Automated Trading in Futures Markets — Update[*]

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Introduction

In March of 2015, the CFTC released a white paper detailing the use of automation within futures market. [1] The paper analyzed the prevalence of automation across different asset classes, how market speeds have adjusted relative to the use of automation, and how automation is used when providing and taking liquidity. In almost all contracts, the level of automation in the analyzed two year time frame increased, sometimes significantly, and market speeds, represented in part by the average time between the submission of an order and its execution, also experienced a coincident increase.

This addendum to that paper updates the tables and charts in the original paper through 2016, extending the prior analysis by an additional two year period. To faciliate comparisons, unless noted otherwise in the table, we show the numbers reported in the prior report in black and the new numbers in red. The prior report covered trading activity from November 12, 2012 to October 31, 2014; the updated information adds information about trading activity from November 1, 2014 to October 31, 2016.

In addition to these updates, this paper also expands the level of coverage to a much broader set of individual contracts to provide a clearer look at automation trends across futures as a whole. The results of this extension further emphasize the trends noted in the previous analysis — both the level of automation and the speed of trading continue to increase. This increase has been more prevalent for asset classes or contract groups where automation penetration had been low relative to the rest of the market; many physical commodity contracts fall into this group. As examples, trading in Energy-related contracts in the prior period was around 47 percent automated. In the more recent period, this has risen to around 57 percent; agricultural commodities have risen a similar amount from

38 to 48 percent. Other groups of products, like foreign exchange and stock index futures, appear to have hit a rough automation equilibrium prior to the most recent period, and so experienced less incremental change (FX, as one case, increased from 80 to 83 percent). Further takeaways from the expanded time frame and contract set are below. Further information about the measures and the data sets used to generate this analysis can be found in the original white paper.

Prevalence of Automated Trading

The level of automated trading has increased, over the past few years, across all of the major product groups traded on the CME. Table 1 shows a breakdown of trading activity by product group.[2] For all categories, the contribution to total volume linked to non-electonic trading has decreased and automated trading has increased relative to the prior sample. This change is most evident in the low volume group where non-electronic volume fell from 98 to 22 percent and automated activity increased from 0.1 percent to 66 percent of total volume. Of the major product groups, agriculture and energy products had the largest increase in automated trading, approximately 10 percent relative to the earlier period.

Drilling down from product groups into CME defined subgroups show similar trends in the distribution between the non-electronic, automated and manual share of traded volume. Table 2 provides a breakdown similar to the prior table, now at more granular the subgroup level. The share of total volume represented by non-electronic trading has decreased across most subgroups (increases were seen in only three of the twenty-two categories). The share of traded volume linked to automated trading increased the most for three agricultural subgroups, all of which had approximately 10 percent increases. Of all the subgroups, dairy has the largest share of manual trading (84 percent) and G10 currencies have the largest share of automated trading.

The remaining tables and charts focus on a selected set of products representing many of the most active products in the main product groups, and mirror the analysis in the prior white paper. Across all products, the share of volume linked to automation has increased (see Table 3), as has the total trade volume for the contracts (FX volume is one exception to this pattern). As with the product groups, most of the largest changes were seen in agricultural commodities, though there were significant jumps in automation in others like gold and silver. Figure 1 provides a view into these changes across time. It provides a smoothed day-to-day breakdown of trading activity into automated and manual categories for the four year time period. For all of the four commodities included in the original white paper, the level of automation has grown, with the largest growth in the commodities starting from a lower base (e.g. crude oil). Interestingly, significant cyclicality in the level of manual trading still remains around the contract roll period. Appendix A contains figures for a number of new products which were not shown in the prior white paper and hopefully provide a more extensive view into other commodity classes.

Table 4 builds on Table 3 by dividing activity into outright or spread trading groups. The largest increases

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[2]The table also contains the count of products found for each product group. We note there has been a slight reduction in the number of products; for example, the energy product group has decreased from 285 products to 275.

in automation have occurred in outright trading, while, in a number of cases, there seem to be much smaller adjustments to the level of automation for spread (e.g. roll) activity. Appendix B includes a set of figures, for the more recent two year time period, broken down into categories related to the type of contracts on each leg of a trade (e.g. (regular) outrights matched with (regular) outrights: RO–RO or spreads with spreads: SP–SP). Again, the largest changes over recent years are generally in the RO–RO category; there are a few exceptions for contracts where spreads are more commonly used on a day-to-day basis like Eurodollars and energy contracts.

We also provide a breakdown of the use of automation relative to the size of a trading participant. Table 5 breaks down participant activity in the 13 primary futures contracts into small and large volume traders and shows the percentage of automated and manual trading for each group by product.[3] The percentages included in the table are relative to the total trading volume in the product, so numbers sum to 100 percent within a row for each sample period. In all cases, automation is more commonly used, often significantly so, by larger traders; in a few cases, automated volumes for large traders are an order of magnitude larger than manual volumes. In contrast, for a number of products, small traders are actually more likely to be trading manually than through automated means. Like other charts and tables, we see a shift towards automation within groups relative to the earlier period.

Speed of Trading

Increases in the level of market automation are often paired with increases in the speed of trading activity. Table 6 shows a breakdown of resting times for executed passive orders; like the previous table, the values are relative to total (buy and sell side) volume and therefore add up to approximately 50 percent for each sample period. This table further highlights relationships between automation and speed, with little manual activity, but a lot of automated activity, occurring within a second of order placement. In addition, while there has been a measurable increase in the amount of automated trading occurring within the fastest time buckets, the same is not true for manual trading — perhaps the fastest manual traders switched to using automated systems, removing themselves from the manual group. Figure 2 provides a similar set of information but now shows the daily time series, for four selected products, over the past two years (see Appendix C for the remaining nine products). In many cases, changes over the two year period for the four primary contracts have been minimal, indicating only slight shifts in the speed of liquidity provision and removal. The one potential exception to this is the fastest time range (0 - 100 ms), where there have been fairly consistent increases, at least one sign that markets have indeed gotten progressively faster even in cases where automation levels have remained flat. The fairly small adjustments in market speed appear to extend to even the lower volume contracts like physical commodities, contrasting with the fairly significant changes in the level of market automation seen in earlier tables.

Table 7 shows a similar breakdown for outright vs. spread trading, with speeds for spread trading (a much less volatile contract type) significantly slower than for outright trades. Appendix C contains the full set of figures, for

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[3]Trading accounts are classified, on a daily basis, as "large volume traders" if they contribute at least 0.5 percent to total daily volume across all expirations.

each product, that show a breakdown of speeds for outright and spread volume. Table 8 summarizes the speed of inventory turnover for the large volume trader group. The table quantifies what percentage of purchases/sales by these traders are closed within a selected set of times (e.g. one minute, a day). These percentages are always significantly higher for automated traders — for many products, the median holding period for automated traders volume is much less than a day, often within a minute of initial execution. In contrast, manual traders have much longer holding periods for most products, pointing to a division between the intraday trading of automated participants versus the interday activity of manual firms.

Figure 3 provides cumulative distribution functions (and distribution variances) for the time between the introduction of a new passive order and its execution, again broken into manual/automated categories. In all cases, automated orders are executed more quickly than manual orders, possibly due to both the speed at which automated orders are cancelled/modified and the higher likelihood of automated orders sitting close to the top of the book. Because of this, markets that tend to have higher levels of automation, like the Euro and the E-Mini, are also the fastest markets for liquidity provision. These updated figures, based on data over the past two years, are similar to the summaries constructed for the earlier two year sample. Appendix D collects figures for the remaining nine products not shown in the prior paper.

Conclusion

In summary, after extending the sample for an additional two years, we find a continued increased in automation across all commodity futures products. Results on the speed of markets are more mixed, with many markets not significantly "faster" (relative to the measures we consider) than the earlier period. Automation trends are likely to continue into the future as market participants adopt and build on technology that automated trading relies on, especially in those future products that currently have relatively low automation levels. Within the larger, cross-time trends, there do generally seem to be patterns of activity differentiating the automated and manual groups, with automated participants acting more quickly, including more often moving into and out of trading positions within short periods of time. In addition, there are similarly distinct patterns of behavior between spread and outright trading. Outrights, more commonly traded using automation and generally more volatile, are much faster markets and see less cyclicality of activity through time. We hope to continue updating, and perhaps expand on, the trading breakdowns developed in the initial white paper and this addendum over time, further examining the prevalence, and other aspects, of market automation.

Figure 1: Daily Volume Percentages for ATS–ATS (Red), ATS–MAN (Blue), and MAN–MAN (Green)

Notes: For each commodity, total daily volume across all expirations, over the past four years, is divided into trades where the orders on both sides of the trade originated from an automated system (ATS–ATS), where one side originated from an automated system (ATS–MAN), where neither side is an automated system (MAN–MAN), and non-electronic volume (not included in the figures below). Percentages are computed, then smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2012 – October 31, 2016.
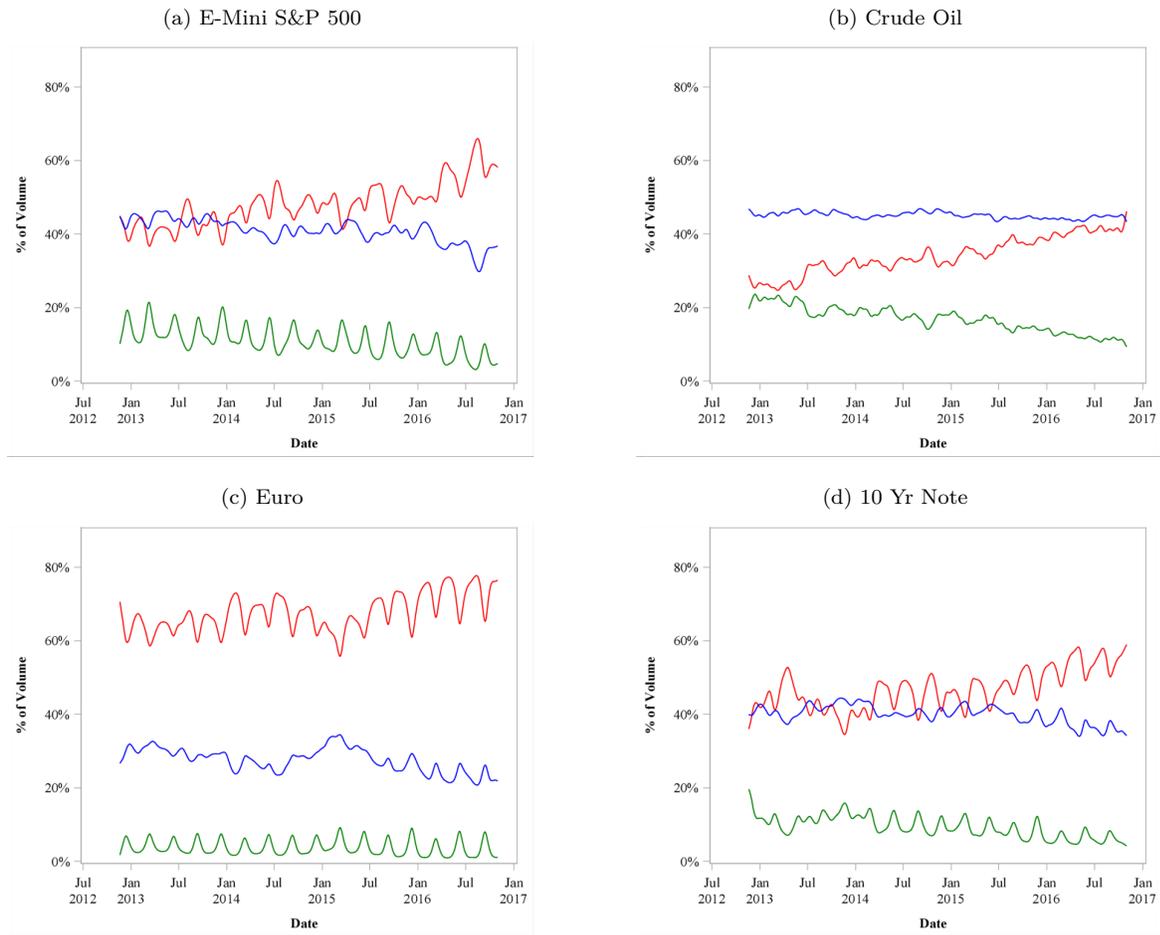
(a) E-Mini S&P 500

(b) Crude Oil

(c) Euro

(d) 10 Yr Note

Table 1: Manual Vs. Automated Trading By Product Group

Product Group Name	Products		Non-Electronic (%)				ATS (%)				Manual (%)			
Low Volume Group	376	354	98.1	(0.0)	21.8	(0.1)	0.1	(0.0)	66.1	(0.2)	0.9	(0.0)	12.1	(0.0)
Agriculture	36	32	6.4	(0.5)	4.1	(0.4)	38.1	(3.0)	48.5	(4.3)	55.6	(4.4)	47.5	(4.2)
Energy	285	275	16.8	(2.2)	11.2	(1.8)	46.9	(6.0)	57.5	(9.1)	36.4	(4.7)	31.4	(4.9)
Equities	25	25	0.9	(0.2)	0.9	(0.2)	66.6	(14.3)	71.6	(14.3)	32.5	(7.0)	27.5	(5.5)
FX	51	48	3.4	(0.2)	1.0	(0.1)	79.9	(5.8)	82.7	(5.6)	16.8	(1.2)	16.3	(1.1)
Interest Rate	15	12	4.2	(2.0)	3.4	(1.5)	62.3	(29.7)	66.8	(30.3)	33.4	(15.9)	29.8	(13.5)
Metals	17	17	5.6	(0.2)	4.6	(0.1)	46.5	(1.4)	54.1	(1.6)	48.0	(1.4)	41.3	(1.2)

Table 2: Manual Vs. Automated Trading By Product Group and Subgroup

Notes: This table summarizes volume as a percentage of the total volume in a product/sub-product pair (initial percentage in a category) and across the full market (percentage in parentheses). Each individual transaction is linked to its associated product, which is then aggregated within the associated product/sub-product category. This table excludes the low volume group of Table 1. Black numbers correspond to the original sample period: November 12, 2012 – October 31, 2014. Red numbers correspond to the new sample period: November 1, 2014 – October 31, 2016. Source: CME transaction data.

