

# TRANSACTION COST ANALYSIS WITH BID-ASK SPREAD EXECUTION STRATEGIES

Krutarth Haveliwala

# AGENDA

Introduction

Implementation

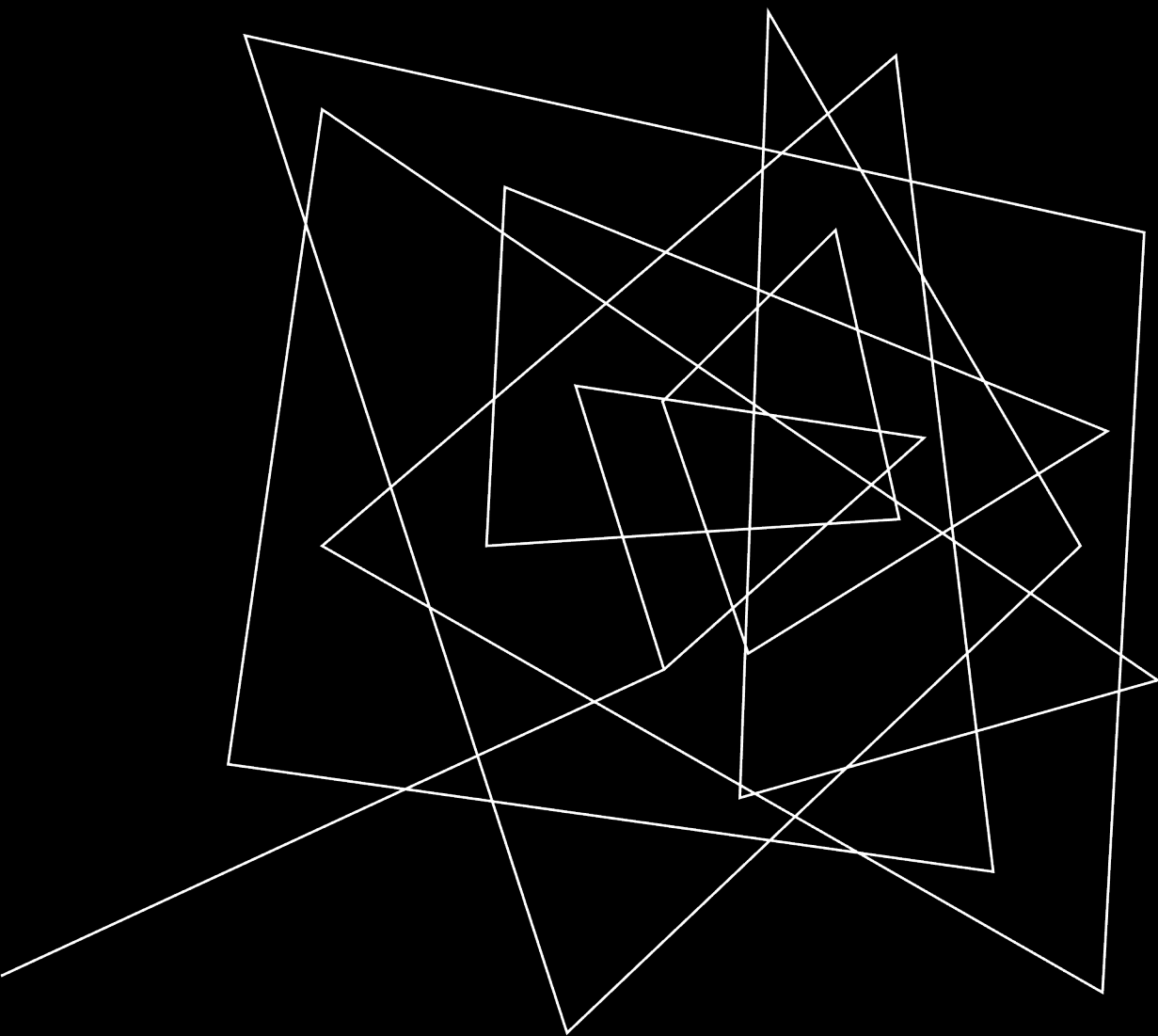
Summary Visualizations

# INTRODUCTION

The objective of this task is to determine the optimal timing for executing an order by considering two options: paying half the Bid/Offer spread to immediate execution at market price or waiting and resting the order with the Bid/Offer spread for a period of time in order to potentially achieve a better execution with the following two strategies.

