



Algorithmic Trading



Electronic vs. Quantitative vs. Algorithmic Trading

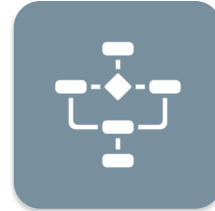




**Electronic
Trading**



**Quantitative
Trading**



**Algorithmic
Trading**

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Electronic Trading

Refers to the use of **computer systems to place trades electronically, without the need for human intervention** in the actual **order placement process**



Years ago, you would
call your broker.



Today, with a few clicks the **trade is
finalized almost instantaneously.**

Main characteristics:



Speed



Efficiency



Direct market access

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Quantitative Trading

Refers to a type of trading. Trading types basically describe the different ways, in which **buy and sell decisions are generated**



Making trading decisions based on **mathematical** and **statistical methodologies**.



Quantitative traders use **data-driven models** to identify potential **trading opportunities**.



Trades are based on analysis of vast amounts of **historical** and **real-time data**.

Main characteristics:



Data-driven



Systematic



Often high frequency

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Algorithmic Trading

Often described as a **subset of quantitative trading** where pre-programmed instructions (i.e. algorithms) automatically **execute trades based on a set of criteria**



Quantitative trading focuses on the "**what**" (what to **buy or sell based on data**).



Algorithmic trading emphasizes the "**how**" (how to execute decisions efficiently using **technology**).

Main characteristics:



Automated order execution



Efficiency and speed

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Why Algorithmic Trading?

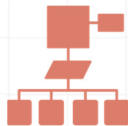


To execute a trading order in the most efficient manner possible,
minimizing costs and **adverse market impact**



Get the **best deal** when
buying or **selling anything**.

