

EURONEXT QUANTITATIVE RESEARCH REPORT

No free lunch as trading on Equiduct's "Apex" turns out to be more costly than on Euronext's "Best of Book"

13 October 2020

- We have considered all Apex and BoB trades from December 2019 to April 2020 on the same stock universe with similar characteristics, thus regrouping **2.3 million trades on Equiduct and 3.6 million Euronext trades**. We then computed the net price improvement on each of these trades using QuantHouse European Best Bid Offer computed at the same microsecond.
- Overall, we found that **BoB improvements, net of fees, are outperforming Apex improvements by +1.36 bps using simple averages, and by +2.47 bps** when using turnover weighted averages. This clearly demonstrates that the Euronext BoB model outperforms the Equiduct Apex zero fee model (see Figure 7).
- As Apex's reference price model does not enable market makers to improve prices, as is the case for BoB, relative net improvement of BoB versus Apex strongly increases as spreads widen. On spreads larger than 10 bps, BoB's improved quotes outperform the EBBO in 40% of cases (see Figure 12).

AUTHORS

Paul Besson

Head of Quantitative Research
Email: pbesson@euronext.com
Tel: +33 1 70 48 26 36 / +33 6 22 47 10 95

Théo Compérot

Quant Research Analyst
Email: tcomperot@euronext.com
Tel: +33 1 70 48 24 22 / +33 7 88 29 80 54

Purpose and presentation of methodology

In this short study we want to compare two main trading models for retail flows from the point of view of retail investors, comparing the net trading prices of both models:

- The display of improved retail quotes on the central limit order book, which represents the BoB (Best of Book) offer on Euronext markets. On this model market makers compete on prices to attract retail orders, and trading fees charged by the platform are paid by all participants (market makers and retail traders).
- A reference price solution where market makers do not compete on prices, and where platform fees are fully supported by the market-makers, and not by retail participants. This model is often referred to as “payment for order flow”, as in the US these platforms often pay retail investors to trade. In Europe the most famous platform of this sort is Equiduct, which promotes the Apex solution that enables trading at no fees for retail participant.

In order to compare the two retail offers, we consider the universe of stocks that can be traded on both Euronext and Equiduct. We also consider December 2019 to April 2020, before and during the Covid-19 pandemic. We then consider all BoB and Apex trades on this universe and we compare trade prices to their coinciding consolidated EBBO (European Best Bid Offer), which we use as a benchmark.

- We first compare the characteristics of the trades that take place on Apex (Equiduct) with those of the trades that take place on BoB (Euronext) on the same stock universe.
- We then review average price improvements in these two markets. Lastly we show how these improvements vary across time, as well as with underlying stocks’ bid-ask spreads.

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DEFINING A COMMON UNIVERSE OF COMPARABLE TRADES

UNDERLYING TRADE UNIVERSE AND MAIN CHARACTERISTICS

Source and elementary data:

We base our findings on publicly available market data. For this purpose we use QuantHouse as data provider for both Apex trades on Equiduct and BoB trades on Euronext.

Elementary trade data contain all the trade characteristics: stock, date, execution price, quantity, side, timestamp (defined at a microsecond precision), MMT (Market Model Typology) and market data Flags that enable us to isolate Equiduct's VBBO (Volume-Weighted Best Bid and Offer) Apex trades and Euronext's BoB trades (see Appendix B p16).

Stock universe and period:

The instruments considered are all stocks on which trading on Apex as well as on BoB was possible from December 2019 to April 2020. Of the 404 stocks traded on BoB and the 806 that traded on Apex, 369 stocks were traded on both venues. These 369 stocks are our reference universe.

We considered the period from December 2019 to April 2020 so as to include months preceding the Covid-19 pandemic, as well as months during the pandemic. This enables us to check the effect of volatility on our results.

All trades considered during the above period and for the above set of instruments represent **2.48 million Apex trades** and **3.71 million BoB trades**. These large numbers enable us to estimate with precision the nature and the performance of these trades.

Retail trades main characteristics:

Both Apex and BoB display similar average trade sizes (€5.0k and €5.2k respectively, see Table 1). Average bid-ask spreads of underlying stocks are tighter on BoB (10 bps) than they are on Apex (12 bps). We will analyse these differences in detail.

Table 1: Main statistics on BoB and Apex trades

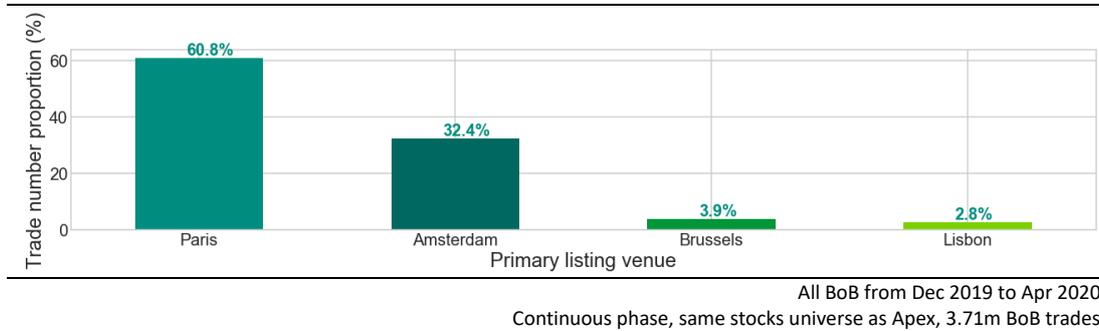
	Average daily trade number	Number of trades	Average trade size	Average spread turn. weighted
BoB (Euronext)	36.5k	3.71m	€5.0k	10 bps
Apex (Equiduct)	23.8k	2.48m	€5.2k	12 bps