1. Strategic Market Price
2. Strategic Market Mid Price

For the dataset, price for GBP/USD is being used, which consists of a large collection of tick data for both Bid and Offer prices. Additionally, a set of orders has been provided for the same time period. Due to the minimum decimal increment of 0.1 basis points in the price data, Stop Loss levels can be set accordingly. The tick interval for the data is 1 second, allowing for a Time Limit to be established in seconds.



# IMPLEMENTATION

Python Programming Language

## FIRST METHOD: IMMEDIATE EXECUTION AT MARKET PRICE

TO EXECUTE EACH ORDER, WE WILL ACT AS A MARKET TAKER AND IMMEDIATELY EXECUTE TRADES AT THE CURRENT BID/OFFER PRICE, WHICH INCURS A COST EQUAL TO HALF OF THE BID/OFFER SPREAD. THEREFORE, EVERY TIME WE TRADE, WE WILL LOSE AN AMOUNT EQUIVALENT TO HALF OF THE SPREAD.

	TimeStamp	Bid	Ask	Bid_Ask_Spread	Side	Mid	PnL
0	2018-01-07 22:04:12	1.35558	1.35615	0.00057	B	1.355865	-0.000285
1	2018-01-07 22:04:13	1.35558	1.35615	0.00057	S	1.355865	-0.000285
2	2018-01-07 22:04:14	1.35558	1.35615	0.00057	B	1.355865	-0.000285
3	2018-01-07 22:04:15	1.35558	1.35615	0.00057	S	1.355865	-0.000285
4	2018-01-07 22:04:16	1.35558	1.35615	0.00057	B	1.355865	-0.000285

## SECOND METHOD: MARKET MAKING WITH STRATEGIC IMPLEMENTATION

FOR EACH ORDER, WE WILL PLACE IT WITHIN THE BID/OFFER SPREAD AND WAIT FOR AN OPPORTUNITY FOR EXECUTION. DURING THIS TIME, THE ORDER MAY BE EXECUTED AT A MORE FAVORABLE PRICE, BUT IF NOT, WE WILL STILL INCUR THE COST OF HALF OF THE SPREAD WHEN THE ORDER IS EVENTUALLY EXECUTED.

WE CAN SET A MAXIMUM STOP LOSS (SL) VALUE TO LIMIT POTENTIAL LOSSES IF THE MARKET MOVES AGAINST US. IF THE SL IS TRIGGERED, WE WILL THEN AGGRESSIVELY EXECUTE THE ORDER. WE CAN CHOOSE A VALUE FOR THE SL, SUCH AS -3 BASIS POINTS (-0.03%).

SIMILARLY, WE CAN SET A MAXIMUM TIME LEFT TO EXECUTION (TTE) VALUE TO LIMIT THE AMOUNT OF TIME WE ARE WILLING TO WAIT FOR AN OPPORTUNISTIC EXECUTION. IF THE TTE IS REACHED, WE WILL ALSO AGGRESSIVELY EXECUTE THE ORDER. WE CAN CHOOSE A VALUE FOR THE TTE, SUCH AS 15 SECONDS.

```
SL = -0.0003
TTE = timedelta(seconds=15).total_seconds()
TTE
```

15.0

---

## 1. STRATEGIC MARKET PRICE

WE ARE WILLING TO TRANSACT AT A PRICE THAT IS FAVORABLE TO THE MARKET MAKER OR LIQUIDITY PROVIDER, RATHER THAN WAITING FOR A BETTER PRICE. THIS CAN RESULT IN A QUICKER EXECUTION, BUT IT ALSO MEANS THAT WE ARE PAYING THE SPREAD, WHICH IS THE DIFFERENCE BETWEEN THE BID AND OFFER PRICE.

