Report

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Data Prep

Sudden Changes

In *suddenchanges.R* script, I prepared the data of sudden changes. I followed the following steps:

1. Used union of timestamps from 3 data set and joined these 3 datasets.
2. Filled missing price values with linear interpolation over time
3. Calculated changes in bid and ask prices for futures and spot market with log difference and multiplied with 10000 to convert them to bps. If passed time since the last observation is greater than 10ms, the price differences are entered 0.
4. To make calculation faster, filtered only price changes greater than 1bps in absolute value
5. Calculated price changes in last 3ms by summing price changes in last 3ms with rolling windows.
6. Also calculated the total quantity in the last 10ms and saved them as quantity_rolled
7. If bid price change in last 3ms is less than -7 it is noted sudden_bid_change_(s or f dependent on market)
8. If ask price change in last 3ms is greater than 7 it is noted sudden_ask_change_(s or f dependent on market)
9. The points with a sudden changes have been saved at *suddenchanges.csv*

Returns after Sudden Changes

In *returns.R* script, I prepared the data of returns after sudden changes. I followed the following steps:

1. Followed step 1 and 2 from previous part. This time used mid-price for price changes in step 3.
2. To make computation faster, filtered the time stamps that have an observation in *suddenchanges.csv* at least 10ms prior.
3. Then calculated and saved maximum of cumulative sums of price changes in 10ms future window as well as minimum of cumulative sums. I had maximum and minimum returns after every sudden changes in all markets.
4. These future returns have been saved at *returns.csv*

Tables, Graphs and Regressions

Average Tables

In the table below, average maximum and minimum returns in 10ms for each market after sudden decreases in bid prices shown

Spot_Bid	Futures_Bid	avg_spot_max	avg_spot_min	avg_futures_max	avg_futures_min	cases
FALSE	TRUE	1.041675	-3.977730	2.275777	-4.104997	2797
TRUE	FALSE	1.990498	-3.943799	1.482867	-3.916206	1428
TRUE	TRUE	1.132588	-11.485655	2.147267	-12.658869	318

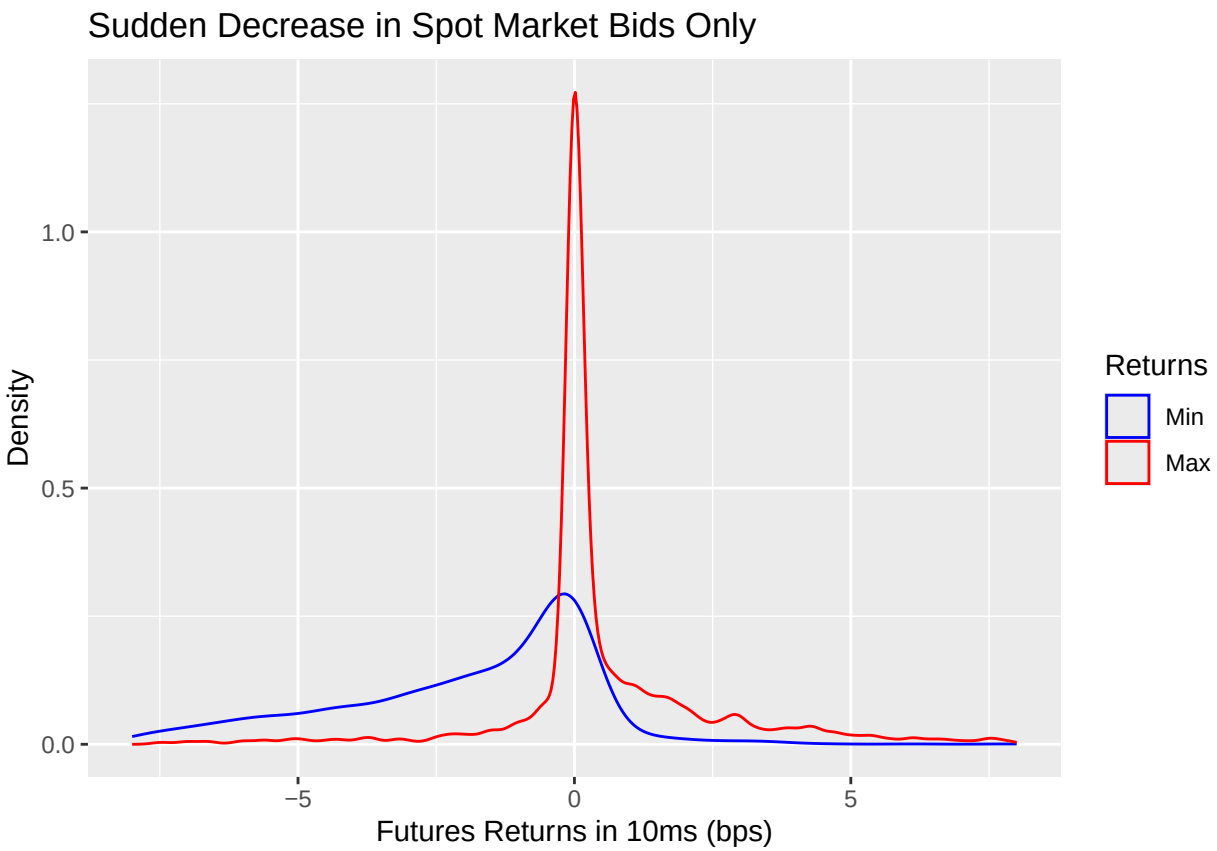
In the table below, average maximum and minimum returns in 10ms for each market after sudden increases in ask prices shown