All BoB and Apex trades from Dec 2019 to Apr 2020
Continuous phase, same stocks universe, 2.48m Apex trades & 3.71m BoB trades

Comparing trades by country:

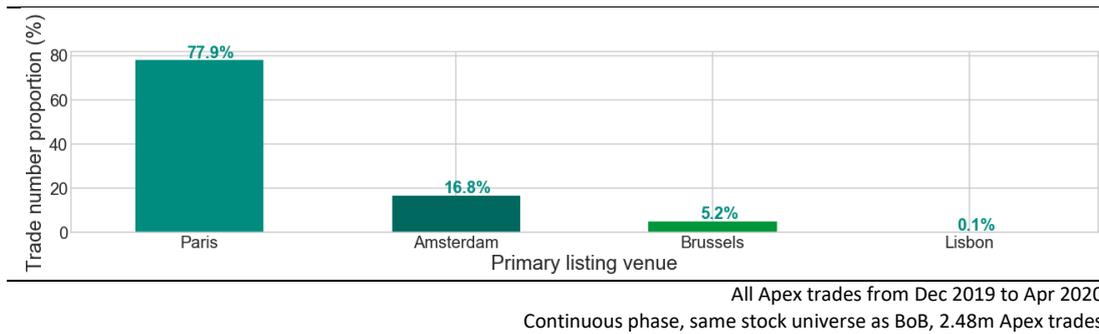
We then study the distribution of trades by country for Apex and BoB trades. On BoB trades, the French market (Paris) represents 60.8% and the Dutch market (Amsterdam) 32.4% of the total number of trades as shown in Figure 1.

Figure 1: BoB trades primary listing venues distribution (proportion in number of trades)



This contrasts with Apex, where French trades make up 77.9% of the total number of Apex trades (see Figure 2).

Figure 2: Apex trades primary listing venues distribution (proportion in number of trades)

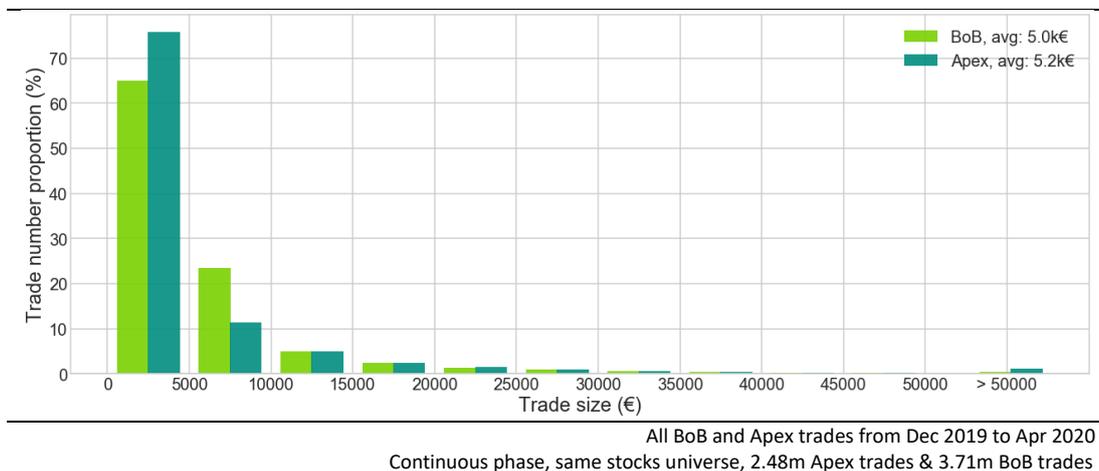


Across Euronext countries, France represents 61% of BoB trades versus 78% for Apex.

APEX DISPLAYS A GREATER SHARE OF LARGE ORDERS THAN BOB

In number of trades, the distribution of order sizes seems similar across BoB trades (light-green bars in Figure 3) and on Apex (turquoise bars).

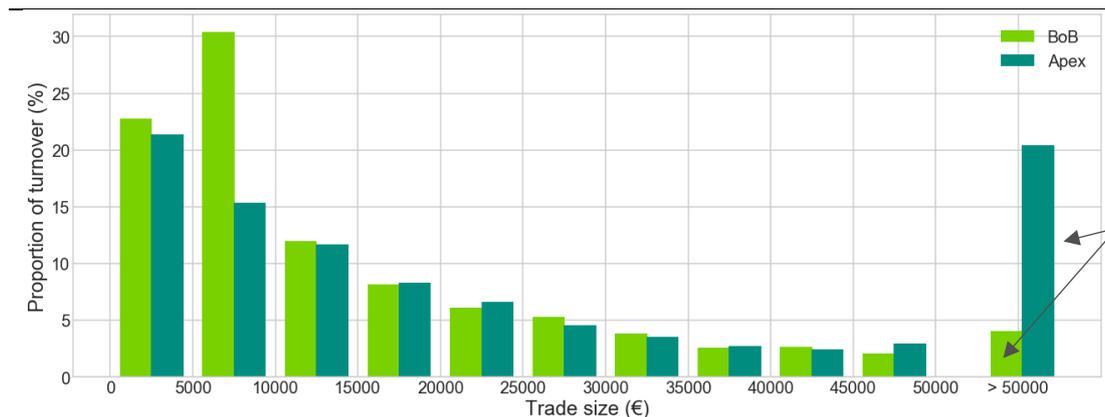
Figure 3: Trade size distribution for Apex and BoB trades by buckets of €5,000