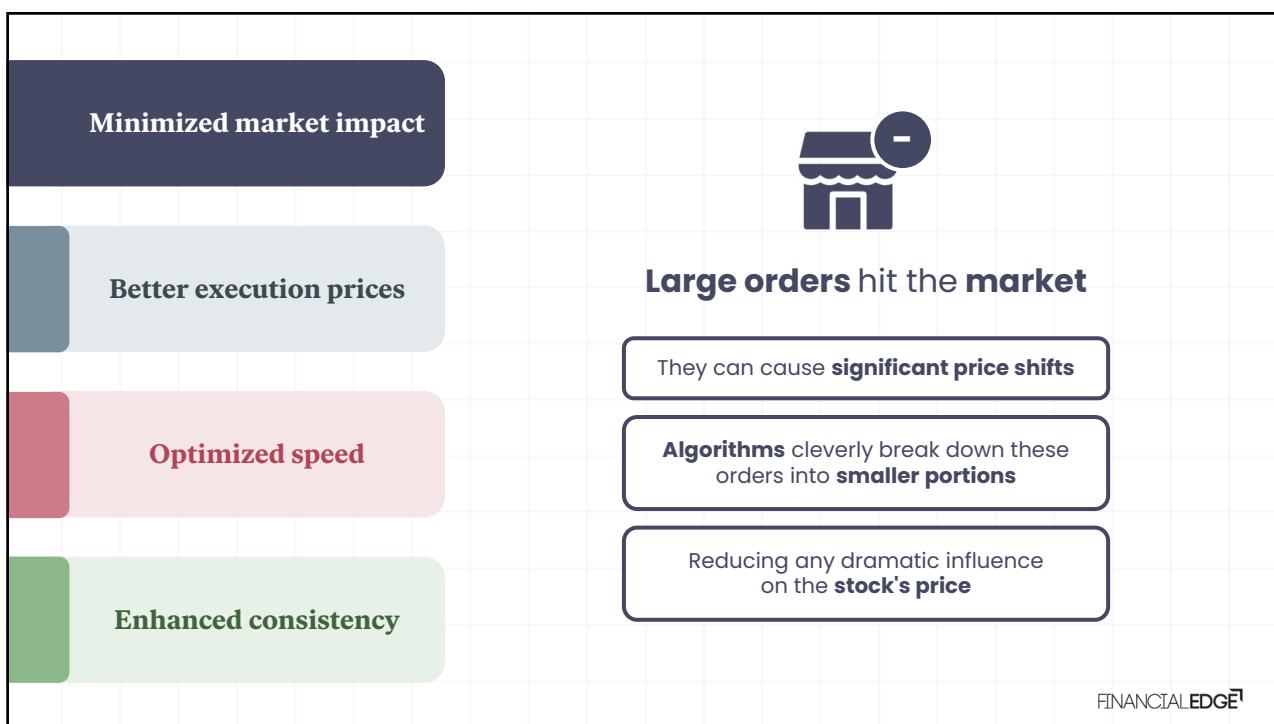
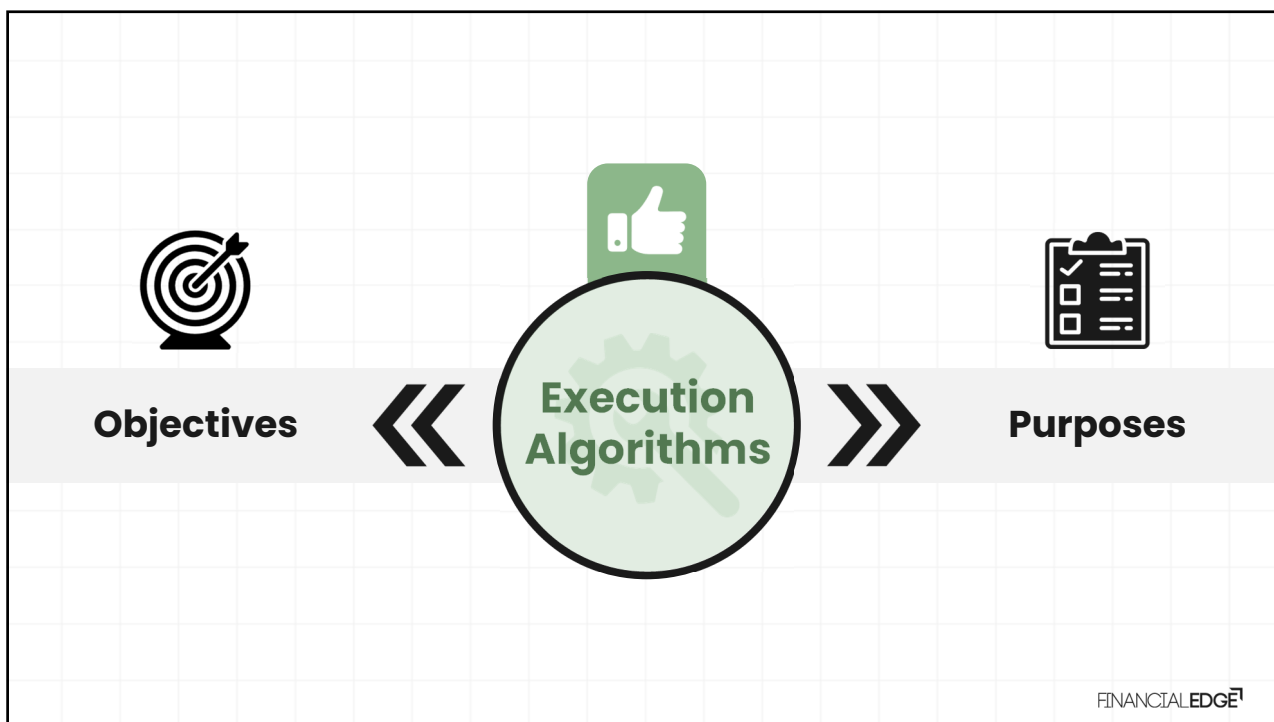
Constantly fluctuating market



Have a **strategy** or
an "**algorithm**".



