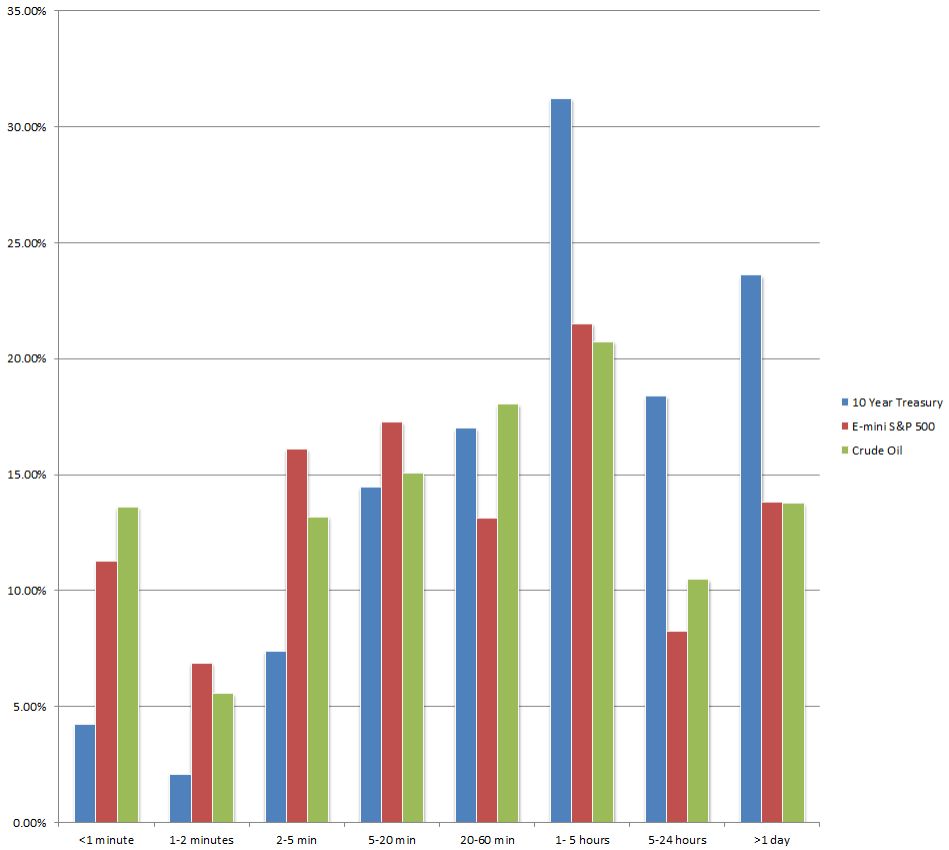


(a) 10 Year Treasuries (b) E-Mini S&P 500 (c) Crude Oil

Figure 9: Average Resting Time - 10 Day Moving Average

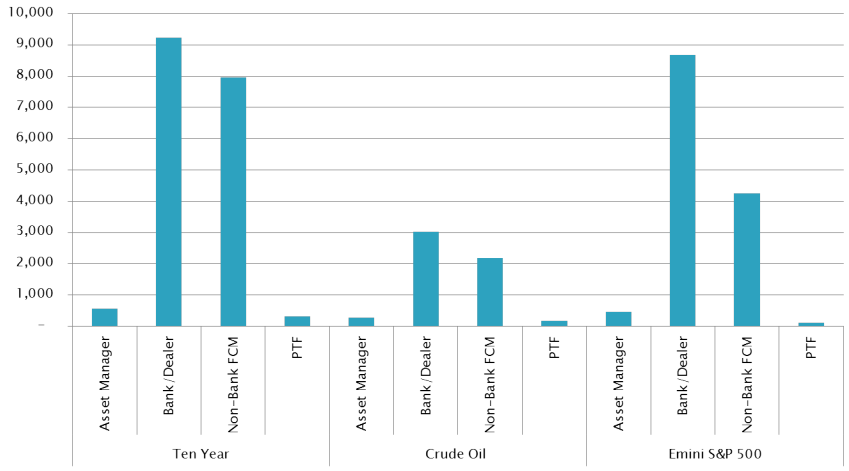
While average resting times seem to be between 15 to 42 minutes, the distribution is also quite interesting. Figure 10 depicts the distribution of resting time of executed stop loss orders from 2014 to 2016 for three products. Over our sample period, for WTI Crude Oil futures, about 13.6% of executed stop loss orders have rest time less than 1 minute verus 11.3% for the E-mini and only 4.2% for ten year treasuries.