	TimeStamp	Bid	Ask	Bid_Ask_Spread	Side	Mid	PnL	SMM_Picking_Pnl	SMM_Picking_TE	SMM_Picking_Execution
0	2018-01-07 22:04:12	1.35558	1.35615	0.00057	B	1.355865	-0.000285	-0.000285	15	TTE
1	2018-01-07 22:04:13	1.35558	1.35615	0.00057	S	1.355865	-0.000285	-0.000285	15	TTE
2	2018-01-07 22:04:14	1.35558	1.35615	0.00057	B	1.355865	-0.000285	-0.000285	15	TTE
3	2018-01-07 22:04:15	1.35558	1.35615	0.00057	S	1.355865	-0.000285	-0.000285	15	TTE
4	2018-01-07 22:04:16	1.35558	1.35615	0.00057	B	1.355865	-0.000285	-0.000285	15	TTE
5	2018-01-07 22:04:17	1.35558	1.35615	0.00057	B	1.355865	-0.000285	-0.000285	15	TTE
6	2018-01-07 22:04:18	1.35558	1.35615	0.00057	B	1.355865	-0.000285	-0.000285	15	TTE
7	2018-01-07 22:04:19	1.35558	1.35615	0.00057	S	1.355865	-0.000285	-0.000285	15	TTE
8	2018-01-07 22:04:20	1.35558	1.35615	0.00057	S	1.355865	-0.000285	-0.000285	15	TTE
9	2018-01-07 22:04:21	1.35558	1.35615	0.00057	S	1.355865	-0.000285	-0.000285	15	TTE
10	2018-01-07 22:04:22	1.35558	1.35615	0.00057	S	1.355865	-0.000285	-0.000285	15	TTE
11	2018-01-07 22:04:23	1.35558	1.35615	0.00057	B	1.355865	-0.000285	-0.000285	15	TTE
12	2018-01-07 22:04:24	1.35558	1.35615	0.00057	S	1.355865	-0.000285	-0.000245	15	TTE
13	2018-01-07 22:04:25	1.35558	1.35615	0.00057	S	1.355865	-0.000285	-0.000245	15	TTE
14	2018-01-07 22:04:26	1.35558	1.35615	0.00057	B	1.355865	-0.000285	-0.000335	15	TTE
15	2018-01-07 22:04:27	1.35558	1.35615	0.00057	B	1.355865	-0.000285	-0.000335	15	TTE
16	2018-01-08 07:51:02	1.35441	1.35446	0.00005	B	1.354435	-0.000025	-0.000025	15	TTE
17	2018-01-08 07:51:03	1.35454	1.35457	0.00003	S	1.354555	-0.000015	-0.000135	15	TTE
18	2018-01-08 07:51:04	1.35453	1.35457	0.00004	B	1.354550	-0.000020	0.000020	9	Success
19	2018-01-08 07:51:05	1.35454	1.35459	0.00005	S	1.354565	-0.000025	-0.000145	15	TTE
20	2018-01-08 07:51:06	1.35454	1.35458	0.00004	B	1.354560	-0.000020	0.000020	7	Success