Execution algorithms merge
the **key attributes of market**
and **limit orders** to secure
optimal execution prices.



Minimized market impact

Better execution prices

Optimized speed

Enhanced consistency



Algorithms, through their ability to analyze **real-time market data** and **historical patterns**

Can pinpoint optimal moments to **buy or sell**

Securing the **most favorable prices for traders**

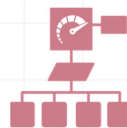
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Minimized market impact

Better execution prices

Optimized speed

Enhanced consistency



Algorithms can act **faster than any human**

Algorithms capitalize **on fleeting market opportunities**

Making instantaneous decisions grounded in **vast sets of data**

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Minimized market impact

Better execution prices

Optimized speed

Enhanced consistency



Algorithms ensure **emotionless**
and **data-driven** trading

Enhances the uniformity of **trading actions**

Diminishes the chance of
costly human errors

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Time Weighted Average Price (TWAP)

TWAP is the average price of a security over a set period:

$$\text{TWAP} = \frac{(P_{T1} + P_{T2} + \dots + P_{Tn})}{n}$$

Observation period:	Timestamp:	Price:
1	09:15	\$81.72
2	09:30	\$81.75
3	09:45	\$81.73
4	10:00	\$81.76
5	10:15	\$81.77
6	10:30	\$81.77
7	10:45	\$81.76
8	11:00	\$81.78

Example: **TWAP of XYZ** shares over a **2-hour period** starting at **9 AM**, sliced into **15-minute intervals**.

$$\text{TWAP} = \frac{(81.72 + 81.75 + 81.73 + 81.76 + 81.77 + 81.77 + 81.76 + 81.78)}{8}$$

$$= 81.7550$$

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TWAP Algorithm



Aim to **execute orders** close to the **TWAP** over a given period at **regular intervals**.

Large orders to minimize **market impact**

Ensure even **execution over time**

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The **basic mechanism** works as follows:



**Determine
order size**

How many shares
should be **bought or
sold in total.**



**Set
duration**

The **total period**
over which the
order should be
executed.



**Specify time
intervals**

How much **time**
there should be
**between the
different
observation points.**



**Divide order
and execute**

Equal sized chunks
that will be **executed
at regular intervals
over the set
duration.**

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The **basic mechanism** works as follows:



10,000 XYZ

Shares



2 - hour period

(15min intervals)



Starting at:

9:00



Divided into chunks

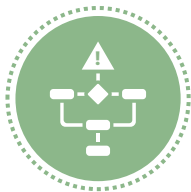
1250

Shares



15 min period

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The **TWAP algorithm** is a simple method to execute large orders whilst **minimizing market impact** and **ensuring even execution over time**, it is not without considerations.

Potential **signaling risk**:

Signaling risk

or

Information leakage



Trader consistently **buying large quantities** of a stock every hour.

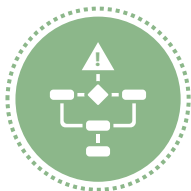


Others market participants might anticipate the **next buy order** and **purchase the stock just before**.

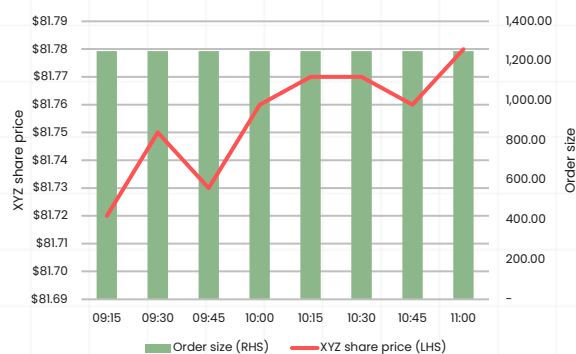


Profiting from the **predictability**.