However, when considering trade distribution in turnover, as represented in Figure 4, we observe that larger trades over €50k represent more than 20% of Apex turnover, while they only amount to 4% of total BoB turnover. This raises two concerns:

- First, it is surprising that such a large proportion of the total “retail” turnover is made of such large trades.
- Second, we need to restrict our sample to trades below €50k so that the trade samples are comparable between Apex and BoB.

Figure 4: Trade size distribution in proportion of turnover for Apex and BoB trades



On Apex, trades over €50k represent more than 20% of turnover, versus 4% on BoB.

All BoB and Apex trades from Dec 2019 to Apr 2020
Continuous phase, same stocks universe, 2.48m Apex trades & 3.71m BoB trades

After restricting our sample to trades below €50k, BoB and Apex average trade sizes only differ by €0.6k (€4.2k versus €4.8k see Table 2).

Table 2: Main statistics on BoB and Apex trades, for trades with trade size < €50k

	Average daily trade number	Total number of trades	Average trade size	Average spread turn. weighted
BoB (Euronext)	35.4k	3.61m	€4.8k	11 bps
Apex (Equiduct)	21.9k	2.28m	€4.2k	14 bps

When considering trades below €50k, trade characteristics are very similar on Apex and BoB

All BoB and Apex trades from Dec 2019 to Apr 2020
Continuous phase, same stocks universe, trade size < €50k, 2.28m Apex trades & 3.61m BoB trades

BID-ASK SPREAD DISTRIBUTIONS OF UNDERLYING STOCKS ARE SIMILAR FOR BOB AND APEX TRADES

Calculating EBBO spreads:

In order to study the liquidity of the underlying stocks, we calculate for each trade the last prevailing EBBO (European Best Bid Offer) spread in bps at the time of the trade t .

$$Spread_t = \frac{BestOffer_{EBBO,t} - BestBid_{EBBO,t}}{BestBid_{EBBO,t}}$$

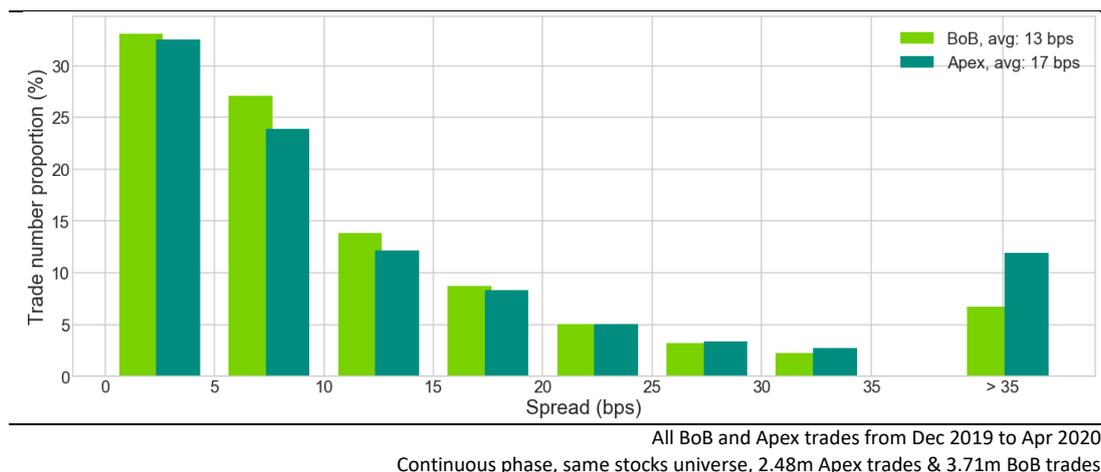
Calculating the EBBO:

At every trade, QuantHouse calculates the prevailing EBBO at the time of the trade. To do this QuantHouse builds a consolidated orderbook using the primary exchanges as well as main MTFs and the Equiduct central limit order book (see Appendix C, Table 6, p18) for the detailed list of exchanges considered. The best bid offer of the consolidated orderbook is the prevailing EBBO at the time of the trade.