Product Group and Subgroup Name	Products		Non-Electronic (%)				ATS (%)				Manual (%)			
Agriculture - Commodity Index	6	5	26.0	(0.0)	35.7	(0.0)	22.6	(0.0)	22.4	(0.0)	51.5	(0.0)	41.9	(0.0)
Agriculture - Dairy	6	6	4.1	(0.0)	1.7	(0.0)	6.8	(0.0)	14.6	(0.0)	89.1	(0.0)	83.7	(0.0)
Agriculture - Grain and Oilseed	16	13	5.6	(0.4)	4.1	(0.3)	39.0	(2.7)	49.0	(3.9)	55.4	(3.8)	46.9	(3.8)
Agriculture - Livestock	3	3	11.3	(0.1)	2.5	(0.0)	32.4	(0.3)	45.8	(0.4)	56.3	(0.5)	51.8	(0.4)
Agriculture - Lumber and Pulp	1	1	6.9	(0.0)	1.4	(0.0)	10.5	(0.0)	20.4	(0.0)	82.6	(0.0)	78.2	(0.0)
Energy - Biofuels	5	5	79.4	(0.0)	85.3	(0.0)	2.5	(0.0)	2.4	(0.0)	18.1	(0.0)	12.2	(0.0)
Energy - Coal	8	8	100.0	(0.1)	100.0	(0.1)	-		0.0	(0.0)	-		0.0	(0.0)
Energy - Crude Oil	22	21	5.5	(0.3)	3.5	(0.3)	54.3	(3.2)	63.0	(5.5)	40.2	(2.4)	33.6	(2.9)
Energy - Electricity	62	59	100.0	(0.5)	100.0	(0.5)	-		0.0	(0.0)	-		0.0	(0.0)
Energy - Natural Gas	40	40	21.2	(0.8)	13.3	(0.5)	44.2	(1.6)	56.8	(2.0)	34.6	(1.2)	29.9	(1.0)
Energy - Refined Products	126	122	15.0	(0.4)	12.2	(0.4)	46.0	(1.2)	54.6	(1.6)	39.0	(1.0)	33.2	(1.0)
Equities - International Index	4	4	0.4	(0.0)	0.2	(0.0)	69.3	(0.4)	76.2	(0.5)	30.3	(0.2)	23.6	(0.1)
Equities - Select Sector Index	9	9	18.8	(0.0)	42.2	(0.0)	59.2	(0.0)	45.3	(0.0)	22.0	(0.0)	12.4	(0.0)
Equities - US Index	12	12	0.9	(0.2)	0.8	(0.2)	66.5	(13.8)	71.5	(13.8)	32.6	(6.8)	27.7	(5.3)
FX - E Micros	8	8	0.0	(0.0)	0.0	(0.0)	66.3	(0.1)	69.3	(0.1)	33.7	(0.0)	30.7	(0.1)
FX - Emerging Markets	18	16	12.5	(0.1)	5.6	(0.0)	70.3	(0.3)	76.2	(0.4)	17.1	(0.1)	18.2	(0.1)
FX - G10	25	24	2.8	(0.2)	0.7	(0.0)	80.7	(5.4)	83.7	(5.1)	16.4	(1.1)	15.6	(1.0)
Interest Rate - Deliverable Swaps	4	4	16.3	(0.0)	10.0	(0.0)	47.8	(0.0)	47.5	(0.0)	35.9	(0.0)	42.5	(0.0)
Interest Rate - Stirs	3	3	2.2	(0.5)	2.1	(0.5)	60.3	(13.0)	65.1	(13.8)	37.5	(8.1)	32.8	(7.0)
Interest Rate - US Treasury	5	5	5.9	(1.5)	4.5	(1.1)	64.0	(16.6)	68.4	(16.4)	30.2	(7.8)	27.1	(6.5)
Metals - Base	4	4	3.1	(0.0)	2.2	(0.0)	49.2	(0.3)	56.9	(0.4)	47.7	(0.3)	40.9	(0.3)
Metals - Precious	8	8	6.1	(0.1)	5.0	(0.1)	45.9	(1.1)	53.5	(1.3)	48.0	(1.1)	41.5	(1.0)

Table 3: Manual Vs. Automated Trading Most Active Products

Values shown as: black = original sample period / red = new sample period.

Product Group and Subgroup	Futures Product Name	Total Volume (mm)	ATS–ATS (%)	ATS–MAN (%)	MAN–MAN (%)
Agriculture - Grain and Oilseed	Corn	128 / 168	15.9 / 23.1	42.8 / 45.1	34.8 / 27.1
Agriculture - Grain and Oilseed	Soybean	93 / 115	15.2 / 25.1	42.5 / 45.6	36.3 / 24.1
Agriculture - Grain and Oilseed	Wheat	49 / 62	18.5 / 29.3	44.9 / 47.5	33.9 / 21.6
Energy - Crude Oil	Crude Oil	280 / 454	30.2 / 38.1	45.5 / 44.5	19.5 / 14.2
Energy - Natural Gas	Natural Gas (Henry Hub)	153 / 175	30.7 / 42.5	45.8 / 41.6	19.1 / 12.3
Energy - Refined Products	RBOB Gasoline Physical	67 / 84	24.6 / 33.5	43.7 / 43.6	23.0 / 15.2
Equities - US Index	E-mini S&P 500	866 / 891	43.4 / 50.6	42.6 / 39.3	13.8 / 9.9
Equities - US Index	E-mini NASDAQ 100	131 / 134	58.2 / 60.1	34.8 / 33.9	6.9 / 5.2
Equities - US Index	E-mini Dow ($5)	73 / 82	60.9 / 64.6	33.6 / 31.1	5.4 / 4.1
FX - G10	Euro	110 / 115	64.5 / 66.3	28.9 / 28.0	4.4 / 5.1
FX - G10	Japanese Yen	76 / 74	68.8 / 77.7	25.0 / 18.8	3.5 / 2.9
FX - G10	British Pound	53 / 52	71.7 / 74.1	21.2 / 21.0	4.1 / 4.3
Interest Rate - Stirs	Eurodollar	1,125 / 1,193	36.1 / 44.0	49.3 / 44.5	12.5 / 9.4
Interest Rate - US Treasury	10 Yr Note	643 / 661	42.6 / 48.0	41.1 / 39.7	11.9 / 8.7
Interest Rate - US Treasury	5 Yr Note	360 / 378	50.5 / 53.2	32.8 / 34.0	8.6 / 7.4
Metals - Precious	Gold	85 / 162	24.0 / 46.1	43.9 / 37.8	25.5 / 9.6
Metals - Base	Copper	31 / 97	27.5 / 31.7	43.5 / 42.9	26.0 / 19.8
Metals - Precious	Silver	27 / 31	27.9 / 36.0	37.0 / 36.2	31.3 / 24.5

Table 4: Volume Shares By Product and Trade Type

Notes: This table provides a further breakdown for the most active products found in Table 3. These thirteen products will be the primary focus for the rest of the study. For each product, percentages of total volume in the product over the sample period are grouped by automated or manual counterparties and by whether the trade matches regular outrights (RO) or spreads (SP). Cases where an outright trade is matched with a spread trade are possible due to implied spread functionality provided by the exchange (when this functionality does not exist, the cells are blank). Note that this chart restricts attention to just electronic trading. Black numbers correspond to the original sample period: November 12, 2012 – October 31, 2014. Red numbers correspond to the new sample period: November 1, 2014 – October 31, 2016. Source: CME transaction data.

Futures Product Name	ATS–ATS						ATS–MAN						MAN–MAN					
	RO–RO		RO–SP		SP–SP		RO–RO		RO–SP		SP–SP		RO–RO		RO–SP		SP–SP	
E-mini S&P 500	43.1	50.3	-	-	0.3	0.4	40.6	37.1	-	-	2.0	2.2	9.5	6.0	-	-	4.3	3.8
E-mini NASDAQ 100	58.0	59.8	-	-	0.3	0.3	33.0	32.3	-	-	1.8	1.6	3.9	3.0	-	-	3.0	2.2
Crude Oil	11.1	17.1	2.5	3.5	16.6	17.6	15.1	19.1	4.5	4.1	25.9	21.3	4.4	4.9	2.1	1.4	13.0	7.8
Natural Gas (Henry Hub)	12.3	15.4	3.6	5.7	14.7	21.5	12.0	10.4	6.0	5.6	27.9	25.6	3.4	2.5	2.4	1.4	13.3	8.4
Eurodollar	11.7	17.1	6.0	5.7	18.3	21.2	17.1	17.6	8.1	6.1	24.2	20.8	5.2	4.8	2.4	1.4	4.8	3.1
10 Yr Note	41.4	45.2	0.3	0.5	1.1	2.2	36.3	32.9	0.4	0.5	4.5	6.3	8.1	5.1	0.1	0.1	3.6	3.5
5 Yr Note	49.2	49.1	0.3	0.9	1.2	3.2	26.8	24.2	0.3	0.7	5.6	9.0	3.2	2.2	0.1	0.1	5.2	5.1
Euro	64.3	65.9	-	-	0.2	0.4	27.0	24.7	-	-	1.9	3.3	2.3	1.8	-	-	2.1	3.4
Japanese Yen	68.4	77.2	-	-	0.3	0.5	23.0	16.5	-	-	2.1	2.3	1.6	0.6	-	-	1.9	2.3
Corn	10.1	15.4	1.9	2.1	3.9	5.7	17.7	18.7	6.9	6.0	18.2	20.3	9.2	6.5	6.1	4.2	19.5	16.4
Soybean	9.1	14.5	2.6	3.8	3.5	6.7	17.9	18.3	9.0	8.1	15.6	19.3	9.8	5.9	8.1	4.4	18.4	13.7
Gold	22.8	30.5	0.5	0.5	0.7	0.7	36.6	34.6	2.3	2.3	5.0	5.9	13.4	7.8	2.2	1.8	10.0	10.1
Silver	27.7	35.6	0.1	0.1	0.1	0.2	31.0	29.1	2.4	2.1	3.5	5.1	7.0	4.7	2.2	1.7	22.1	18.1

Table 5: Volume Shares By Product and Trader Group

Futures Product Name	Small Volume Trader						Large Volume Trader					
	N	N	ATS (%)	ATS (%)	MAN (%)	MAN (%)	N	N	ATS (%)	ATS (%)	MAN (%)	MAN (%)
E-mini S&P 500	126,675	143,363	19.2	19.5	29.3	25.5	469	423	45.5	50.8	5.8	4.0
E-mini NASDAQ 100	52,793	59,030	17.4	16.8	20.0	17.2	544	446	58.2	60.3	4.3	5.0
Crude Oil	65,410	91,325	18.4	18.3	30.5	27.7	538	388	34.6	42.1	11.8	8.8
Natural Gas (Henry Hub)	35,181	35,136	15.1	17.8	24.5	21.7	649	565	38.5	45.6	17.5	11.4
Eurodollar	21,223	20,423	14.5	16.2	30.3	25.2	619	575	46.1	50.0	6.9	6.4
10 Yr Note	47,773	50,232	20.5	21.3	27.4	23.7	716	702	42.7	46.5	5.1	4.9
5 Yr Note	22,399	24,741	20.0	22.3	18.7	18.0	1,126	1,102	47.0	47.9	6.4	6.4
Euro	45,064	43,434	14.9	15.7	15.1	14.5	477	467	64.1	64.6	3.7	4.6
Japanese Yen	29,191	26,595	14.4	15.2	12.7	8.9	485	441	66.9	71.9	3.3	3.4
Corn	76,290	72,535	18.7	20.8	36.0	27.8	868	731	18.6	24.9	20.2	21.8
Soybean	59,739	61,960	19.2	22.1	42.2	33.0	815	772	17.2	25.8	15.4	13.9
Gold	52,675	56,301	19.0	19.4	31.8	26.4	630	626	26.9	33.7	15.8	14.8
Silver	23,934	23,186	17.0	18.1	24.4	20.5	696	709	29.3	35.9	25.4	22.1

Table 6: Time Between Order Placement and Execution for Liquidity Providers

Notes: This table breaks down trading volume by the time between the initial placement (or most recent modification) of the order representing the passive side of the trade and the trade itself. This volume is then scaled by the total two-sided volume for the given product. Note that a small subset of trades for active intra-commodity spreads have both sides marked as non-aggressive, so values in the rows may sum to a number greater than 50 percent (e.g., Eurodollar row percentages sum to 54.5 percent for the early period). Black numbers correspond to the original sample period: November 12, 2012 – October 31, 2014. Red numbers correspond to the new sample period: November 1, 2014 – October 31, 2016. Source: CME transaction data.

| Futures Product Name | 0 – 100 ms | | 100 ms – 500 ms | | 500 ms – 1 sec | | 1 sec – 10 sec | | 10 sec – 1 min | | Remaining |
	ATS	MAN	ATS	MAN	ATS	MAN	ATS	MAN	ATS	MAN	Elec Volume
E-mini S&P 500	6.4 / 9.6	0.6 / 0.6	3.1 / 4.1	0.5 / 0.5	2.1 / 2.8	0.5 / 0.5	10.0 / 10.7	3.7 / 3.1	6.6 / 5.3	3.7 / 2.8	12.7 / 9.9
E-mini NASDAQ 100	8.9 / 11.3	0.8 / 0.9	5.5 / 6.7	0.6 / 0.6	3.5 / 3.8	0.5 / 0.5	11.8 / 10.8	2.9 / 2.8	5.0 / 4.0	2.4 / 2.1	8.0 / 6.2
Crude Oil	3.9 / 5.6	1.3 / 1.1	2.2 / 2.9	0.6 / 0.6	1.4 / 1.8	0.4 / 0.4	6.2 / 7.5	2.7 / 2.6	5.0 / 5.2	3.5 / 3.0	22.8 / 20.2
Natural Gas (Henry Hub)	3.2 / 4.4	1.2 / 1.1	1.4 / 1.5	0.5 / 0.3	1.0 / 1.0	0.3 / 0.2	5.8 / 6.9	2.4 / 1.8	5.4 / 7.2	3.6 / 2.9	26.3 / 24.2
Eurodollar	2.2 / 3.2	0.9 / 0.9	1.9 / 2.3	0.8 / 0.6	0.9 / 1.3	0.4 / 0.3	4.5 / 6.0	1.7 / 1.5	5.9 / 6.7	3.0 / 2.6	31.2 / 27.0
10 Yr Note	5.4 / 6.5	0.6 / 0.5	2.0 / 2.1	0.4 / 0.3	1.2 / 1.4	0.3 / 0.2	7.2 / 7.8	2.2 / 1.9	7.7 / 7.9	3.3 / 2.8	17.8 / 17.0
5 Yr Note	5.9 / 6.6	0.8 / 0.7	2.3 / 2.3	0.4 / 0.3	1.3 / 1.4	0.2 / 0.2	7.2 / 7.7	1.7 / 1.5	7.8 / 8.0	2.6 / 2.2	16.1 / 16.9
Euro	10.8 / 12.4	0.7 / 0.9	4.5 / 5.1	0.3 / 0.4	2.3 / 2.7	0.3 / 0.3	10.2 / 10.6	1.7 / 1.8	6.3 / 4.9	1.8 / 1.6	10.1 / 9.1
Japanese Yen	11.7 / 12.6	0.9 / 0.7	4.3 / 5.2	0.3 / 0.2	2.1 / 2.7	0.2 / 0.2	10.0 / 11.6	1.3 / 1.0	6.7 / 6.5	1.4 / 1.0	9.7 / 8.2
Corn	1.6 / 2.3	0.6 / 0.5	1.0 / 0.9	0.5 / 0.2	0.7 / 0.7	0.4 / 0.2	4.2 / 4.2	3.0 / 1.8	4.5 / 4.8	4.7 / 3.3	30.0 / 32.4
Soybean	2.0 / 2.8	1.1 / 0.8	1.4 / 1.3	0.7 / 0.4	1.0 / 1.0	0.6 / 0.3	5.3 / 5.8	4.2 / 2.7	4.2 / 5.1	5.6 / 3.7	26.6 / 28.1
Gold	4.2 / 4.8	1.8 / 1.3	3.1 / 3.3	1.0 / 0.6	1.9 / 2.1	0.7 / 0.5	7.7 / 8.8	4.0 / 3.1	3.7 / 4.5	3.4 / 2.8	16.6 / 16.7
Silver	4.1 / 5.0	1.4 / 0.9	2.3 / 2.2	0.5 / 0.3	1.6 / 1.5	0.4 / 0.3	7.6 / 8.2	2.9 / 2.1	4.9 / 6.3	3.6 / 3.0	20.1 / 19.7

Table 7: Time Between Order Placement and Execution for Liquidity Providers: Outright (Black) Vs. Spread (Blue)

Notes: This table breaks down trading volume by the time between the initial placement (or most recent modification) of the order representing the passive side of the trade and the trade itself. This volume is then scaled by the total two-sided volume for the given product. Note that a small subset of trades for active intra-commodity spreads have both sides marked as non-aggressive, so values in the rows may sum to a number greater than 50 percent. Black (blue) numbers correspond to outright (spread) trading in the updated period. Source: CME transaction data, November 1, 2014 – October 31, 2016.

