

Empirical Analysis of Liquidity Demographics and Market Quality For Less Liquid NMS Stocks

Office of Analytics and Research*
Division of Trading and Markets
U.S. Securities and Exchange Commission

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Introduction

There are more than 8,500 stocks in the National Market System (NMS). These stocks have a broad range of quoting and trading characteristics; for example, average daily share volume (ADV) ranges from zero shares per day to nearly eighty million shares per day, and the average daily number of trades ranges from zero to more than two-hundred thousand. This data summary characterizes the lower end of the liquidity spectrum for NMS stocks—those symbols with, for example, a lower ADV, fewer trades per day, more-concentrated quoting activity, and wider spreads.

The paper begins with visualizations and tables highlighting several characteristics of less-liquid equities. An appendix includes a more comprehensive summary of statistics and visualizations for both quoting and trading.

Among other things, the data show that:

- Half of all NMS stocks have an ADV of less than 100,000 shares, but collectively these stocks make up just under two percent of all daily share volume.
- Trading and quoting are less fragmented for less-liquid symbols than for more-liquid symbols; for less-liquid symbols, on the whole, trading is spread across fewer venues, fewer exchanges are quoting at the inside, and there are longer durations when a single exchange is alone at either or both the national best bid (NBB) and national best offer (NBO).

*This is a memorandum by the Staff of the Office of Analytics and Research in the Division of Trading and Markets of the U.S. Securities and Exchange Commission. The Commission has expressed no view regarding the analysis, findings or conclusions contained herein.

- Generally, common stocks and exchange-traded products (ETPs) have distinct liquidity profiles; a number of differences appear more pronounced at the lower end of the liquidity spectrum.

This summary is based on NYSE Daily TAQ (Trade and Quote) data for all NMS stocks during the fourth quarter of 2017. The stocks evaluated in this analysis include stocks in the Tick Size Pilot,¹ most of which are on the lower end of the liquidity spectrum. The final section of the paper provides a detailed description of the data and methodology.

Data Highlights

The following table provides basic statistics for the number of symbols, and the proportion of overall share volume that these symbols represent, in the following ADV ranges: at or below 50,000 shares, between 50,001 and 100,000 shares, and above 100,000 shares.

ADV	TYPE	COUNT	% NMS	%TYPE	% NMS ADV
≤ 50K	Common	890	10.2%	19.1%	0.27%
	ETP	1,420	16.2%	66.4%	0.23%
	Other	1,156	13.2%	58.9%	0.27%
	All NMS	3,466	39.6%	39.6%	0.77%
50-100K	Common	411	4.7%	8.8%	0.47%
	ETP	197	2.2%	9.2%	0.21%
	Other	306	3.5%	15.6%	0.33%
	All NMS	914	10.4%	10.4%	1.01%
>100K	Common	3,355	38.3%	72.1%	73.64%
	ETP	522	6.0%	24.4%	16.15%
	Other	502	5.7%	25.6%	8.43%
	All NMS	4,379	50.0%	50.0%	98.22%

Table 1: *NMS Average Daily Volume (ADV) distribution partitioned by ADV bin and security type.*

The distribution of symbols by ADV is also reflected in the following plot, which indicates the location of 50,000 and 100,000 ADV:

¹See, e.g., Order Approving the National Market System Plan To Implement a Tick Size Pilot Program, Exch. Act. Rel. No. 74892, 80 FR 27513 (May 5, 2015).

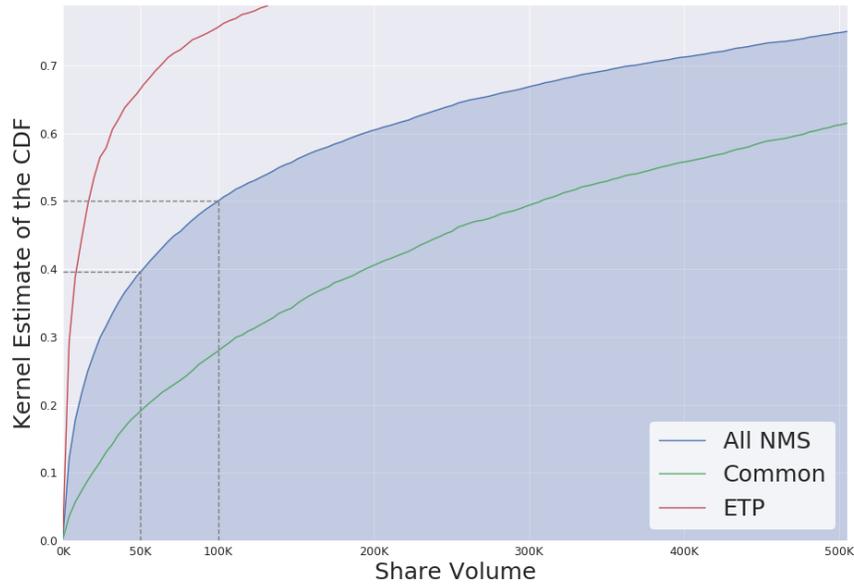


Figure 1: *Cumulative Distribution Function of ADV, for All NMS Stocks and By Security Type*

Trade statistics indicate that the less liquid symbols have different profiles than more liquid symbols. The following tables provide basic trade statistics for all NMS stocks, common stocks, ETPs, and constituents of the Russell 2000, each broken out by the ADV ranges used above. As described more fully in the methodology section below, block size means a trade of 10,000 shares or more, or for a value of \$200,000 or more,² and the measure of fragmentation is a daily Herfindahl-Hirschman Index (HHI), where no fragmentation would be indicated by zero, and complete fragmentation approaches one.

²As described below, this metric follows the definition for block size with respect to an order in Regulation NMS. See 17 C.F.R. 242.600(b)(9).

Less Liquid NMS Stocks–Data Summary

	NMS Stock	≤50K	50-100K	>100K
Trades Per Day	474	40	320	3,069
ADV	99,931	9,939	71,039	505,183
Price	\$25.10	\$25.26	\$20.75	\$24.82
% Share Vol. as Block	5%	1%	4%	8%
Avg. Block Size	19,834	18,000	19,526	20,459
% Share Vol. in Auctions	6%	5%	5%	7%
Avg. Auction Share Vol.	2,673	491	1,826	15,553
% Share Vol. on TRF	43%	52%	48%	35%
Fragmentation	0.63	0.45	0.62	0.74
Count	8759	3466	914	4379

Table 2: Trade Variables (Medians) for All NMS Stocks

	Commons	≤50K	50-100K	>100K
Trades Per Day	1,946	113	524	3,664
ADV	308,043	17,877	75,165	561,775
Market Cap. (\$MM)	\$777	\$124	\$290	\$1,564
Price	\$19.92	\$14.06	\$13.45	\$23.38
% Share Vol. as Block	6%	1%	3%	8%
Avg. Block Size	19,772	16,296	17,456	20,340
% Share Vol. in Auctions	8%	8%	7%	8%
Avg. Auction Share Vol.	10,123	530	2,280	19,656
% Share Vol. on TRF	35%	41%	37%	34%
Fragmentation	0.73	0.59	0.69	0.75
Count	4656	890	411	3355

Table 3: Trade Variables (Medians) for Common Stocks

	ETPs	≤50K	50-100K	>100K
Trades Per Day	61	23	268	1,336
ADV	16,469	5,504	66,985	408,705
Market Cap. (\$MM)	\$88	\$27	\$313	\$1,313
Price	\$31.47	\$29.68	\$34.89	\$38.34
% Share Vol. as Block	5%	2%	10%	15%
Avg. Block Size	19,648	18,776	23,733	19,403
% Share Vol. in Auctions	4%	4%	4%	3%
Avg. Auction Share Vol.	768	477	1,412	5,920
% Share Vol. on TRF	61%	62%	68%	56%
Fragmentation	0.42	0.36	0.47	0.62
Count	2139	1420	197	522

Table 4: Trade Variables (Medians) for ETPs

Less Liquid NMS Stocks–Data Summary

	R2000	≤50K	50-100K	>100K
Trades Per Day	2,046	273	754	2,841
ADV	260,103	24,198	78,563	410,609
Market Cap. (\$MM)	\$837	\$314	\$582	\$1,107
Price	\$23.62	\$30.02	\$26.09	\$21.90
% Share Vol. as Block	6%	1%	3%	7%
Avg. Block Size	21,918	11,750	16,491	23,861
% Share Vol. in Auctions	9%	12%	10%	8%
Avg. Auction Share Vol.	11,434	1,419	3,666	16,934
% Share Vol. on TRF	32%	29%	29%	33%
Fragmentation	0.75	0.7	0.74	0.75
Count	1994	292	212	1490

Table 5: *Trade Variables (Medians) for Members of the Russell 2000*

On any given day, a meaningful number of symbols do not trade, or have only a few trades³:

	All NMS	Common	ETP	R2000
No Trades	301	32	154	1
Five or Fewer	785	106	414	1
Ten or Fewer	1052	156	542	1
Twenty or Fewer	1416	226	710	4

Table 6: *Median Number of Symbols with Few Trades Each Day*

A higher proportion of volume in less-liquid symbols is also traded off-exchange than in more-liquid symbols. This relationship is more pronounced for ETPs than for common stocks. For trading on exchanges, a slightly higher proportion of share volume occurs on the listing exchange of less-liquid symbols relative to non-listing exchanges; for more-liquid symbols, a higher proportion of share volume occurs on non-listing exchanges relative to the listing exchange.

³The difference between the totals for all NMS stocks and the columns on the right is accounted for by preferreds, rights, warrants, and other smaller categories of NMS stock.

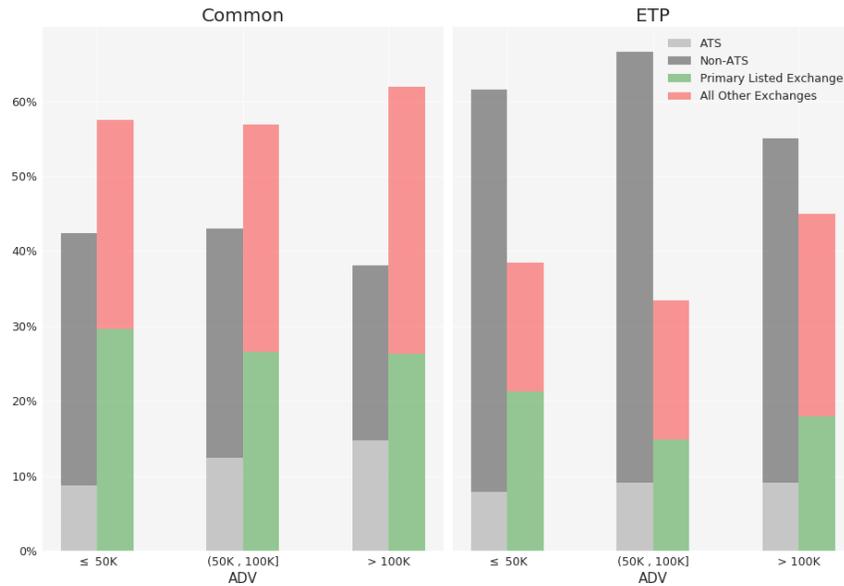


Figure 2: Mean Percentage of Share Volume by Type, Source, and ADV Ranges

Less-liquid symbols have, on average, fewer exchanges quoting at the NBB or NBO than more-liquid symbols. This relationship holds for both common stocks and ETPs.

		≤50K	50-100K	>100K
# at NBB	Common	1.8	2.4	3.5
	ETP	2.4	3.0	4.4
# at NBO	Common	1.7	2.4	3.6
	ETP	2.6	3.5	4.9

Table 7: Number of exchanges quoting at the NBB and NBO partitioned by security type and share volume bin.

Less-liquid symbols also have a greater proportion of regular trading hours with only one exchange quoting at both the NBB and NBO, or at either the NBB or NBO. Again, this is true of both common stocks and ETPs. For reference, during this period, thirteen national securities exchanges were operating.

Less Liquid NMS Stocks–Data Summary

		≤50K	50-100K	>100K
At Both the NBB and NBO	Common	23.3%	7.7%	1.8%
	ETP	10.6%	4.0%	0.7%
At Either the NBB or NBO	Common	41.7%	42.2%	23.5%
	ETP	35.5%	35.7%	21.1%

Table 8: *Percent of regular hours where a single exchange is quoting at the NBB and NBO partitioned by security type and share volume bin.*

Quoted depths at the inside are also smaller for less-liquid symbols than for more-liquid ones. The average depths for ETPs are greater than the average depths for commons stocks, across the liquidity spectrum.

		≤50K	50-100K	>100K
Depth at NBB	Common	5.6	7.2	9.9
	ETP	10.4	14.4	35.2
Depth at NBO	Common	5.7	7.6	9.9
	ETP	14.5	20.6	63.2

Table 9: *Quoted depth, in round lots, at the NBB and NBO partitioned by security type and share volume bin.*

Quoted spreads and relative quoted spreads are greater for less-liquid stocks than for more-liquid symbols. Across the liquidity spectrum, the average spreads for ETPs are smaller than the average spreads for common stocks.

		≤50K	50-100K	>100K
Quoted Spread	Common	\$0.21	\$0.09	\$0.04
	ETP	\$0.09	\$0.04	\$0.02
Relative Quoted Spread	Common	1.56%	0.64%	0.19%
	ETP	0.27%	0.11%	0.05%

Table 10: *Quoted spread and relative quoted spread partitioned by security type and share volume bin.*

Appendix

Exploratory Visualizations

Figures 6-21 include visualizations of the symbol-level distributions, meaning there is one observation for each NMS stock, for the following sixteen variables. Detailed descriptions of each variable and its construction methodology can be found in the following section.

1. Market Capitalization
2. Share Volume
3. Trade Count
4. Turnover
5. Off-Exchange Volume
6. Auction Volume
7. Block Volume
8. Block Volume Executed Off-Exchange
9. Average Size of Block Trades
10. Cumulative Depth Quoted at the National Best Bid and Offer (NBBO)
11. Quoted Spread
12. Relative Quoted Spread
13. Number of Exchanges Quoting at the NBBO
14. One Exchange Alone at Both Sides of the NBBO
15. One Exchange Alone at Either Side of the NBBO (Not Both)
16. Fragmentation

Each figure is primarily focused on a single variable and contains three subplots:

1. The upper left subplot is a cumulative distribution function (CDF) kernel estimate for the primary variable.
2. The lower left subplot is a heat map showing the relationship between deciles of the primary variable and the associated proportion of total NMS ADV.
3. The subplots on the right half of the figure depict a series of joint probability density function (PDF) kernel estimates showing the primary variable versus each of the remaining variables.

The following sample subplots and descriptions are intended to aid with interpretation of Figures 6-21. These examples address the subplots for ADV, but the principles of interpretation apply across each of the variables.

Upper Left: Kernel Estimate of the CDF

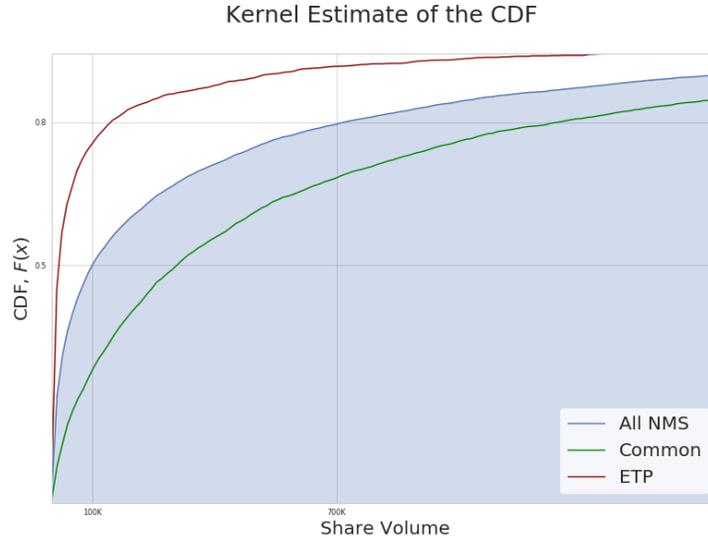


Figure 3: *Kernel Estimate of the CDF*

For the purposes in this summary, this subplot can be used to visually approximate the proportion of symbols having an ADV less than or equal to any value on the x-axis. Similarly, one could approximate the proportion of symbols having an ADV between any two values on the x-axis.

For example, to approximate the proportion of NMS stocks having an ADV up to 100,000, evaluate the CDF at 100,000, which can be estimated at 50%.

Similarly, the proportion of NMS stocks having an ADV of less than 700,000 can be estimated at 80%. To approximate the proportion of all NMS stocks with an ADV between 100,000 and 700,000, subtract 50% from 80%, for an estimate of 30%.

The distribution for all NMS stocks is shown in blue, common stocks are shown in green, and ETPs in red.

Lower Left: Heat Map of Total NMS ADV for Set of Symbols At or Below Deciles

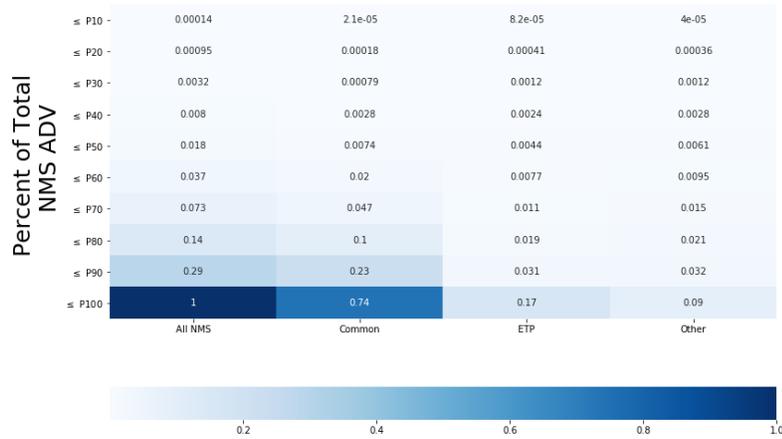


Figure 4: Heat Map

This subplot can be used to estimate the proportion of ADV contributed by the symbols in a given range of the distribution for the main variable. While the subplot above helps estimate the proportion of individual NMS stocks below a given level, this heat map helps estimate the total proportion of share volume accounted for by those stocks. Darker blues indicate higher proportions of total NMS ADV.

Rows of the heat map delineate deciles of the ADV distribution. Columns of the heat map organize NMS stocks into four groups, moving left to right: (1) all NMS stocks; then, mutually exclusive groups of (2) common stocks; (3) ETPs; and (4) all other NMS stocks. Moving down a column, into higher deciles, accumulates total NMS ADV proportion. In a given row, the all-NMS cell, in the leftmost column, is equal to the sum of the three remaining cells in that row, to the right.

To extend the example above, this heat map can be used to estimate the proportion of total NMS ADV contributed by symbols with an ADV below the median. The fifth row represents the fifth decile, or the median. This row indicates that NMS stocks in the bottom half of the ADV distribution represent approximately 1.8% of the total ADV of NMS stocks. Of that 1.8%, common stocks represent 0.74% of the total ADV of NMS stocks, while ETPs represent 0.44%, and all other NMS stocks represent 0.61%.