Spot_Ask	Futures_Ask	avg_spot_max	avg_spot_min	avg_futures_max	avg_futures_min	cases
FALSE	TRUE	4.247643	-1.1825333	4.090902	-2.191496	2870
TRUE	FALSE	4.252997	-1.3976924	4.317045	-1.644127	1309
TRUE	TRUE	12.434045	-0.3330754	12.868851	-2.536530	335

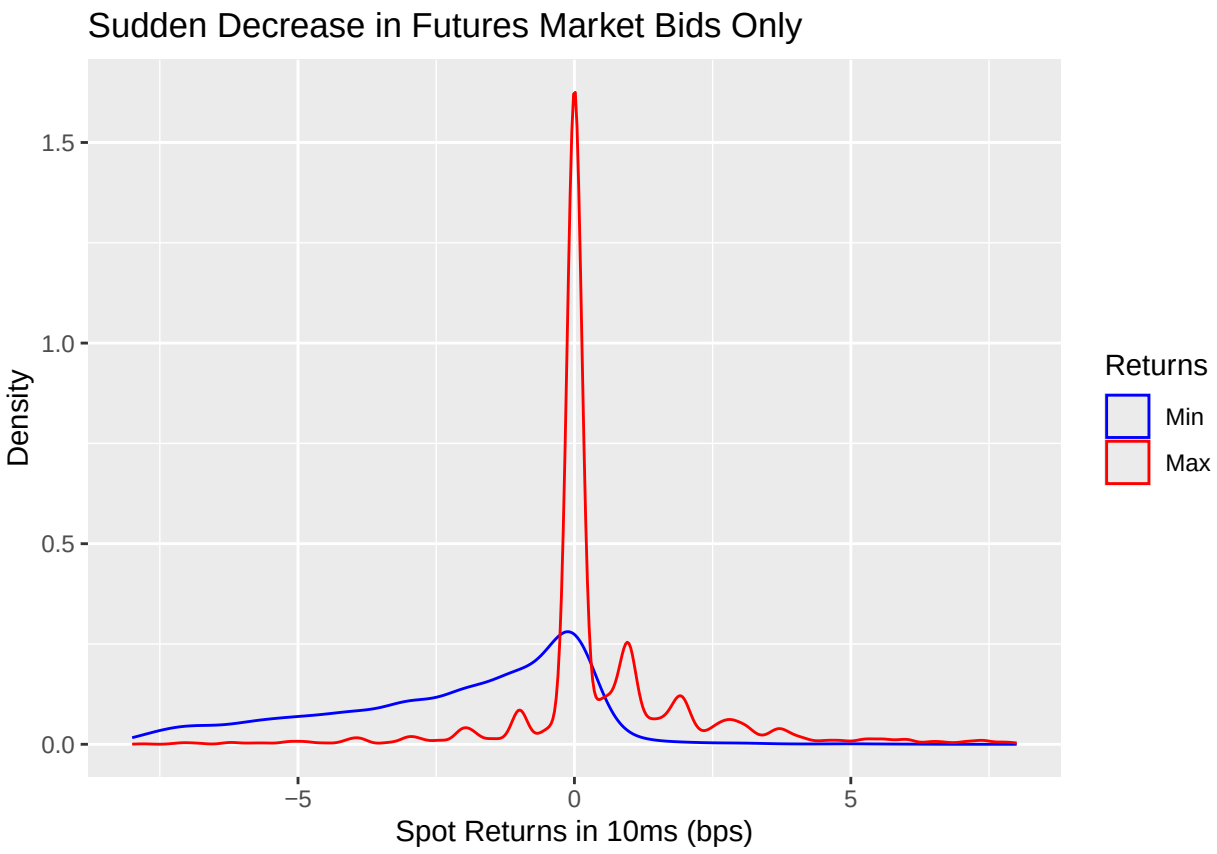
For the rest of the analysis, I will focus on the sudden changes when they happen in one market only.

