5/2/2019

Opportunistic Execution Strategy Analysis

Homework 3

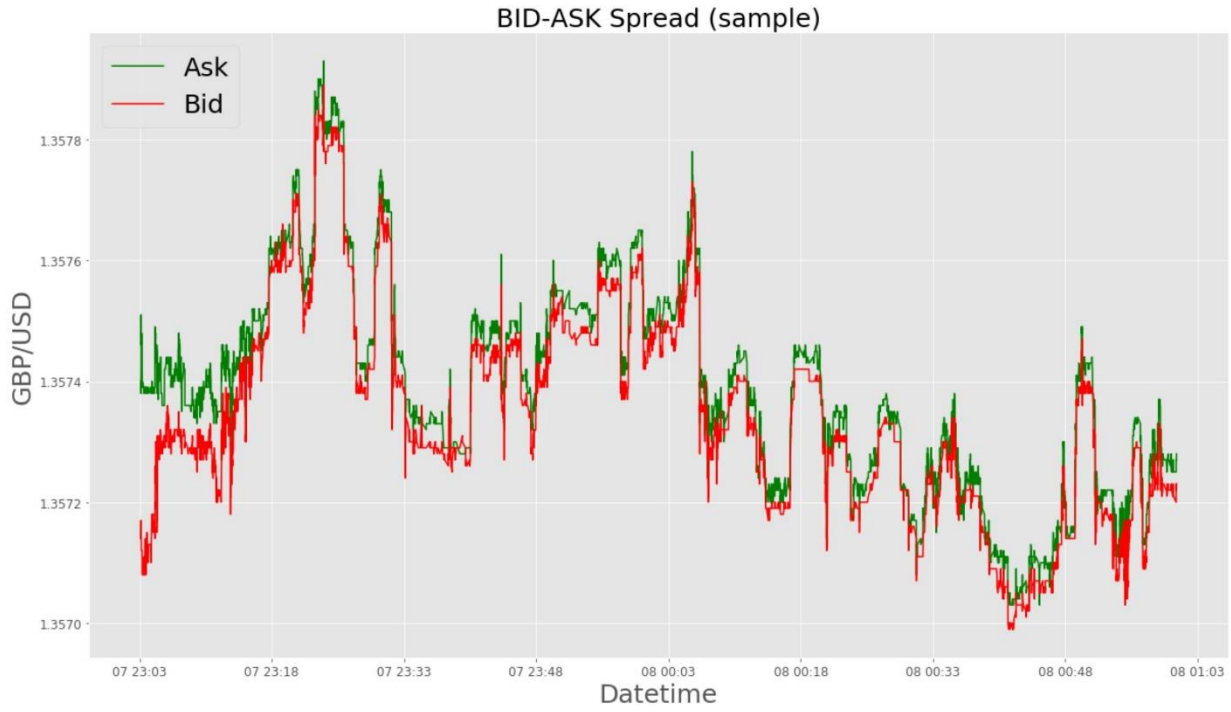
Report Compiled by: Abhirit Kanti, Liqin Guan, Supreeth Sundar

AK7349, LG1656, SS11346

Homework 3: Opportunistic Execution Strategy Analysis

CONTEXT

Given high frequency tick data of the very liquid GBP/USD instrument from January 7th to January 12th, 2018 and a corresponding list of orders over a subset of that time period. The orders are categorized by different Alpha Engines (SOM, DIS and MAR). The purpose of this assignment is to contrast different execution strategies (Market Taking and Opportunistic Market Making Mid / Side) and Alpha Engines.



DateTime	Bid	Ask
2018-01-07 22:02:03.832	1.35560	1.35616
2018-01-07 22:02:03.845	1.35560	1.35617
2018-01-07 22:02:03.851	1.35554	1.35617
2018-01-07 22:02:03.859	1.35554	1.35618
2018-01-07 22:02:04.114	1.35554	1.35619