Futures Product Name	0 – 100 ms ATS		0 – 100 ms MAN		100 ms – 500 ms ATS		100 ms – 500 ms MAN		500 ms – 1 sec ATS		500 ms – 1 sec MAN		1 sec – 10 sec ATS		1 sec – 10 sec MAN		10 sec – 1 min ATS		10 sec – 1 min MAN		Remaining Elec Volume	
E-mini S&P 500	10.3	0.1	0.6	0.4	4.4	0.1	0.5	0.1	3.0	0.1	0.5	0.1	11.4	0.5	3.3	0.8	5.6	1.2	2.8	3.0	7.5	43.7
E-mini NASDAQ 100	11.7	0.3	0.9	0.7	6.9	0.2	0.6	0.4	4.0	0.1	0.5	0.1	11.3	0.7	2.8	1.0	4.0	1.9	2.1	3.9	4.7	40.9
Crude Oil	8.3	3.2	1.0	1.1	4.8	1.3	0.7	0.4	3.0	0.7	0.6	0.2	10.5	4.8	3.8	1.5	4.2	6.2	3.1	3.0	8.5	30.7
Natural Gas (Henry Hub)	7.2	2.8	1.5	0.9	2.5	0.9	0.5	0.2	1.7	0.6	0.3	0.1	10.8	4.7	2.6	1.4	7.5	7.0	2.8	3.0	10.5	32.1
Eurodollar	3.2	3.2	0.7	1.2	2.3	2.3	0.5	0.7	1.4	1.2	0.2	0.3	6.6	5.4	1.7	1.3	6.9	6.6	3.0	2.3	23.1	30.5
10 Yr Note	7.4	0.7	0.5	0.4	2.4	0.4	0.3	0.2	1.6	0.2	0.2	0.1	8.7	2.1	2.0	1.1	8.6	3.8	2.9	2.3	13.8	37.9
5 Yr Note	8.0	0.7	0.8	0.4	2.7	0.5	0.3	0.1	1.7	0.2	0.2	0.1	9.0	2.0	1.7	0.9	9.0	3.6	2.3	2.1	11.6	39.7
Euro	13.3	0.1	0.9	0.3	5.5	0.0	0.4	0.0	2.9	0.1	0.3	0.0	11.4	0.7	1.9	0.3	5.2	1.0	1.6	0.9	6.3	45.6
Japanese Yen	13.2	0.2	0.7	0.1	5.5	0.0	0.3	0.1	2.8	0.0	0.2	0.0	12.2	0.6	1.1	0.3	6.7	1.3	1.0	1.0	6.1	45.8
Corn	4.1	0.4	0.6	0.3	1.6	0.2	0.4	0.1	1.2	0.2	0.3	0.1	7.1	1.2	2.6	1.1	7.4	2.1	4.1	2.5	17.5	47.5
Soybean	4.6	0.8	1.1	0.6	2.2	0.4	0.6	0.2	1.7	0.3	0.5	0.2	9.0	2.4	3.6	1.7	6.2	3.9	4.1	3.4	12.7	44.3
Gold	6.0	0.1	1.5	0.3	4.2	0.0	0.7	0.1	2.6	0.0	0.6	0.0	11.1	0.2	3.7	0.5	5.5	0.5	3.1	1.4	8.3	49.4
Silver	6.7	0.0	1.1	0.3	3.0	0.0	0.4	0.1	2.0	0.0	0.3	0.1	11.0	0.3	2.4	1.2	8.3	0.5	2.8	3.6	10.4	45.8

Table 8: Non-Directional Trading of Large Volume Traders

Notes: This table summarizes the level of intraday trading activity of "large traders", using the classification described in Table 5. It calculates the amount of non-directional trading, for a selected time range, as a percentage of group trade volume during that range. For example, for the full day summary, all buy and sell activity within a given trading day is aggregated by contract expiration and account. T The level of non-directional trading is then defined as the minimum of the aggregated buy and sell quantities (the quantity which would be netted off at the end of the day). These levels are then summed across all expirations and accounts and accounts and scaled by total trading volume for the day. The same procedure is used for the smaller time intervals of 1, 3 and 5 minutes. Black numbers correspond to the original sample period: November 12, 2012 – October 31, 2014. Red numbers correspond to the new sample period: November 1, 2014 – October 31, 2016. Source: CME transaction data.

Total Large Volume Trader VM (%)

Values shown as black (original sample) / red (new sample).

Futures Product Name	Full Day ATS	Full Day MAN	1 Min ATS	1 Min MAN	3 Min ATS	3 Min MAN	5 Min ATS	5 Min MAN
E-mini S&P 500	86.7 / 90.8	8.1 / 4.9	57.7 / 66.8	3.7 / 2.3	69.3 / 77.0	5.0 / 2.9	73.5 / 80.4	5.5 / 3.1
E-mini NASDAQ 100	89.2 / 89.1	2.0 / 4.6	59.9 / 63.0	0.4 / 1.9	70.8 / 73.1	0.6 / 2.5	74.6 / 76.7	0.7 / 2.7
Crude Oil	68.8 / 78.7	17.6 / 12.3	39.5 / 47.5	4.5 / 3.6	47.2 / 56.0	6.5 / 5.1	50.6 / 59.6	7.7 / 5.8
Natural Gas (Henry Hub)	59.8 / 69.6	19.0 / 9.9	28.1 / 32.3	3.8 / 1.4	35.2 / 41.3	5.7 / 2.2	38.6 / 45.4	6.9 / 2.7
Eurodollar	75.4 / 78.2	6.8 / 5.4	22.9 / 20.6	0.8 / 0.5	30.2 / 28.6	1.3 / 0.8	34.5 / 33.3	1.5 / 1.0
10 Yr Note	86.3 / 86.5	5.8 / 4.9	42.0 / 41.0	0.8 / 0.7	56.1 / 55.4	1.4 / 1.2	62.4 / 61.8	1.7 / 1.5
5 Yr Note	82.0 / 79.8	3.4 / 3.3	32.5 / 30.0	0.4 / 0.4	45.9 / 43.5	0.6 / 0.6	52.3 / 49.7	0.8 / 0.7
Euro	90.9 / 89.3	3.0 / 2.4	49.1 / 47.5	0.6 / 0.4	61.4 / 59.3	0.9 / 0.6	66.5 / 64.2	1.0 / 0.7
Japanese Yen	90.5 / 89.7	1.8 / 1.2	43.4 / 41.3	0.2 / 0.1	56.1 / 53.7	0.3 / 0.3	61.5 / 59.2	0.4 / 0.4
Corn	42.1 / 46.3	33.6 / 31.0	19.8 / 19.2	6.2 / 5.2	25.2 / 25.5	9.3 / 8.1	27.9 / 28.5	11.2 / 9.7
Soybean	48.8 / 60.3	28.1 / 21.7	25.4 / 29.0	4.8 / 3.4	32.2 / 37.4	7.3 / 5.1	35.2 / 41.1	8.9 / 6.1
Gold	58.2 / 64.8	22.8 / 18.1	30.3 / 34.2	2.4 / 2.3	38.0 / 42.9	4.0 / 3.8	41.2 / 46.5	5.0 / 4.7
Silver	50.7 / 57.6	30.4 / 22.8	25.6 / 28.3	3.6 / 2.7	33.7 / 37.5	6.1 / 4.6	37.0 / 41.2	7.5 / 5.7

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Figure 2: Daily Liquidity Provision of ATS by Time Groups

Notes: This figure summarizes the speed of passive order execution across four futures products. The difference between order entry (or most recent modification) and trade execution for the passive side of each trade is calculated; these differences are then average across all transactions in a trading day and grouped into five ranges. These five ranges are: (1) 0 – 100 ms (Blue), (2) 101 ms – 500 ms (Red), (3) 501 ms – 1 s (Green), (4) 1.001 s – 10 s (Purple), and (5) 10.001 s – 60 s (Orange), and are charted as percentages of total volume for each trading day. The charts are smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) E-Mini S&P 500

(b) Crude Oil

(c) Euro

(d) 10 Yr Note

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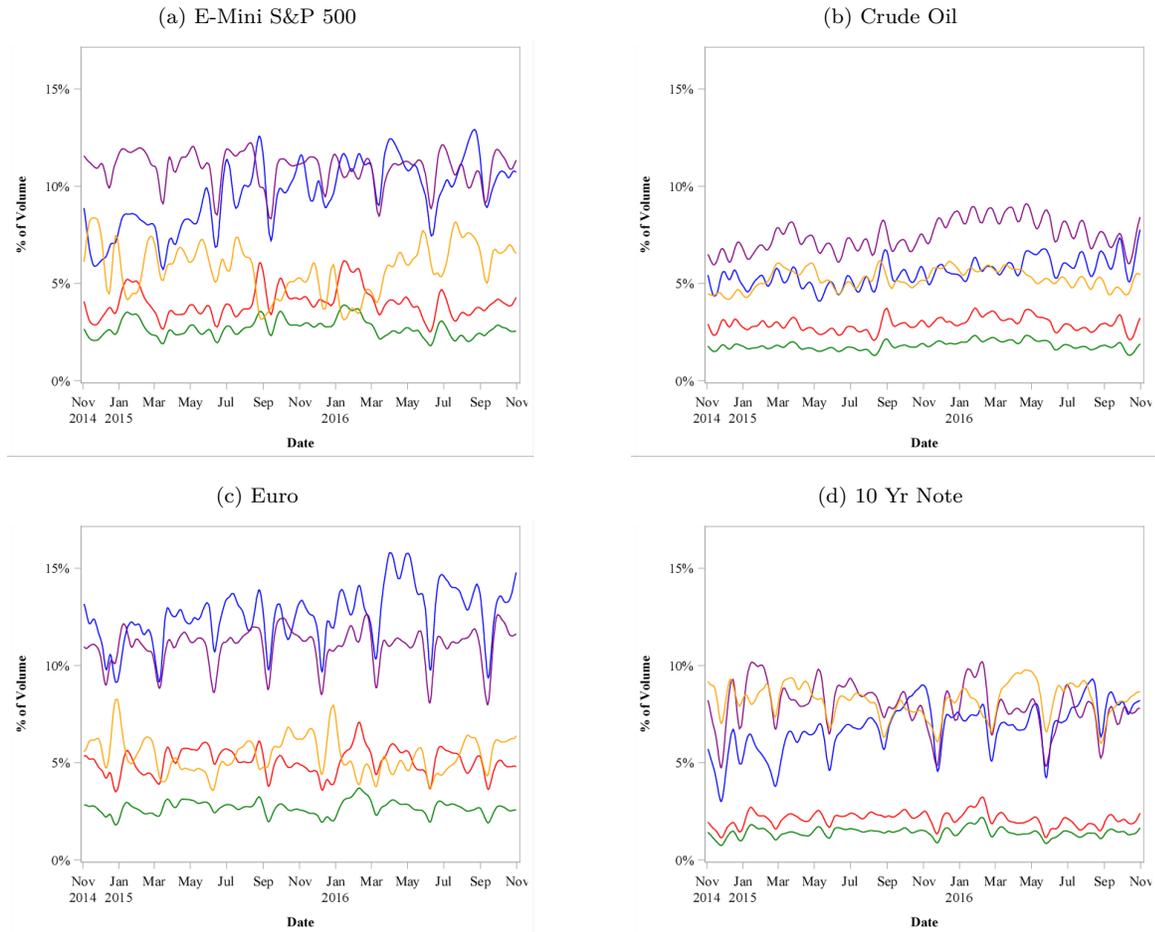
Figure 3: Liquidity Provision Time Between Order Placement and Execution for ATS (Blue) and Manual (Red)

Notes: This figure summarizes the cumulative volume of passive execution across four futures contracts. For each transaction the time between order entry (or most recent modification) and execution was computed. These differences were rounded to the nearest 10 ms and ordered by increasing time. From this ordered set, the cumulative volume as a percent of total in both the ATS or MAN categories is charted. The bands show 1 standard deviation above and below the average across the sample period. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) E-Mini S&P 500

(b) Crude Oil

(c) Euro

(d) 10 Yr Note
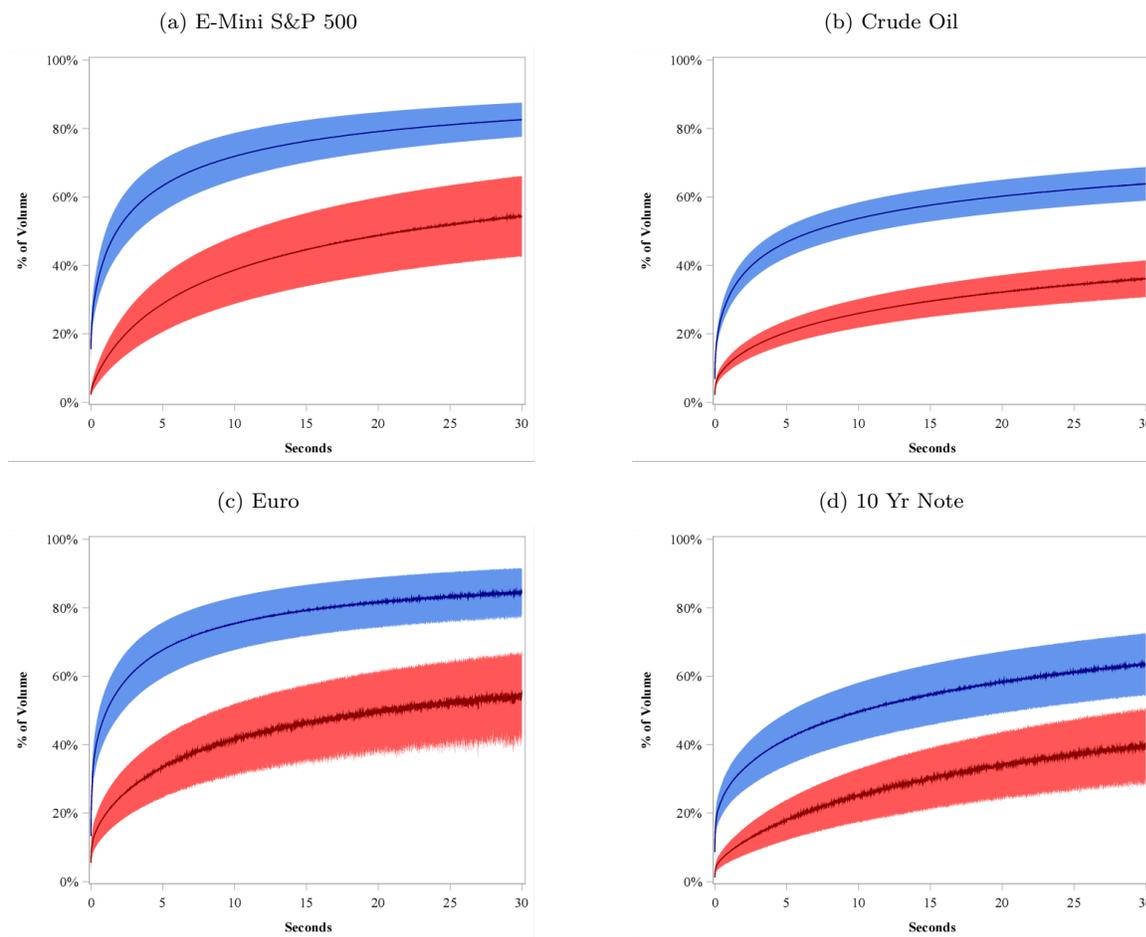
Appendix A: Daily Volume Percentages for ATS–ATS, ATS–MAN, and MAN–MAN

