# White Paper : Extending execution algos to equity options

Algorithms have become a staple of equity execution, while block trading and manual screen execution remain the norm for equity options. It may be time to change this.
Indeed, block trading requires a liquidity provider to take on the risk, which comes at a significant cost and manual screen execution is clearly suboptimal.

**The purpose of this note is to call for a third way in which a smart algo will let a liquidity taker show his interest to whoever is active in the orderbook and avoid paying for instant liquidity if he doesn't require it.**

What would an option execution algo service look like?

- No need for a SOR (Smart Order Routing) as each clearing facility has only one corresponding trading venue.
- Lower liquidity (compared to stocks) and availability of highly correlated instruments (underlying stock and similar options on nearby strikes) means that we should add price control to execution timing.
- As for stocks, the algo's main task will be to optimize timing and look for hidden liquidity by showing parts of the order to liquidity providers.

## 1/ Price control

### 1.1/ Underlying Stock adjustment

Some options traders look to buy or sell volatility, so they want to trade delta hedged options. Some want to trade options with no hedge, but even for these, if the size is substantial, it is much more efficient:

- either to trade a hedged block OTC and then unwind the delta in the stock market
- or to trade the option in the orderbook, but work the order by adjusting the limit for the underlying stock movement in order to avoid trading at suboptimal price if the stock is moving in a favorable direction (and not at all otherwise)

In the end, buying a hedged or no hedge option requires basically the same tool.

The most simple of such tools is a "delta adjusted" quoter. This is widely used inside banks and allows the user to enter an option price, a stock reference price and a delta.
The algo sends the single order on the option and adjusts the limit over time such that:
Option limit price = option price + (current stock price - reference stock price) * delta

1.2/ Volatility adjustment

The next step is to adjust for volatility movements. This is particularly warranted for liquid options markets (especially for equity index options trading) and/or long working order durations.

The logic is the same and requires a live market calibration engine able to transmit current vol levels to the algo. The user inputs an additional parameter: the reference implicit vol. Delta and vega are likely to be fed by the pricer.
The order limit now follows the following formula:
Option limit price = option price + (current stock price - reference stock price) * delta + (current volatility - reference volatility) * vega

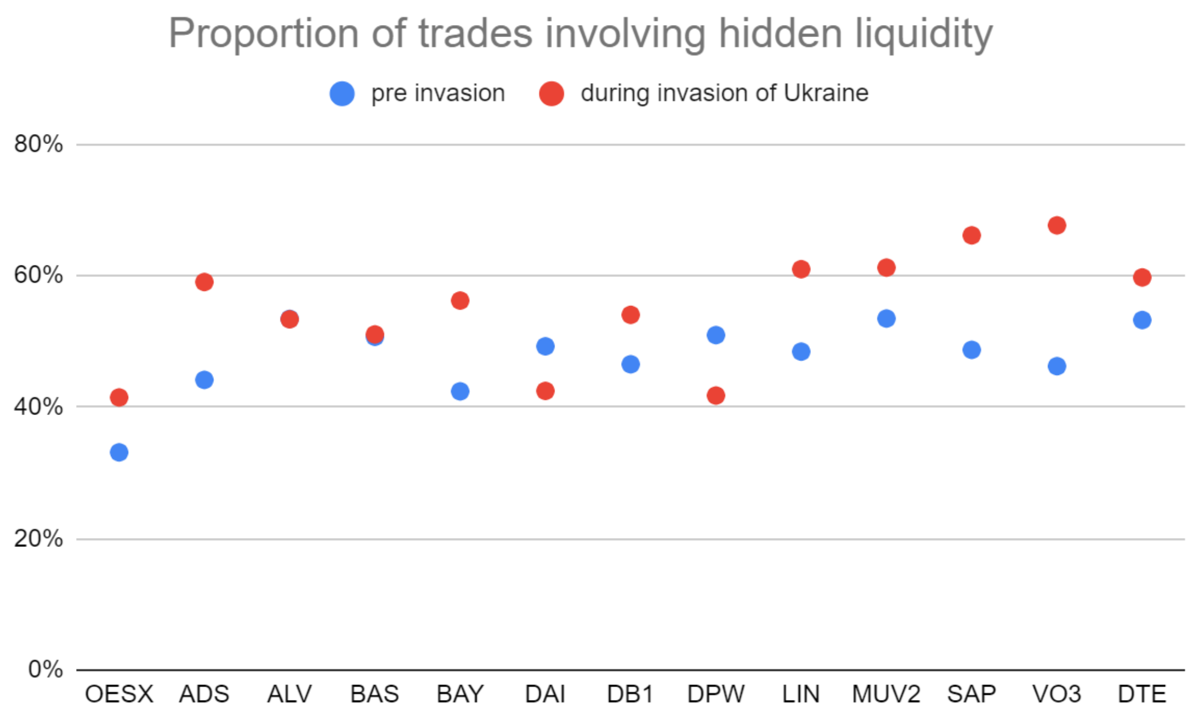
1.3/ Going further:

We can add alpha signals to the volatility parameters (potentially also to the underlying's price, but this is probably less efficient). These signals would detect when the option's implicit volatility is temporarily expensive (respectively cheap) and diminish (respectively increase) a buy order's aggressiveness accordingly.