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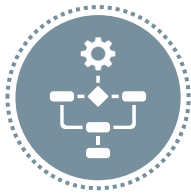


Additional considerations:



Strict adherence to time schedule leads to **signaling risk** and **exposes to drops in liquidity** and **unfavorable price moves**

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Modern **TWAP algorithms** come with **tweaks**:



Order sizes and execution **times**

Avoid **predictability**



Allow **price constraints**

No buying or selling occurs
beyond desired price levels

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Volume Weighted Average Price (VWAP)



VWAP gives the **average price** a security has traded at throughout the day, based on **both price and volume**



$$\text{VWAP} = \frac{\text{Total dollar amount traded in the observation period}}{\text{Total volume traded in the observation period}}$$

$$\text{VWAP} = \frac{\$19,944,109.90}{243,960} = 81.7516$$

Timestamp:	Price:	Volume:	Price * Volume:
09:15	\$81.72	34,250	\$2,798,910.00
09:30	\$81.75	37,800	\$3,090,150.00
09:45	\$81.73	41,410	\$3,384,439.30
10:00	\$81.76	36,555	\$2,988,736.80
10:15	\$81.77	32,100	\$2,624,817.00
10:30	\$81.77	25,730	\$2,103,942.10
10:45	\$81.76	18,500	\$1,512,560.00
11:00	\$81.78	17,615	\$1,440,554.70

Total dollar
amount traded:
\$19,944,109.90

Total volume: 243,960

VWAP

Considers both **price and volume**

Comprehensive view of **market activity throughout the day**

A **realistic** average price

VWAP gives the **average price** a security has traded at throughout the day, based on **both price and volume**



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Total dollar
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\$19,944,109.90