Figure 4: Daily Volume Percentages for ATS–ATS (Red), ATS–MAN (Blue), and MAN–MAN (Green)
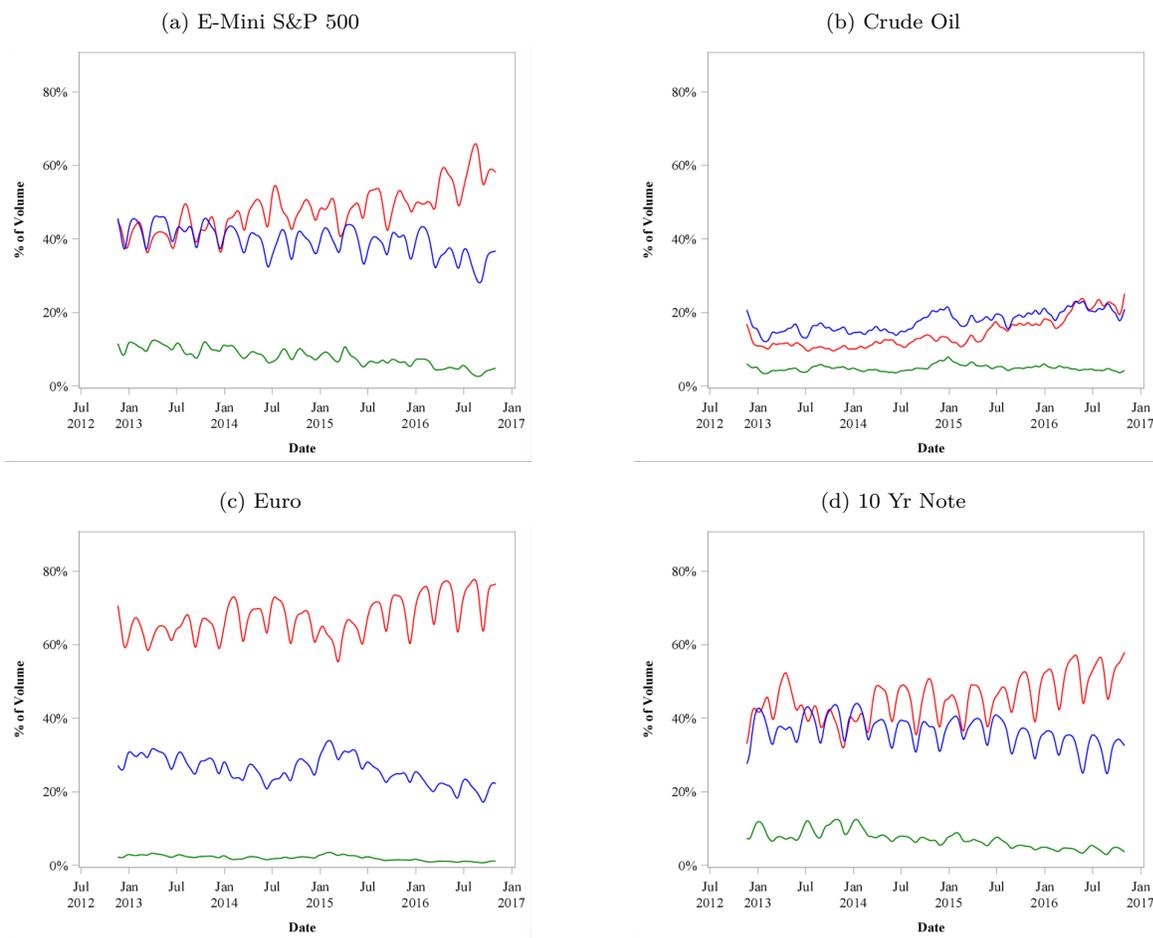
Notes: For each commodity, total daily volume, over the past four years, across all expirations is divided into trades where both sides result from an automated system (ATS–ATS), where one side is an automated system (ATS–MAN), neither side is an automated system (MAN–MAN), and non-electronic volume (not included in the figures below). Percentages are computed, then smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2012 – October 31, 2016.

(a) NASDAQ 100

(b) Natural Gas

(c) Eurodollar

(d) 5 YR Note
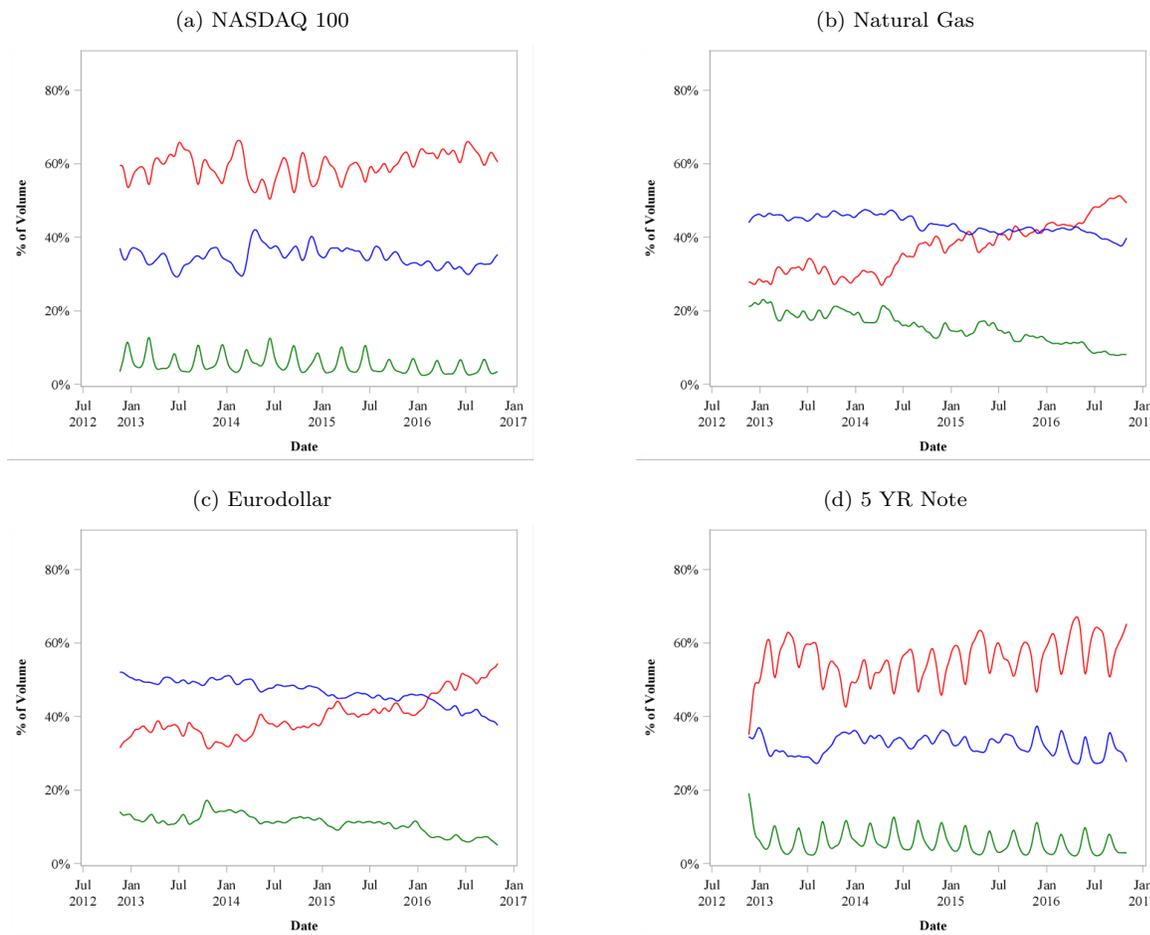
Appendix A: Cont.

Figure 5: Daily Volume Percentages for ATS–ATS (Red), ATS–MAN (Blue), and MAN–MAN (Green)
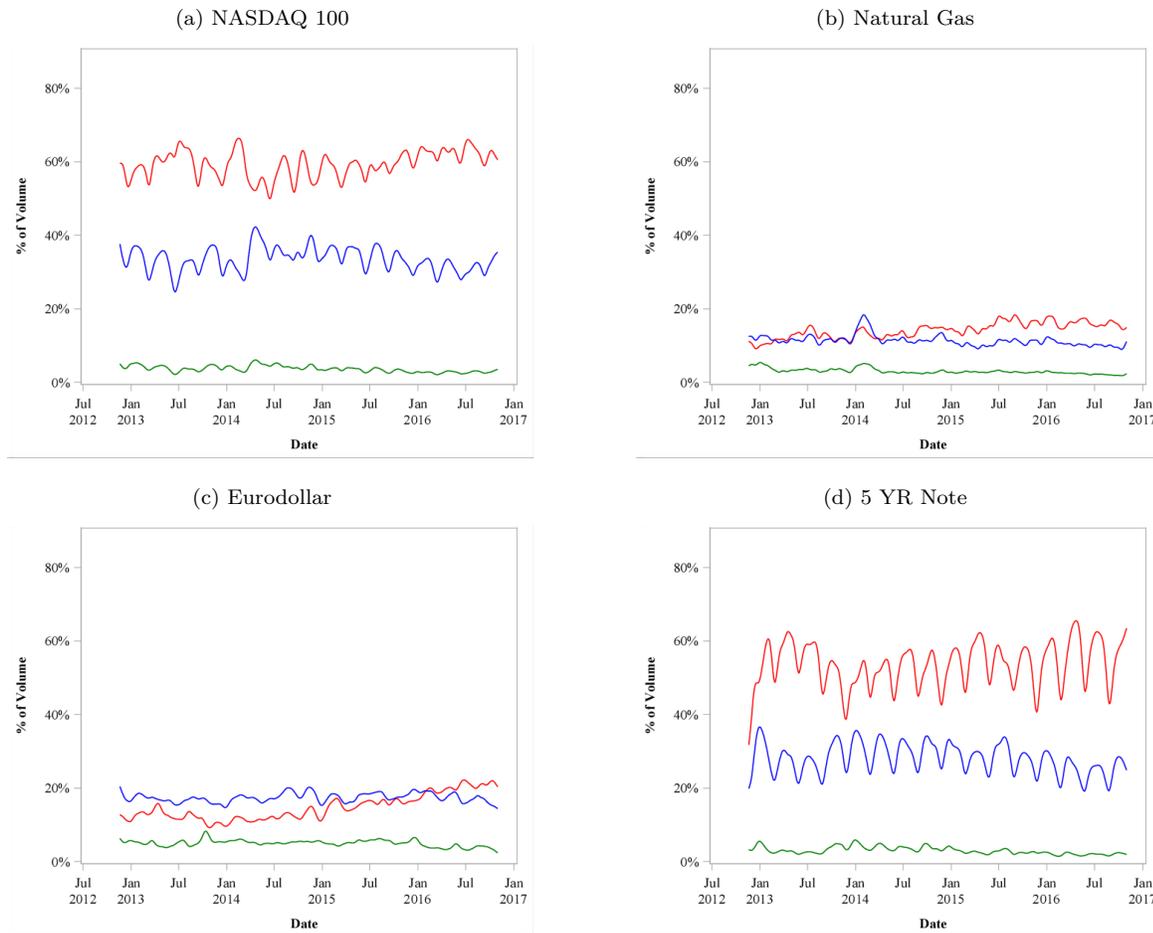
Notes: For each commodity, total daily volume, over the past four years, across all expirations is divided into trades where both sides result from an automated system (ATS–ATS), where one side is an automated system (ATS–MAN), neither side is an automated system (MAN–MAN), and non-electronic volume (not included in the figures below). Percentages are computed, then smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2012 – October 31, 2016.

(a) Yen FX

(b) Corn

(c) Soybean

(d) Gold
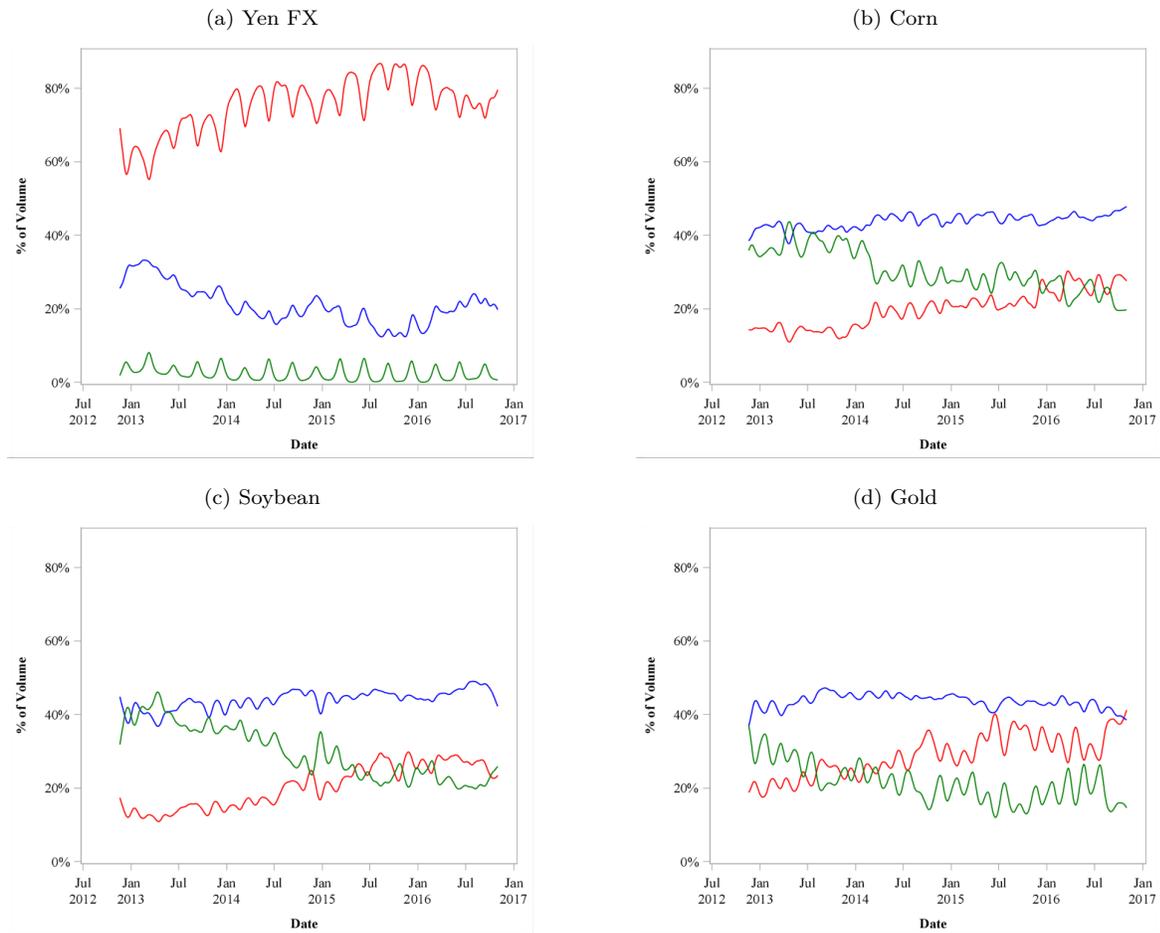
Appendix A: Cont.