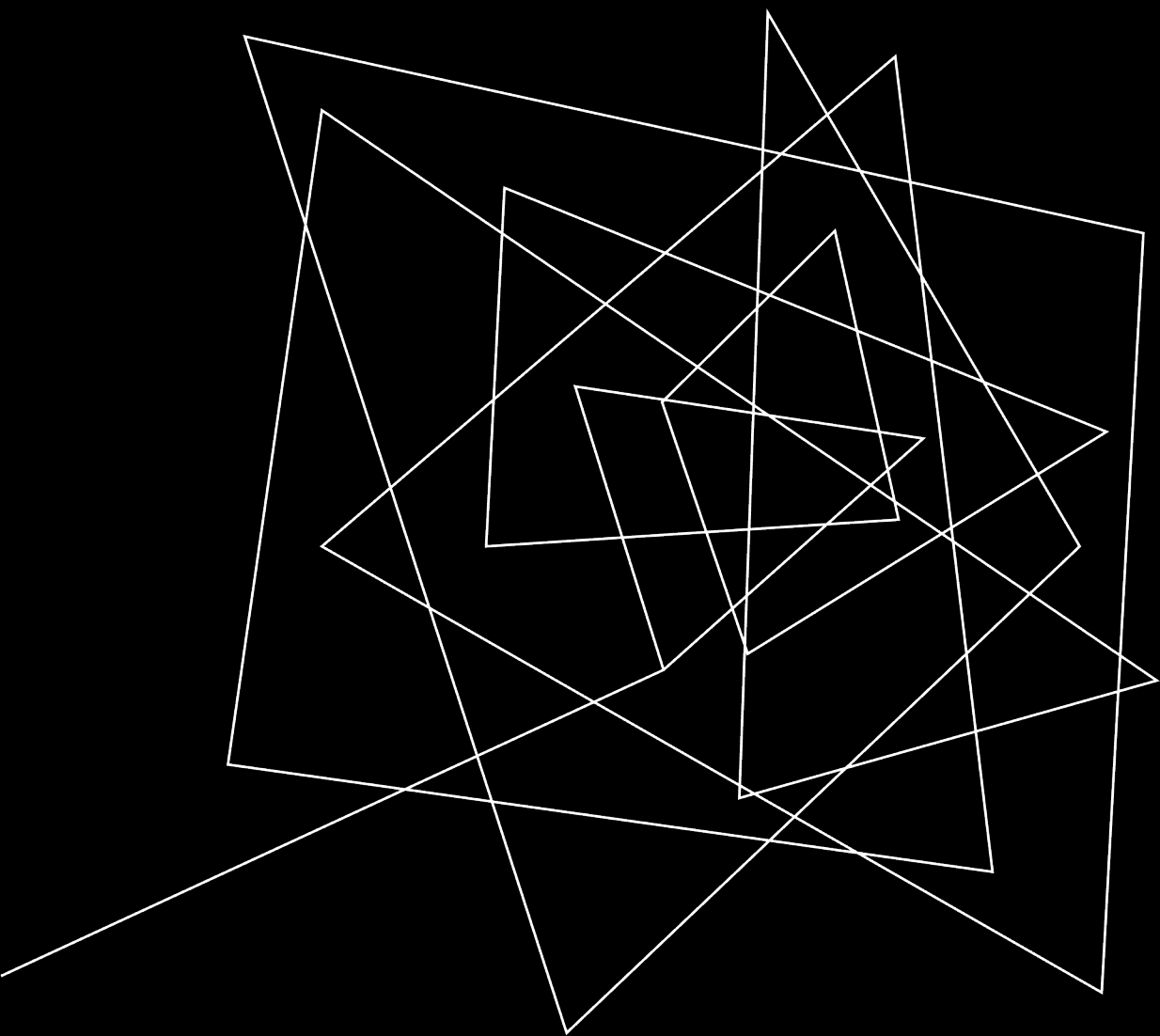
## 2. STRATEGIC MARKET PRICE MID

PLACING AN ORDER AT THE MID PRICE MEANS THAT YOU ARE PLACING AN ORDER TO BUY OR SELL A SECURITY AT A PRICE THAT IS IN BETWEEN THE CURRENT BID AND ASK PRICES. BY PLACING AN ORDER AT THE MID PRICE, YOU ARE ESSENTIALLY WAITING FOR THE MARKET TO MOVE TOWARDS YOUR DESIRED PRICE LEVEL BEFORE EXECUTING THE TRADE.

IF THE MARKET MOVES TOWARDS YOUR ORDER, IT IS LIKELY THAT YOU WILL BUY OR SELL THE SECURITY AT THE MID PRICE. THIS STRATEGY IS OFTEN USED BY TRADERS WHO WANT TO MINIMIZE THEIR TRANSACTION COSTS AND ARE WILLING TO WAIT FOR THE MARKET TO MOVE IN THEIR FAVOR.

Side	Mid	PnL	SMM_Picking_PnL	SMM_Picking_TE	SMM_Picking_Execution	SMM_Mid_PnL	SMM_Mid_TE	SMM_Mid_Execution
B	1.355865	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE
S	1.355865	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE
B	1.355865	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE
S	1.355865	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE
B	1.355865	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE
B	1.355865	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE
B	1.355865	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE
S	1.355865	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE
S	1.355865	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE
S	1.355865	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE
S	1.355865	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE
B	1.355865	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE
S	1.355865	-0.000285	-0.000245	15	TTE	-0.000245	15	TTE
S	1.355865	-0.000285	-0.000245	15	TTE	-0.000245	15	TTE
B	1.355865	-0.000285	-0.000335	15	TTE	-0.000335	15	TTE





VISUALIZATIONS

# PROFIT AND LOSS ANALYSIS

Minimum Profit and Loss : Immediate Execution > Strategic Market Price = Strategic Market Price Mid

Maximum Profit and Loss : Strategic Market Price > Strategic Market Price Mid = Immediate Execution

Standard deviation of Profit and Loss : Strategic Market Price > Strategic Market Price Mid > Immediate Execution

Mean of Profit and Loss : Immediate Execution > Strategic Market Price > Strategic Market Price Mid