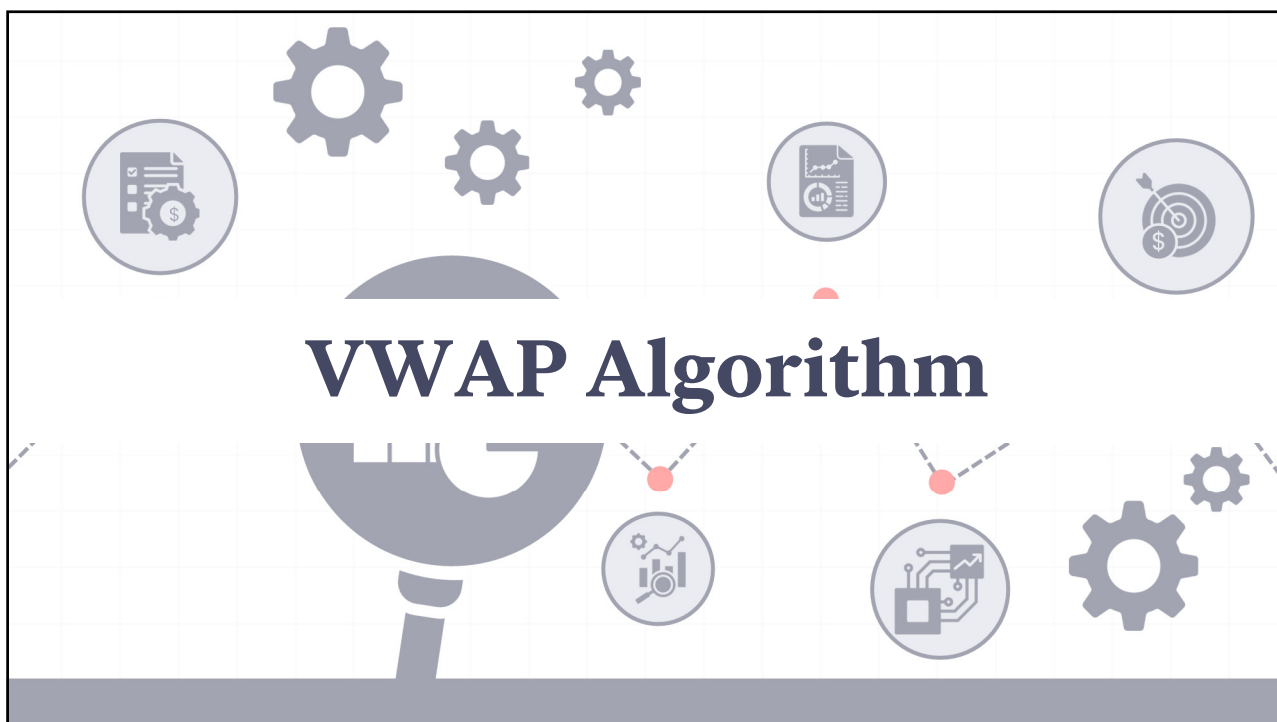
Total volume: 243,960

TWAP

Considers the **passage of time and ignores volume**

Equal importance to **periods of low trading and high trading**

It doesn't account for the **depth or intensity of trading**



VWAP Algorithm



Developed to help traders achieve or outperform the **VWAP benchmark** for a **particular order**.



Trading in precise proportions in line with **fluctuating market volumes**.



Often based on averages of **trading volumes**.

VWAP Algorithm



Number of shares we want to buy or sell.



Historical data to predict the volume distribution.



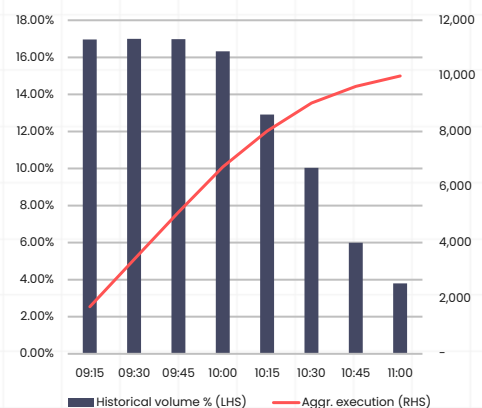
The orders will be **released** at different times.

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VWAP Algorithm

Historical volume		
Timestamp:	Volume:	Volume in %:
09:15	43,760	16.96%
09:30	43,850	17.00%
09:45	43,800	16.98%
10:00	42,125	16.33%
10:15	33,315	12.91%
10:30	25,890	10.03%
10:45	15,460	5.99%
11:00	9,800	3.80%
	258,000	100.00%

Child order:	
	1,696
	1,700
	1,698
	1,633
	1,291
	1,003
	599
	380
	10,000



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VWAP Algorithm

Timestamp:	Price:	Child order:	Price * Volume:
09:15	\$81.72	1,696	\$138,607.26
09:30	\$81.75	1,700	\$138,943.31
09:45	\$81.73	1,698	\$138,750.93
10:00	\$81.76	1,633	\$133,493.80
10:15	\$81.77	1,291	\$105,587.89
10:30	\$81.77	1,003	\$82,055.24
10:45	\$81.76	599	\$48,992.62
11:00	\$81.78	380	\$31,063.72