Average bid-ask spreads distribution:

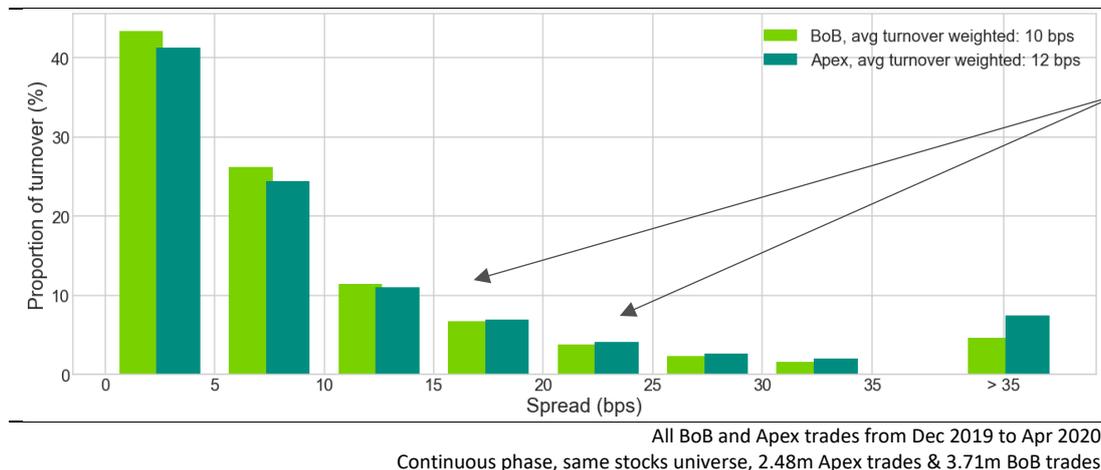
We observe that the distributions of the number of trades per bucket of spreads share similar profiles on Apex and on BoB trades. The main difference between these two distributions is that the average spread on BoB amounts to 13 bps versus 17 bps for Apex. Accordingly, the proportion of trades with spreads greater than 35 bps is close to 12% for Apex versus only 7% for BoB (see Figure 5).

Figure 5: Spread distribution for Apex and BoB trades by buckets of 5 bps



When considering trades distribution in turnover, as represented in Figure 6, we observe that trades on stocks with bid-ask spreads wider than 35 bps represent 8% of Apex turnover versus only 5% of BoB turnover. Overall the turnover weighted average bid-ask spread amounts to 10 bps for BoB versus 12 bps for Apex. This shows that the distribution of trades across spreads is similar for BoB and Apex.

Figure 6: Spread distribution in proportion of turnover for Apex and BoB trades



Spread distributions of underlying stocks are similar on Apex and BoB

COMPARING PRICE IMPROVEMENTS FOR APEX AND BOB TRADES

OVERALL BOB SHOWS STRONGER PRICE IMPROVEMENTS THAN APEX

Price improvements versus EBBO benchmarks for both trading models:

Once we have defined a comparable universe of trades across two different trading models, a benchmark must be defined so as to estimate their relative advantages. The most recognised benchmark to assess the quality of a trade is the EBBO. Since both Apex and BoB trades are aggressive, we will compare buy trade prices with European Best Offer and sell trade prices with corresponding European Best Bid prices.

For more detail on QuantHouse EBBO calculations please refer to Table 6 p18 in the appendix.

More precisely we define the “EBBO improvement” of a trade price versus the EBBO price, expressed in bps as follows:

$$imp_t = \frac{price_t - BestBid_{EBBO,t}}{price_t} \text{ If sell side, and}$$

$$imp_t = \frac{BestOffer_{EBBO,t} - price_t}{price_t} \text{ If buy side.}$$

A positive improvement represents the benefit of a trade price versus its corresponding best EBBO limit

A positive EBBO improvement shows that the trade price improved the EBBO price while a negative price improvement worsened the EBBO price.

Best execution and net improvements:

In order to fully address the question of best execution for a retail investor, the improvement should be calculated not only based on gross trading prices, but also using net trading prices. For this reason we subtract -0.75 bps from BoB improvements when we calculate the net improvements. As Apex does not charge any fees to retail traders, net and gross improvements will be the same on Apex trades. For more details on fee schemes, refer to Appendix A, p16.

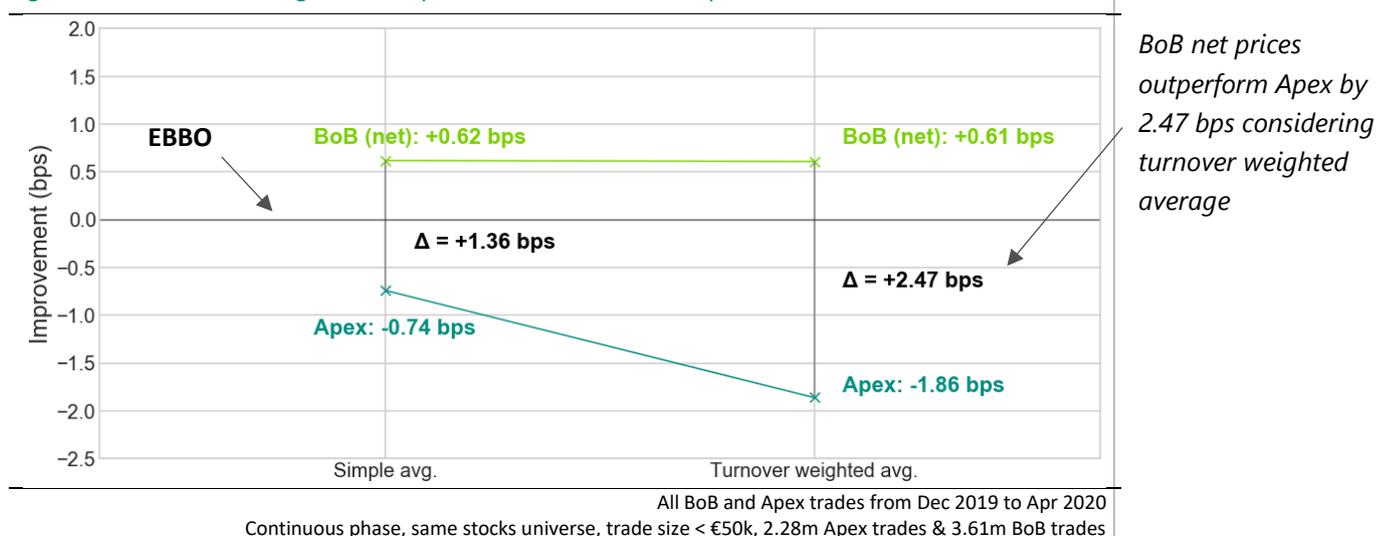
BoB net prices outperform Apex by +1.4 bps to +2.5 bps:

In Figure 7 we have displayed the improvements versus EBBO over three different periods: the “full period” from December 2019 to April 2020.

- Overall BoB improvements net of fees amount to $+0.6$ bps versus EBBO, both using simple and turnover weighted average.
- Apex trades worsen EBBO prices by -0.74 bps using simple averages and by -1.86 bps using turnover weighted averages.
- When comparing BoB versus Apex net improvement BoB outperforms Apex by $+1.36$ bps in terms of average per trade, or by $+2.47$ bps in terms of turnover weighted averages.

This means that by using BoB instead of Apex, retail investors saved +2.47 bps. For a €10k trade, this difference amounts to €2.47.

Figure 7: Net of fees average EBBO improvements for BoB and Apex trades



For more detail we have computed both gross and net improvements on BoB and Apex in Table 3 over 3 different periods.

- Full period: from December 2019 to April 2020
- Pre-pandemic: from December 2019 to January 2020
- Pandemic: February 2020 to April 2020

We can observe that BoB's price improvement over Apex's is accentuated when using turnover weighted averages, as large trades are more detrimental for the Apex pricing model as already discussed in the earlier 10 July 2020 Quant Note on VBBO trading¹.

Table 3: Average improvements for BoB and Apex executions, before, and during the pandemic

EBO Improvement in bps		Full period	Pre-pandemic	Pandemic
BoB vs Apex (net of fees)	Trade avg.	+1.36	+0.55	+1.81
	Turnover avg.	+2.47	+1.51	+3.14
BoB (gross)	Trade avg.	+1.37	+0.79	+1.68
	Turnover avg.	+1.36	+0.93	+1.64
BoB (net of fees)	Trade avg.	+0.62	+0.04	+0.93
	Turnover avg.	+0.61	+0.18	+0.89
Apex	Trade avg.	-0.74	-0.51	-0.88
	Turnover avg.	-1.86	-1.33	-2.25

All BoB and Apex trades from Dec 2019 to Apr 2020
Continuous phase, same stocks universe, trade size < €50k, 2.28m Apex trades & 3.61m BoB trades

One can also notice that during the Covid-19 Pandemic, as volatility increased, BoB's outperformance over Apex's rose from 1.51 bps to 3.14 bps (turnover weighted). This phenomenon results from two elements: a worsening of Apex improvement, and an increase in BoB's improvement during the crisis (more details will be presented on this evolution in Figure 8, p12).

¹ **'VBBO Trading: A best execution solution for retail investors or for market makers?'**, 10 July 2020

For a €10,000 trade size using BoB over Apex saves €2.47 on average:

In **Table 4** below improvements are expressed in euros given a €10,000 trade.

Table 4: Net gains/losses in euros for BoB and Apex executions

EBBO Improvement in Euros for a €10,000 trade		Full period	Pre-pandemic	Pandemic
BoB vs Apex (net of fees)	Trade avg.	+€1.36	+€0.55	+€1.81
	Turnover avg.	+€2.47	+€1.51	+€3.14
BoB (gross)	Trade avg.	+€1.37	+€0.79	+€1.68
	Turnover avg.	+€1.36	+€0.93	+€1.64
BoB (net of fees)	Trade avg.	+€0.62	+€0.04	+€0.93
	Turnover avg.	+€0.61	+€0.18	+€0.89
Apex	Trade avg.	-€0.74	-€0.51	-€0.88
	Turnover avg.	-€1.86	-€1.33	-€2.25

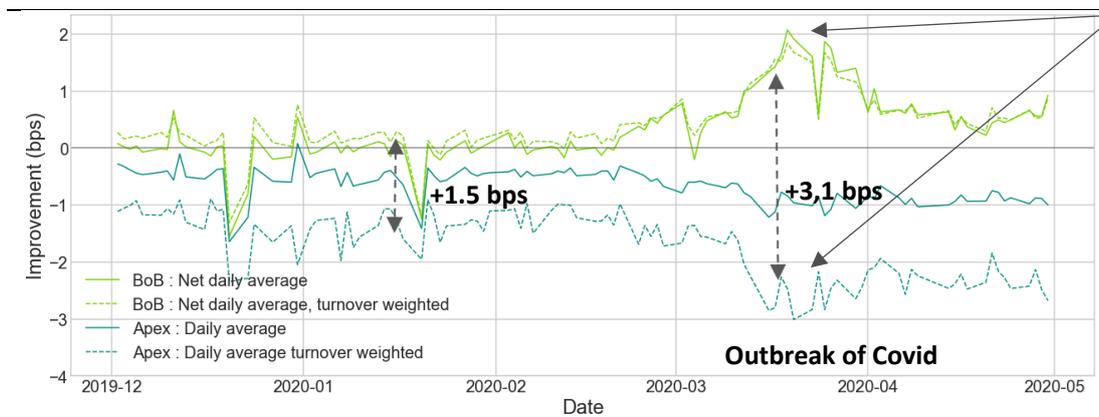
All BoB and Apex trades from Dec 2019 to Apr 2020
Continuous phase, same stocks universe, trade size < €50k, 2.28m Apex trades & 3.61m BoB trades