Figure 1: Market Data

datetime	trade_id	buy/sell	notional	price	instrument	alpha
2018-01-08 00:07:49.749000	107414.0	1.0	150,000	1.357	GBP/USD	SOM
2018-01-08 00:15:23.152300	107427.0	1.0	310,000	1.357	GBP/USD	SOM
2018-01-08 12:38:48.384800	107638.0	-1.0	310,000	1.355	GBP/USD	SOM
2018-01-08 13:10:55.105500	107649.0	-1.0	310,000	1.354	GBP/USD	SOM
2018-01-08 13:19:10.191000	107654.0	-1.0	320,000	1.354	GBP/USD	SOM

Figure 2: Order Data

EXECUTION

Key Assumptions:

1. There is always enough liquidity to fill the order 100% upon execution.

Homework 3: Opportunistic Execution Strategy Analysis

2. Order execution happens instantly and at the expected price, that is, there is no slippage.

PnL Accounting:

For the purpose of this report, we are only tracking the Execution PnL that is earned upon placing the order until order execution. This means that we will disregard PnL earned from the trades over the trading period.

Market Taking

This strategy executes the order as soon as it is placed regardless of the desired Execution Price. This means that for an order placed at $t_i : t_0 \leq t_i \leq t_1$ where the market is quoted at t_0 then moves to t_1, the order will be executed at the offered market at t_0 irrespective of the desired Execution Price at t_i.

$$PnL = -\frac{1}{2} \times (bid - offer\ spread)$$

Opportunistic Market Making

The fundamental premise of Opportunistic Market Making is a flexibility of choosing the time at which an order is executed. This time is determined by a few factors:

1. The Maximum Time to Execution (max t_e): it is the Upper Limit before which the Order must be executed. If the market does not move in the trader's favor within the Maximum Time to Execution limit, the Order is executed at the last available market.
2. The Stop Loss: this is highest allowable loss that an order can incur in the market before the position is closed to "cut one's losses". It is determined by a Trading Group based on their regulatory VaR requirements.

Based on these additional variables, the time constraints for Opportunistic Market Making are:

$$t_0 \leq t_i < t_e \leq \max t_e : t_e \leq t_{stop\ loss}$$

The two Opportunistic Market Making (OMM) Strategies we consider are OMM Side and OMM Mid.

Homework 3: Opportunistic Execution Strategy Analysis

Side

This strategy places the order on either the Bid (for Sell order) or the Ask (for Buy order) prices offered by the market at t_0 and pays half the bid offer spread to enter that position. The position is closed when the opposite order is placed when the market moves in the trader's favor.

$$PnL = -\frac{1}{2} \times (bid - offer\ spread)_{t_0} + (position\ closing\ price)_{t_e} - (position\ open\ price)_{t_i}$$

Mid

This strategy places the order at the middle of the Bid – Ask Spread at t_0. The position is closed when the opposite order is placed when the market moves in the trader's favor.

$$PnL = -\frac{1}{2} \times (bid - offer\ spread)_{t_0} + (position\ closing\ price)_{t_e} - (position\ open\ price)_{t_i}$$

General Conditions

	Market Taking	OMM Side	OMM Mid
TTE	0	[0, max TTE]	[0, max TTE]
PnL	$-\frac{1}{2} \times (bid - offer\ spread)$	$\leq \frac{1}{2} \times (bid - offer\ spread)$	≤ 0

Stop Loss Determination

In general, the Stop Loss for each order is a function of the Expectation of the future market behavior and the trader's risk appetite, which is often dictated by Regulatory and Compliance. Because this analysis has no Regulatory constraints, the Stop Loss for each trade is determined purely mathematically:

$$Stop\ Loss = (1 + \sigma_{window}) \times Order\ Price$$

The Standard Deviation of a "window" of ticks is calculated to capture market behavior. It is chosen to be the past 100 ticks. This window can be modified at the trader's discretion.

Homework 3: Opportunistic Execution Strategy Analysis

ANALYSIS

1. For a given Maximum Time to Execution and Stop Loss, the Mean and Median PnLs for each strategy are calculated.
2. For each Maximum Time to Execution, a count of the number of times that the Stop Loss is triggered and the number of times that the order is executed within the limit is kept.
3. This data is also used to compare the different Alpha Engines.
4. A graph depicting the median execution PnL against the length of the max TTE is depicted for each relevant strategy.