Median Profit and Loss : Strategic Market Price Mid > Immediate Execution = Strategic Market Price

## Keynotes from above results

- Immediate execution strategy has the highest mean for profit and loss, so that concludes that Market Making with Strategic Implementation is not always a good idea for saving our money.
- Immediate execution strategy has the highest minimum profit and loss because there is no stopping time as it executes at the market price and it does not trigger the stop loss and there is no time left to execution.
- Strategic Market Price has the highest maximum profit and loss. This is the only strategy that is giving us positive profit and loss at execution.
- Strategic Market Price also has the highest standard deviation, that means that the risk increases the more we try to save our costs while executing the orders.

	Immediate Execution	SMM_Picking	SMM_Mid
<b>PnL_min</b>	-2.850	-4.300	-4.300
<b>PnL_max</b>	-0.000	0.500	0.000
<b>PnL_std</b>	1.023	1.520	1.437
<b>PnL_mean</b>	-0.667	-1.196	-1.243
<b>PnL_median</b>	-0.200	-0.925	-0.125

## ANALYSIS OF TIME TO EXECUTION (TTE) / DURATION

WE DON'T HAVE TO CALCULATE THE DURATION OR TIME LEFT FOR EXECUTION FOR THE IMMEDIATELY EXECUTION STRATEGY BECAUSE IT EXECUTES AT MARKET PRICE.

HERE WE CAN SEE THAT THE TIME OF EXECUTION IS HIGHER FOR SMM STRATEGY THAN SMM MID STRATEGY.

THIS IS ACHIEVED BECAUSE THE SMM STRATEGY IS IMPLEMENTED IN OUR FAVOR, THUS IT REQUIRES MORE TIME TO EXECUTE AND WE HAVE TO WAIT FOR THAT PRICE TO REACH TO OUR ORDER PRICE.

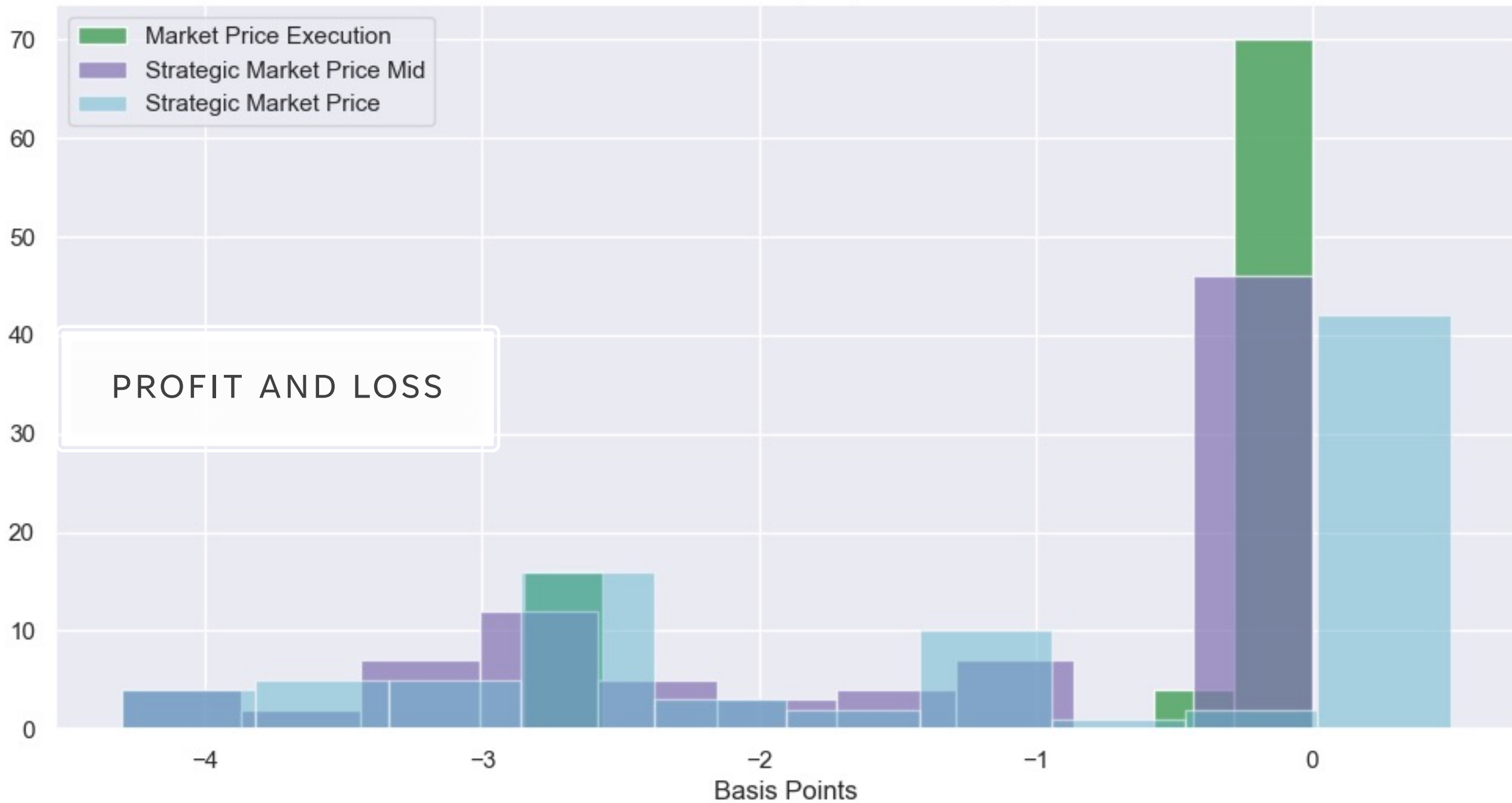
	SMM_Picking	SMM_Mid
Mean of the Duration	8.966667	8.322222
Median of the Duration	9.000000	7.000000