Right: Kernel Estimate(s) of the Joint Probability Density Function

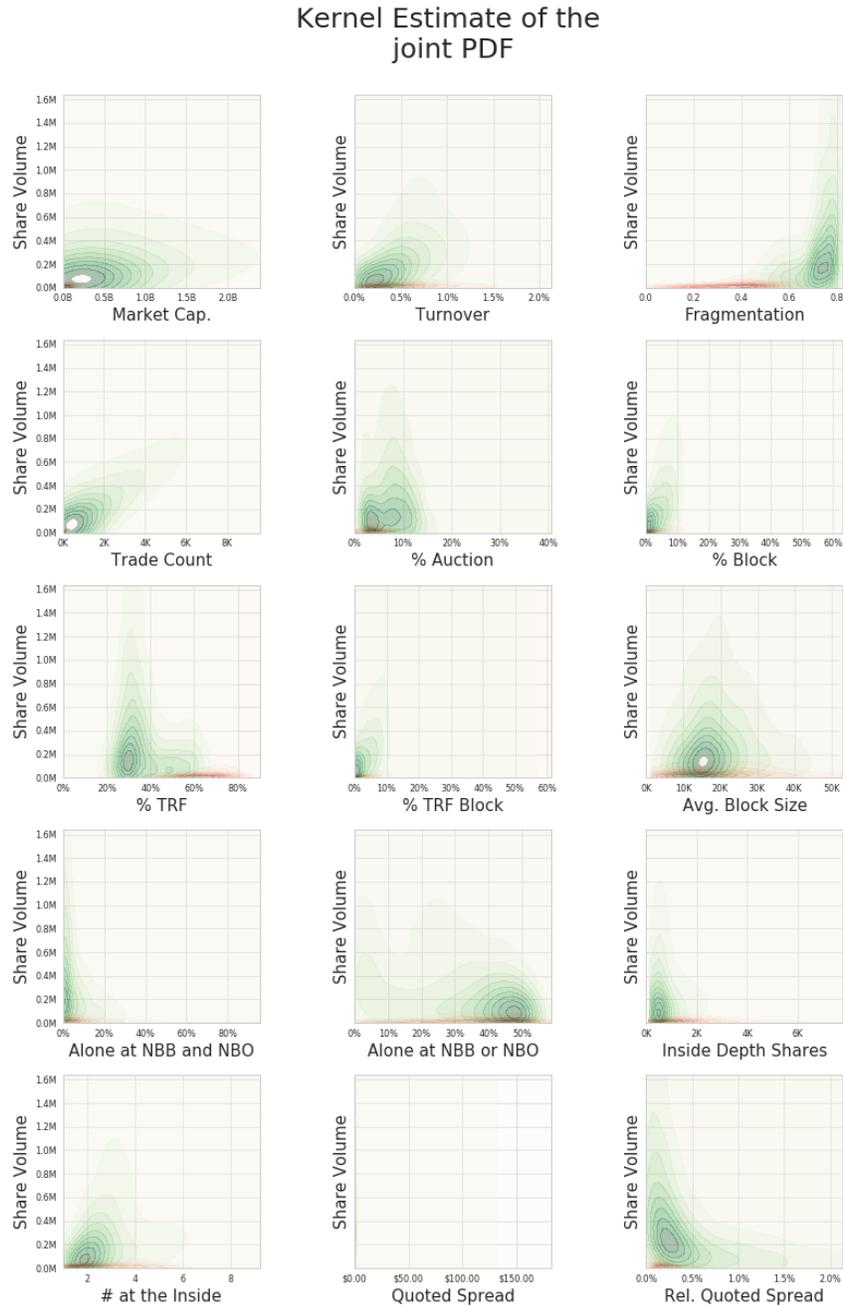


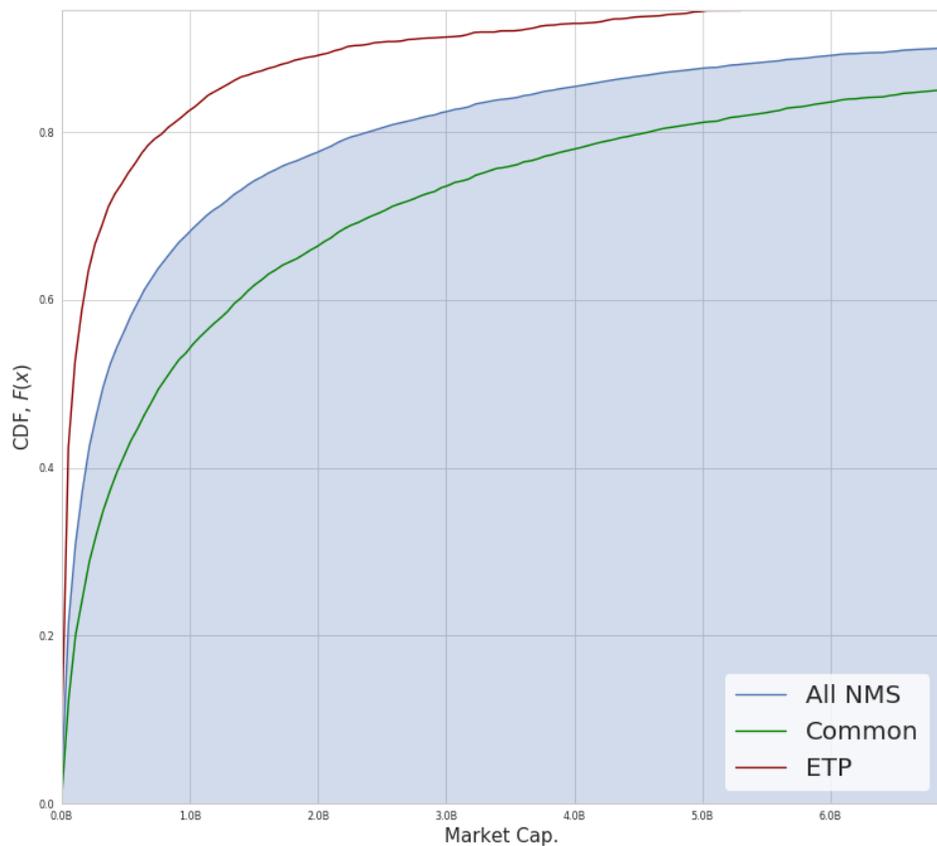
Figure 5: *Kernel Estimate of the Joint PDF*

This subplot depicts the contours of the joint distribution(s) of the primary variable against each of the other fifteen variables. An individual plot can be used to visually inspect the relationship between the two variables, as well as compare the distributions for common stocks and ETPs with respect to those variables.

Kernel estimate surfaces are plotted for common stocks in green and ETPs in red. Darker, more saturated, levels of the surface indicate a higher concentration of NMS stocks in that region of the bivariate space. The primary variable is shown on every y-axis, with one of the remaining variables shown on the x-axis of each of the fifteen separate plots.

As an example, consider the upper right plot, which depicts the bivariate relationship between ADV and fragmentation. Variation along the x-axis suggests that fragmentation is distributed differently for common stocks and ETPs; for example, common stocks are more tightly distributed and are centered on higher levels of fragmentation. It also appears, from inspection of the joint variation in that same plot, that common stocks higher in the ADV distribution have higher fragmentation values than common stocks lower in the ADV distribution.

Kernel Estimate of the CDF



Kernel Estimate of the joint PDF

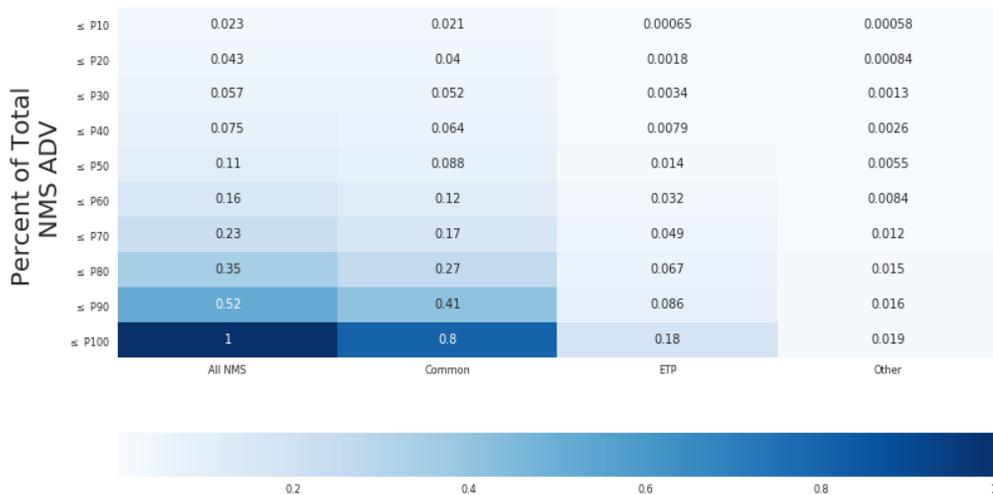
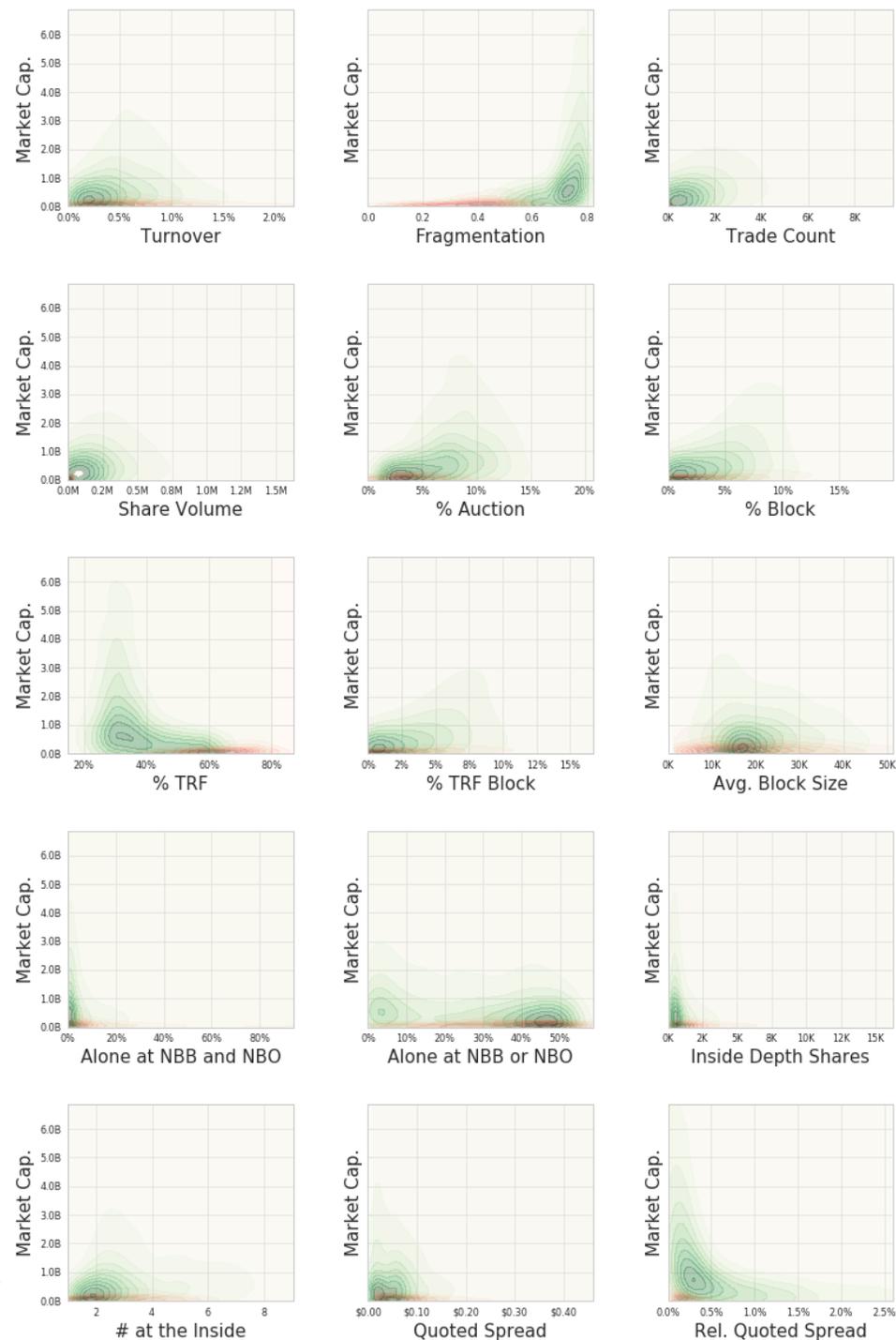
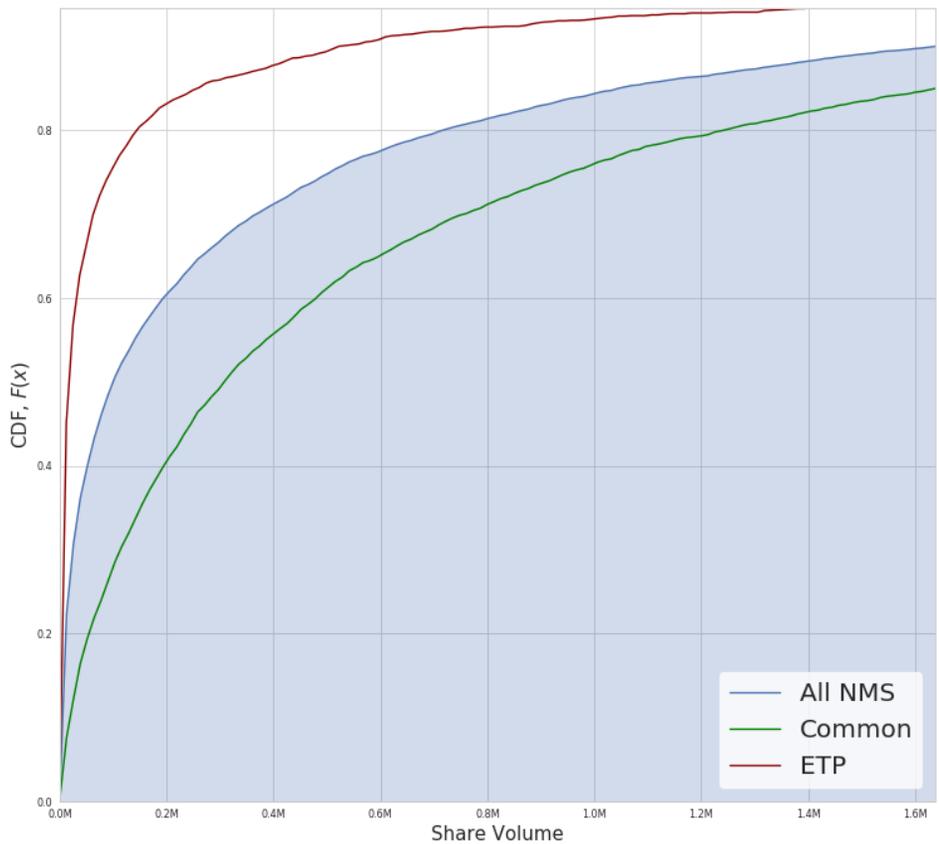
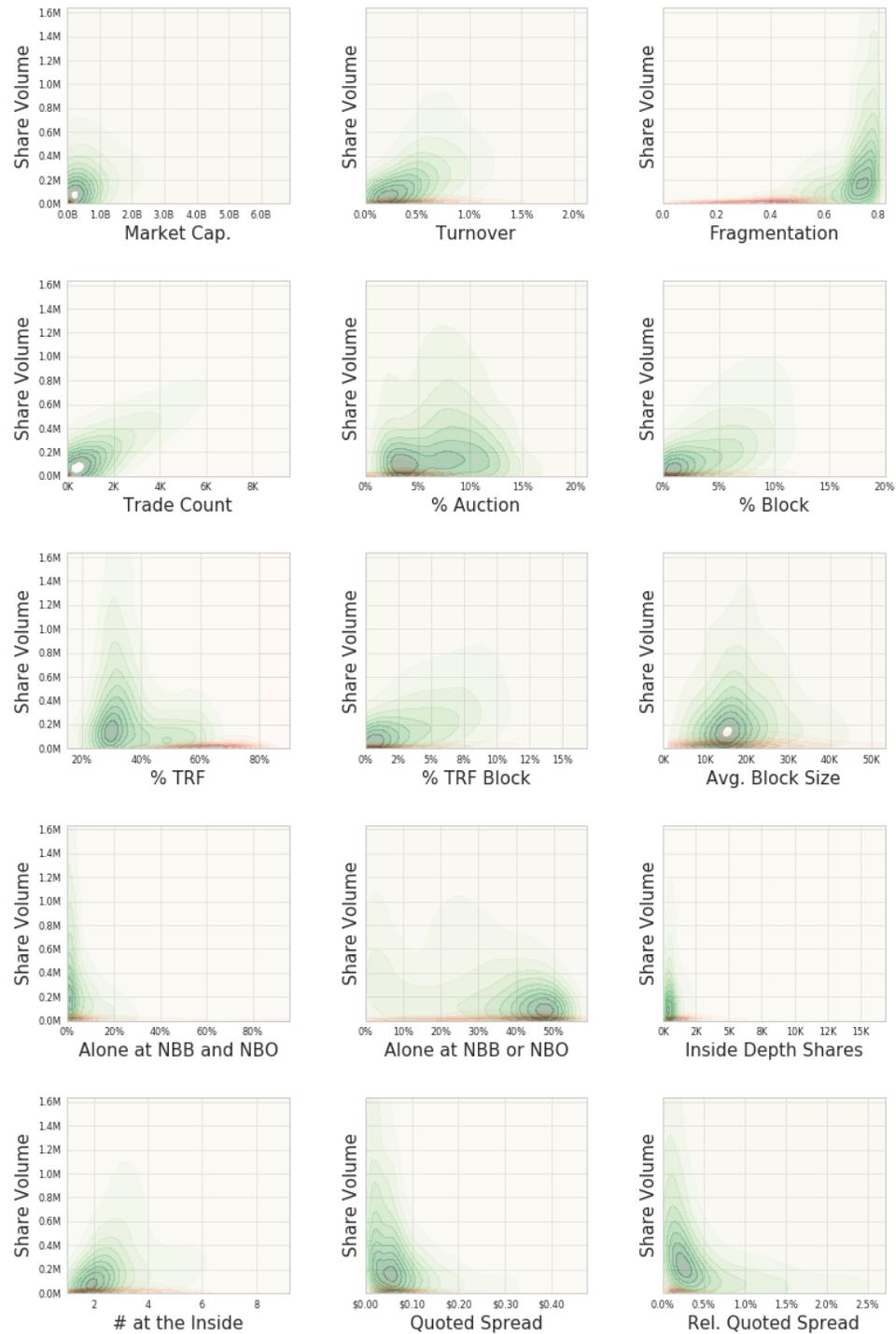