THE RELATIVE ADVANTAGE OF BOB INCREASES WITH LARGER SPREADS AND VOLATILITY

Volatility is as favourable to BoB as it is detrimental to Apex:

When volatility increases, the BoB average net improvement rises. During the recent Covid-19 pandemic, for example, the daily BoB average net improvements rose from almost 0 to +2 bps at the height of the pandemic (see green lines in **Figure 8**). In the same time period, Apex average improvements (see dotted-turquoise line) worsened from -1 to almost -3 bps.

Figure 8: Daily average EBBO improvements for BoB and Apex, trade size < €50k



Volatility is as favourable to BoB as it is detrimental to Apex

All BoB and Apex trades from Dec 2019 to Apr 2020
 Continuous phase, same stocks universe, trade size < €50k, 2.28m Apex trades & 3.61m BoB trades

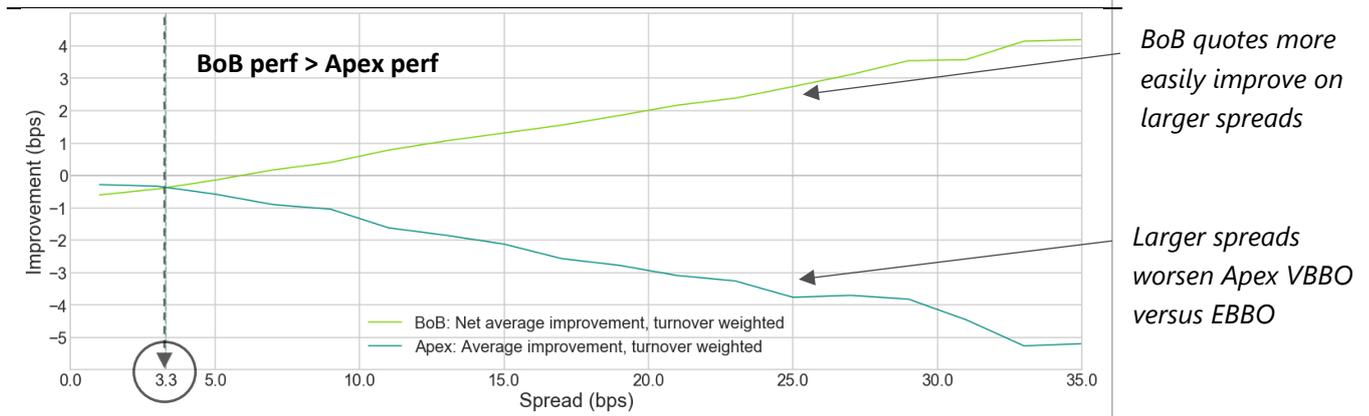
The worsening performance of Apex during the Covid-19 pandemic comes from the fact that during a crisis available quantities become thinner, while at the same time spreads become wider. These two factors are highly detrimental to the VBBO calculation, which worsens as trading on the second limit becomes more probable. These adverse factors were already discussed in our earlier Quant Note on VBBO trading².

BoB outperforms Apex for all stocks with bid-ask spreads larger than +3.3 bps:

In order to understand the relationship between bid-ask spreads and BoB performance, we must remember that the BoB model enables market makers to display improved quotes that only retail investors can consume. Therefore, the wider the spread, the more possibilities exist for market makers to post an improved quote inside the existing bid-ask spreads. On the contrary, when the spread is close to one tick large, then improving the existing spread by one tick is not possible. That is why the net BoB improvement increases from 0 to 2.8 bps when spreads increase from 5 to 25 bps (see rising green line in Figure 9).

² 'VBBO Trading: A best execution solution for retail investors or for market makers?', 10 July 2020

Figure 9: BoB outperforms Apex for all stocks with bid-ask spreads larger than +3.3 bps