Figure 6: Daily Volume Percentages for ATS–ATS (Red), ATS–MAN (Blue), and MAN–MAN (Green)
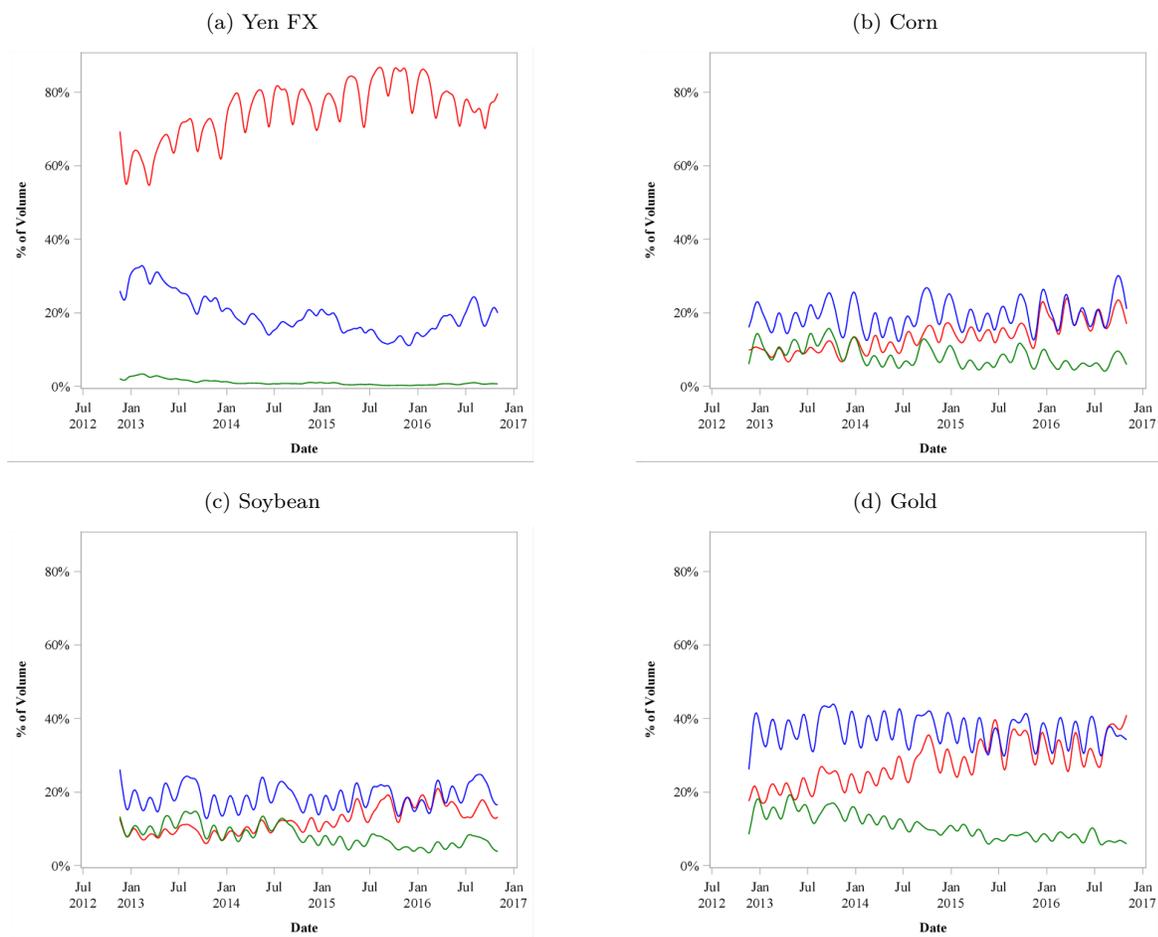
Notes: For each commodity, total daily volume, over the past four years, across all expirations is divided into trades where both sides result from an automated system (ATS–ATS), where one side is an automated system (ATS–MAN), neither side is an automated system (MAN–MAN), and non-electronic volume (not included in the figures below). Percentages are computed, then smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2012 – October 31, 2016.

(a) Silver

(b) Wheat

(c) Soybean Oil

(d) Soybean Meal
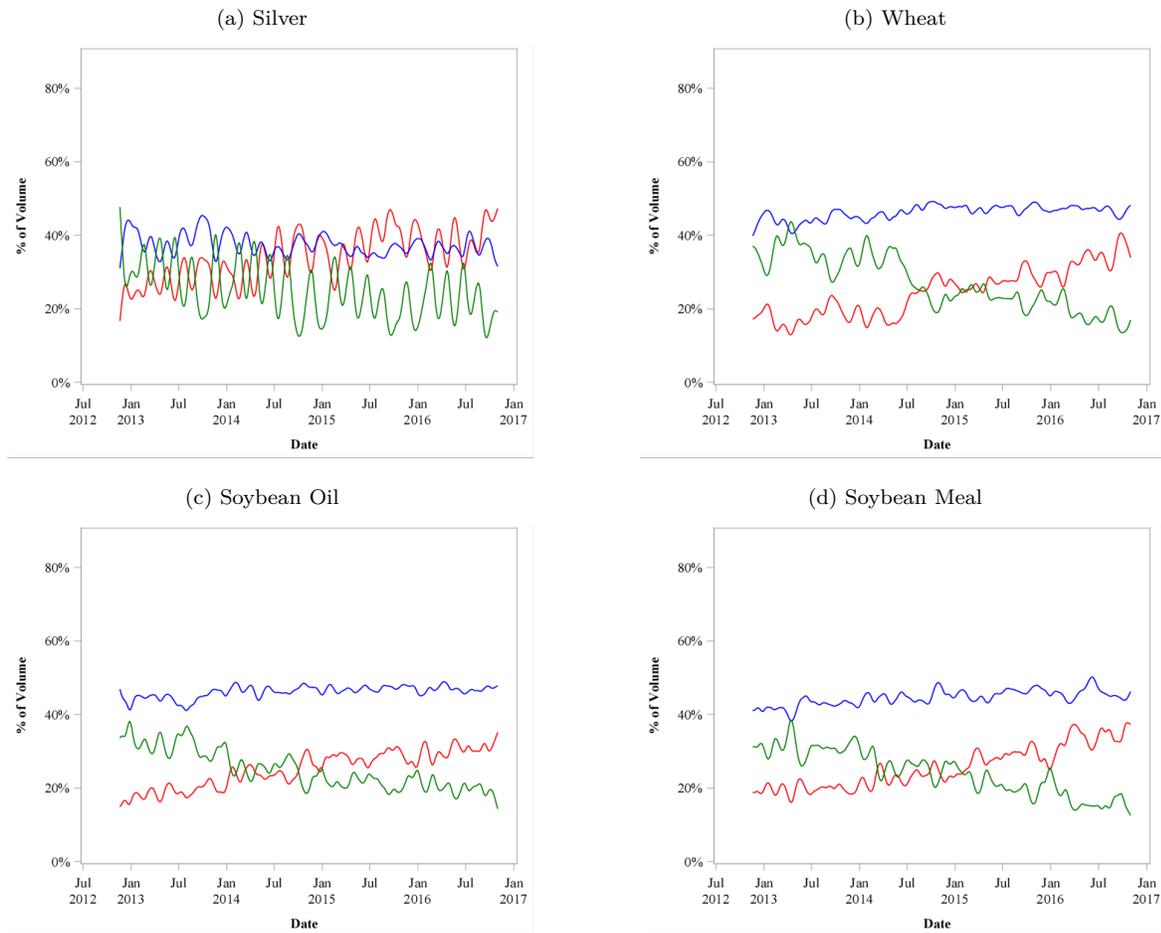
Appendix A: Cont.

Figure 7: Daily Volume Percentages for ATS–ATS (Red), ATS–MAN (Blue), and MAN–MAN (Green)

Notes: For each commodity, total daily volume, over the past four years, across all expirations is divided into trades where both sides result from an automated system (ATS–ATS), where one side is an automated system (ATS–MAN), neither side is an automated system (MAN–MAN), and non-electronic volume (not included in the figures below). Percentages are computed, then smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2012 – October 31, 2016.

(a) Live Cattle

(b) Lean Hog

(c) Feeder Cattle

(d) Kansas City Wheat

Figure 8: RO–RO, Daily Volume Percentages for ATS–ATS (Red), ATS–MAN (Blue), and MAN–MAN (Green)
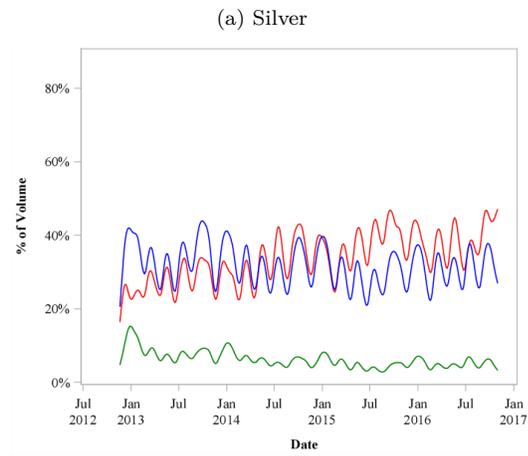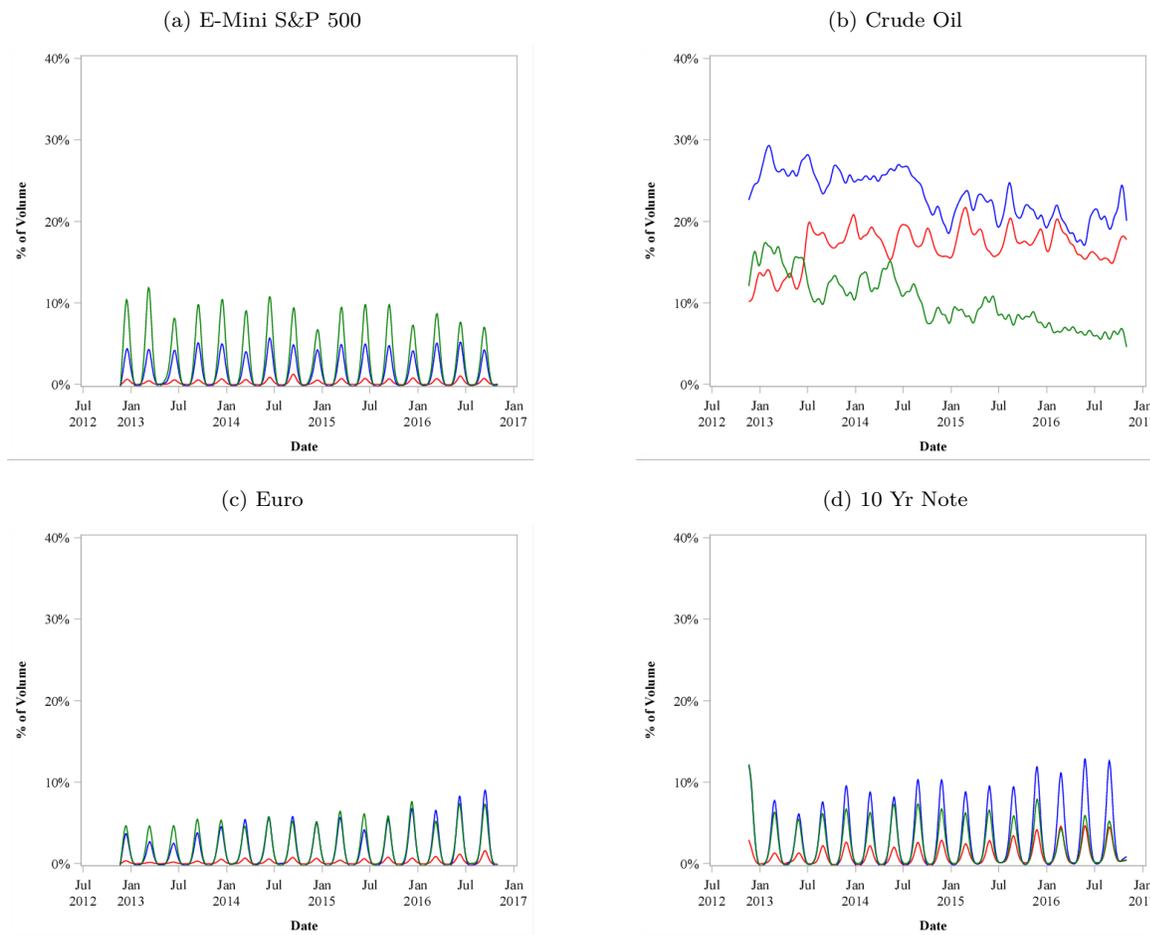
Notes: For each commodity, total daily volume linked to outright trades across all expirations is divided into trades where both sides result from an automated system (ATS–ATS), where one side is an automated system (ATS–MAN), neither side is an automated system (MAN–MAN), and non-electronic volume (not included in the figures below). Percentages are computed, then smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) E-Mini S&P 500

(b) Crude Oil

(c) Euro

(d) 10 Yr Note

Figure 9: RO–RO, Daily Volume Percentages for ATS–ATS (Red), ATS–MAN (Blue), and MAN–MAN (Green)

Notes: For each commodity, total daily volume linked to outright trades across all expirations is divided into trades where both sides result from an automated system (ATS–ATS), where one side is an automated system (ATS–MAN), neither side is an automated system (MAN–MAN), and non-electronic volume (not included in the figures below). Percentages are computed, then smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) NASDAQ 100

(b) Natural Gas

(c) Eurodollar

(d) 5 YR Note

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Appendix B: Cont.

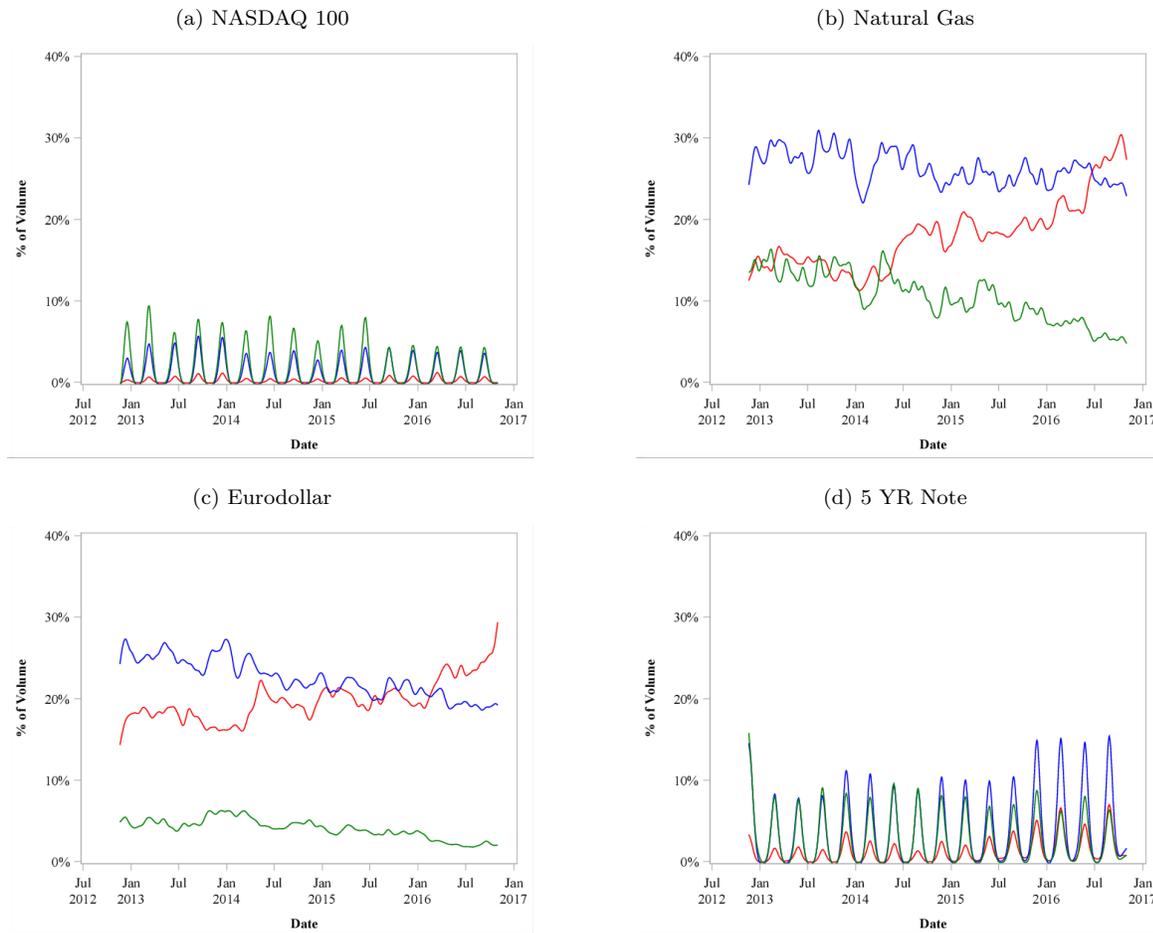Figure 10: RO–RO, Daily Volume Percentages for ATS–ATS (Red), ATS–MAN (Blue), and MAN–MAN (Green)

Notes: For each commodity, total daily volume linked to outright trades across all expirations is divided into trades where both sides result from an automated system (ATS–ATS), where one side is an automated system (ATS–MAN), neither side is an automated system (MAN–MAN), and non-electronic volume (not included in the figures below). Percentages are computed, then smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

Appendix B: Cont.