Figure 6: Market Capitalization

Kernel Estimate of the CDF



Kernel Estimate of the joint PDF

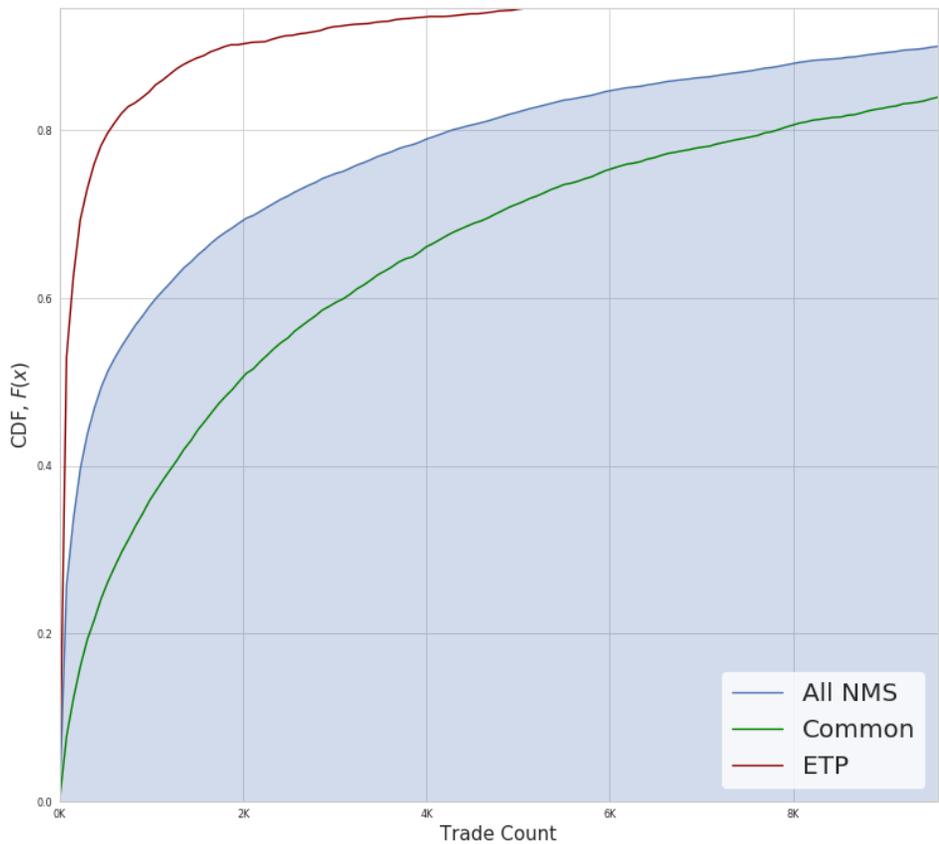


Percent of Total NMS ADV

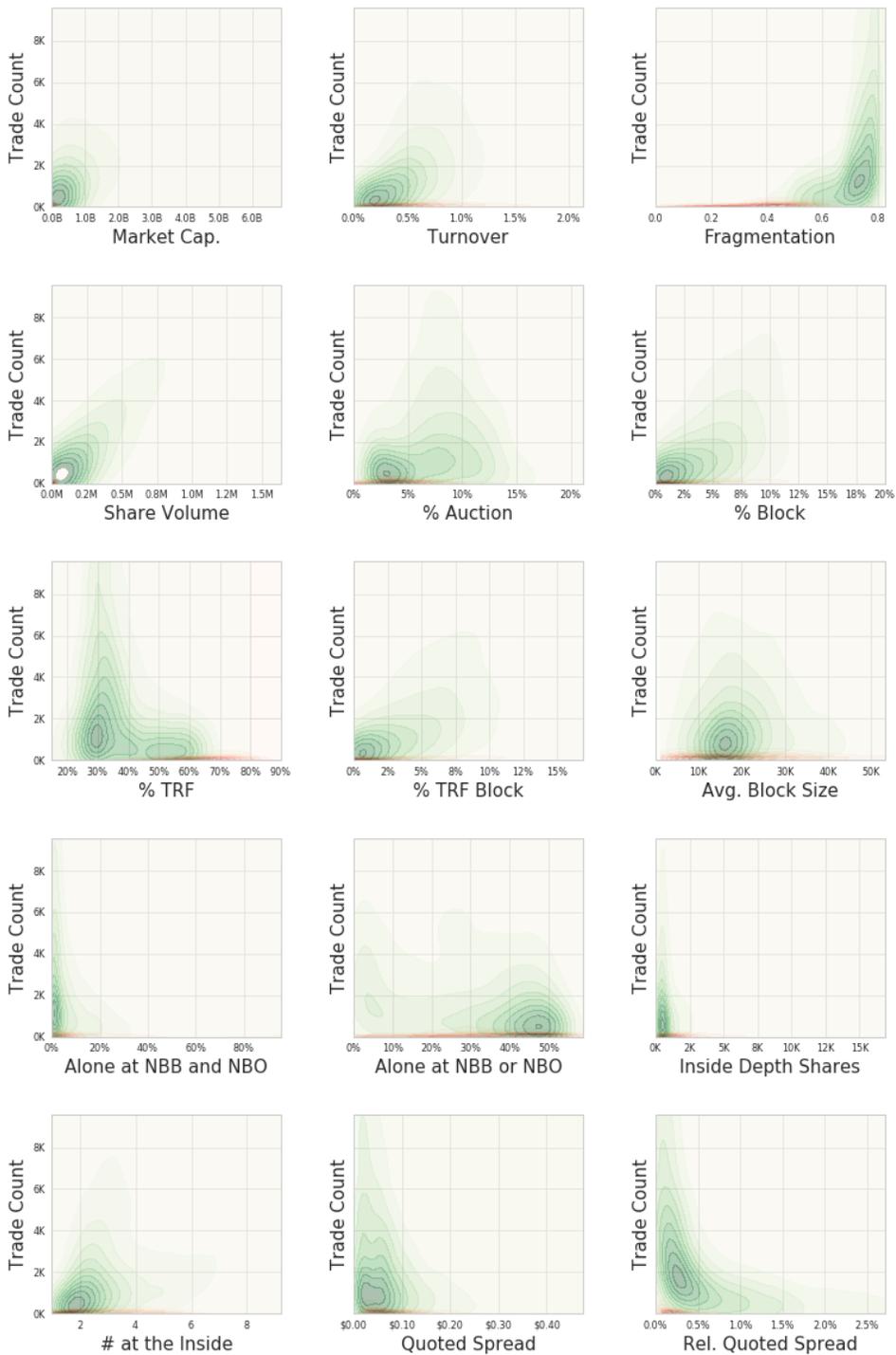
≤ P10	0.00014	2.1e-05	8.2e-05	4e-05
≤ P20	0.00095	0.00018	0.00041	0.00036
≤ P30	0.0032	0.00079	0.0012	0.0012
≤ P40	0.008	0.0028	0.0024	0.0028
≤ P50	0.018	0.0074	0.0044	0.0061
≤ P60	0.037	0.02	0.0077	0.0095
≤ P70	0.073	0.047	0.011	0.015
≤ P80	0.14	0.1	0.019	0.021
≤ P90	0.29	0.23	0.031	0.032
≤ P100	1	0.74	0.17	0.09
	All NMS	Common	ETP	Other

Figure 7: Share Volume

Kernel Estimate of the CDF



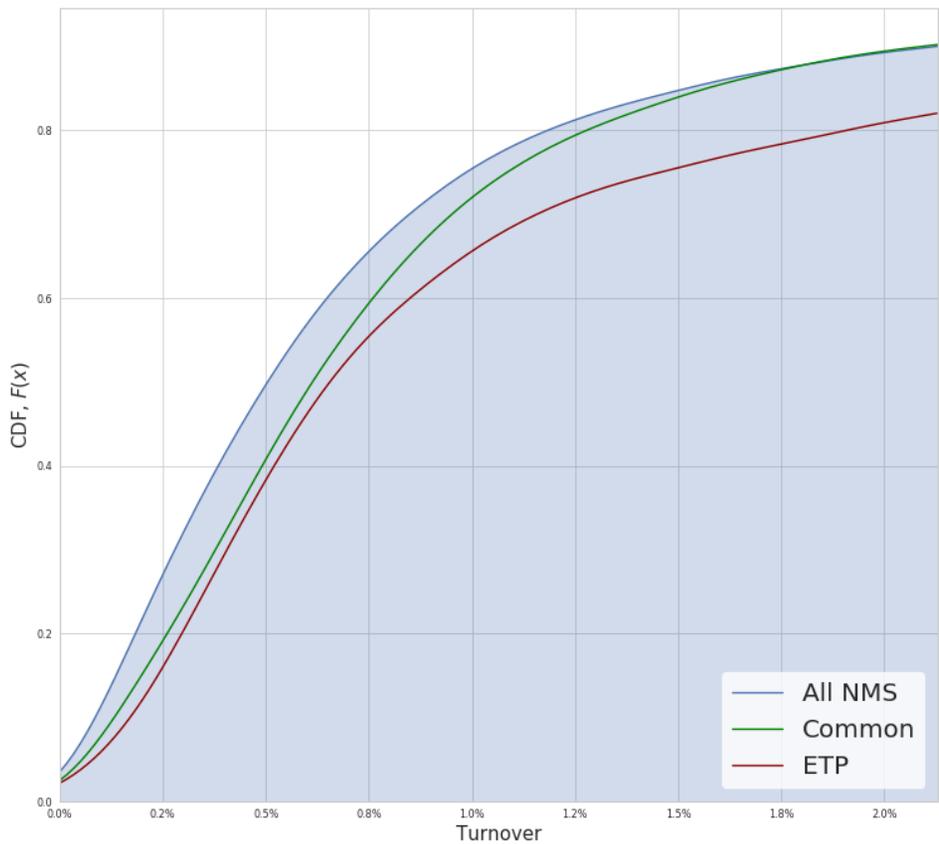
Kernel Estimate of the joint PDF



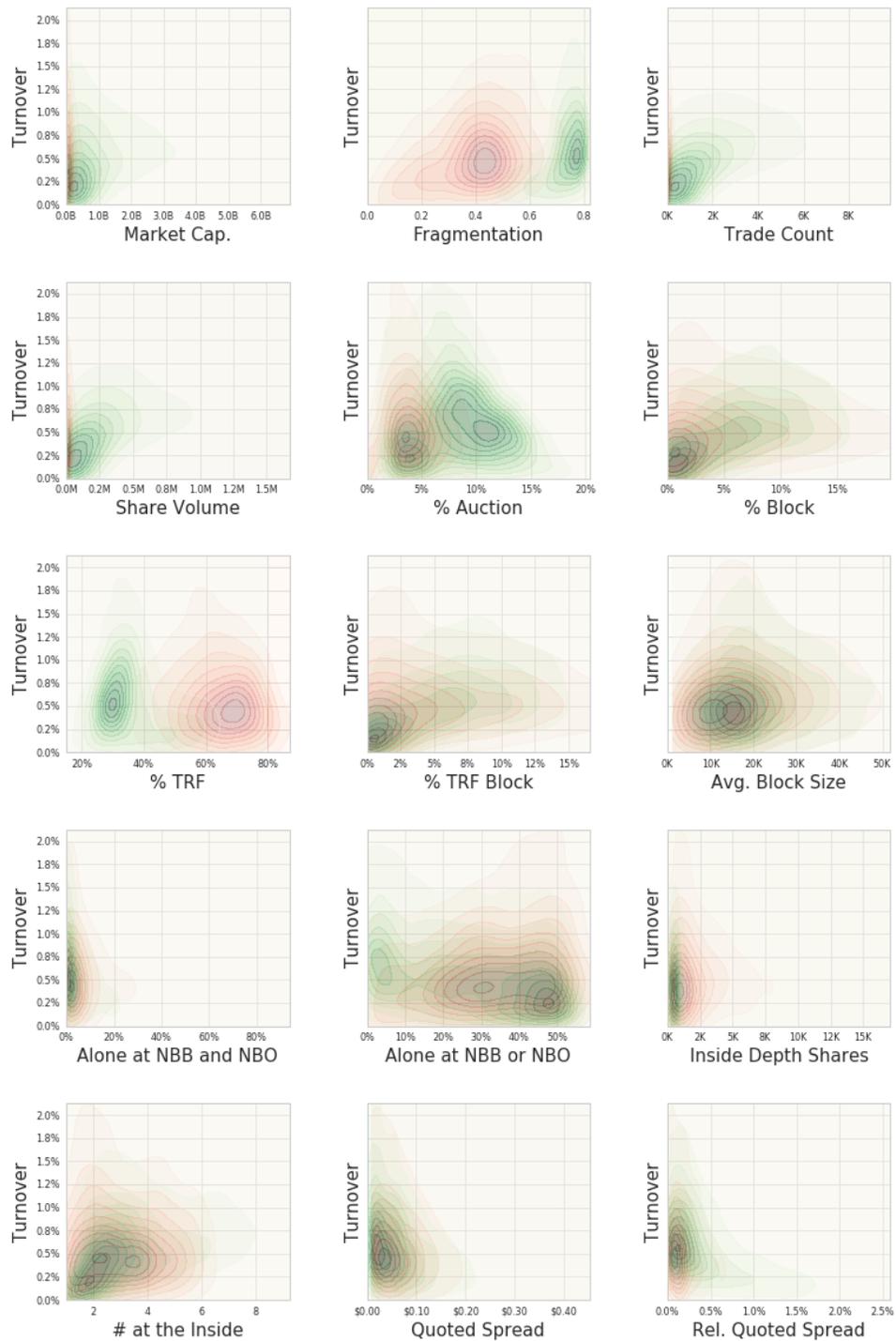
Percent of Total NMS ADV	All NMS	Common	ETP	Other
≤ P10	0.00067	0.00012	0.00028	0.00027
≤ P20	0.0021	0.00037	0.00081	0.00087
≤ P30	0.0049	0.00098	0.0019	0.0021
≤ P40	0.011	0.0028	0.0035	0.0045
≤ P50	0.022	0.0074	0.0063	0.0087
≤ P60	0.046	0.021	0.011	0.014
≤ P70	0.088	0.053	0.018	0.018
≤ P80	0.17	0.11	0.026	0.024
≤ P90	0.32	0.23	0.044	0.04
≤ P100	1	0.74	0.17	0.09

Figure 8: Trade Count

Kernel Estimate of the CDF



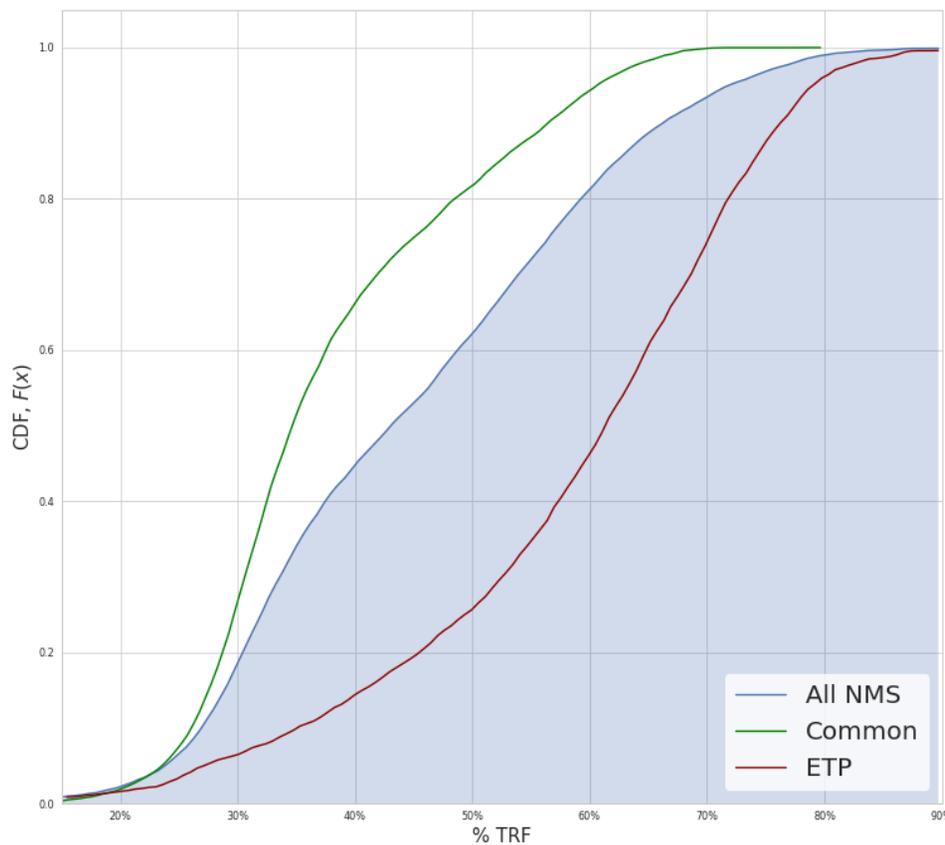
Kernel Estimate of the joint PDF



Percent of Total NMS ADV	All NMS	Common	ETP	Other
≤ P10	0.02	0.0023	8.1e-06	0.018
≤ P20	0.039	0.0073	8.3e-05	0.032
≤ P30	0.067	0.022	0.00097	0.043
≤ P40	0.11	0.06	0.0037	0.05
≤ P50	0.18	0.12	0.0083	0.054
≤ P60	0.28	0.2	0.014	0.064
≤ P70	0.39	0.3	0.02	0.071
≤ P80	0.53	0.43	0.027	0.072
≤ P90	0.67	0.56	0.041	0.077
≤ P100	1	0.75	0.17	0.088