RESULTS

Market Taking Statistics

	Bid	Ask	trade_id	buy/sell	alpha	spread	PnL_MT	Mid
2018-01-08 00:07:49.749000	1.357	1.357	107414.0	1.0	SOM	4.000e-05	-0.20	1.357
2018-01-08 00:15:23.152300	1.357	1.357	107427.0	1.0	SOM	3.000e-05	-0.15	1.357
2018-01-08 12:38:48.384800	1.355	1.355	107638.0	-1.0	SOM	4.000e-05	-0.20	1.355
2018-01-08 13:10:55.105500	1.354	1.354	107649.0	-1.0	SOM	4.000e-05	-0.20	1.354
2018-01-08 13:19:10.191000	1.354	1.354	107654.0	-1.0	SOM	4.000e-05	-0.20	1.354

Figure 3: Sample of Market Taking Trades and PnL

	PnL_MT
Mean	-0.177
Std_Dev	0.077
Median	-0.200
Information Ratio	-2.291

Figure 4: Market Taking PnL Statistics

alpha	DIS	MAR	SOM
Mean	-0.173	-0.197	-0.173
Std_Dev	0.078	0.113	0.065
Median	-0.200	-0.200	-0.200

Figure 5: Market Taking alpha-wise PnL Statistics

Since this is Market Taking, therefore there is no Stop Loss, and it is triggered 0 times. The orders are executed instantly by aggressing the offered market, and therefore average and median TTE is 0 seconds. The orders are always executed within the Time Limit.

Homework 3: Opportunistic Execution Strategy Analysis

Opportunistic Market Making Side Statistics

	Bid	Ask	trade_id	buy/sell	alpha	spread	Mid	SideLimit	PnL_Side	TTE	SL_Triggered	SL_value	TTE_Triggered
2018-01-08 00:07:49.749000	1.357	1.357	107414.0	1.0	SOM	0.4	1.357	1.357	-0.40	0.492	True	6.169e-05	False
2018-01-08 00:15:23.152300	1.357	1.357	107427.0	1.0	SOM	0.3	1.357	1.357	-0.35	5.427	True	6.169e-05	False
2018-01-08 12:38:48.384800	1.355	1.355	107638.0	-1.0	SOM	0.4	1.355	1.355	-0.40	0.596	True	6.169e-05	False
2018-01-08 13:10:55.105500	1.354	1.354	107649.0	-1.0	SOM	0.4	1.354	1.354	-0.50	7.003	True	6.169e-05	False
2018-01-08 13:19:10.191000	1.354	1.354	107654.0	-1.0	SOM	0.4	1.354	1.354	-0.20	10.000	False	6.169e-05	True

Figure 6: Sample of OMM Side Trades and PnLs for max TTE of 10 seconds

	Mean PnL $	Median PnL $	Mean TTE (s)	Median TTE (s)	Stop Loss Trigger Count	Time Limit Execution Count
TTE1	-0.176	-0.20	0.849	1.000	56	104
TTE3	-0.159	-0.15	2.035	3.000	92	183
TTE5	-0.154	-0.20	2.898	3.017	114	226
TTE10	-0.149	-0.20	4.400	3.017	138	282
TTE15	-0.140	-0.15	5.355	3.017	151	309
TTE20	-0.139	-0.15	6.024	3.017	159	328
TTE25	-0.143	-0.20	6.520	3.017	165	336
TTE30	-0.150	-0.20	6.927	3.017	170	341

Figure 7: OMM Side Statistics with max TTE(seconds)

alpha	mean_PnL	median_PnL	median_TTE	mean_TTE	SL_Triggered	TTE_Triggered
DIS	-0.171	-0.20	2.86	4.49	22	15
MAR	-0.186	-0.25	2.20	3.86	25	11
SOM	-0.136	-0.15	3.13	4.50	91	61