2/ Hidden liquidity

2.1/ Sudden market moves make options liquidity providers wary of quoting tight spreads, as it exposes them to losses if they don't adjust their quotes fast enough to changing conditions.
They also don't want to give too much information away regarding their trading axis.
They usually complement their mass quotes with "hitters", which are continuously scanning the market for orders at levels that are more aggressive than their mass quotes.

In order to measure this, we have analyzed how much volume was traded at a level where no order was placed 0.1 second before. This is a clear indication that a liquidity provider's "hitter" has been triggered by an incoming order chasing hidden liquidity.
Here are the results:
Based on 12 DAX constituents, the percentage of trades (weighted by their size) involving hidden liquidity (automatic hitters) is 51% of total order book trades.



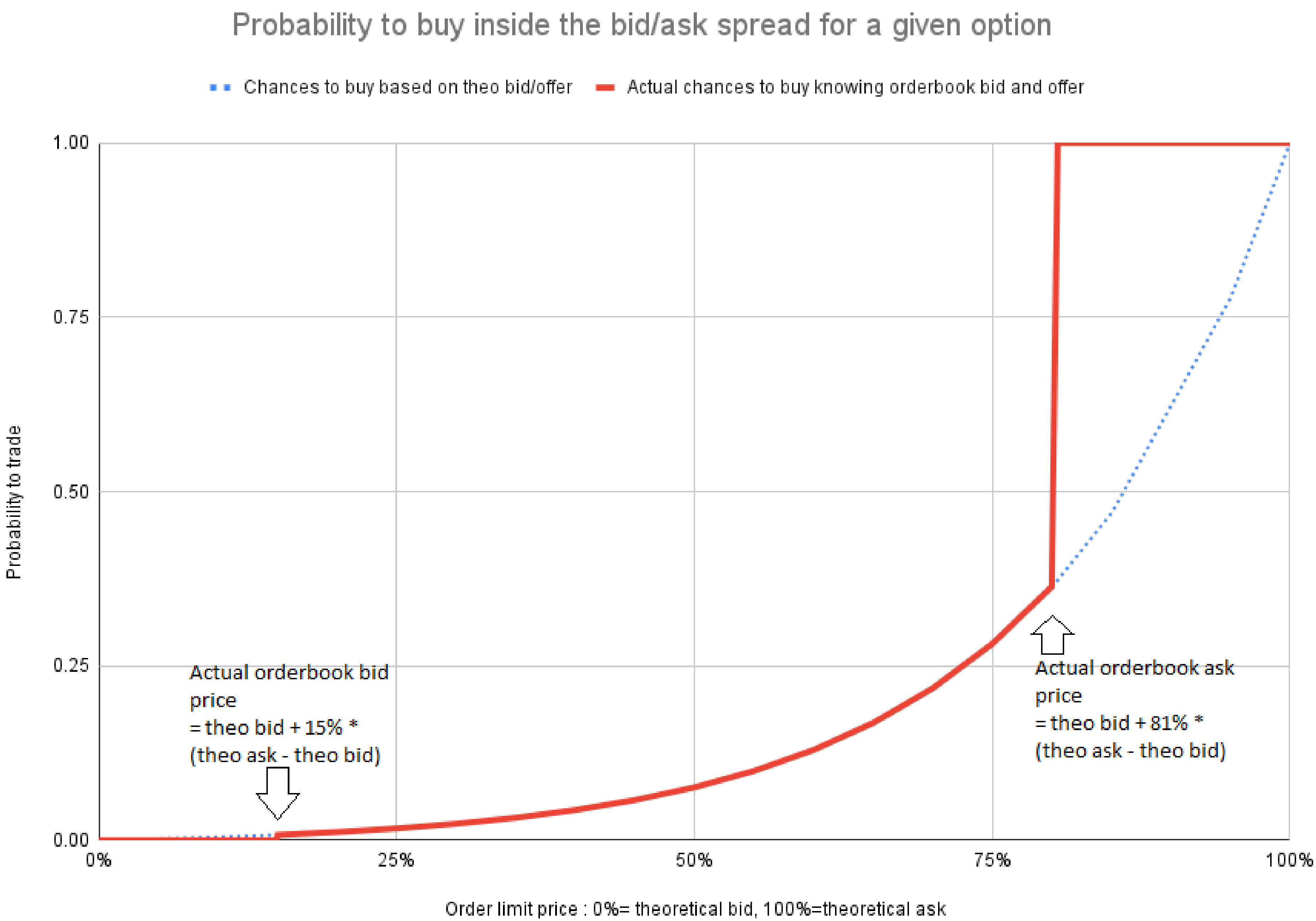

*This chart shows that hidden liquidity is even more important in times of market stress.*
*It is also less important on Eurostoxx50 (OESX) as spreads are tighter.*

Among deals involving hidden liquidity, the average gain compared to crossing the bid offer spread is at **28% of bid-offer spread**.

2.2/ Limitations to optimizing hidden liquidity:

It is important to keep in mind that Deutsche Boerse tracks an OTR (Order Transaction Ratio : [https://www.eurex.com/ex-en/rules-regs/order-to-trade-ratio](https://www.eurex.com/ex-en/rules-regs/order-to-trade-ratio)). This limits the possibility to test every possible tick between the screen bid and the order's limit for a buy order.
An extensive use of "trial" quotes to find the best possible hidden level may also backfire as this search could be spotted by the market or send the price in the wrong direction by sending signals to quoting automats.

2.3/ In order to optimize the levels at which we will test for hidden liquidity, one approach is to model our proba to trade as a function of our order's limit price :


Probability to buy inside the bid/ask spread for a given option
Chances to buy based on theo bid/offer
Actual chances to buy knowing orderbook bid and offer
1.00
0.75
0.50
0.25
0.00
Probability to trade
0%
25%
50%
75%
100%
Order limit price : 0%= theoretical bid, 100%=theoretical ask
Actual orderbook bid price = theo bid + 15% * (theo ask - theo bid)
Actual orderbook ask price = theo bid + 81% * (theo ask - theo bid)

As shown in the chart, the probability to trade (buy) has to be 100% from and above the screen offer price and 0% from and below the bid price.
But apart from these levels, the proba depends primarily on the theoretical bid and ask prices. This is a way to say that if there is an aggressive offer in the market, it is less likely that an arriving bid just below this offer will be successful, than if the offer is at the theoretical offer price. Hence the simplification stating that the red curve follows the blue dotted line (which only depends on theoretical prices) in between screen prices.