Density Graphs

Sudden Bid Price Decreases

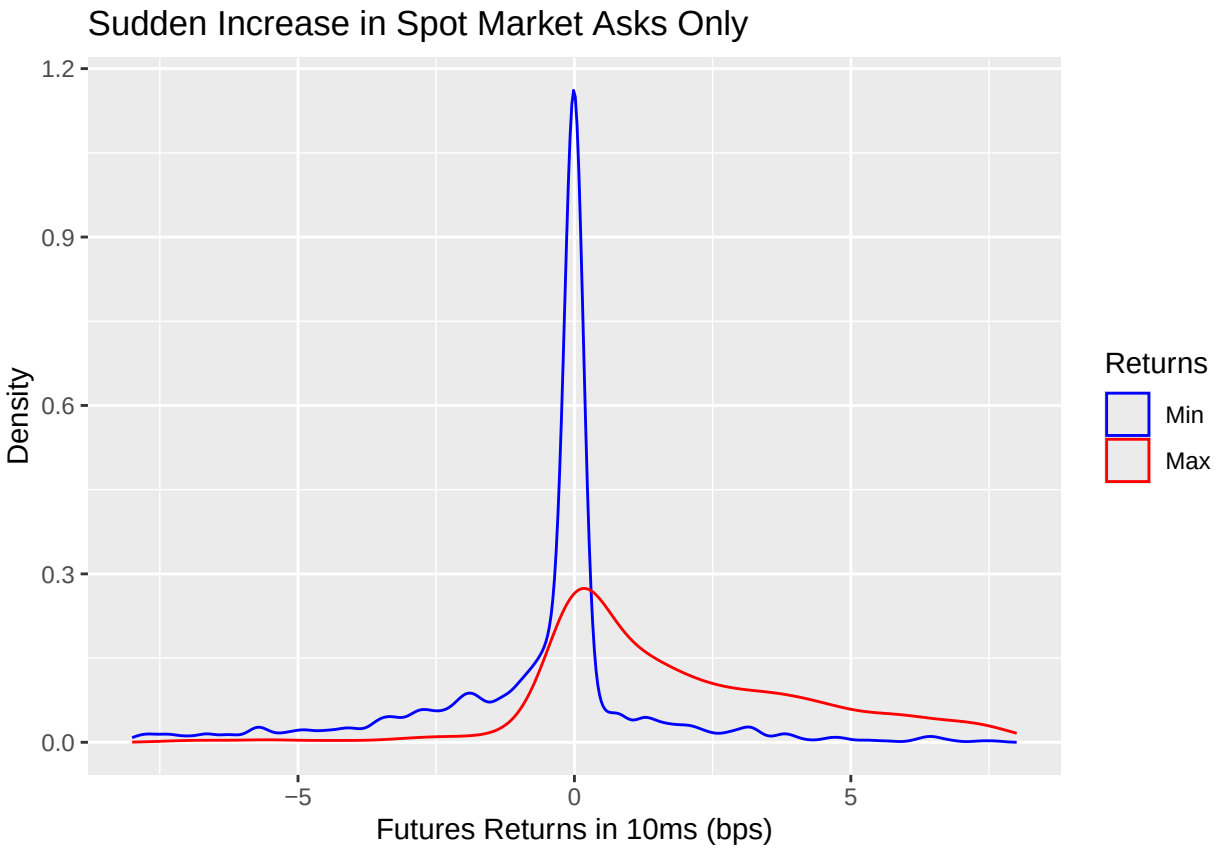


In the graph above, density of maximum and minimum returns in futures market after a bid decrease in spot market only.