Figure 10: Resting Time Distribution 2014-2016



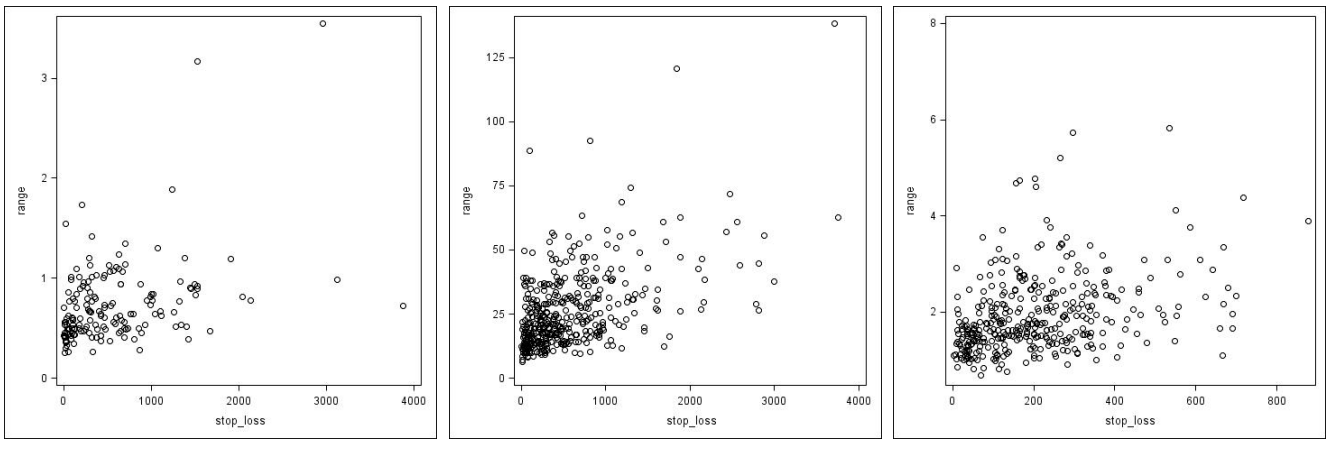
Analyzing resting times of stop orders by participant also reveals interesting details. Figure 11 shows average resting time by participant type across the three markets. In all three markets, Bank/Dealer and Non-bank FCM categories have the longest rest times while PTFs have the shortest.

Figure 11: Average Rest Time by Participant Type



4.5 How Correlated are Stop Order Executions with Price Volatility?

Figure 12 displays the positive relationship between the daily price range which is computed as difference between maximum transacted price and minimum transacted price and the number of executed stop loss orders for all three products. This chart indicates that as daily price volatility increases, so does the percentage of trades executed by stop order. These relationships are intuitive. If the price does not move all day, only stop orders placed at the best bid or ask will get hit. In addition, high volatility incentivizes market participants to use more stop orders to limit loss.