Figure 8: Sample alpha-wise statistics for max TTE of 10 seconds

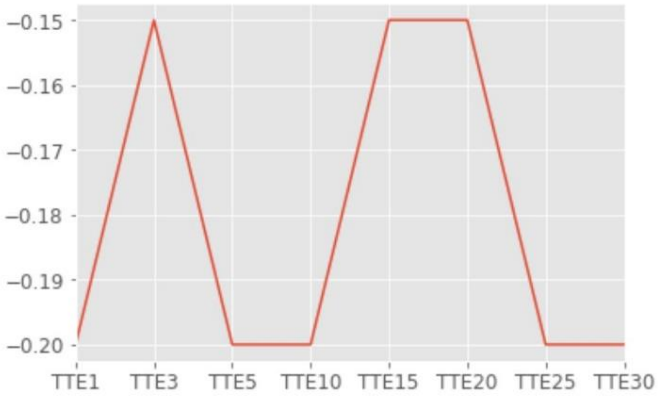


Figure 9: Median PnL versus max TTE(seconds)

Homework 3: Opportunistic Execution Strategy Analysis

Opportunistic Market Making Side Statistics

	Bid	Ask	trade_id	buy/sell	alpha	spread	PnL_MT	Mid	MidLimit	PnL_Mid	TTE	SL_Triggered	TTE_Triggered
2018-01-08 00:07:49.749000	1.357	1.357	107414.0	1.0	SOM	4.000e-05	-0.20	1.357	1.357	-4.000e-01	0.492	True	False
2018-01-08 00:15:23.152300	1.357	1.357	107427.0	1.0	SOM	3.000e-05	-0.15	1.357	1.357	-3.500e-01	5.427	True	False
2018-01-08 12:38:48.384800	1.355	1.355	107638.0	-1.0	SOM	4.000e-05	-0.20	1.355	1.355	-4.000e-01	0.596	True	False
2018-01-08 13:10:55.105500	1.354	1.354	107649.0	-1.0	SOM	4.000e-05	-0.20	1.354	1.354	2.220e-12	1.867	False	False
2018-01-08 13:19:10.191000	1.354	1.354	107654.0	-1.0	SOM	4.000e-05	-0.20	1.354	1.354	-2.000e-01	10.000	False	True

Figure 10: Sample of OMM Mid Trades and PnLs for max TTE of 10 seconds

	Mean PnL	Median PnL	Mean TTE	Median TTE	Stop Loss Trigger Count	Time Limit Execution Count
TTE1	-0.180	-0.20	0.792	1.00	54	132
TTE3	-0.173	-0.15	1.810	1.96	86	214
TTE5	-0.174	-0.15	2.499	1.96	106	258
TTE10	-0.175	-0.05	3.651	1.96	124	301
TTE15	-0.170	0.00	4.330	1.96	137	332
TTE20	-0.173	0.00	4.776	1.96	143	340
TTE25	-0.174	0.00	5.122	1.96	147	346
TTE30	-0.178	0.00	5.394	1.96	151	351

Figure 11: OMM Mid Statistics with max TTE(seconds)

alpha	mean_PnL	median_PnL	median_TTE	mean_TTE	SL_Triggered	TTE_Triggered
DIS	-0.199	-0.075	1.88	3.62	21	10
MAR	-0.192	0.000	1.42	2.92	20	7
SOM	-0.166	-0.075	2.10	3.83	83	51

Figure 12: Sample alpha-wise statistics for max TTE of 10 seconds

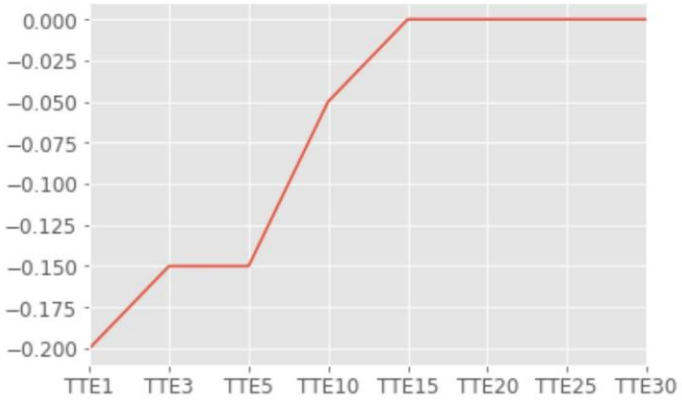


Figure 13: Median PnL versus max TTE(seconds)

Homework 3: Opportunistic Execution Strategy Analysis

ANNEX

Please refer to the attached .html file for code and its Annex for the complete data tables.