Figure 11: RO–RO, Daily Volume Percentages for ATS–ATS (Red), ATS–MAN (Blue), and MAN–MAN (Green)
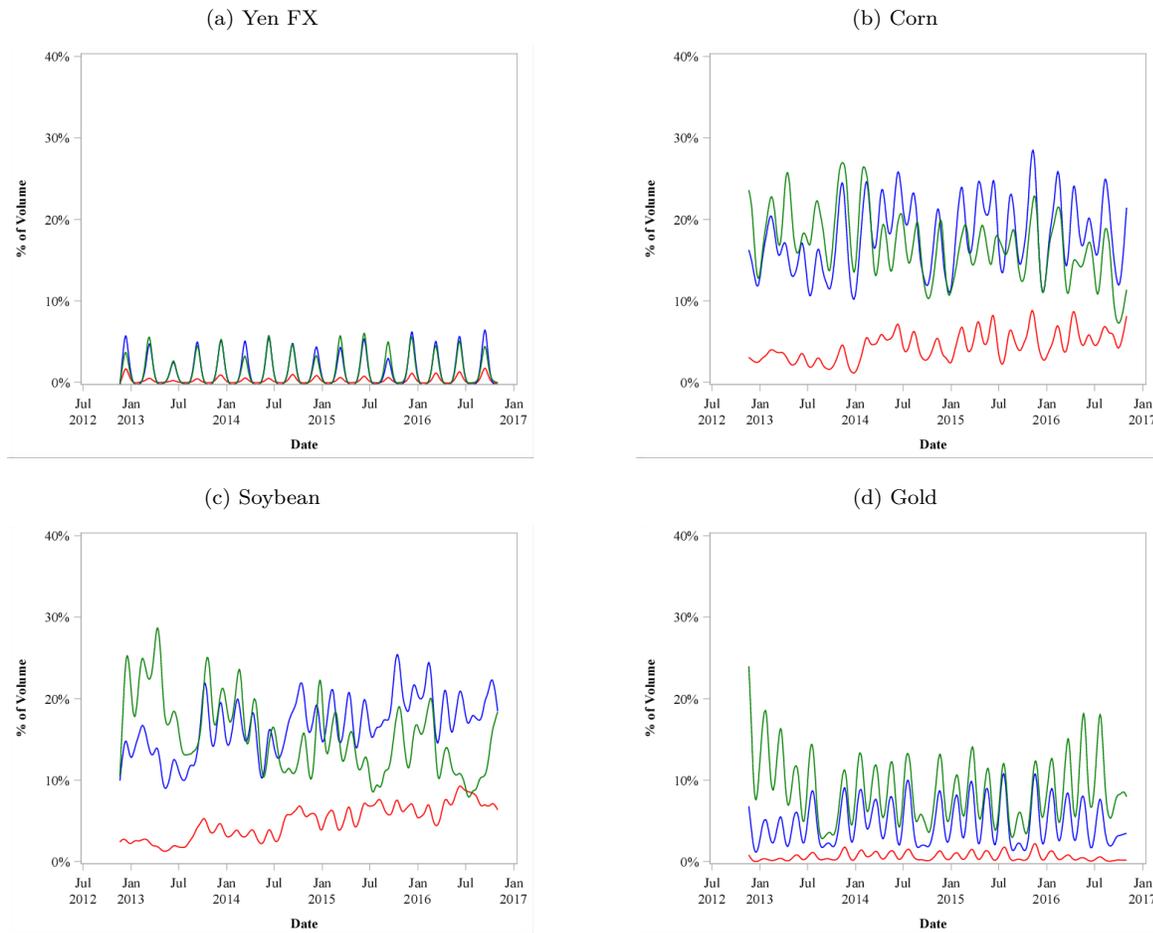
Notes: For each commodity, total daily volume linked to outright trades across all expirations is divided into trades where both sides result from an automated system (ATS–ATS), where one side is an automated system (ATS–MAN), neither side is an automated system (MAN–MAN), and non-electronic volume (not included in the figures below). Percentages are computed, then smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) Silver

Figure 12: SP–SP, Daily Volume Percentages for ATS–ATS (Red), ATS–MAN (Blue), and MAN–MAN (Green)

Notes: For each commodity, total daily volume linked to intracommodity spreads across all expirations is divided into trades where both sides result from an automated system (ATS–ATS), where one side is an automated system (ATS–MAN), neither side is an automated system (MAN–MAN), and non-electronic volume (not included in the figures below). Percentages are computed, then smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) E-Mini S&P 500

(b) Crude Oil

(c) Euro

(d) 10 Yr Note

Appendix B: Cont.

Figure 13: SP–SP, Daily Volume Percentages for ATS–ATS (Red), ATS–MAN (Blue), and MAN–MAN (Green)
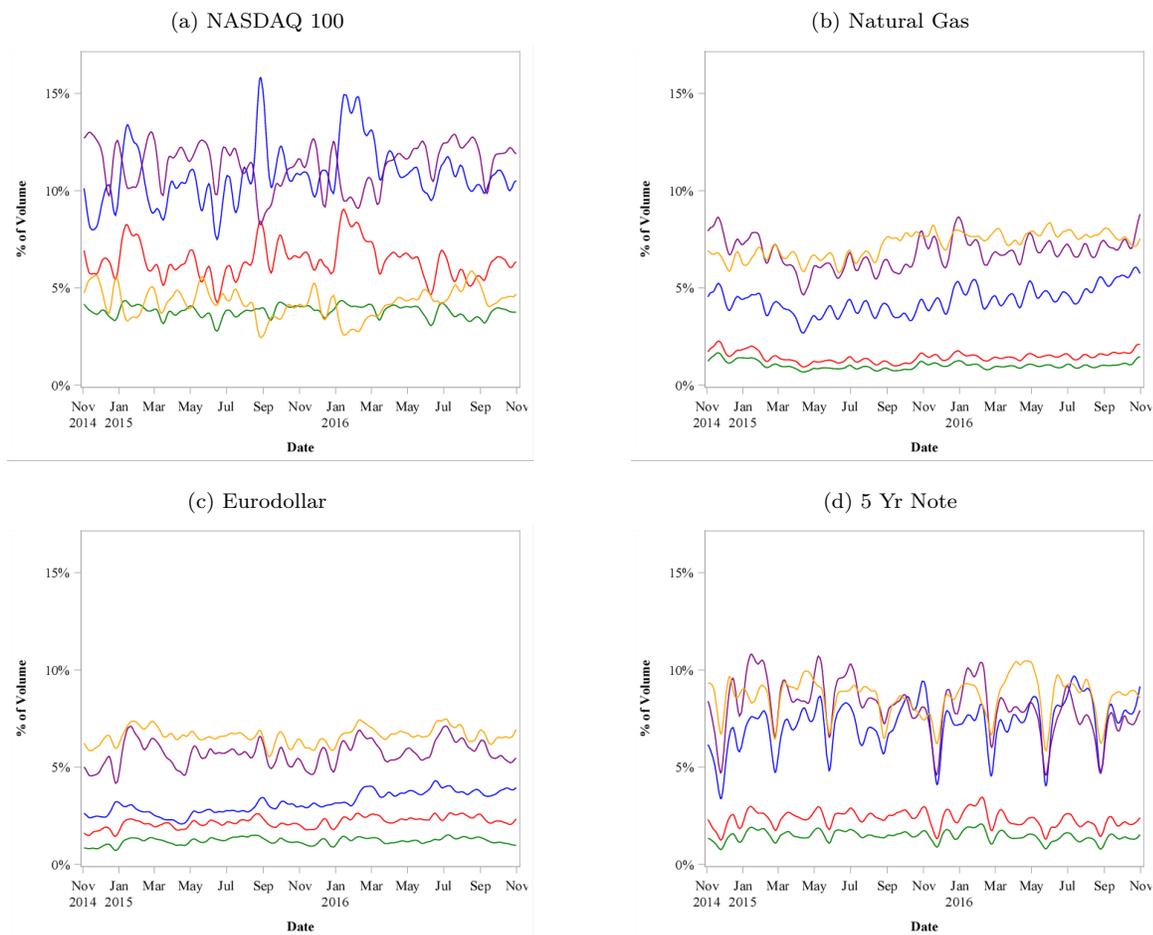
Notes: For each commodity, total daily volume linked to intracommodity spreads across all expirations is divided into trades where both sides result from an automated system (ATS–ATS), where one side is an automated system (ATS–MAN), neither side is an automated system (MAN–MAN), and non-electronic volume (not included in the figures below). Percentages are computed, then smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) NASDAQ 100

(b) Natural Gas

(c) Eurodollar

(d) 5 YR Note

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Figure 14: SP–SP, Daily Volume Percentages for ATS–ATS (Red), ATS–MAN (Blue), and MAN–MAN (Green)

Notes: For each commodity, total daily volume linked to intracommodity spreads across all expirations is divided into trades where both sides result from an automated system (ATS–ATS), where one side is an automated system (ATS–MAN), neither side is an automated system (MAN–MAN), and non-electronic volume (not included in the figures below). Percentages are computed, then smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) Yen FX

(b) Corn

(c) Soybean

(d) Gold

Appendix B: Cont.

Figure 15: SP–SP, Daily Volume Percentages for ATS–ATS (Red), ATS–MAN (Blue), and MAN–MAN (Green)

Notes: For each commodity, total daily volume linked to intracommodity spreads across all expirations is divided into trades where both sides result from an automated system (ATS–ATS), where one side is an automated system (ATS–MAN), neither side is an automated system (MAN–MAN), and non-electronic volume (not included in the figures below). Percentages are computed, then smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) Silver
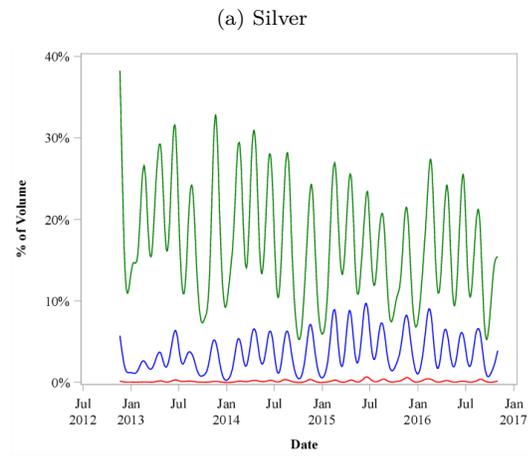
Appendix C: Additional Products: Daily Liquidity Provision of ATS by Time Groups

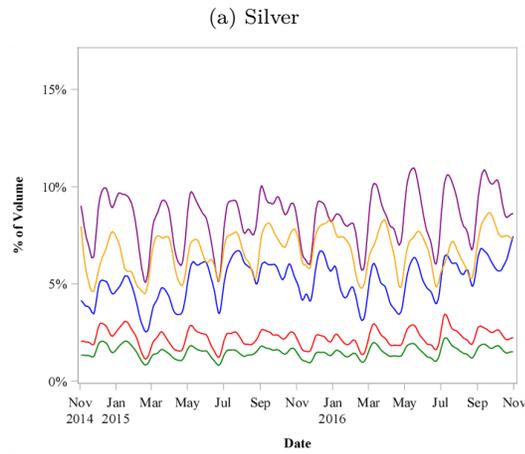Figure 16: Daily Liquidity Provision of ATS by Time Groups

Notes: This figure summarizes the speed of passive order execution across four futures products. The time difference between passive order entry (or most recent modification) and trade execution is calculated for each transaction. These times are then grouped into five ranges: (1) 0 – 100 ms (Blue), (2) 101 ms – 500 ms (Red), (3) 501 ms – 1 s (Green), (4) 1.001 s – 10 s (Purple), and (5) 10.001 s – 60 s (Orange), and then charted as percentages of total volume for each trading day. The charts are smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) NASDAQ 100

(b) Natural Gas

(c) Eurodollar

(d) 5 Yr Note

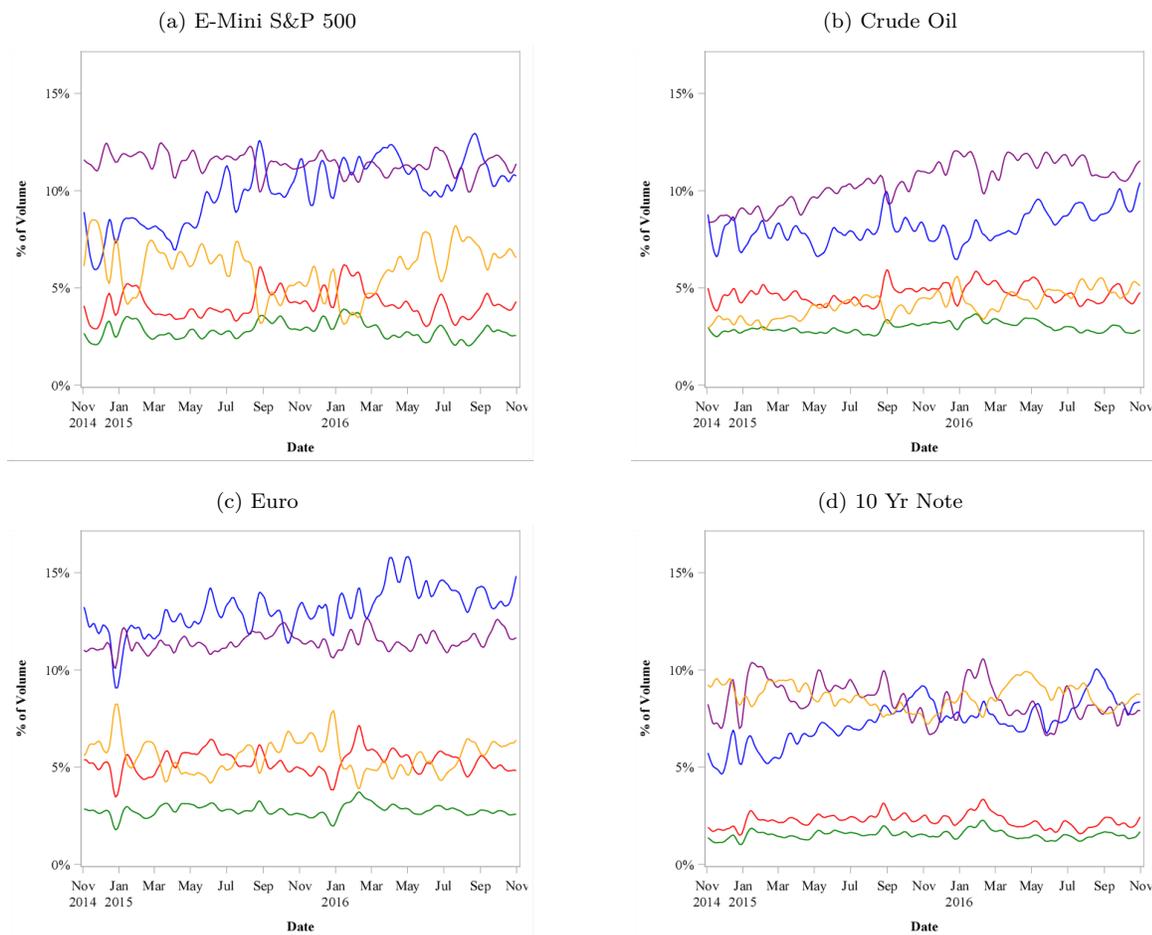Figure 17: Daily Liquidity Provision of ATS by Time Groups