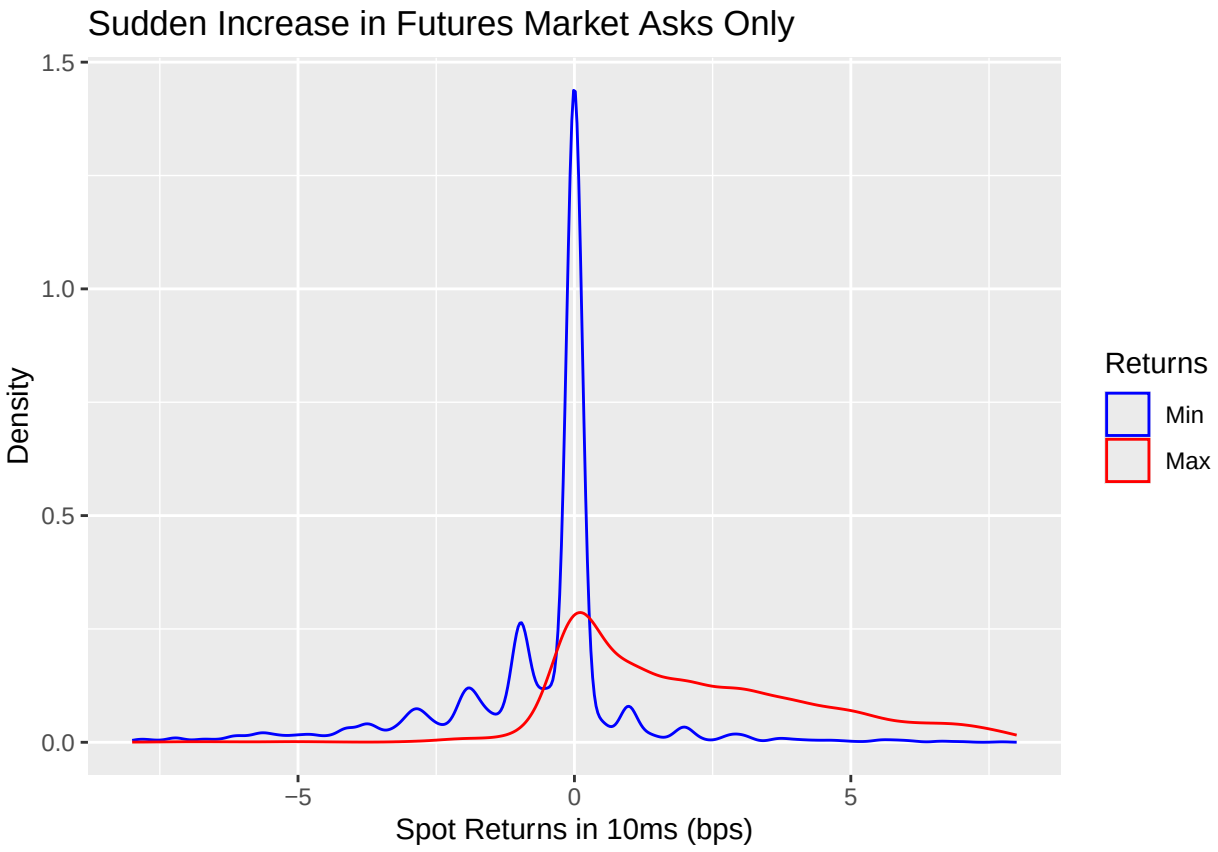


In the graph above, density of maximum and minimum returns in spot market after a bid decrease in futures market only.