Figure 9: Turnover

Kernel Estimate of the CDF



Kernel Estimate of the joint PDF

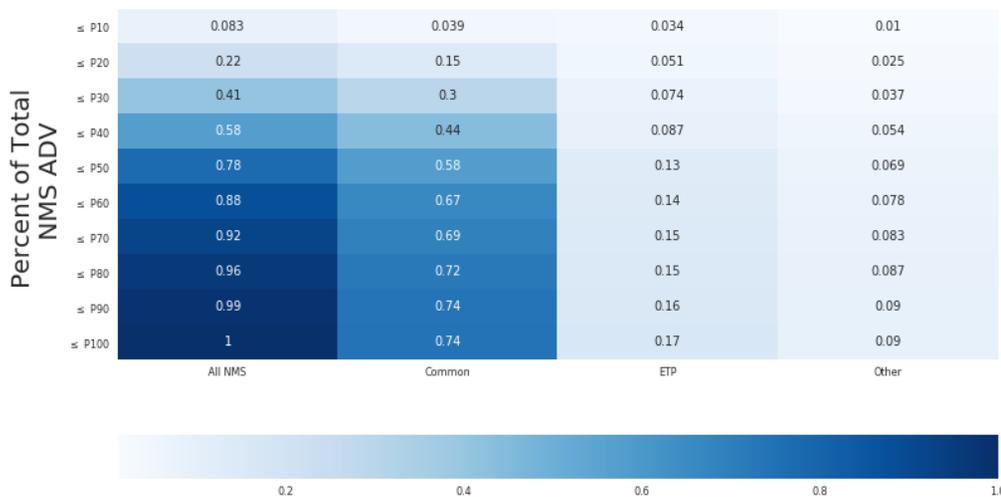
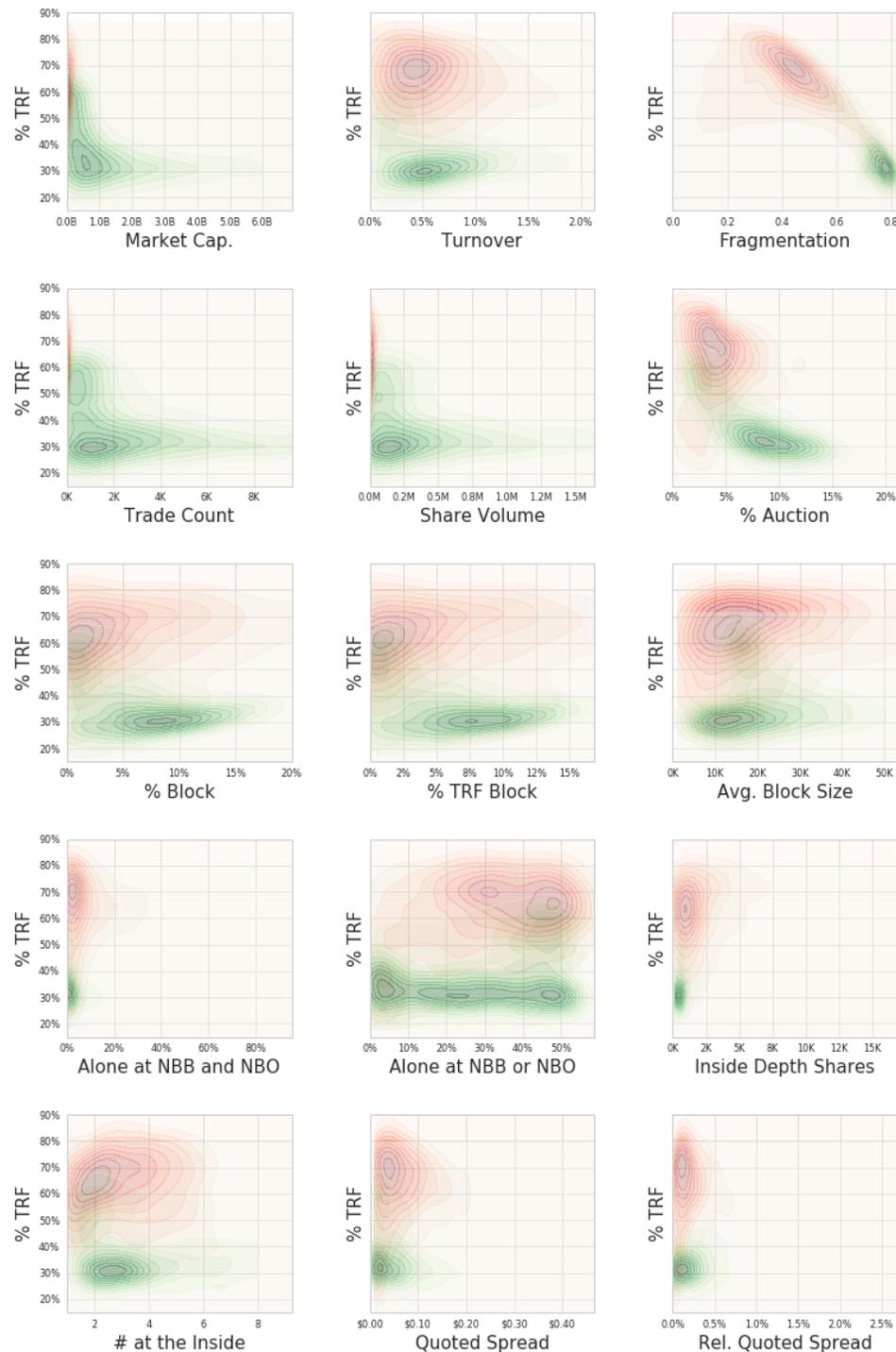
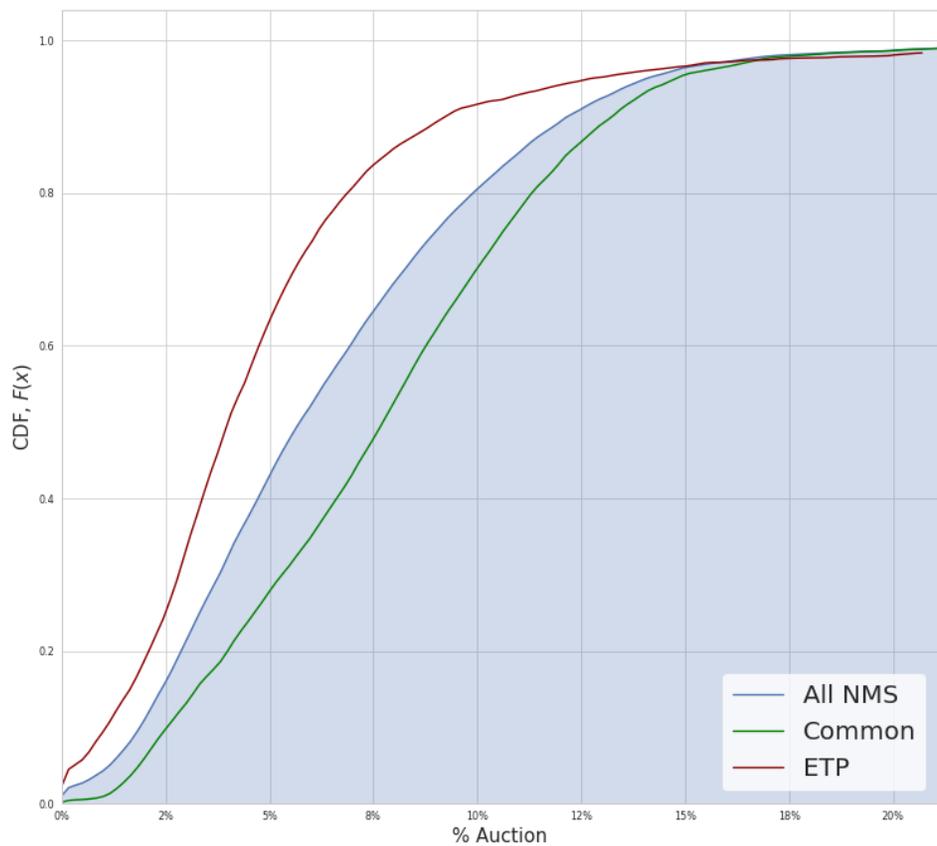


Figure 10: Off-Exchange Volume

Kernel Estimate of the CDF



Kernel Estimate of the joint PDF

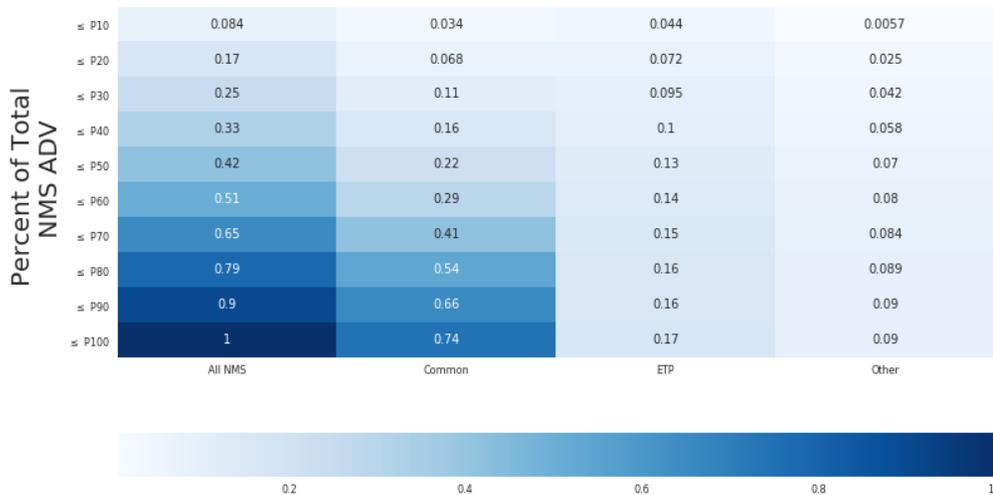
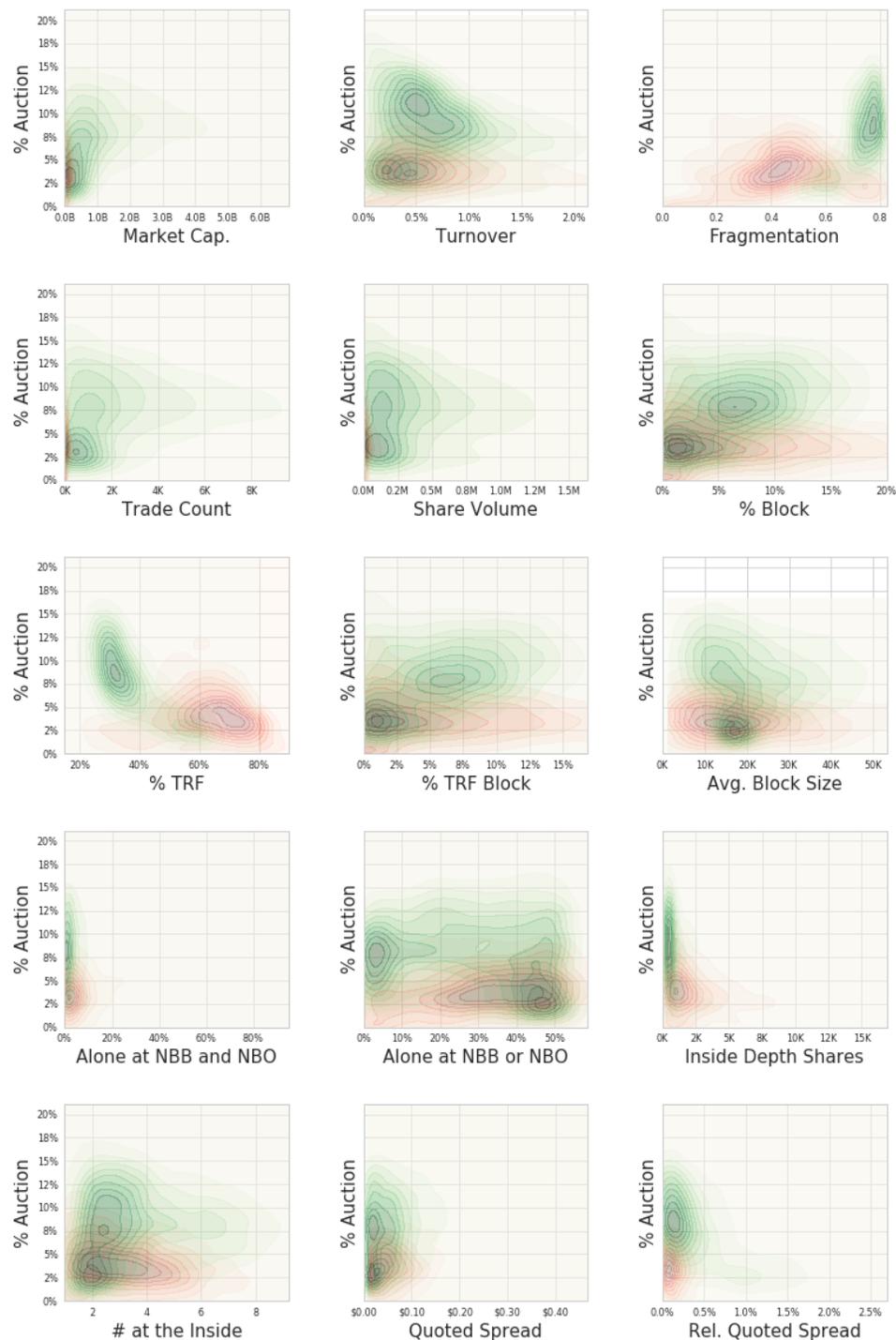
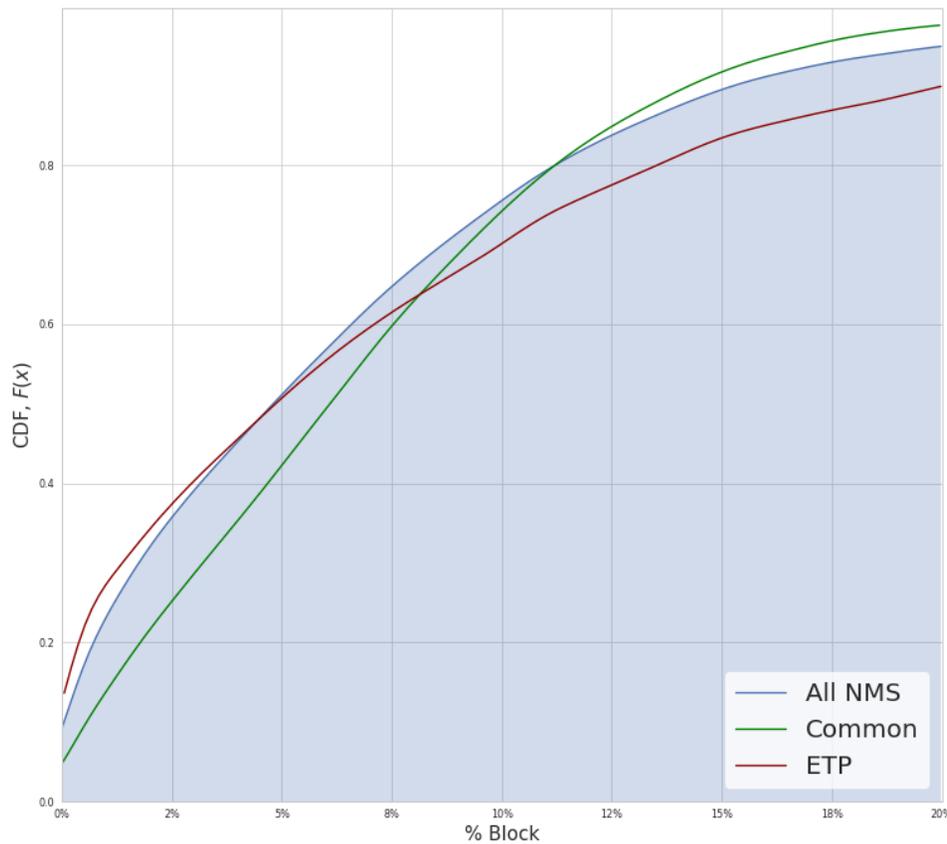