Notes: This figure summarizes the speed of passive order execution across four futures products. The time difference between passive order entry (or most recent modification) and trade execution is calculated for each transaction. These times are then grouped into five ranges: (1) 0 – 100 ms (Blue), (2) 101 ms – 500 ms (Red), (3) 501 ms – 1 s (Green), (4) 1.001 s – 10 s (Purple), and (5) 10.001 s – 60 s (Orange), and then charted as percentages of total volume for each trading day. The charts are smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) Yen FX

(b) Corn

(c) Soybean

(d) Gold

Figure 18: Daily Liquidity Provision of ATS by Time Groups
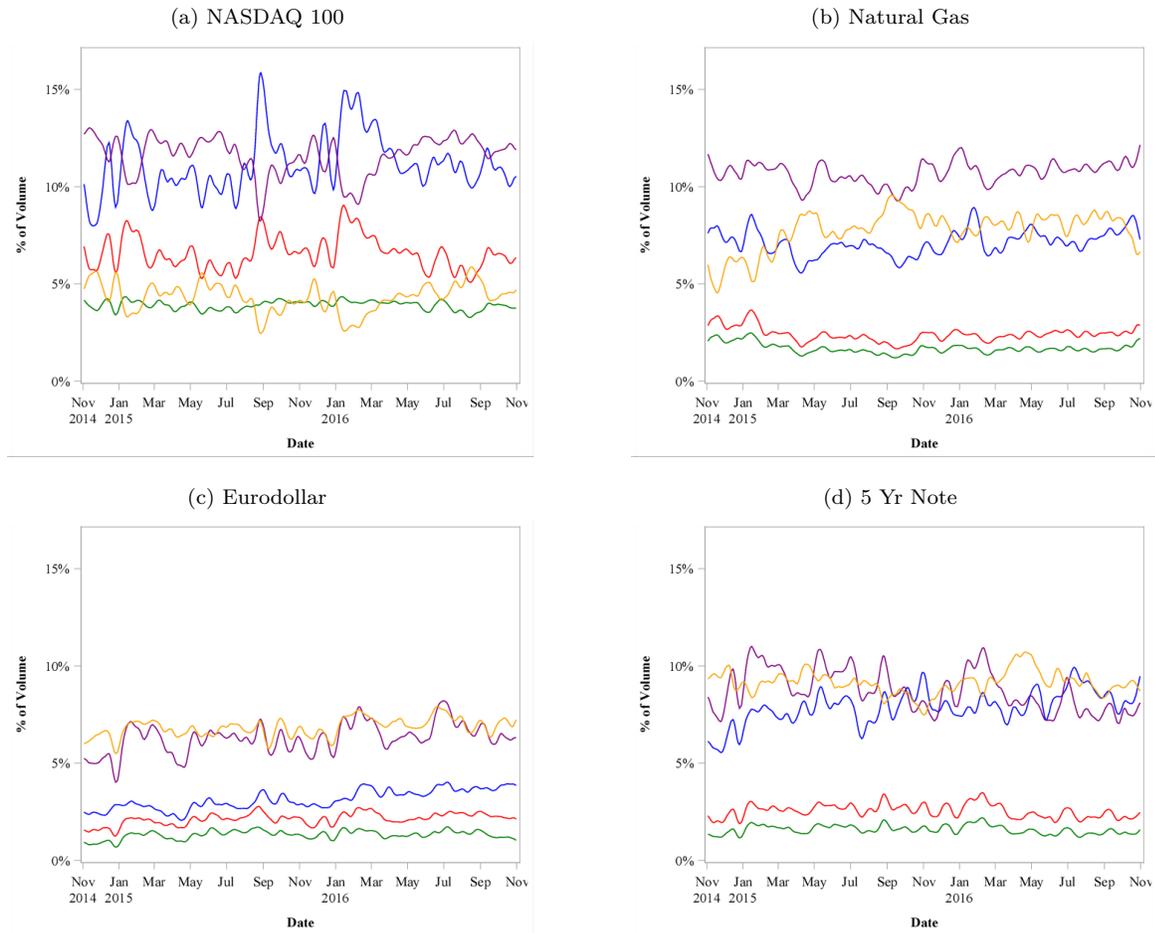
Notes: This figure summarizes the speed of passive order execution across four futures products. The time difference between passive order entry (or most recent modification) and trade execution is calculated for each transaction. These times are then grouped into five ranges: (1) 0 – 100 ms (Blue), (2) 101 ms – 500 ms (Red), (3) 501 ms – 1 s (Green), (4) 1.001 s – 10 s (Purple), and (5) 10.001 s – 60 s (Orange), and then charted as percentages of total volume for each trading day. The charts are smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) Silver

Appendix C: Cont.

Figure 19: Outright Volume: Daily Liquidity Provision of ATS by Time Groups

Notes: This figure summarizes the speed of passive order execution across four futures products for outright trades. The time difference between passive order entry (or most recent modification) and trade execution is calculated for each transaction. These times are then grouped into five ranges: (1) 0 – 100 ms (Blue), (2) 101 ms – 500 ms (Red), (3) 501 ms – 1 s (Green), (4) 1.001 s – 10 s (Purple), and (5) 10.001 s – 60 s (Orange), and then charted as percentages of total volume for each trading day. The charts are smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) E-Mini S&P 500

(b) Crude Oil

(c) Euro

(d) 10 Yr Note

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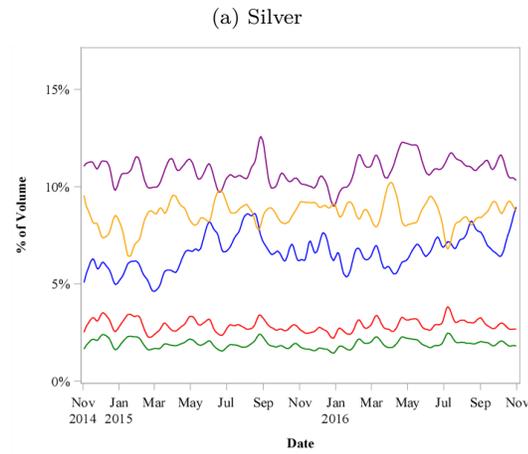Figure 20: Outright Volume: Daily Liquidity Provision of ATS by Time Groups

Notes: This figure summarizes the speed of passive order execution across four futures products for outright trades. The time difference between passive order entry (or most recent modification) and trade execution is calculated for each transaction. These times are then grouped into five ranges: (1) 0 – 100 ms (Blue), (2) 101 ms – 500 ms (Red), (3) 501 ms – 1 s (Green), (4) 1.001 s – 10 s (Purple), and (5) 10.001 s – 60 s (Orange), and then charted as percentages of total volume for each trading day. The charts are smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) NASDAQ 100

(b) Natural Gas

(c) Eurodollar

(d) 5 Yr Note

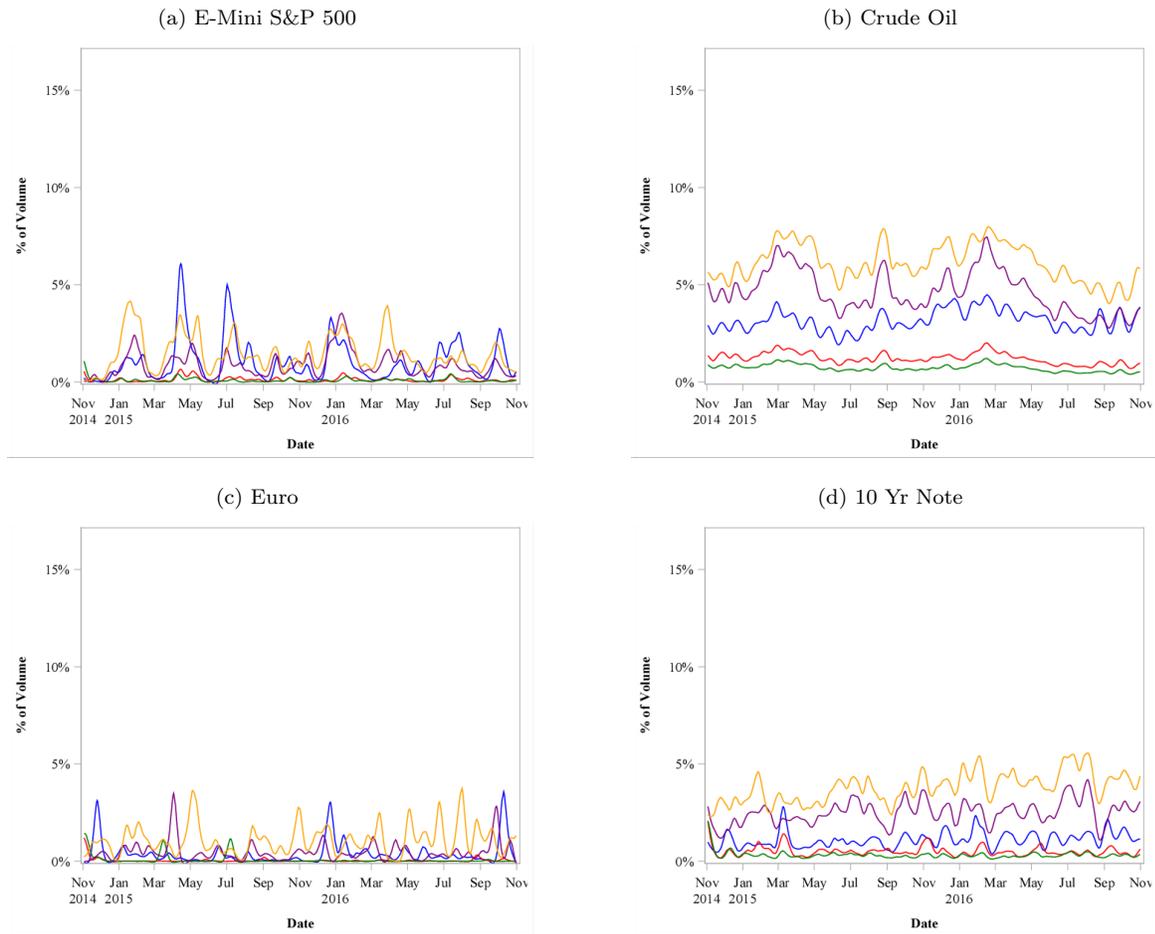Figure 21: Outright Volume: Daily Liquidity Provision of ATS by Time Groups

Notes: This figure summarizes the speed of passive order execution across four futures products for outright trades. The time difference between passive order entry (or most recent modification) and trade execution is calculated for each transaction. These times are then grouped into five ranges: (1) 0 – 100 ms (Blue), (2) 101 ms – 500 ms (Red), (3) 501 ms – 1 s (Green), (4) 1.001 s – 10 s (Purple), and (5) 10.001 s – 60 s (Orange), and then charted as percentages of total volume for each trading day. The charts are smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) Yen FX

(b) Corn

(c) Soybean

(d) Gold

Figure 22: Outright Volume: Daily Liquidity Provision of ATS by Time Groups

Notes: This figure summarizes the speed of passive order execution across four futures products for outright trades. The time difference between passive order entry (or most recent modification) and trade execution is calculated for each transaction. These times are then grouped into five ranges: (1) 0 – 100 ms (Blue), (2) 101 ms – 500 ms (Red), (3) 501 ms – 1 s (Green), (4) 1.001 s – 10 s (Purple), and (5) 10.001 s – 60 s (Orange), and then charted as percentages of total volume for each trading day. The charts are smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) Silver

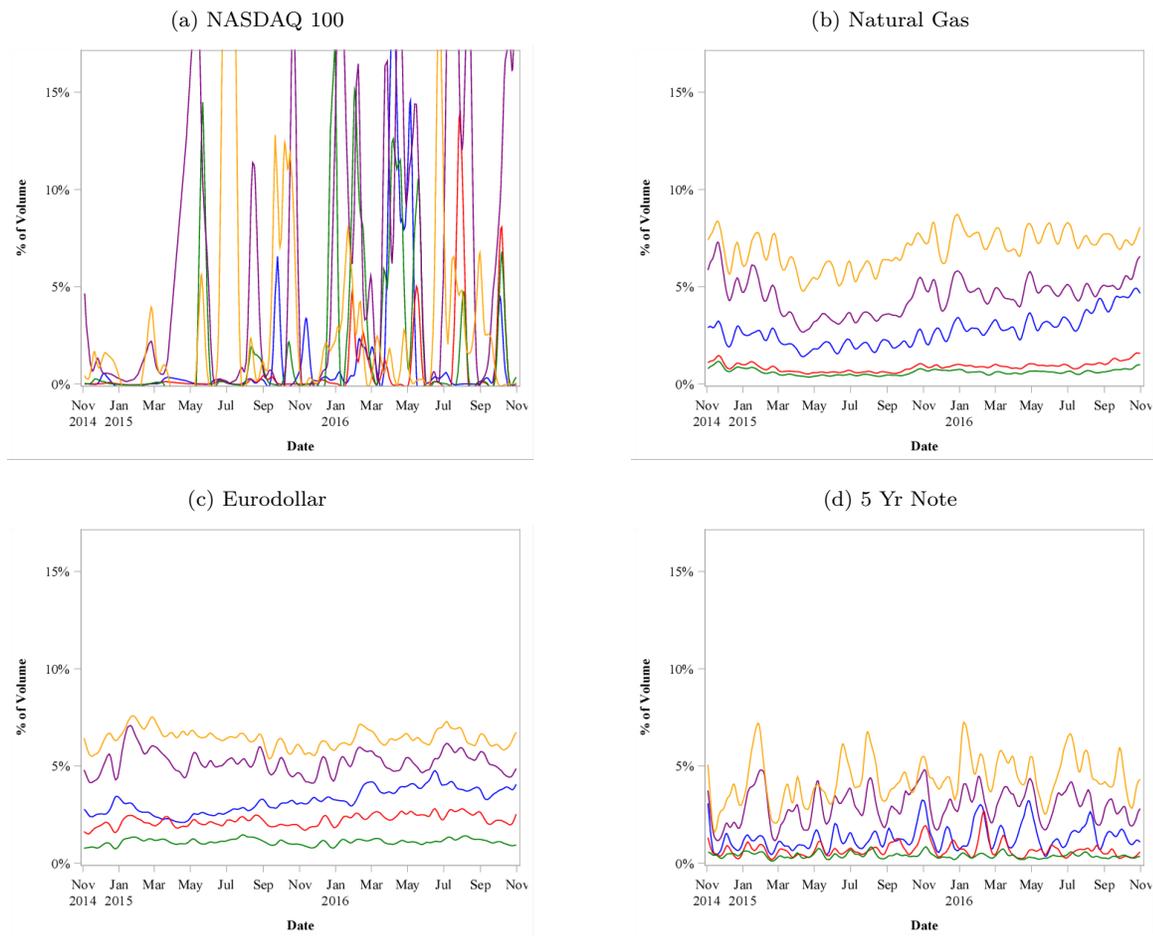Figure 23: Spread Volume: Daily Liquidity Provision of ATS by Time Groups

Notes: This figure summarizes the speed of passive order execution across four futures products for intracommodity spread trades. The time difference between passive order entry (or most recent modification) and trade execution is calculated for each transaction. These times are then grouped into five ranges: (1) 0 – 100 ms (Blue), (2) 101 ms – 500 ms (Red), (3) 501 ms – 1 s (Green), (4) 1.001 s – 10 s (Purple), and (5) 10.001 s – 60 s (Orange), and then charted as percentages of total volume for each trading day. The charts are smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) E-Mini S&P 500

(b) Crude Oil

(c) Euro

(d) 10 Yr Note

Appendix C: Cont.