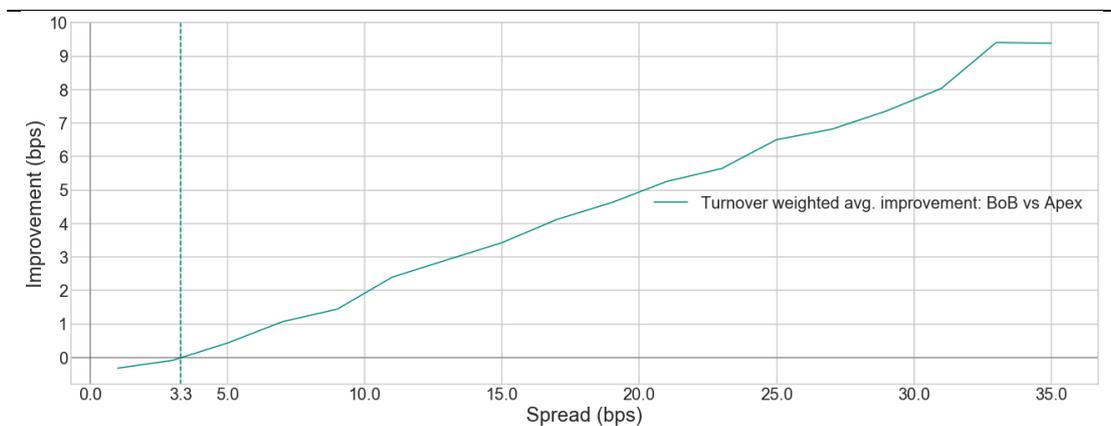


All BoB and Apex trades from Dec 2019 to Apr 2020
 Continuous phase, same stocks universe, trade size < €50k, 2.28m Apex trades & 3.61m BoB trades

Unlike on BoB, market makers on Apex trade on a reference price model and therefore do not improve prices when spreads are wider. In fact, quite the opposite phenomenon takes place on Apex. When spreads are large, the second best limit is less likely to stand one tick after the best limit, and therefore trading on the second limit becomes more detrimental on larger spreads. This in turn worsens VBBO prices.

This explains why Apex price worsening deteriorates from -0.6 bps for a 5 bps spread to almost -3.8 bps for a 25 bps spread, as shown by the downward turquoise line in Figure 9.

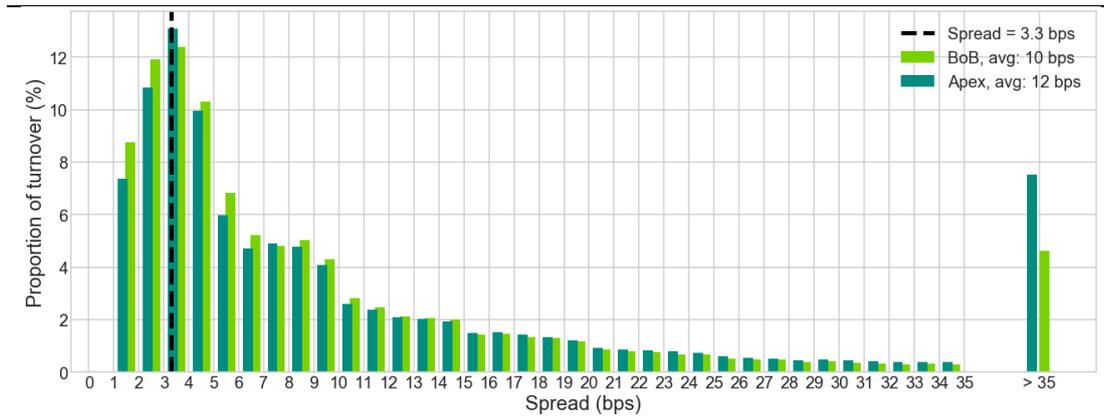
Figure 10: Net average EBBO improvements for BoB trades vs spread



All BoB and Apex trades from Dec 2019 to Apr 2020
 Continuous phase, same stocks universe as Apex trades, trade size < €50k, 3.61m BoB trades

Looking at the relative net improvement of BoB versus Apex, we show that when EBBO spreads are larger than 3.3 bps it is beneficial to trade on BoB. This difference in improvements reaches +2 bps for a 10 bps spread (see rising turquoise line in Figure 10). As spreads below 3.3 bps represent 20% of the turnover (in Figure 11, refer to the left part of the dotted vertical line), this means that BoB trades are more advantageous than Apex's in 80% of the turnover.

Figure 11: Spread distribution in proportion of turnover for Apex and BoB trades by buckets of 1 bp

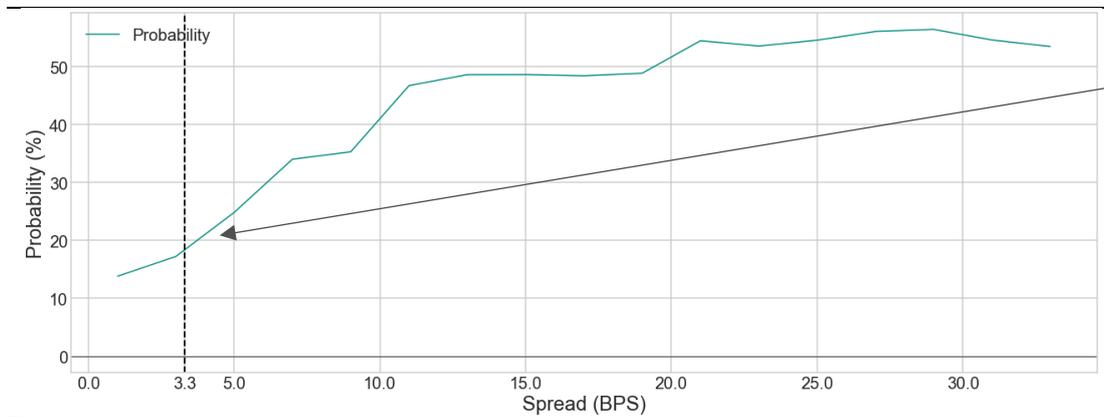


All BoB and Apex trades from Dec 2019 to Apr 2020
 Continuous phase, same stocks universe, trade size < €50k, 2.28m Apex trades & 3.61m BoB trades

BoB improvement probability increases on wider spreads

Best of Book (BoB) offers the possibility for market makers to display improved quotes to trade with retail investors. The probability of trading at an improved quote compared to the EBBO strongly rises with underlying spreads. Thus, for a 3.3 bps spread, the probability of trading at an improved quote reaches 18%, to 40% for 10 bps spreads, and up to 50% for 20 bps spreads.