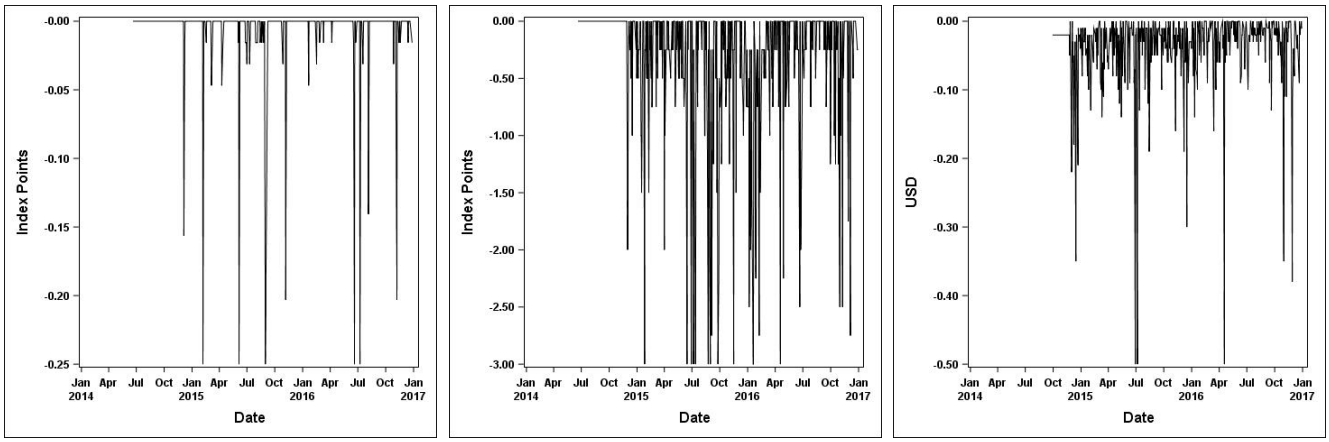


(a) 10 Year Treasuries (b) E-Mini S&P 500 (c) Crude Oil

Figure 12: Price Range and Executed Stop Loss Volume

4.6 How about Stop Order Slippage?

One concern of market participants when placing stop loss orders (not stop limit) is that upon triggering the stop, a market order is placed. As there have been occasional flash crashes or other large, nearly vertical price moves, participants worry about their market order executing at a price well below their stop price. CME offers protection for these types of orders to limit very large price moves. While slippage is a rare occassion, since most stop orders are placed as limits, it can be significant for the participants who still do place these stop orders subject to slippage. Slippage is calculated as (stop price - trade price) for stop loss buy orders. Minimum slippage for ES stop loss sell market orders is -3, minimum slippage for CL is -0.5, and minimum slippage for 10 Y Treasury is -0.25. You can see that on many occasions from Figure 13, the protection of the orders was hit. An abundance of these days may indicate that the protection range is too tight.

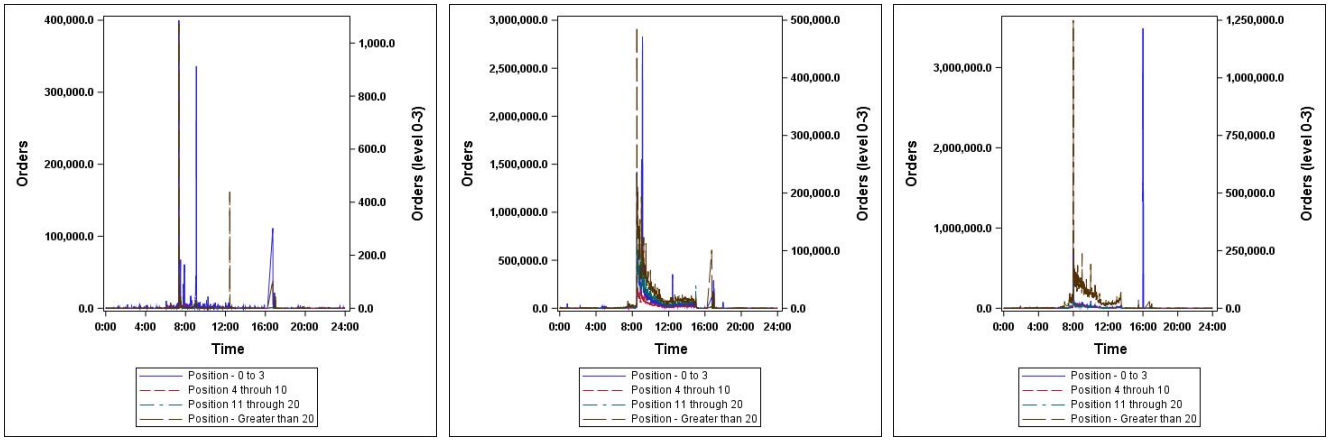


(a) 10 Year Treasuries (b) E-Mini S&P 500 (c) Crude Oil

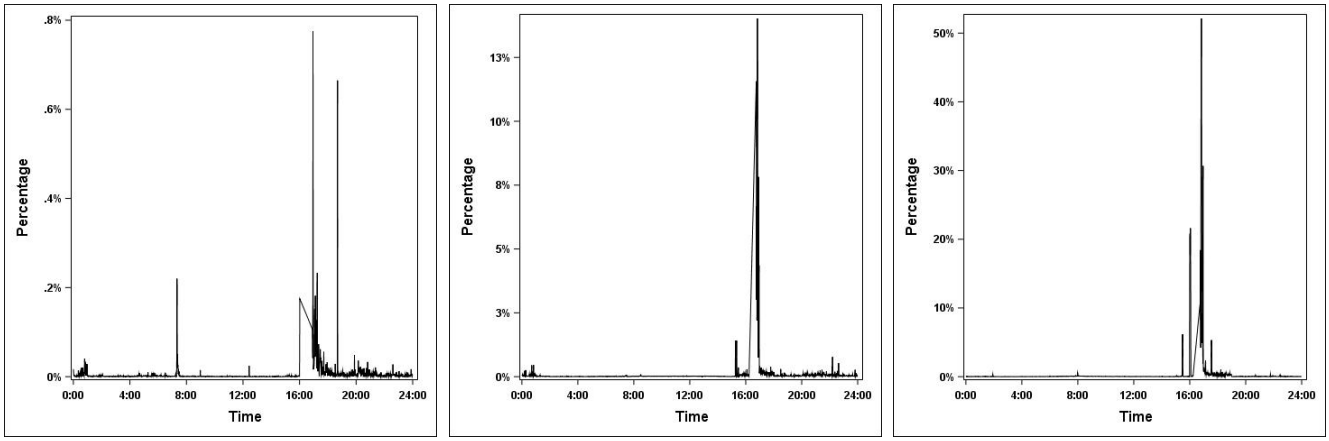
Figure 13: Minimum Slippage Levels

4.7 What are intraday trading patterns of stop orders?

As shown in Figure 14 , stop orders tend to cluster at the beginning and end of the day, a similar trend seen in most orders. The similarity to other orders breaks however when we look at the time of the day when the highest percentage of orders placed are stop orders. In all three products, right after the close, stop percentages increase to levels not seen during other parts of the day. This makes sense from the view of the traditional use case of stop orders; after the trading day is over, participants place stop orders so that they don't have to follow the market closely throughout the night.