Total volume:
10,000

Total:
\$817,494.77

Average price algorithm =

$\frac{\$817,494.77}{10,000}$

= 81.7495

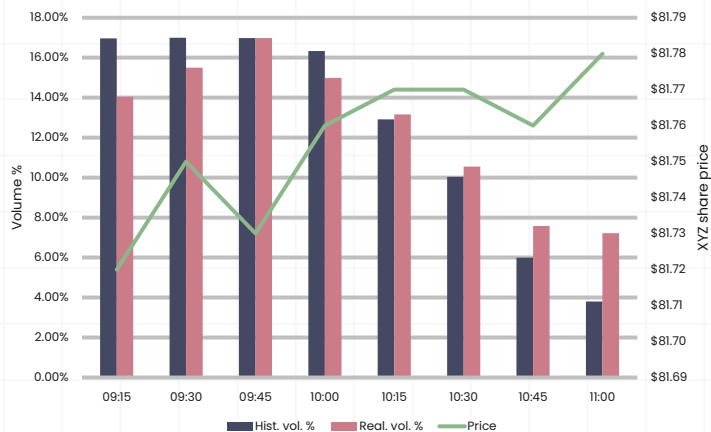
VWAP =

$\frac{\$19,944,109.90}{243,960}$

= 81.7516

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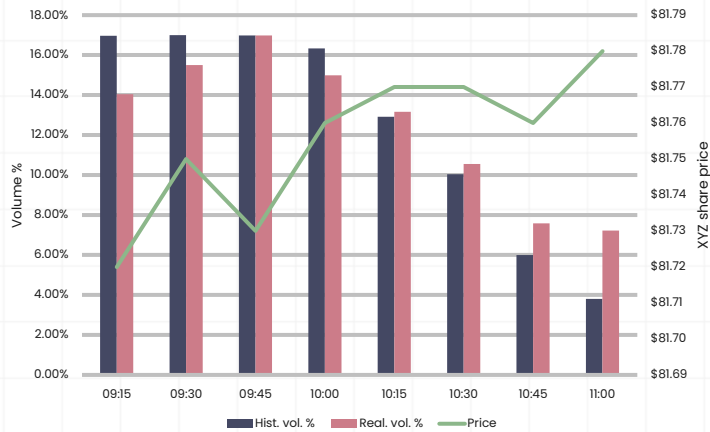
VWAP Algorithm



As we can see the **realized volume percentage was lower than the historical one** for the first part of the period

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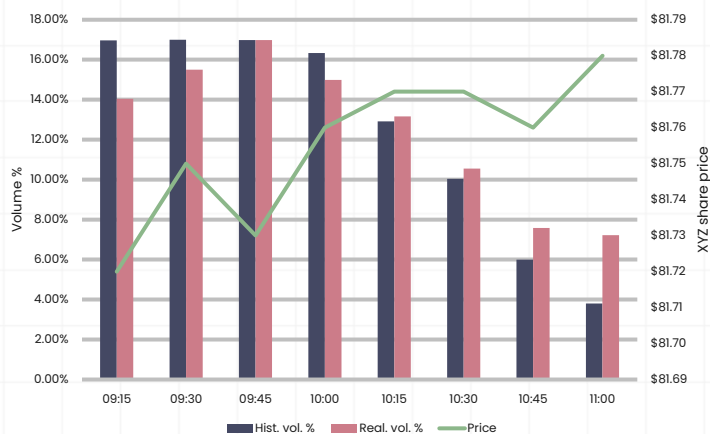
VWAP Algorithm



Second half

The **realized volumes** were **higher than the historical ones** and share prices were **relatively high**

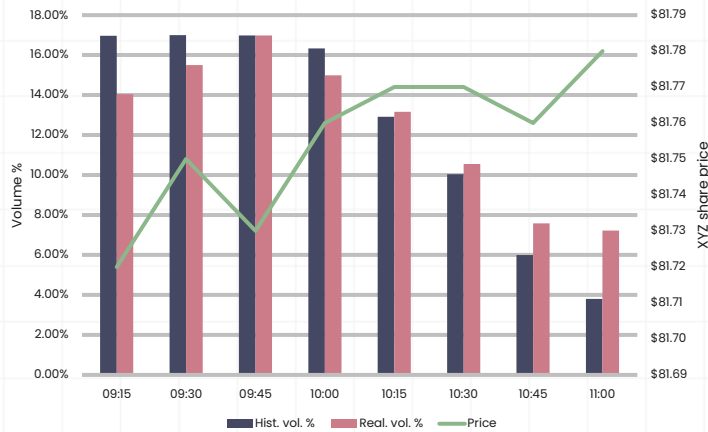
VWAP Algorithm



Algorithm

Based on the historical volume distribution - bought more **shares at lower prices** and fewer shares at higher prices

VWAP Algorithm



**Algorithm beat
the benchmark**

The average price
achieved by the
algorithm might differ
significantly from
the benchmark