Sudden Ask Price Increases

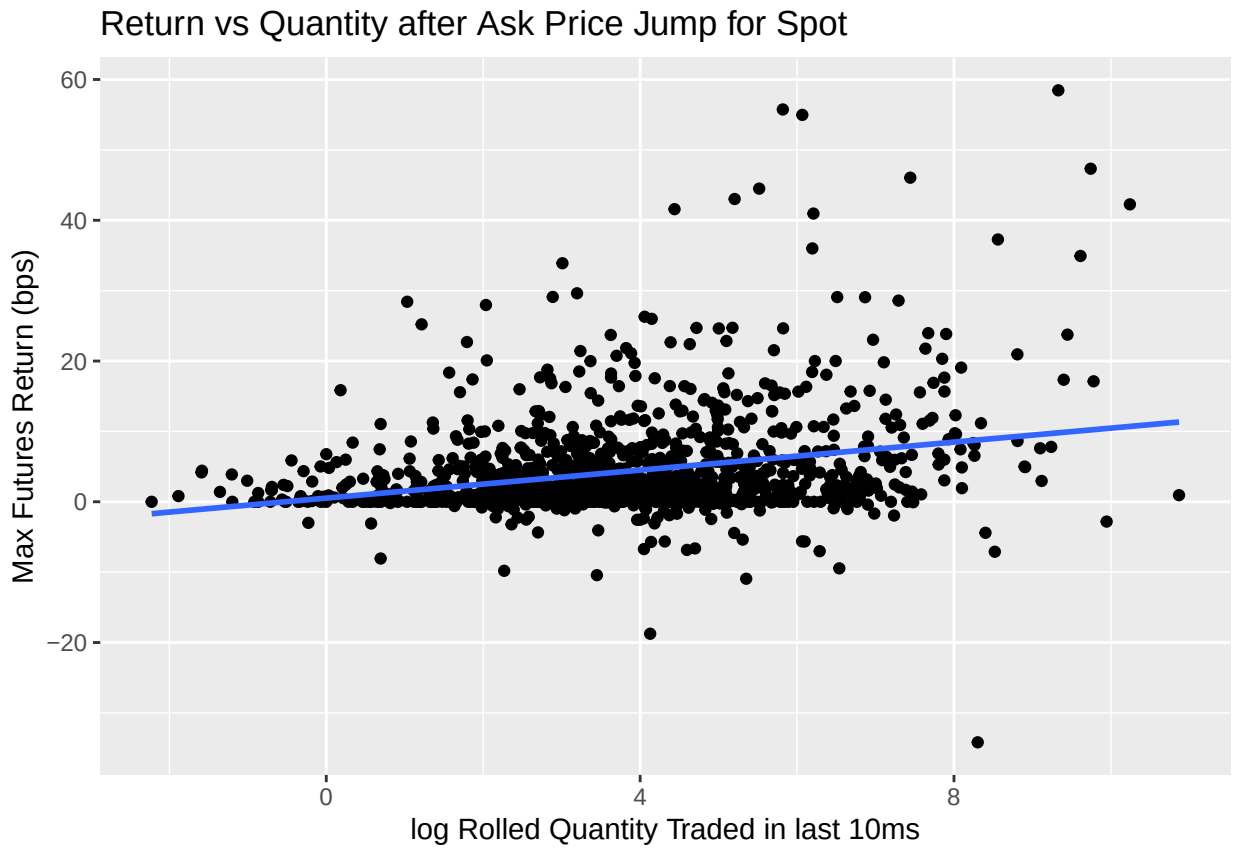


In the graph above, density of maximum and minimum returns in futures market after a ask increase in spot market only.



In the graph above, density of maximum and minimum returns in spot market after an ask increase in futures market only.

Quantity Effect The graph below shows the effect of quantity.



The graph above shows that quantity traded in the last moments plays a significant role to predict the effect. We could see similar graphs with variations but I will use this one only to show visually. The table below shows the difference between averages for higher and lower half of quantity traded before the sudden increase in spot ask.

QuantityTraded	avg_max_futures_return	avg_min_futures_return
Lower Half	2.908630	-0.9730224
Upper Half	5.727613	-2.3162574

Linear Regressions

% latex table generated in R 4.4.2 by xtable 1.8-4 package % Sat Jun 28 17:06:04 2025

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	0.3487	0.5028	0.69	0.4881
log(quantity_rolled)	1.0726	0.1178	9.10	0.0000