Figure 11: Percentage of Volume in Auctions

Kernel Estimate of the CDF



Kernel Estimate of the joint PDF

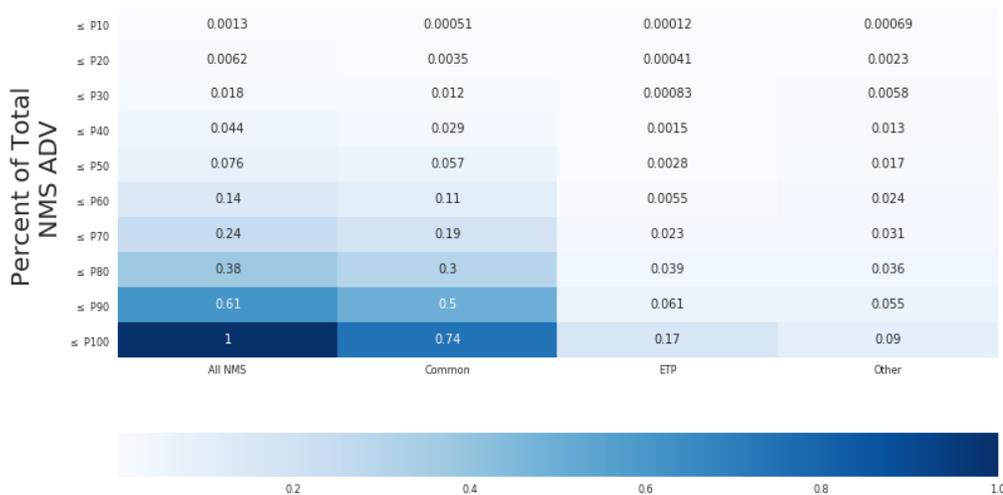
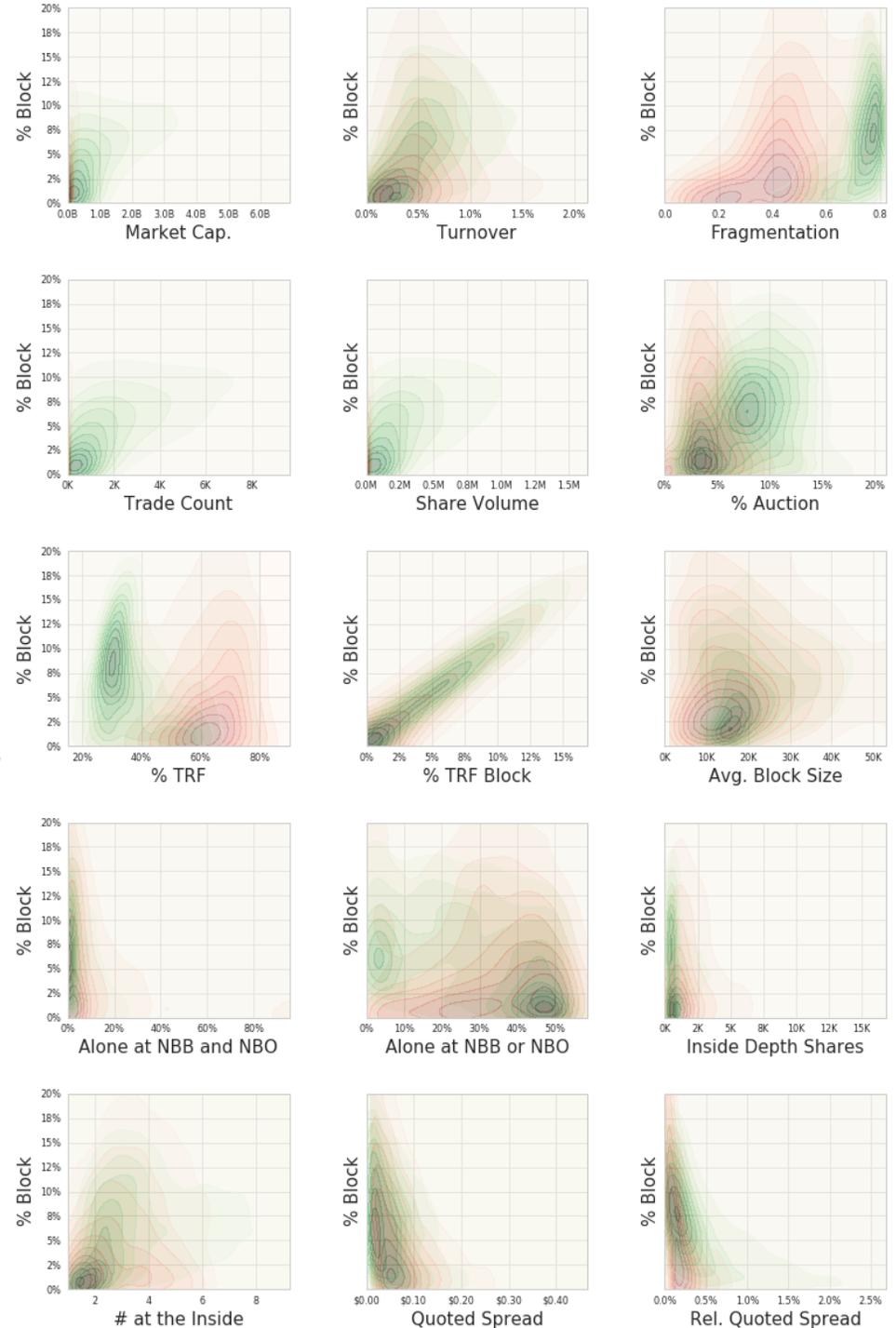
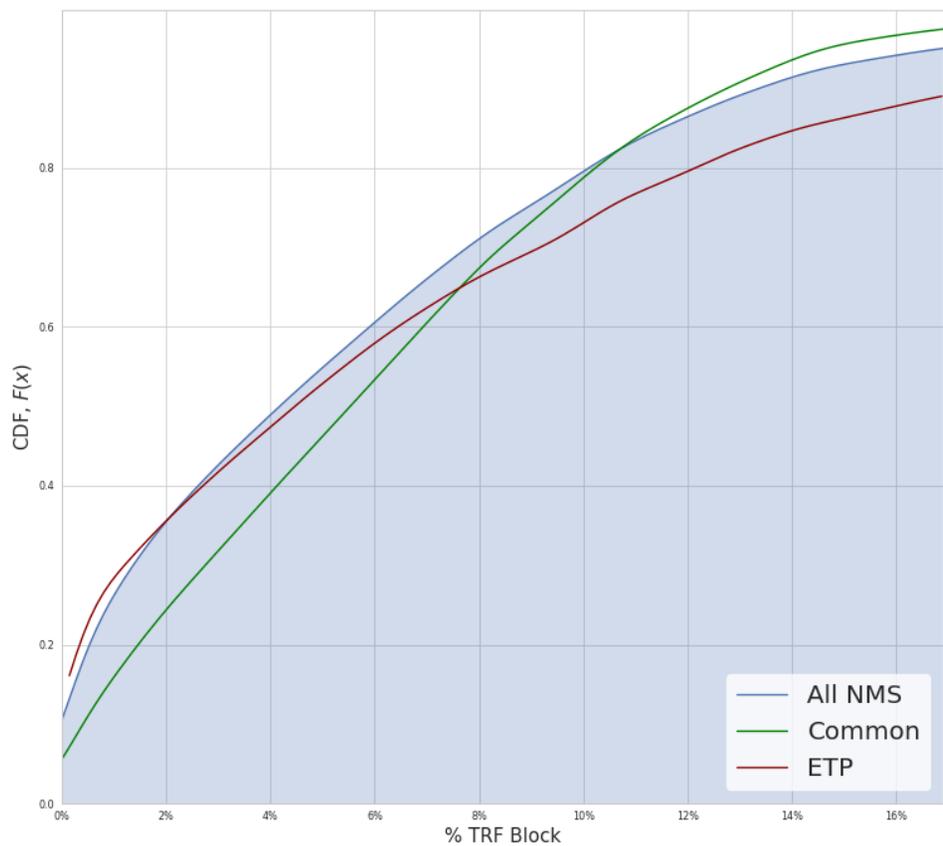
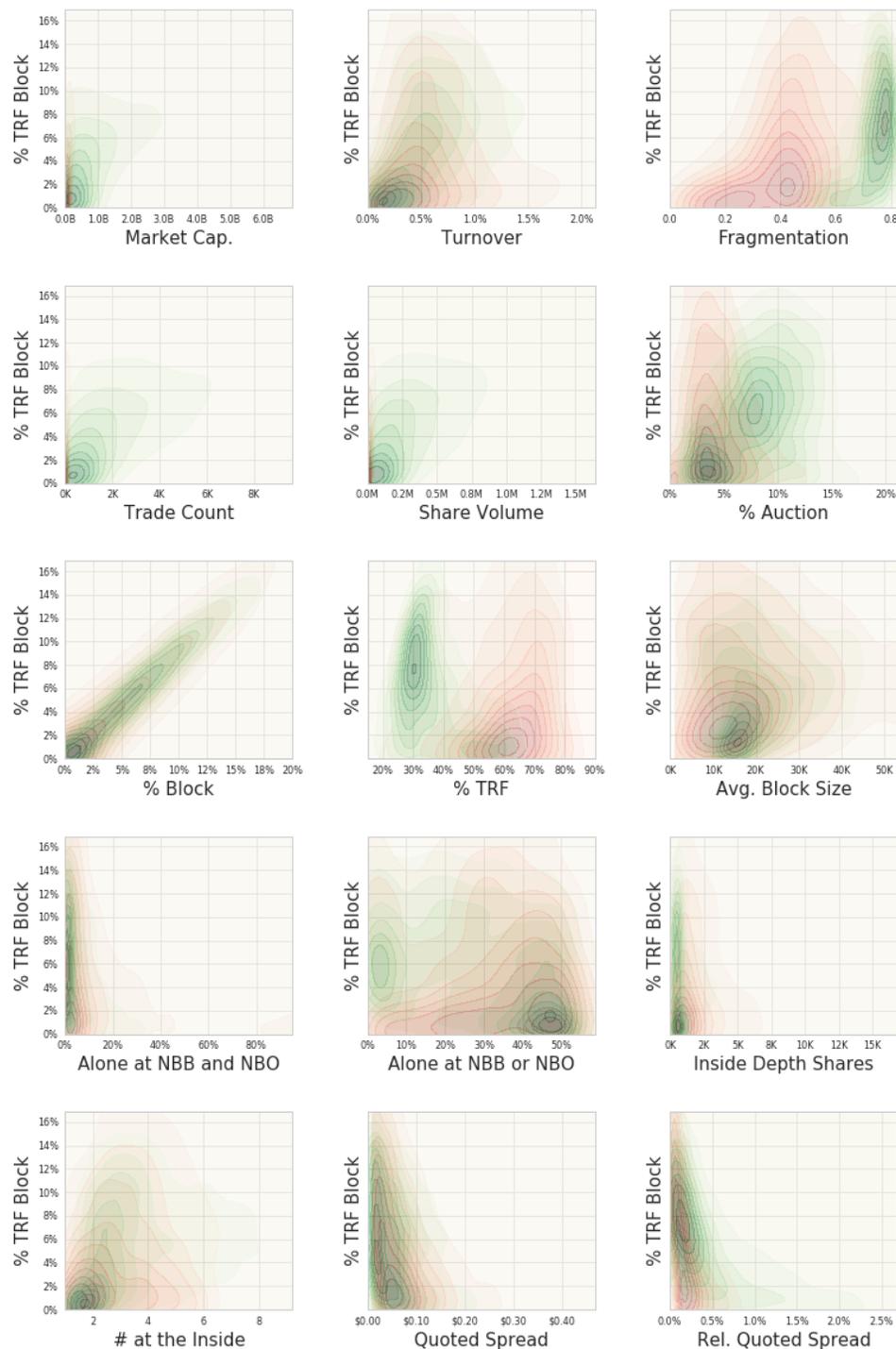


Figure 12: Percentage of Volume in Executed in Blocks

Kernel Estimate of the CDF



Kernel Estimate of the joint PDF

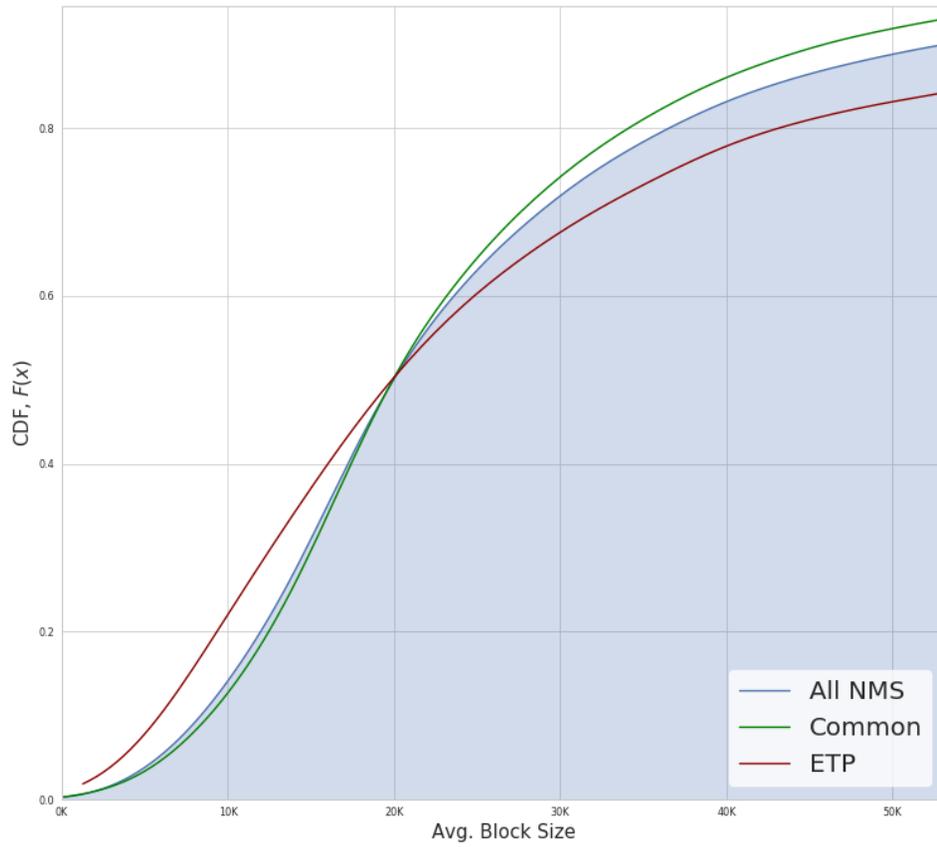


Percent of Total NMS ADV	All NMS	Common	ETP	Other
≤ P10	0.0016	0.00057	0.00012	0.00091
≤ P20	0.0058	0.003	0.00027	0.0026
≤ P30	0.022	0.012	0.00086	0.0086
≤ P40	0.045	0.029	0.0015	0.015
≤ P50	0.086	0.063	0.0032	0.02
≤ P60	0.16	0.11	0.015	0.028
≤ P70	0.27	0.2	0.032	0.039
≤ P80	0.42	0.32	0.046	0.052
≤ P90	0.7	0.53	0.092	0.072
≤ P100	1	0.74	0.17	0.09

Color scale for Percent of Total NMS ADV: 0.2 to 1.0

Figure 13: Percentage of Blocks Executed Off-Exchange

Kernel Estimate of the CDF



Kernel Estimate of the joint PDF

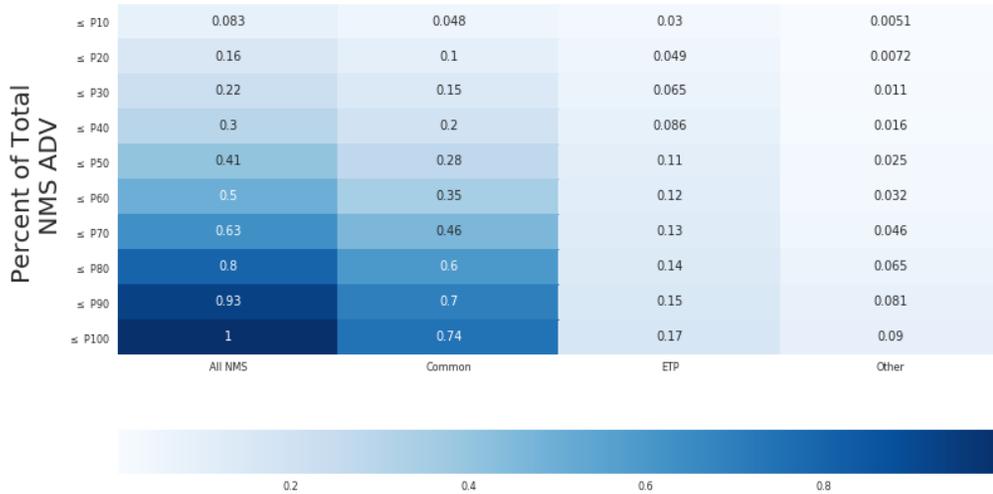
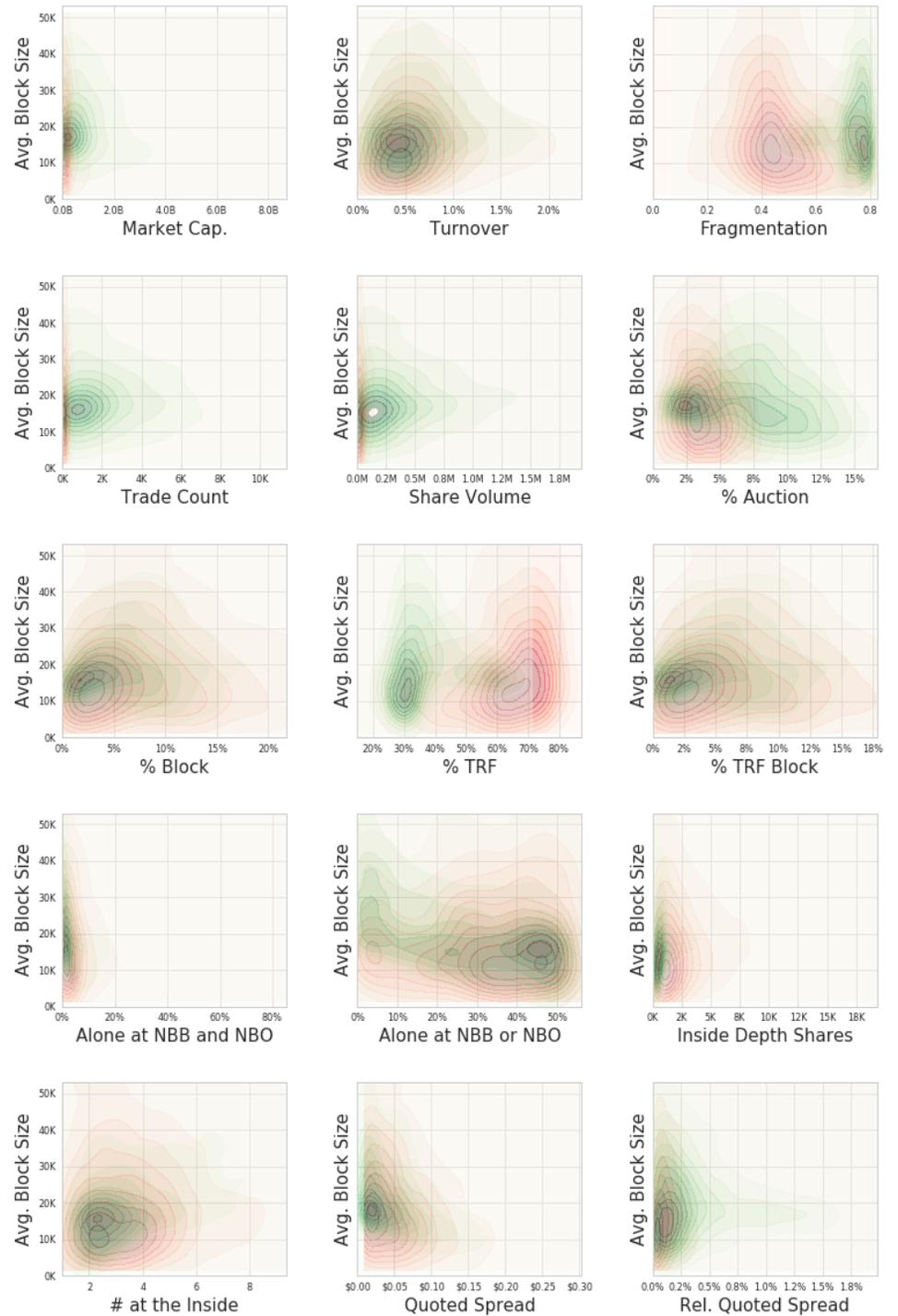
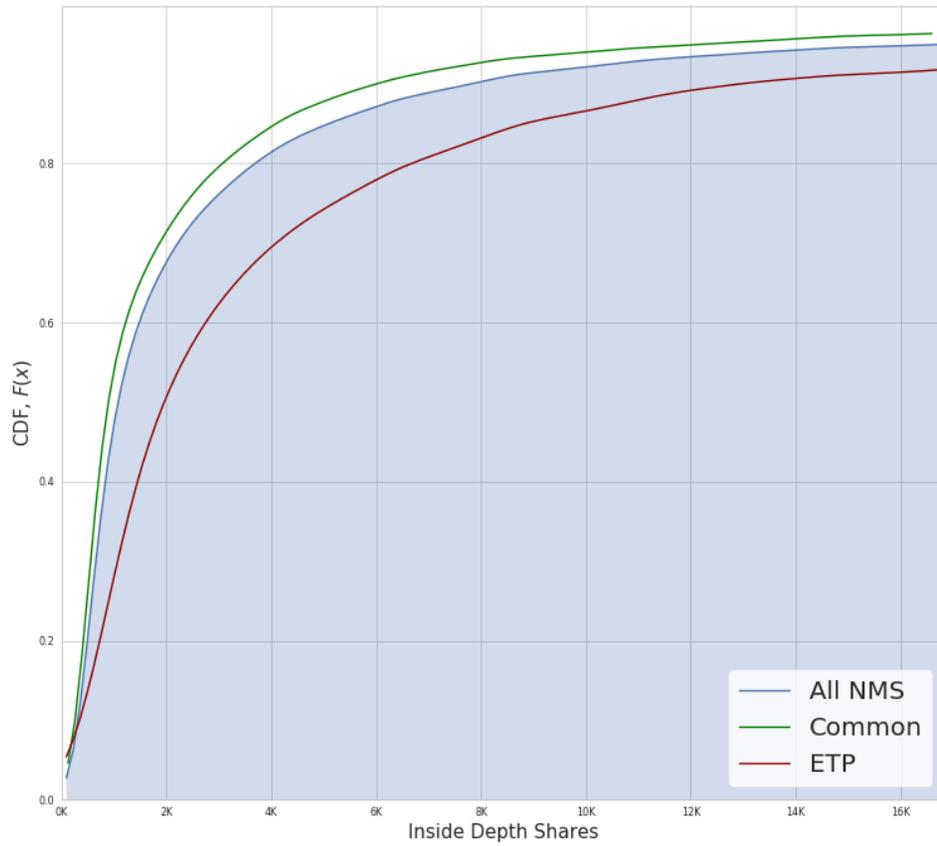