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Percent of Volume (POV) Algorithm





Main consideration of **VWAP algorithm**:
Exposure to deviations in **trading volume profiles from historical averages**

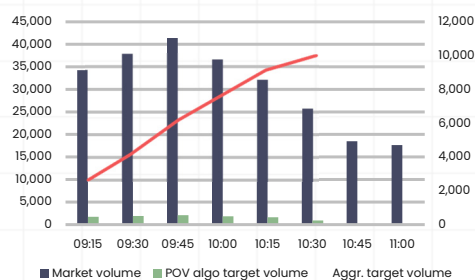
POV Algorithm:



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Buy **10,000 XYZ shares** at **5% POV** over a **2-hour period** with **15-minute intervals**, starting at 09:00

Timestamp:	Price:	Market volume	POV algo target volume
09:15	81.72	34,250	1713
09:30	81.75	37,800	1890
09:45	81.73	41,410	2071
10:00	81.76	36,555	1828
10:15	81.77	32,100	1605
10:30	81.77	25,730	893
10:45	81.76	18,500	
11:00	81.78	17,615	

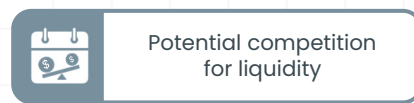
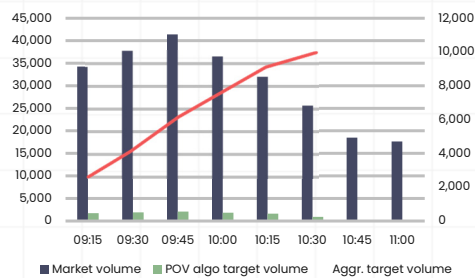