## ANALYSIS OF STOP LOSSES AND TIME LIMITS

- By analyzing the above data-frame we can say that both, the SMM strategies are likely to get triggered by time limit.
- The bid ask spread updates every seconds, so it is less likely to hit stop losses.
- SMM\_Picking strategy has more stop losses than SMM\_Mid because of the conditions that we added.

	SMM_Picking	SMM_Mid
<b>Mean of the Duration</b>	8.966667	8.322222
<b>Median of the Duration</b>	9.000000	7.000000

Profit and Loss Analysis (Basis Points)



TIME LEFT FOR EXECUTION = 15, SL RANGE = -6 BASIS POINTS TO 0.

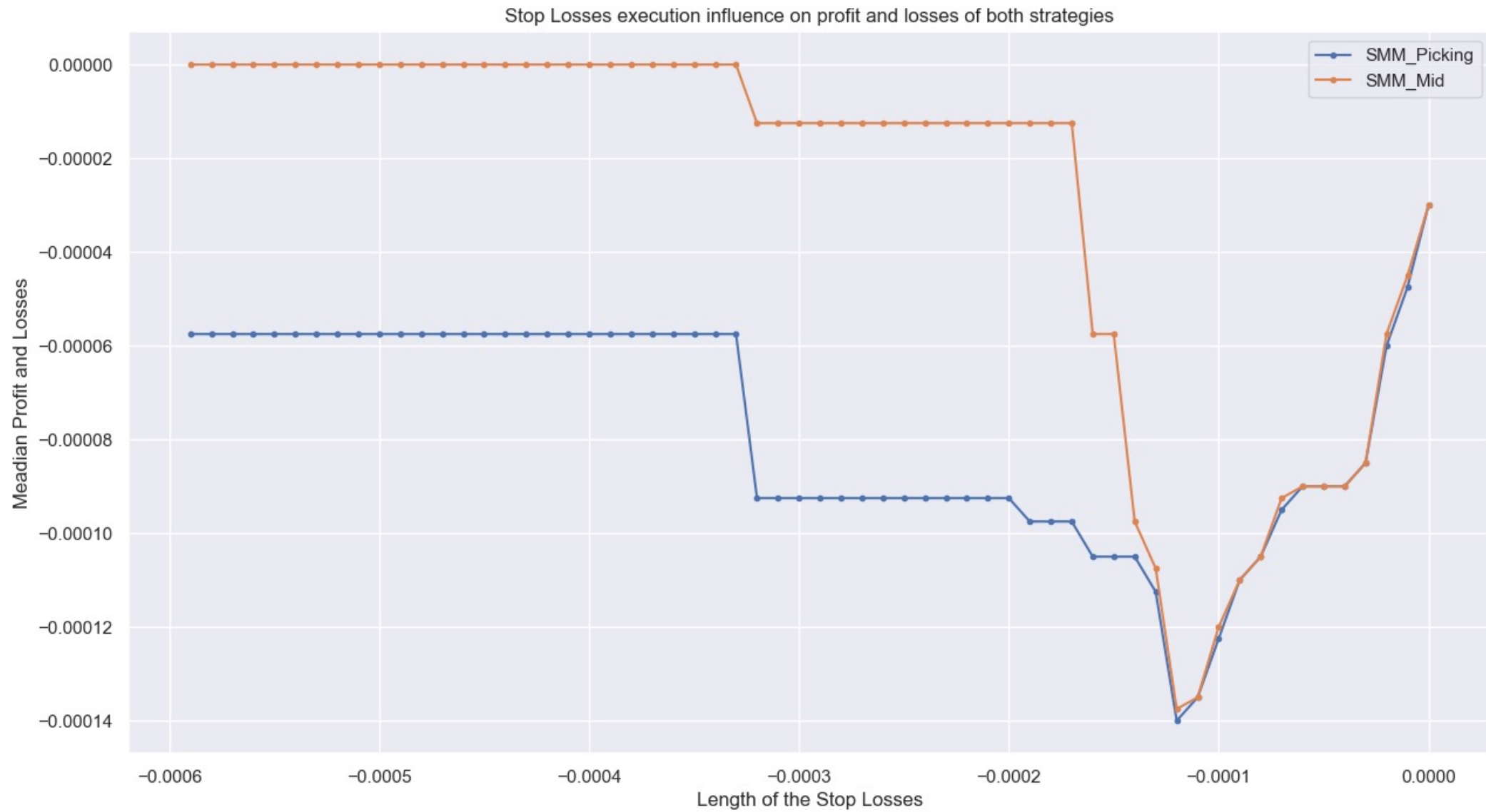
AS THE STOP LOSSES GETS CLOSER TO 0, THE SMM\_PICKING STRATEGY IS GETTING HIGHER PROFIT AND LOSS COMPARED TO SMM\_MID STRATEGY.

AS THE STOP LOSSES GETS LOWER THAN 0, THE SMM\_MID STRATEGY IS GETTING HIGHER PROFIT AND LOSS.

---

**Impact of different strategies on stop losses**

# IMPACT OF DIFFERENT STRATEGIES ON STOP LOSSES



FROM ABOVE PLOT, IT CAN BE SEEN THAT THE SMM\_MID STRATEGY'S PROFITS AND LOSSES ARE HIGHER ALL THE TIME COMPARED TO SMM\_PICKING STRATEGY.

AS SOON AS TIME LEFT TO EXECUTE REACHES 20 FOR SMM\_MID, THE PNL REACHES ZERO LEVEL.