Figure 14: Average Size of Block Volume

Kernel Estimate of the CDF



Kernel Estimate of the joint PDF

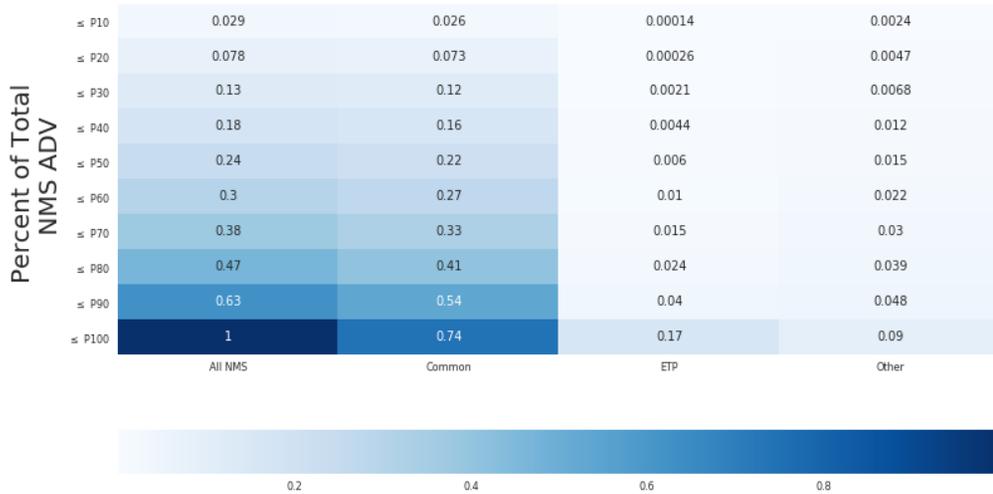
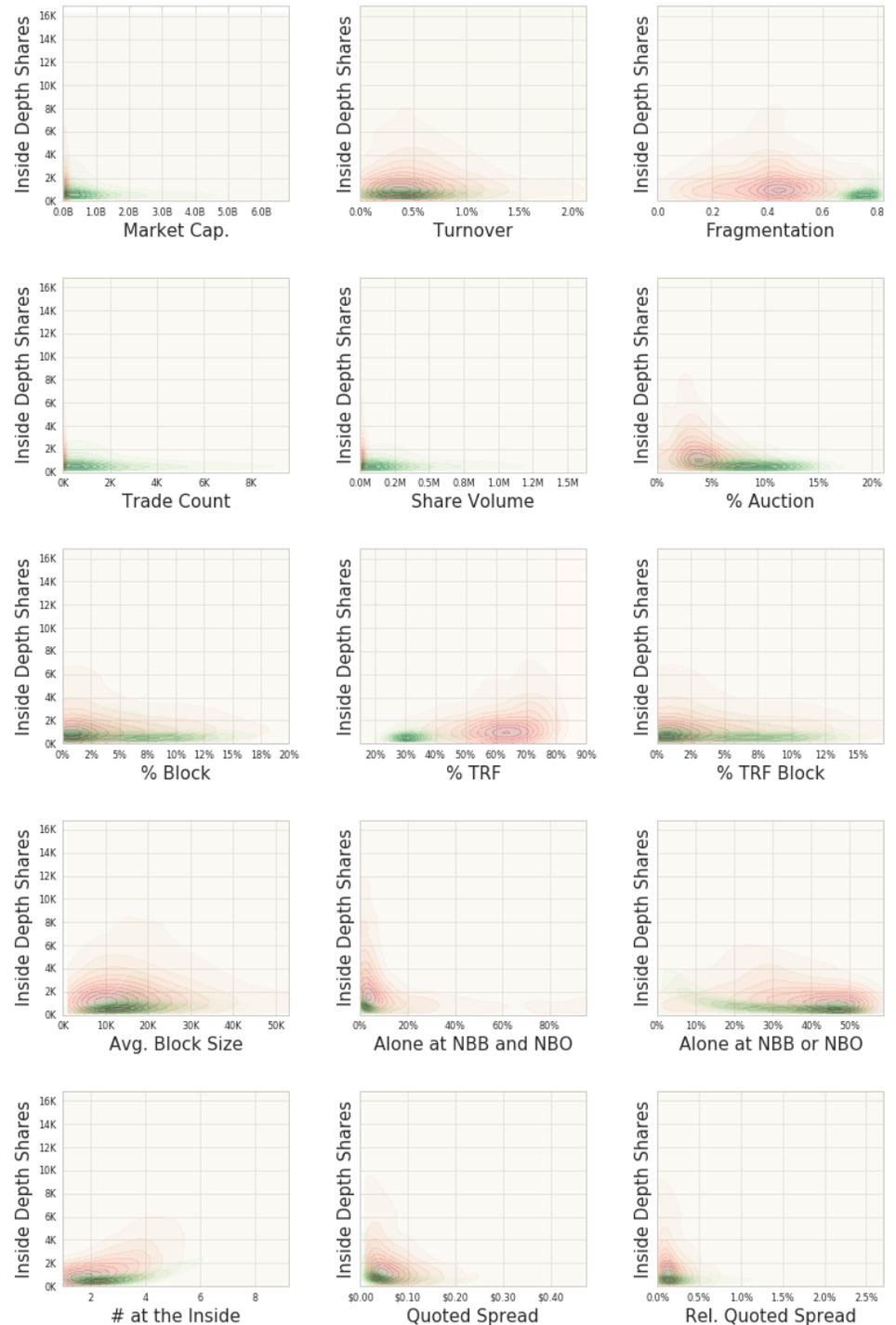
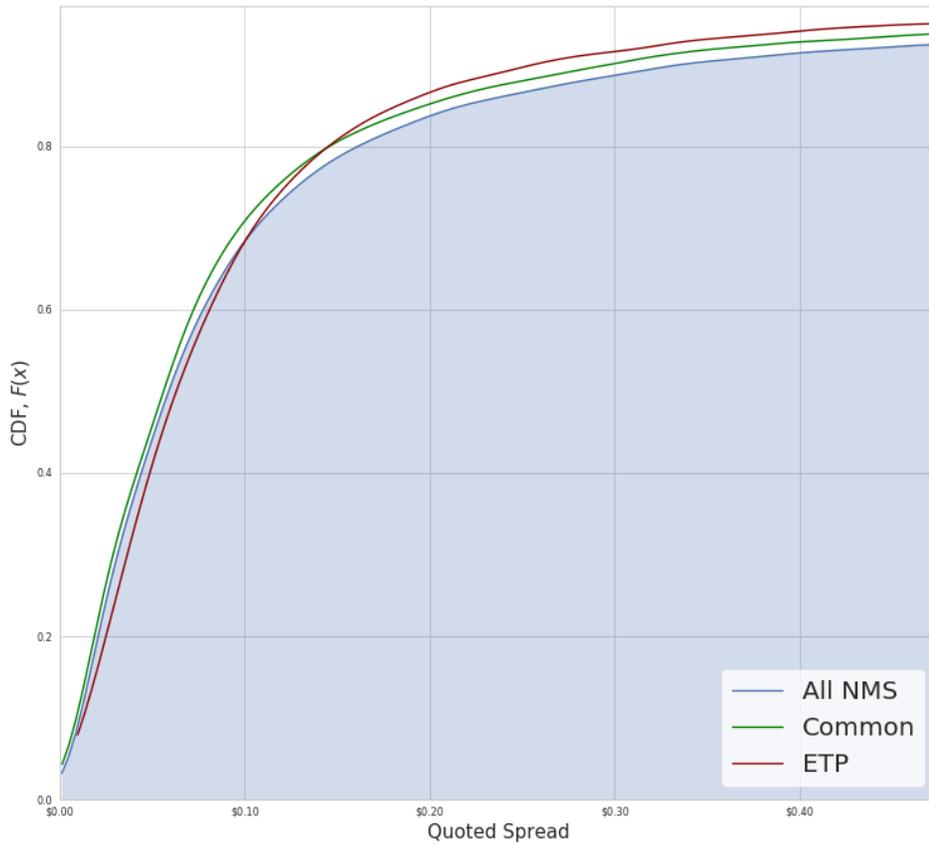


Figure 15: Time-Weighted Depth at the Inside

Kernel Estimate of the CDF



Kernel Estimate of the joint PDF

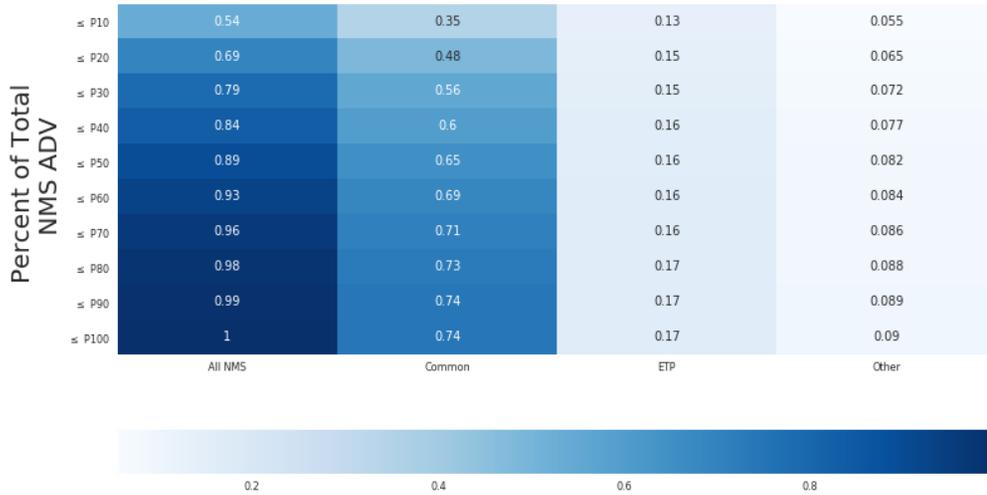
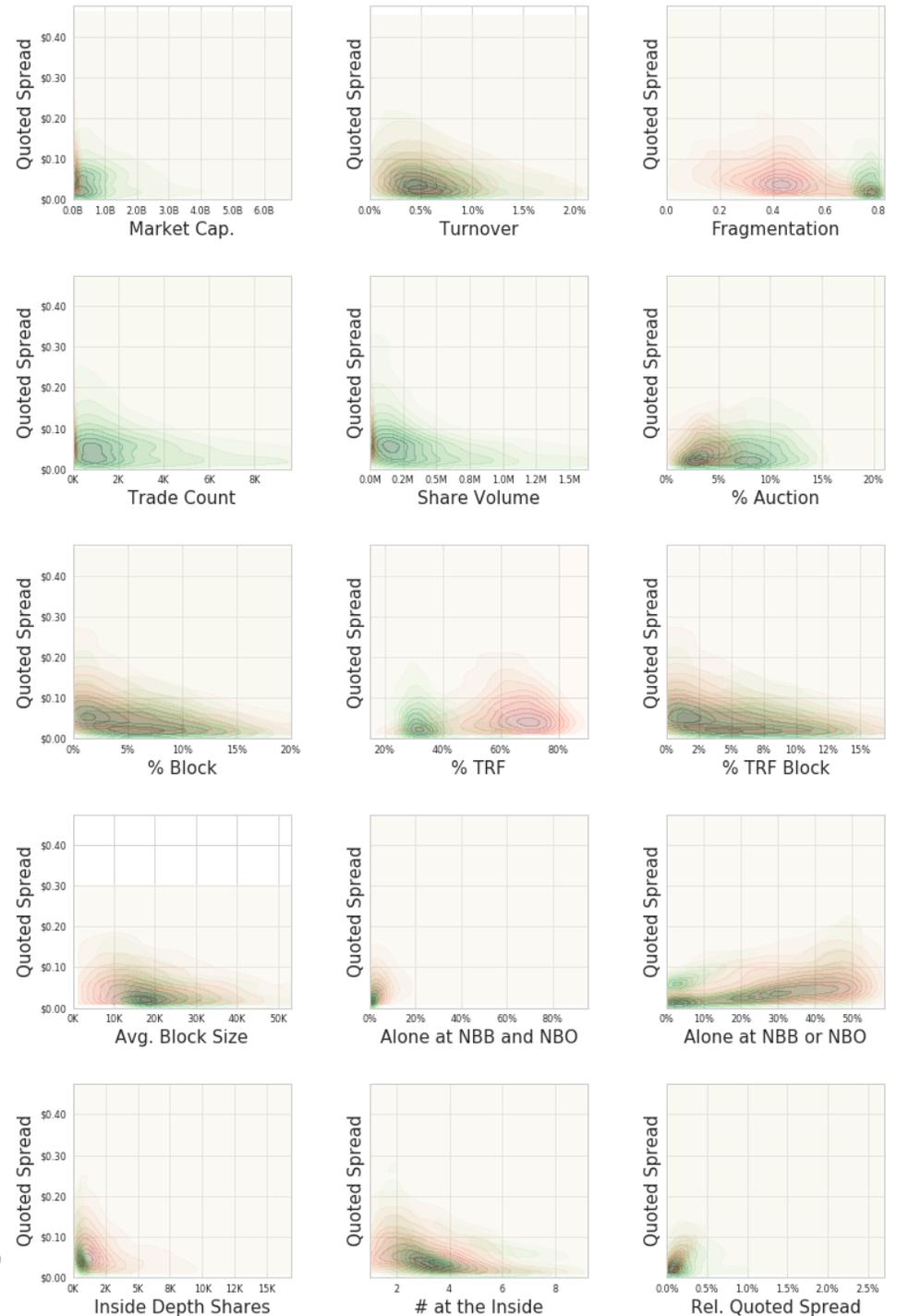
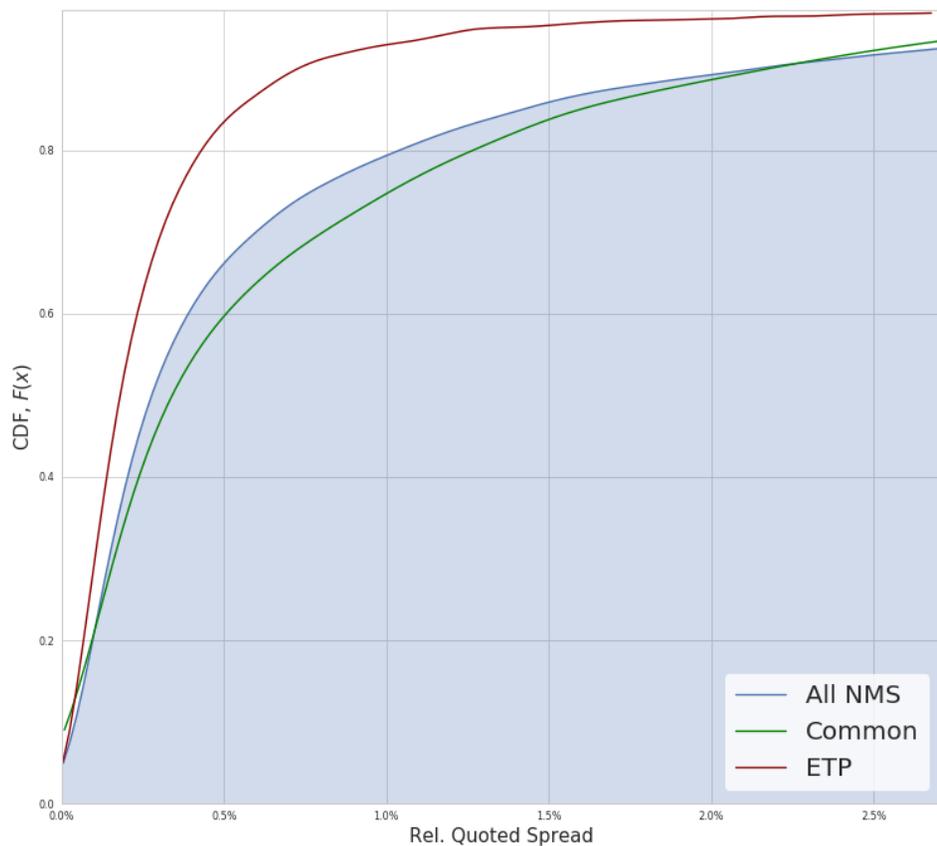