(a) 10 Year Treasuries (b) E-Mini S&P 500 (c) Crude Oil

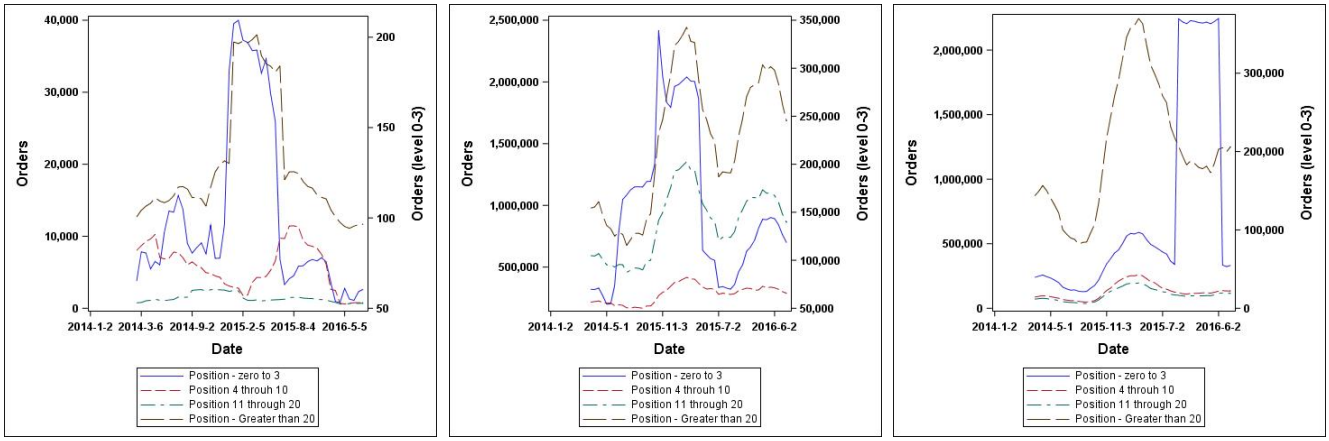


(d) 10 Year Treasuries (e) E-Mini S&P 500 (f) Crude Oil

Figure 14: Time of Day of Stop Orders - 10 Day Moving Average

4.8 What price level are stop orders placed?

Most of orders are placed at price levels greater than 20 ticks away from the best bid/ask. Figure 15 shows that although most of the orders are placed a large number of ticks awaye from the best bid/ask, many orders are still placed within the first few levels of the orderbook. To give an example, if the price of the E-mini is 2,000 and the minimum tick is 0.25, then Position Zero would be 2,000, Position 1 at 1,999.75, Position 2 at 1,999.50 and so on. For these contracts, the placement shows how close many of the stop orders actually are to the top of the book. This definitely indicates that there might be two different groups of market participants using stop orders for different hedging needs. The traditional hedging against big price movements are represented by stop orders placed far away (greater than 20 ticks) from the best bid and ask. Orders that were placed much closer to the best bid and ask, on the other hand, might be a different hedging strategy that might signal a more urgent need to put on a hedge against even small price movements.



(a) 10 Year Treasuries (b) E-Mini S&P 500 (c) Crude Oil

Figure 15: Daily Average Placement off the Book - 10 Day Moving Average

5 Conclusion

The granularity in the regulatory data we receive on futures products allows us to take a close look at stop order trends within a few active contracts: the E-mini S&P 500, Ten Year Treasuries, and WTI Crude Oil. The results of this paper provide evidence of continued and developing strategic use of stop orders in the futures market. The number of stop orders and placement in the book varies greatly by product and participant type. Despite traditional views that stop orders are placed as insurance in a falling market, a large number of stop orders are placed at market prices and used as a way to reduce latency in order placement. Stop orders, as expected, are executed more often on volatile days and provide significant liquidity in the direction of the move. Average rest times for stop orders have come down over the past few years, however many participants still use stops as longer term bottoms for their trades. Slippage values can sometimes be significant, however exchange implemented protection of stop orders successfully limit the magnitude of large values. Future direction of research can include expanding on the number of covered products and exploring the relationship of stop orders and volatility in futures markets.