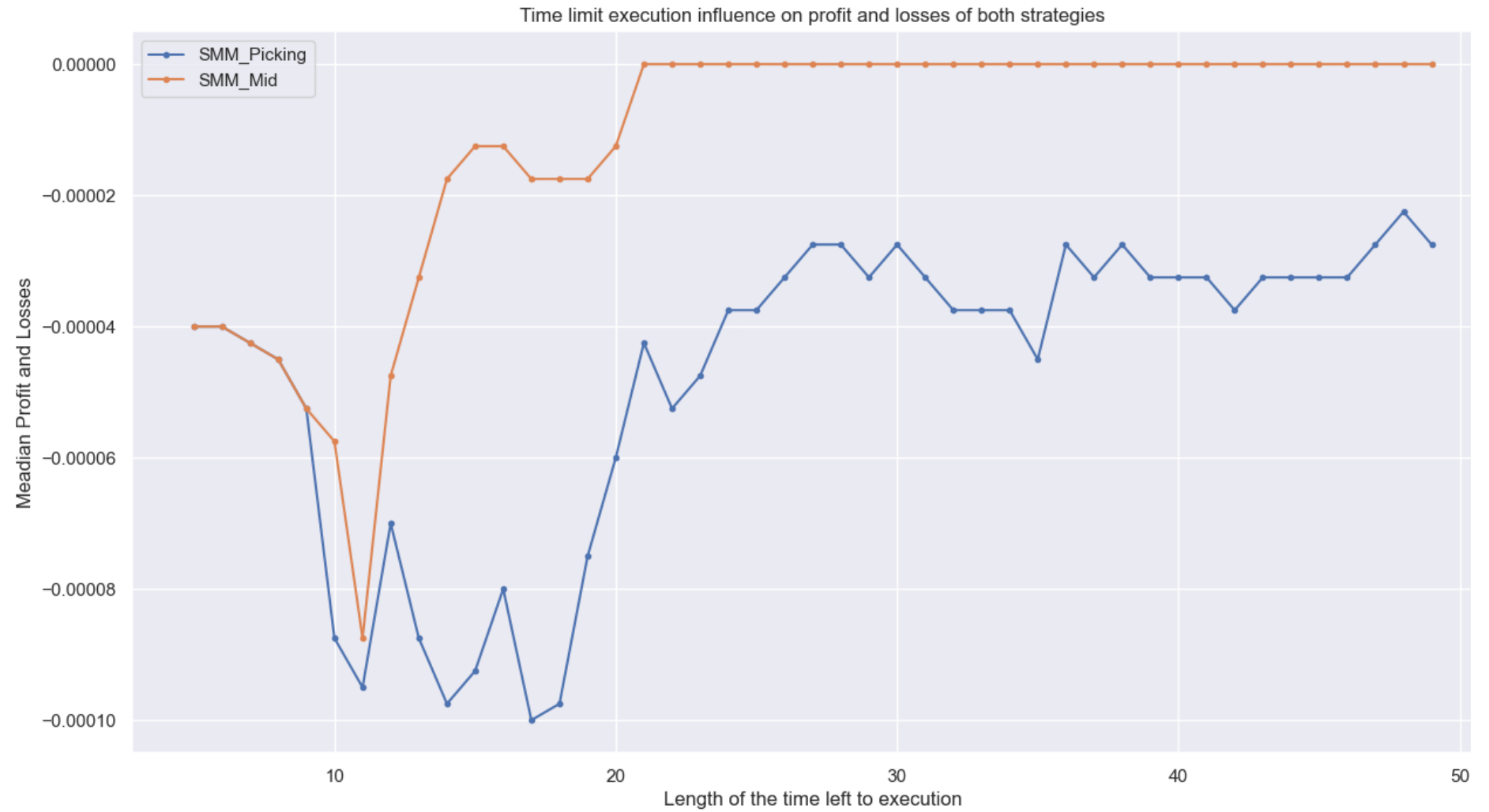
THE SMM\_PICKING STRATEGY WAS VOLATILE THROUGHT THE LENGTH OF TIME.

---

**Impact of different strategies on time left to execution**



IMPACT OF  
DIFFERENT  
STRATEGIES  
ON TIME  
LEFT TO  
EXECUTION.



# FINAL RESULTS

Side	PnL	SMM_Picking	SMM_Picking	SMM_Picking	SMM_Mid_P	SMM_Mid_T	SMM_Mid_Execution		
B	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE		
S	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE		
B	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE		
S	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE		
B	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE		
B	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE		
B	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE		
S	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE		
S	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE		
S	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE		
S	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE		
B	-0.000285	-0.000285	15	TTE	-0.000285	15	TTE		
S	-0.000285	-0.000245	15	TTE	-0.000245	15	TTE		
S	-0.000285	-0.000245	15	TTE	-0.000245	15	TTE		
B	-0.000285	-0.000335	15	TTE	-0.000335	15	TTE		
B	-0.000285	-0.000335	15	TTE	-0.000335	15	TTE		
B	-2.50E-05	-2.50E-05	15	TTE	-2.50E-05	15	TTE		
S	-1.50E-05	-0.000135	15	TTE	-0.000135	15	TTE		
B	-2.00E-05	2.00E-05	9	Success	0	8	Success		
S	-2.50E-05	-0.000145	15	TTE	-0.000145	15	TTE		
B	-2.00E-05	2.00E-05	7	Success	0	6	Success		
B	-2.00E-05	2.00E-05	6	Success	0	5	Success		
B	-2.00E-05	2.00E-05	5	Success	0	4	Success		
S	-2.00E-05	-0.00025	15	TTE	-0.00025	15	TTE		
S	-2.00E-05	-0.00024	15	TTE	-0.00024	15	TTE		
S	-2.00E-05	-0.00021	15	TTE	-0.00021	15	TTE		

# THANK YOU

Krutarth Haveliwala