Figure 16: Time-Weighted Quoted Spreads

Kernel Estimate of the CDF



Kernel Estimate of the joint PDF

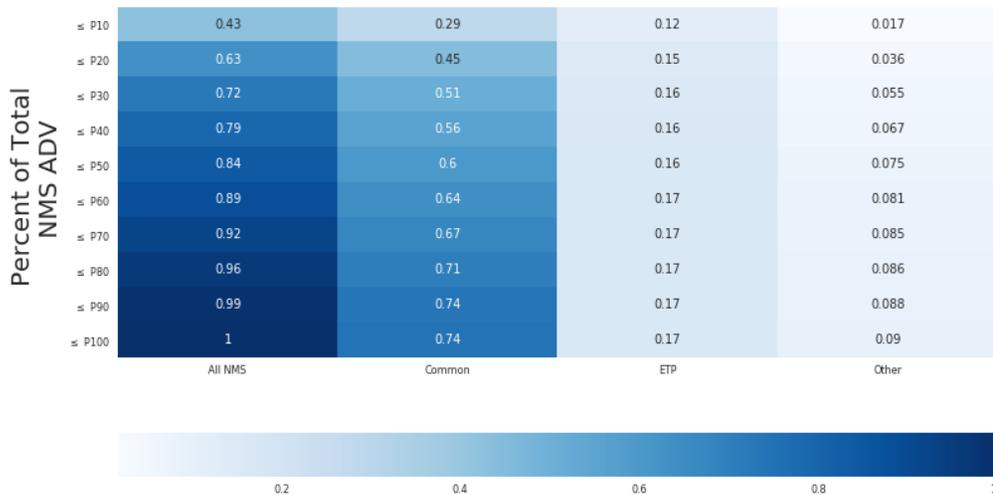
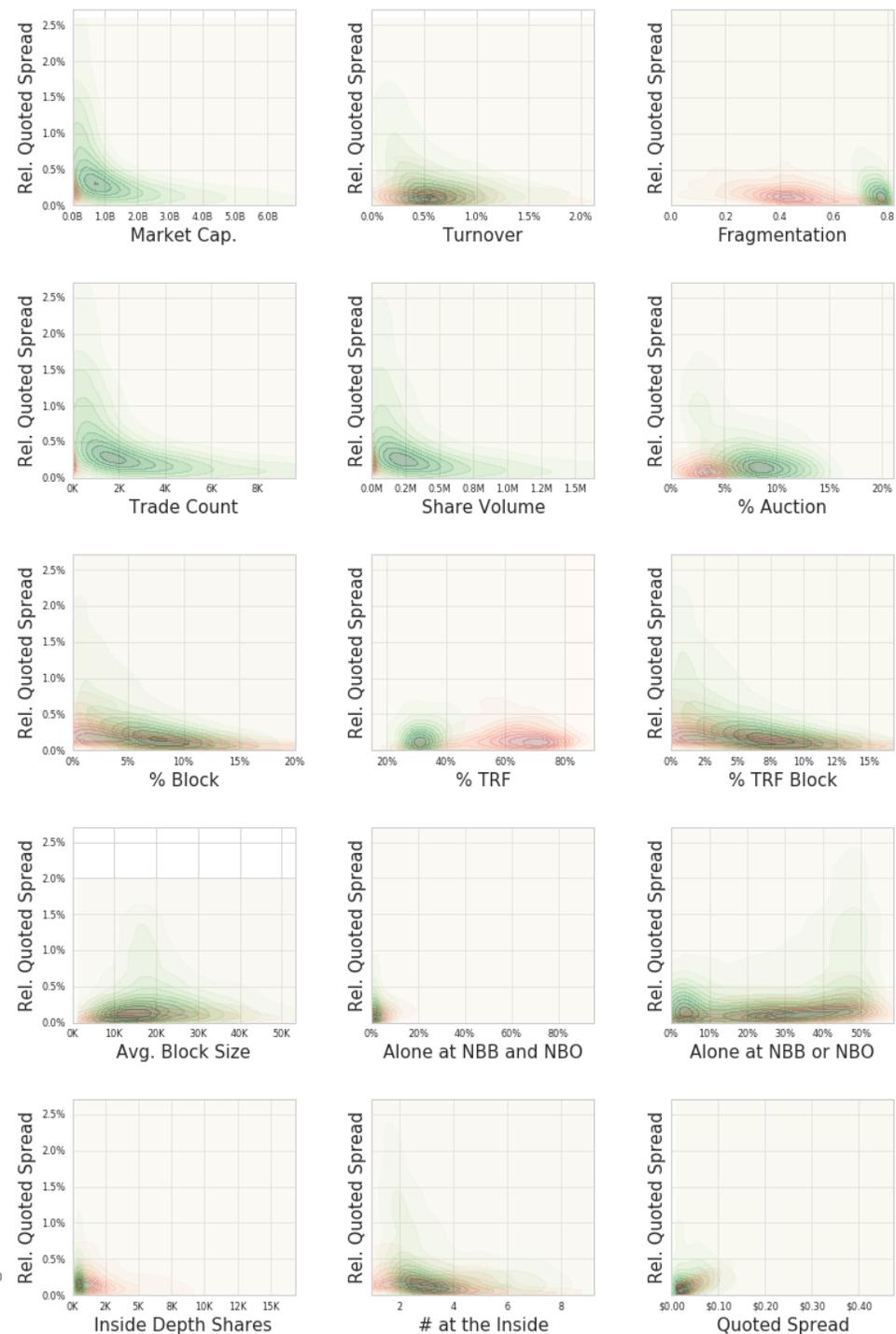
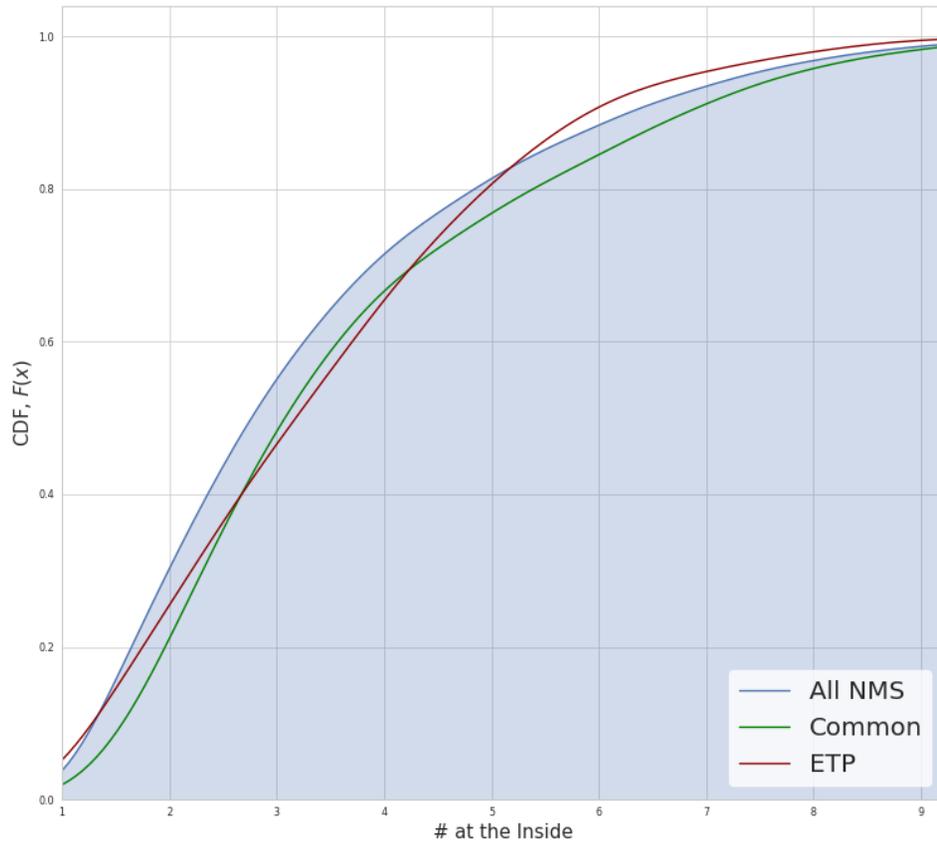


Figure 17: Time-Weighted Relative Quoted Spreads

Kernel Estimate of the CDF



Kernel Estimate of the joint PDF

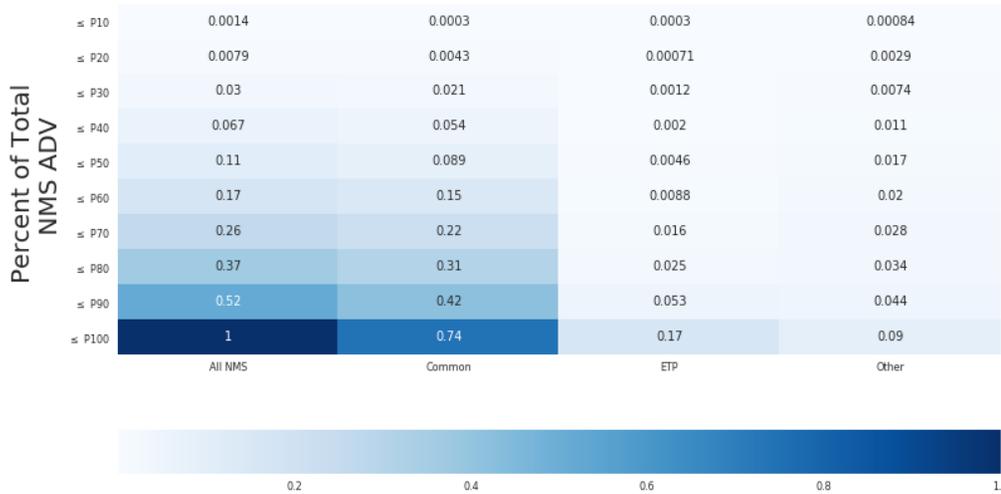
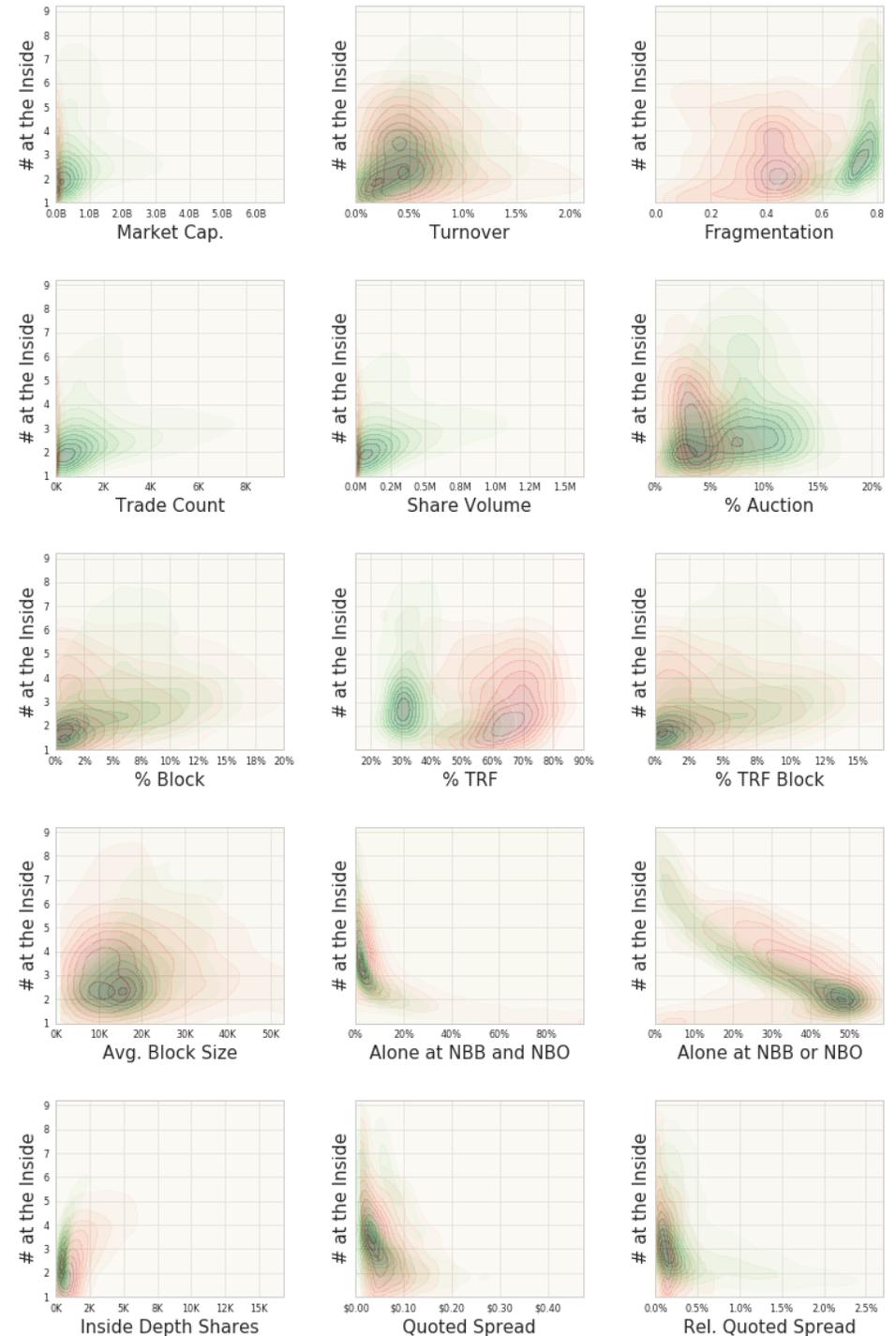
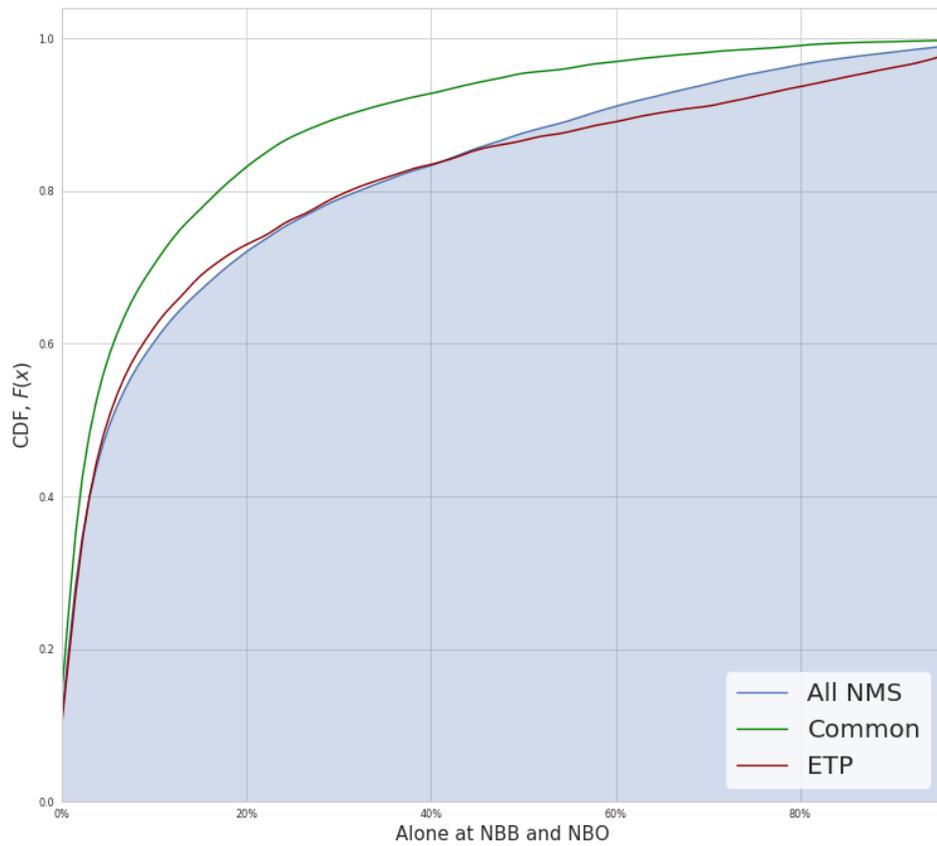


Figure 18: Time-Weighted Average Exchanges at Inside

Kernel Estimate of the CDF



Kernel Estimate of the joint PDF

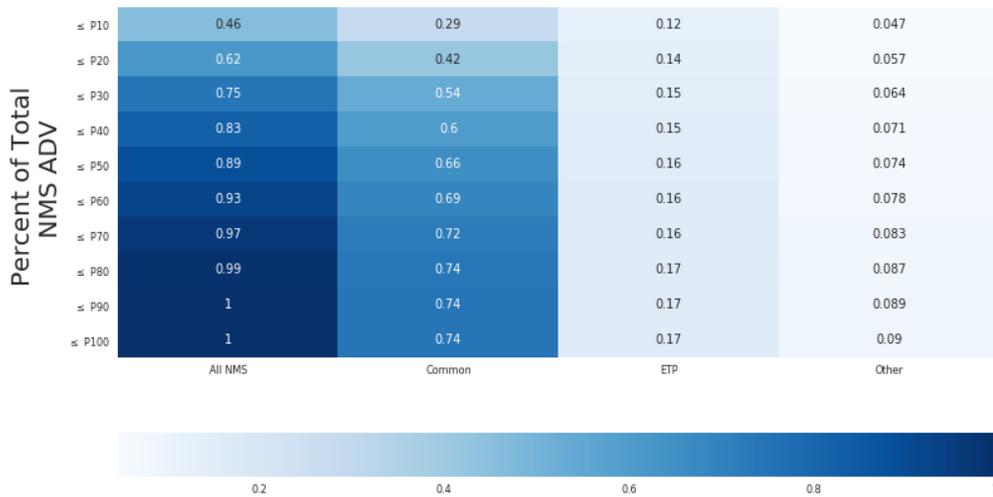
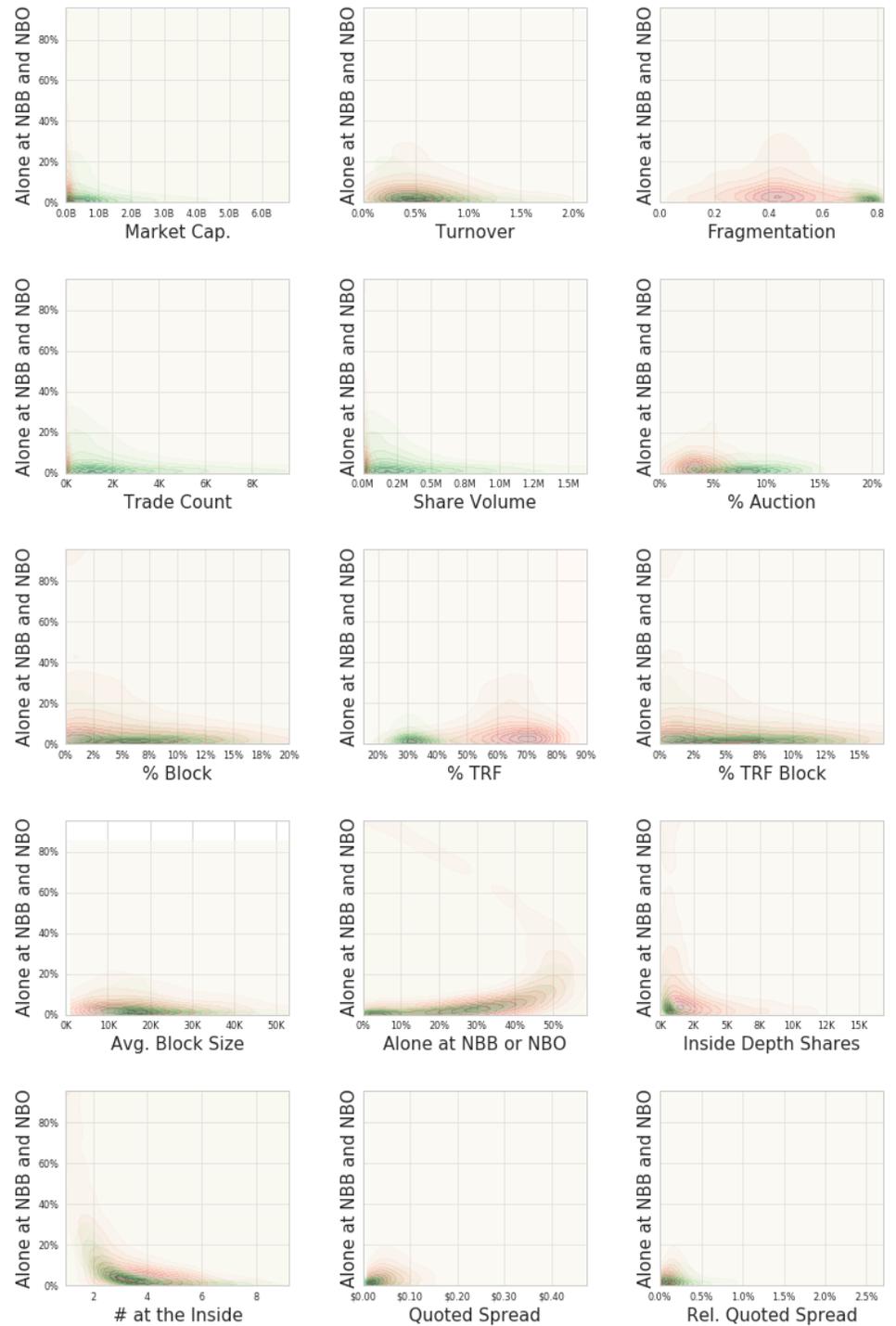
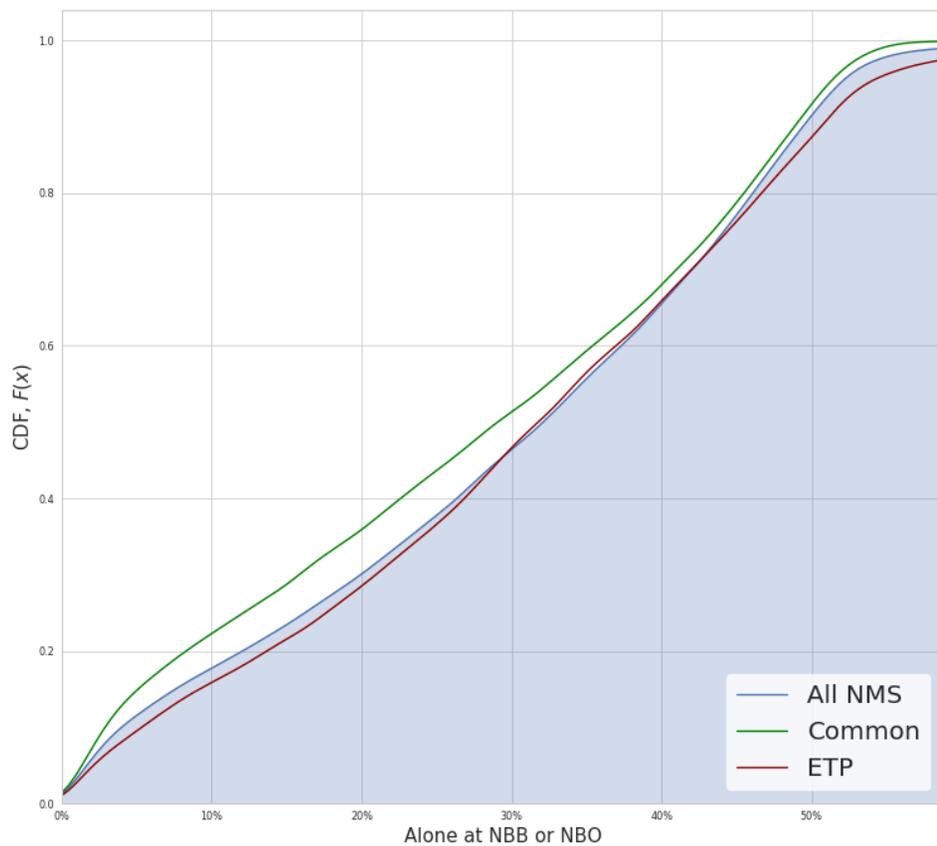