In this model, the probability that the buy order will be met with hidden liquidity follows an exponential rule:
Proba = (exp(alpha*x) -1) / (exp(alpha) - 1)
Where x is the limit of the order, expressed in percent of the bid-ask theoretical prices (0% for bid, 100% for ask).

A crude implicitation of the alpha parameter gives a level around 5, but the real target would be to describe alpha as a function with the following inputs :

- order size
- stock vs index
- size of spread
- recent trades, …

2.4/ We also need to assess how many lots to show and for how long

As mentioned above, staying for too long in the market may have an impact on liquidity providers' valuation. Indeed, their volatility calibration is likely to be based on snapshots of the options market every x seconds. The longer our order is shown, the more chances it has to move their volatility calibration in the wrong direction. Furthermore, almost all hidden liquidity providers have sub millisecond latency so there is little incentive to stay beyond one second.

On top of that, traders cloud identify that a buying algo is operating and be wary of trading with it not knowing the total size it wants to execute.

The right number of lots to send to the market at each trial will probably be somewhere just below mass quote sizes (ie. what is mandated by rebate rules). Indeed, this minimum lot size is potentially being used by calibration as a threshold to avoid being tricked by insignificant (small size) orders.

Finally, when a trade happens, how long should we wait before resuming testing the market? Human traders in charge of working orders in the market also routinely wait for a few hours and get forgotten before resuming their attempt based on their experience that you need some stealth to optimize some executions. An AI would potentially validate this kind of approach.

Conclusion :

At present, a liquidity taker in the option market has a choice between:
1/ a competitive bidding between liquidity providers (for example via Eurex Insights) and paying a liquidity premium trade immediately.
2/ a messy manual execution in the orderbook
3/ a hybrid solution proposed by Morgan Stanley where the orderbook is used if the RfQ has not been successful.

**With the proposed service, this liquidity taker would have the option to work his order efficiently, against all market participants, admittedly without assurance that it will be completed, but saving significant intermediary and liquidity costs.**

It is a service which would make options trading more accessible to buy side traders but requires both pricing and machine learning capabilities, along with numerous protections against special market events.