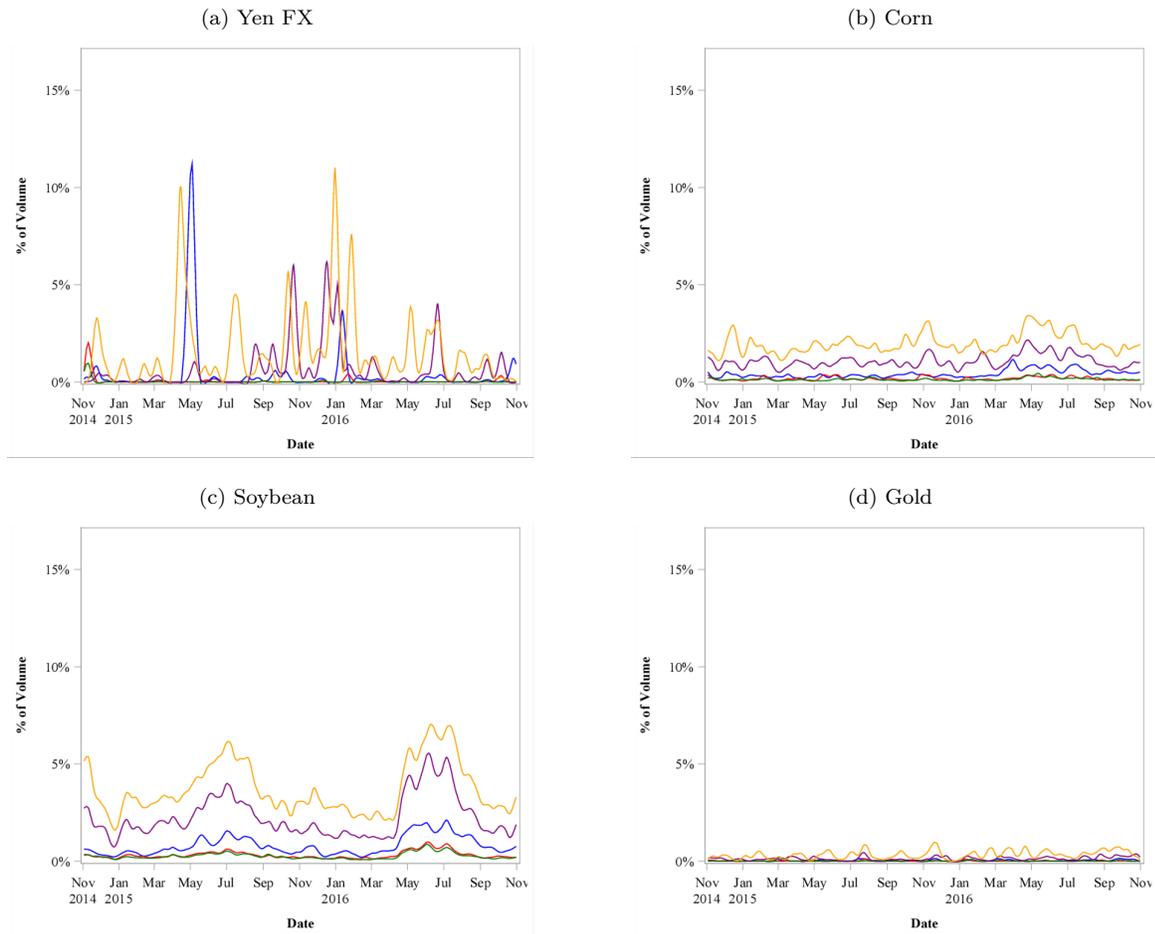Figure 24: Spread Volume: Daily Liquidity Provision of ATS by Time Groups

Notes: This figure summarizes the speed of passive order execution across four futures products for intracommodity spread trades. The time difference between passive order entry (or most recent modification) and trade execution is calculated for each transaction. These times are then grouped into five ranges: (1) 0 – 100 ms (Blue), (2) 101 ms – 500 ms (Red), (3) 501 ms – 1 s (Green), (4) 1.001 s – 10 s (Purple), and (5) 10.001 s – 60 s (Orange), and then charted as percentages of total volume for each trading day. The charts are smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) NASDAQ 100

(b) Natural Gas

(c) Eurodollar

(d) 5 Yr Note

Appendix C: Cont.

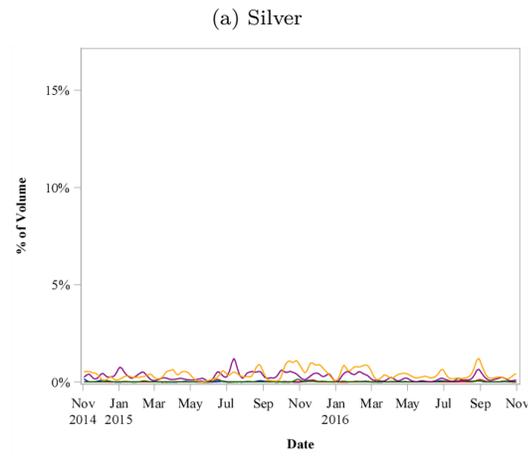Figure 25: Spread Volume: Daily Liquidity Provision of ATS by Time Groups

Notes: This figure summarizes the speed of passive order execution across four futures products for intracommodity spread trades. The time difference between passive order entry (or most recent modification) and trade execution is calculated for each transaction. These times are then grouped into five ranges: (1) 0 – 100 ms (Blue), (2) 101 ms – 500 ms (Red), (3) 501 ms – 1 s (Green), (4) 1.001 s – 10 s (Purple), and (5) 10.001 s – 60 s (Orange), and then charted as percentages of total volume for each trading day. The charts are smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) Yen FX

(b) Corn

(c) Soybean

(d) Gold

Figure 26: Spread Volume: Daily Liquidity Provision of ATS by Time Groups

Notes: This figure summarizes the speed of passive order execution across four futures products for intracommodity spread trades. The time difference between passive order entry (or most recent modification) and trade execution is calculated for each transaction. These times are then grouped into five ranges: (1) 0 − 100 ms (Blue), (2) 101 ms − 500 ms (Red), (3) 501 ms − 1 s (Green), (4) 1.001 s − 10 s (Purple), and (5) 10.001 s − 60 s (Orange), and then charted as percentages of total volume for each trading day. The charts are smoothed in SAS according to a noniterative smoothing spline transformation (Reinsch; 1967) with smoothing parameter of 5. Source: CME transaction data, November 1, 2014 − October 31, 2016.

(a) Silver

Appendix D: Liquidity Provision Time Between Order Placement and Execution

Figure 27: Liquidity Provision Time Between Order Placement and Execution for ATS (Blue) and Manual (Red)
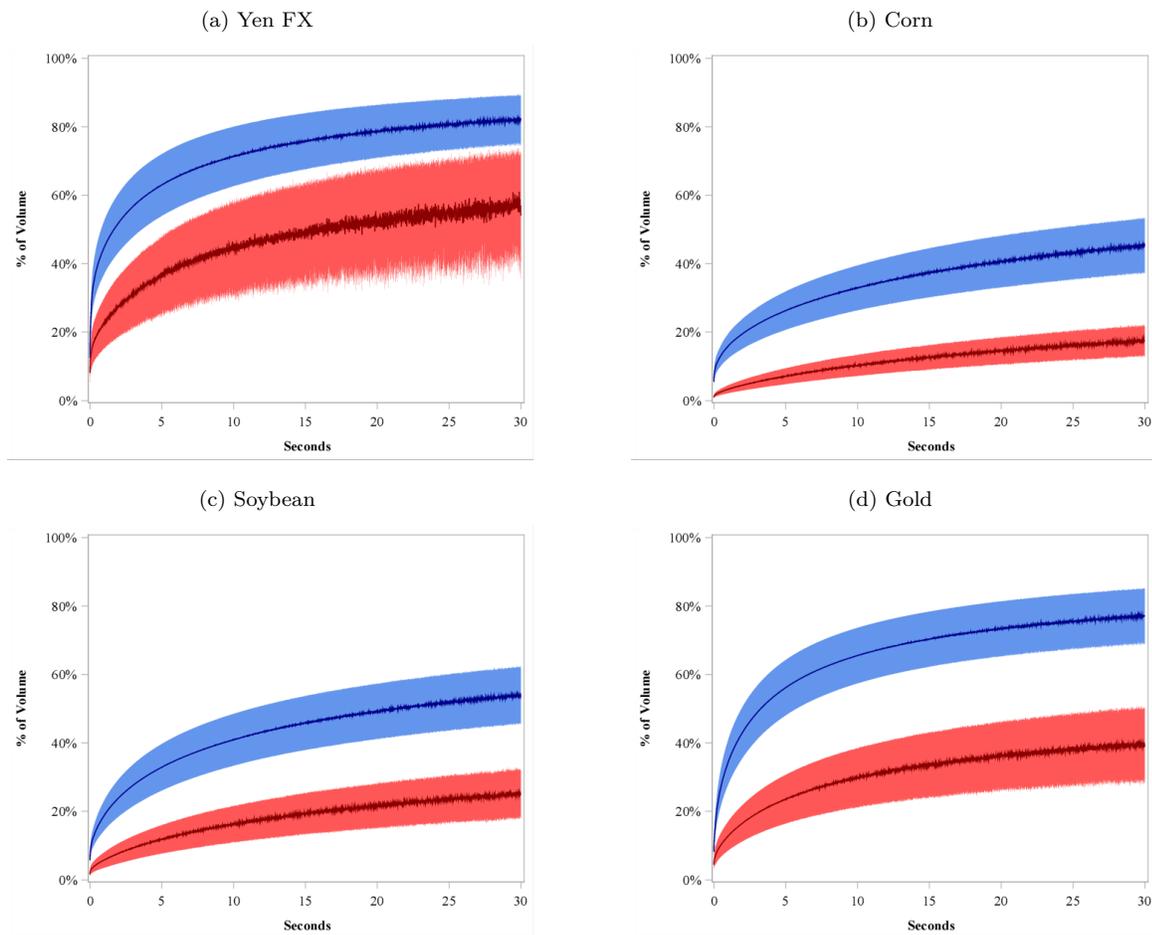
Notes: This figure summarizes the cumulative volume of passive execution across four futures contracts. For each transaction the time between order entry (or most recent modification) and execution was computed. These differences were rounded to the nearest 10 ms and ordered by increasing time. From this ordered set, the cumulative volume as a percent of total in both the ATS or MAN categories is charted. The bands show 1 standard deviation above and below the average across the sample period. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) NASDAQ 100

(b) Natural Gas

(c) Eurodollar

(d) 5 Yr Note
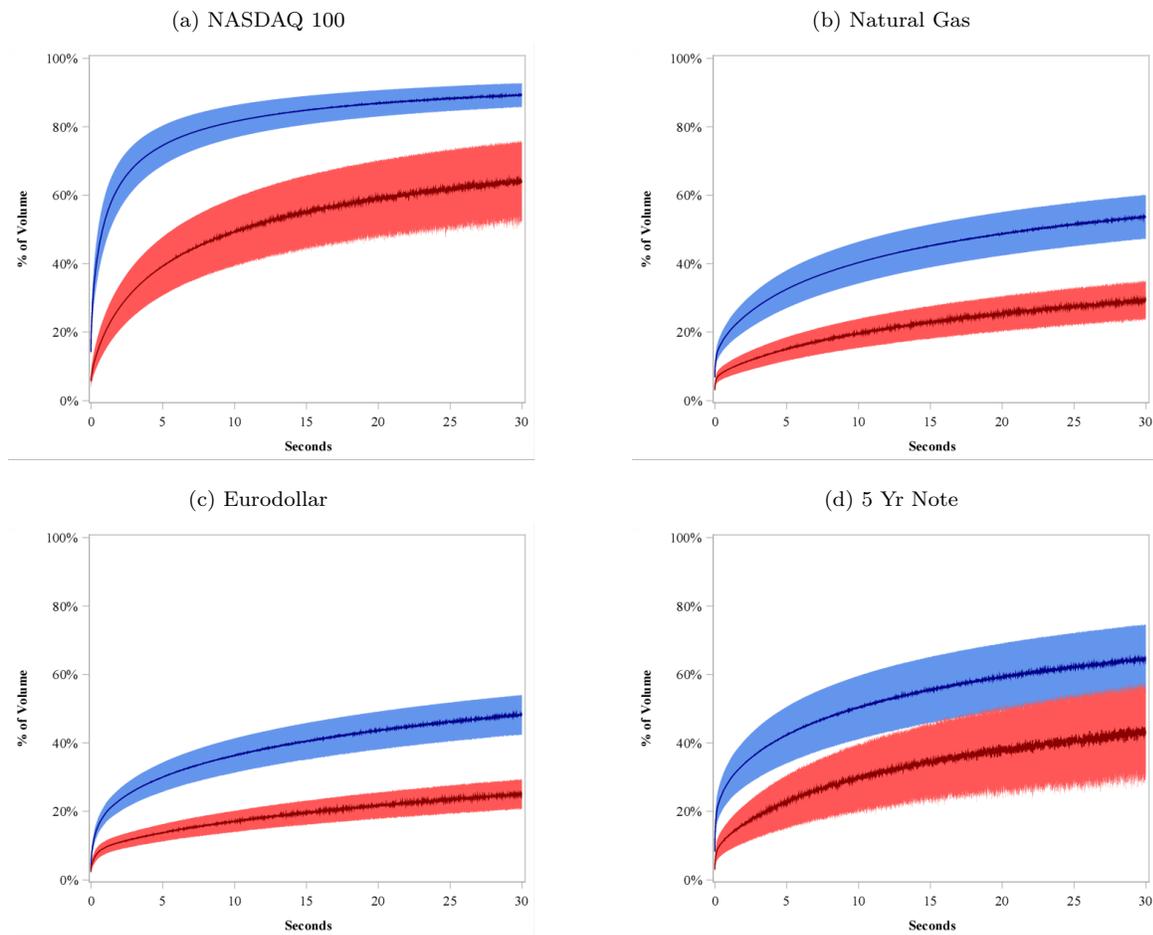
Figure 28: Liquidity Provision Time Between Order Placement and Execution for ATS (Blue) and Manual (Red)

Notes: This figure summarizes the cumulative volume of passive execution across four futures contracts. For each transaction the time between order entry (or most recent modification) and execution was computed. These differences were rounded to the nearest 10 ms and ordered by increasing time. From this ordered set, the cumulative volume as a percent of total in both the ATS or MAN categories is charted. The bands show 1 standard deviation above and below the average across the sample period. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) Yen FX

(b) Corn

(c) Soybean

(d) Gold

Figure 29: Liquidity Provision Time Between Order Placement and Execution for ATS (Blue) and Manual (Red)

Notes: This figure summarizes the cumulative volume of passive execution across four futures contracts. For each transaction the time between order entry (or most recent modification) and execution was computed. These differences were rounded to the nearest 10 ms and ordered by increasing time. From this ordered set, the cumulative volume as a percent of total in both the ATS or MAN categories is charted. The bands show 1 standard deviation above and below the average across the sample period. Source: CME transaction data, November 1, 2014 – October 31, 2016.

(a) Silver