Completion of total order not certain

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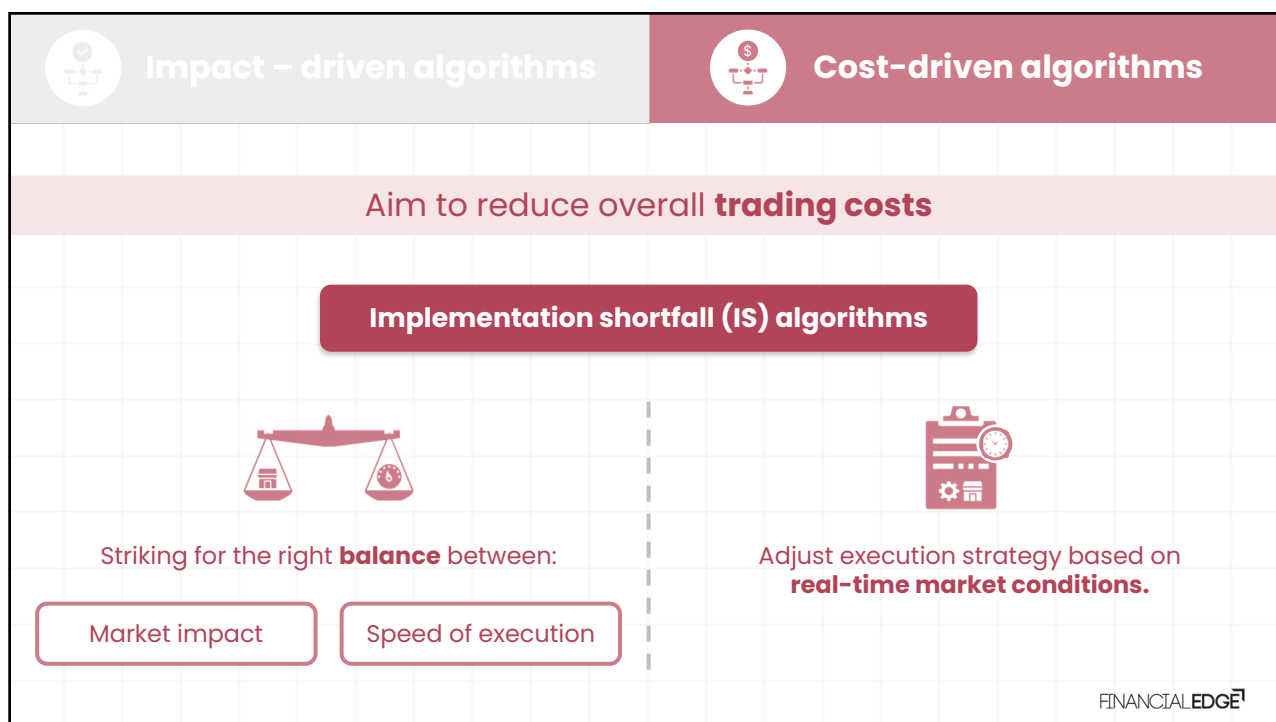
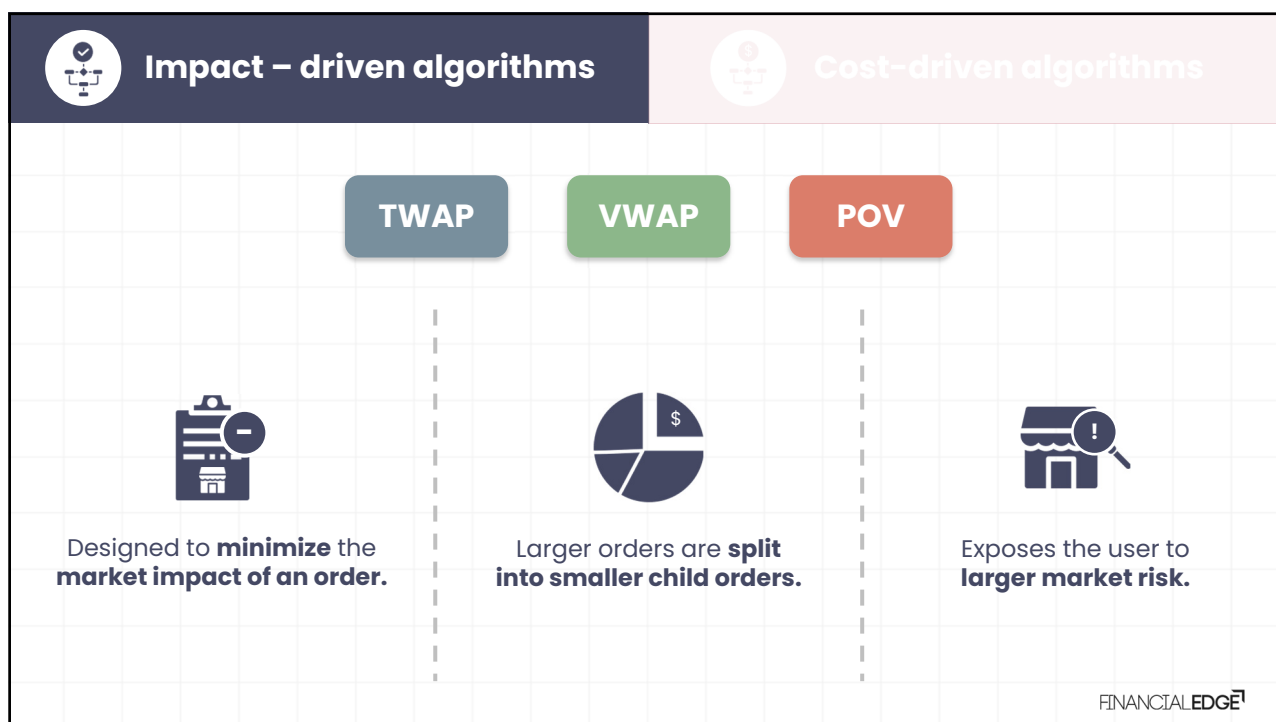
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Potential competition
for liquidity

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Impact vs. Cost Driven Algorithms





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