Figure 19: Mean Duration With One Exchange Alone at Both NBB and NBO

Kernel Estimate of the CDF



Kernel Estimate of the joint PDF

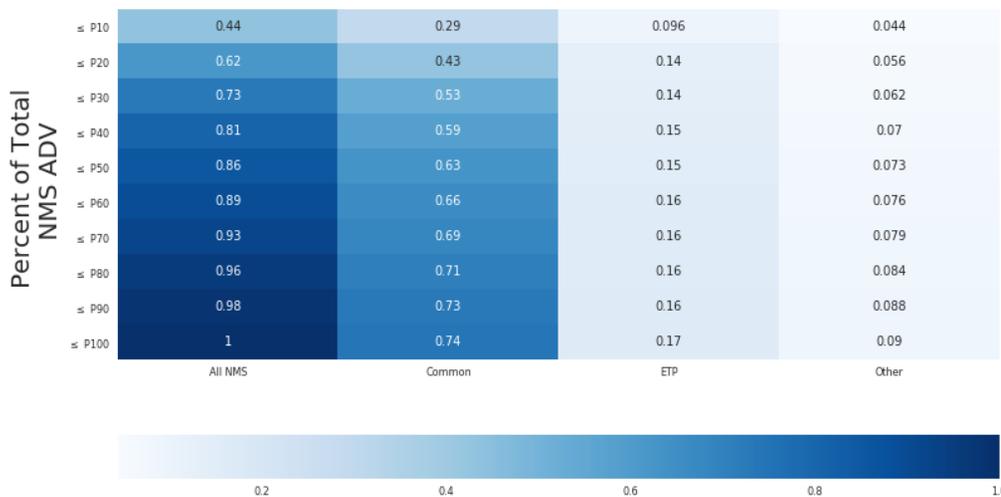
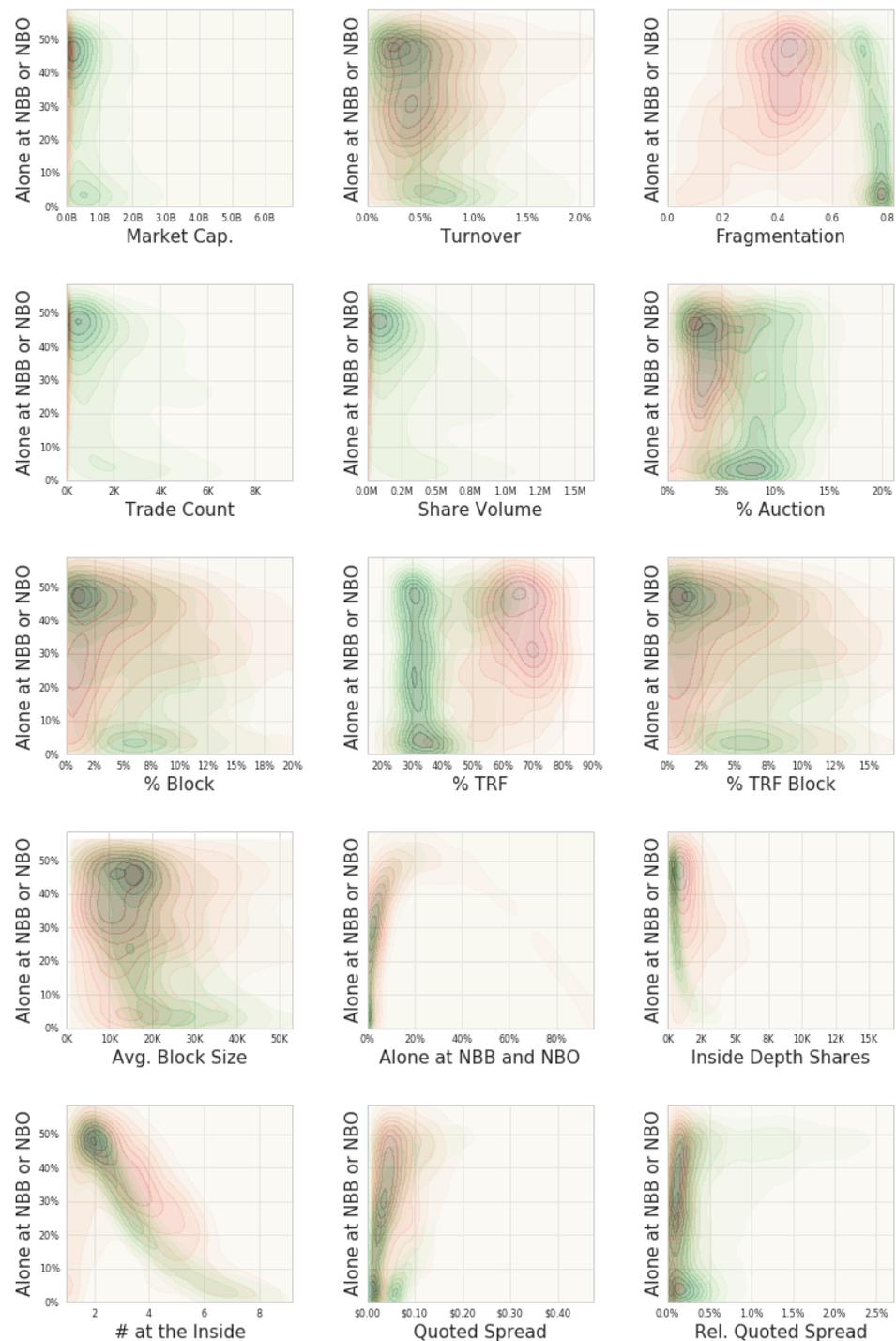
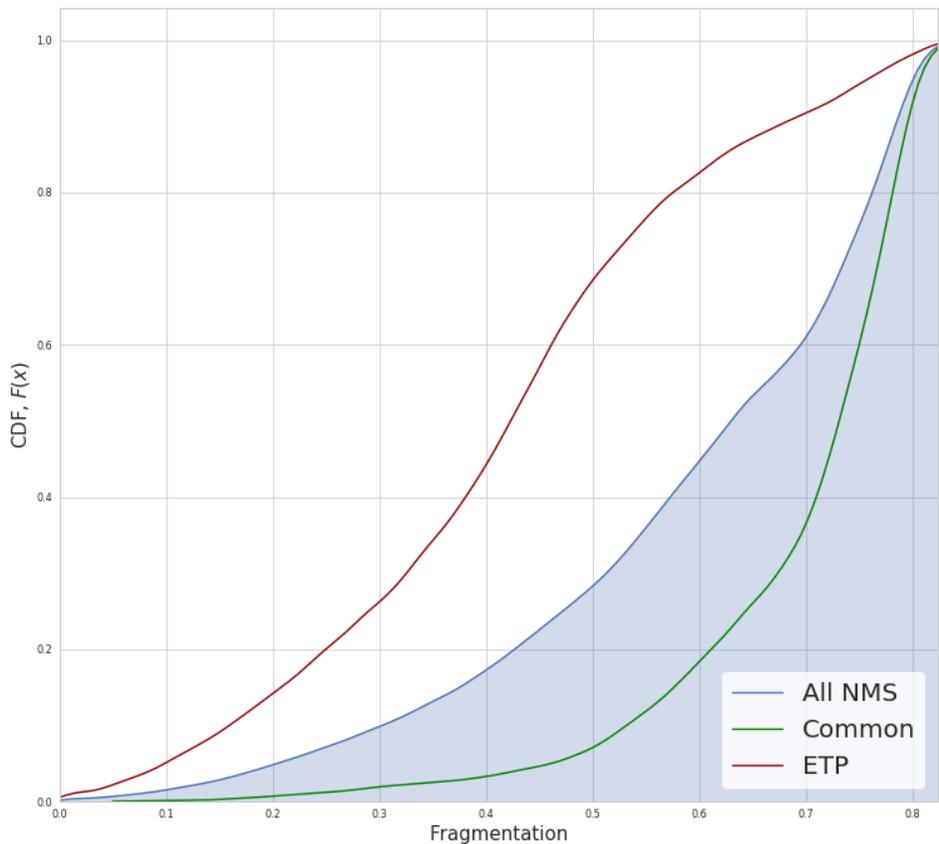


Figure 20: Mean Duration With One Exchange Alone at Either NBB or NBO

Kernel Estimate of the CDF



Kernel Estimate of the joint PDF

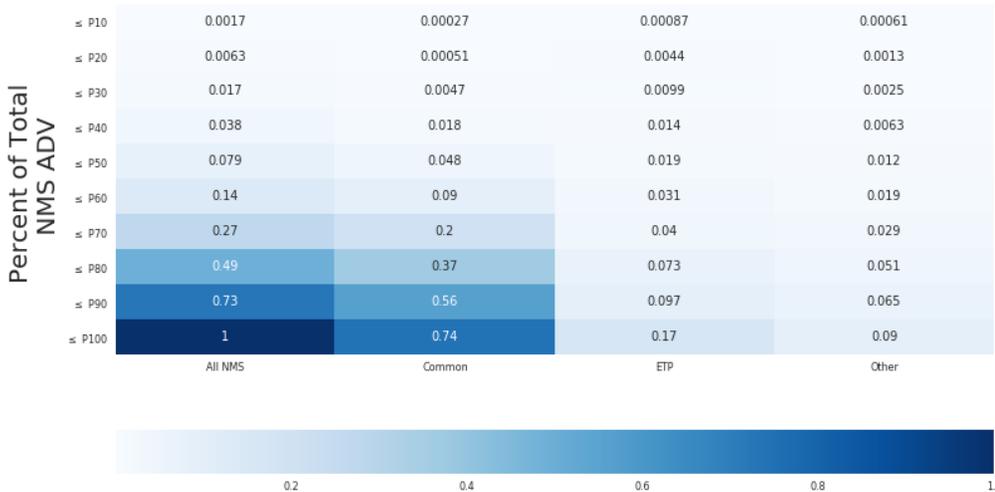
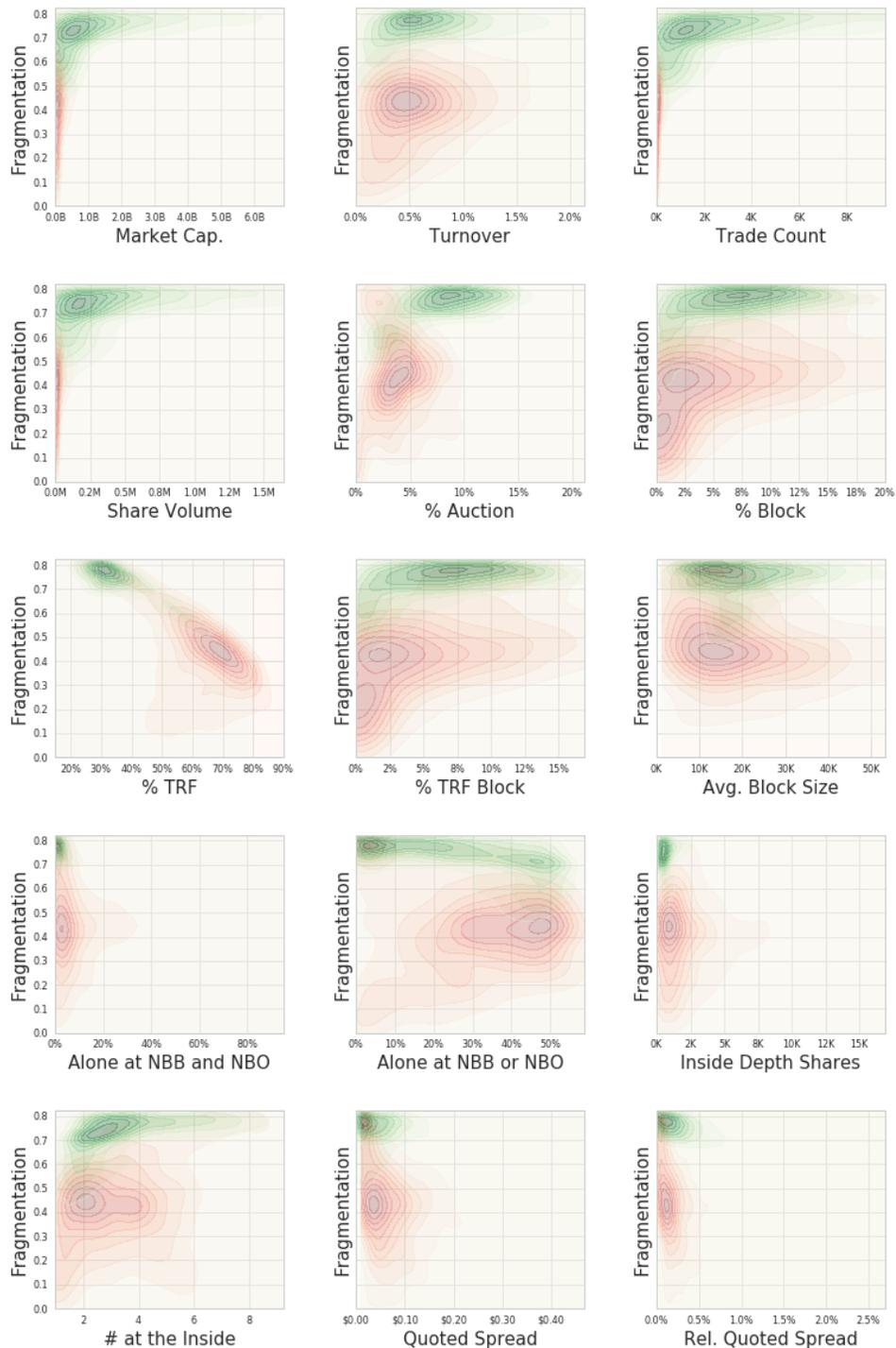


Figure 21: Fragmentation

Methodology

This summary is almost entirely based on NYSE Daily TAQ (Trade and Quote) data for the fourth quarter of 2017, for all NMS stocks that appear on any day in the Daily TAQ Master file during the period. ATS and non-ATS off-exchange volume were distinguished using Trade Reporting Facility (TRF) data that can be recreated through the publicly-available FINRA OTC Transparency data.⁴

The analysis excludes the short trading day on November 24, 2017 (the day after Thanksgiving). The analysis also excludes October 2, 2017 due to data quality issues. Consequently, the period examined contained 61 trading days and 8,759 unique symbols, producing 515,380 symbol-day observations (not all symbols existed on each day in the period).

Symbol Attributes

Certain attributes were assigned to each symbol across the entire period:

- **Price:** The last trade price during regular trading hours, on a ticker's first available date during the period. Trades were deemed eligible based on sale condition codes according to the Consolidated Tape Association (CTA) and Unlisted Trading Privileges (UTP) guidelines for updating the consolidated last sale.
- **Shares Outstanding:** Shares outstanding in the TAQ Master file on a ticker's first available date in the period.
- **Market Capitalization:** Price (determined as described above) multiplied by shares outstanding (determined as described above).
- **Security Type:** "Commons" include symbols with the code "A" in the Security Type field in the TAQ Daily Master file; "ETPs" include symbols with the codes "ETF", "ETN", and "ETV"; and "Other" includes all other symbols. Where the TAQ Master file contained different security types for the same symbol on different days, the most frequent type assigned during the period was used; if the different types were assigned on the same number of days, the last type in the TAQ Master file was used.
- **Russell 2000 membership:** Determined as of September 29, 2017, the last trading day before the period examined.

Trade Statistics

- **Block Size:** Following the definition in Rule 600(b)(9) of Regulation NMS for an order of block size, calculated as a trade of at least 10,000 shares or for a quantity of stock having a market value of at least \$200,000.

⁴See, e.g., <http://www.finra.org/industry/otc-transparency>

- **Turnover:** The average daily share volume divided by shares outstanding (determined as described above).
- **Fragmentation:** A daily Herfindahl-Hirschman Index (HHI) based on the share volume of each venue. All off-exchange trading reported through the TRFs is combined into a single venue. Formally, $HHI_{it} = \sum_{v=1}^N MS_{v,it}^2$, or the squared market share of venue v , summed over all N venues for symbol i on day t . To make the measure of fragmentation more intuitive, HHI is subtracted from one (so, $1 - HHI$), such that a single dominant market has zero fragmentation and a completely fragmented market goes to one. Given the 14 venues available during the period analyzed, in this context the measure would go to 0.92857 in a completely fragmented market.

Quote Statistics

All quote statistics are time series averages weighted by the number of microseconds the observation was in force. Symbol-level observations are derived from averages of the time-weighted symbol-date observations.

- **Quoted Depth:** The midpoint, in round lots, of the cumulative quoted depth at the national best bid and national best offer.
- **Quoted Spread at NBBO:** The difference, in dollars, between the national best bid and national best offer.
- **Relative Quoted Spread at NBBO:** Quoted spread relative to the NBBO midpoint, as a percentage.
- **Number of Exchanges at the Inside:** The midpoint of the number of exchanges at the national best bid and national best offer.
- **Alone at Both the NBB and NBO:** Duration of time, expressed as a percentage of regular trading hours, with a single exchange at both the national best bid and the national best offer.
- **Alone at Either the NBB or NBO:** Duration of time, expressed as a percentage of regular trading hours, with a single exchange at either the national best bid or the national best offer, but not at both simultaneously.

Contacts

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