Figure 12: Probability to trade better than the EBBO on BoB versus bid-ask spreads



All BoB and Apex trades from Dec 2019 to Apr 2020
 Continuous phase, same stocks universe, trade size < €50k, 2.28m Apex trades & 3.61m BoB trades

For spreads wider than 3.3 bps, there is probability greater than 18% that BoB quotes will improve EBBO

BOB NET PRICES OUTPERFORM APEX DESPITE APEX'S NO-FEE POLICY

WHEN ZERO FEE DOES NOT MEAN MORE VALUE TO PARTICIPANTS

Charging only one type of participant does not mean that the other side benefits:

Platform pricing is a complex issue. While fees enable platforms to generate revenue in order to support the platform costs, fees are also designed to attract customers. Trading venues can also be considered as two-sided platforms, enabling retail and market makers to interact. But charging only market makers does not necessarily mean that more value is provided to retail participants.

On the contrary, it is often the case that platforms charge only one type of participant when there is an excess of that type of participant. If market makers are predominant on a given platform despite the fees they have to pay, it is perhaps a signal that the pricing of the trades on this platform is in the market makers' favour. Paradoxically, the offer of zero fee could be at the retail participant's expense.

On its BoB service, Euronext charges both participants, retail investors as well as market makers. On Apex, Equiduct only charges market makers; but despite this first sight advantage, price comparison shows that in reality, relative net price improvements are larger on BoB compared to Apex.

BoB net prices outperform Apex by +1.4 bps to +2.5 bps on average:

Using all BoB and Apex trades and comparable universe from December 2019 to April 2020, we evidence that using simple averages, Apex trade price improvements show a +1.4 bps difference in favour of BoB, and +2.5 bps using turnover weighted averages.

We also show that the relative advantage of BoB is all the stronger when spreads are wider than one tick. From stocks with 5 bps spread to stocks with 20 bps spread, the net outperformance of BoB prices over Apex prices increases from +0.5 bps to +5.0 bps (as shown in Figure 10). This comes from the fact that market makers can more easily improve quotes in orderbooks when spreads are wider.

More generally it comes as no surprise that the BoB model, which enables price competition across market makers in an orderbook, generates better prices than the reference price offered by Apex model, where retail investors cannot benefit from market makers' price improvements.

APPENDIX

APPENDIX A. FEE SCHEMES

Table 5: Fee schemes for Apex and BoB

Fee schemes (bps)	Apex	BoB
Retail clients	0	0.75
LP	0.55	0.3

APPENDIX B. MARKET DATA FLAGS

Apex flag

In the data provided by QuantHouse, Apex trades are identified by their Fix MMT (Market Model typology) initiative Flag (v3.04): **72-----PH---** which corresponds to a plain-vanilla algo trade during a continuous phase on a hybrid order book.

BestofBook flag In Euronext market data, there are 2 messages where this information is conveyed:

- In the Trade message (Full trade information message - 1004)

In the field "Trade Type": **Flag = 20 "BoB Trade (Cash Only)"**

- In the "Market Data Update" message (1001)

In the field "Market Data Update type": **Flag = 46 "BoB Trade (Cash Only)".**

APPENDIX C. ELIGIBLE VENUES TO COMPUTE THE EBBO

Table 6: Exchanges considered in order to build the EBBO references for QuantHouse calculations

MARKET TYPE	MIC	OPERATING MIC	NAME	
Primary Markets	MTAA	XMIL	Electronic share market, Borsa Italiana	
	XAMS	XAMS	EURONEXT – Euronext Amsterdam	
	XBRU	XBRU	EURONEXT – Euronext Brussels	
	XCSE	XCSE	NASDAQ COPENHAGEN A/S	
	XETR	XETR	Xetra – Deutsche Börse	
	XHEL	XHEL	NASDAQ HELSINKI LTD	
	XLIS	XLIS	EURONEXT – Euronext Lisbon	
	XLON	XLON	London Stock Exchange	
	XMAD	BMEX	BOLSA DE MADRID	
	XPAR	XPAR	EURONEXT – Euronext Paris	
	XSTO	XSTO	NASDAQ STOCKHOLM AB	
	MTFs	AQXE	AQXE	AQUIS EXCHANGE PLC
		TRQX	TRQX	Turquoise
BATE		BCXE	CBOE EUROPE - CXE ORDER BOOKS	
CHIX		BCXE	CBOE EUROPE - CXE ORDER BOOKS	
EQUIDUCT	EQDT	XBER	BOERSE BERLIN EQUIDUCT TRADING	

APPENDIX D. IMPROVEMENTS WHEN CONSIDERING ALL TRADE SIZES

Table 7: Average improvements for BoB and Apex executions, all dates, before, and during the Covid-19 pandemic

EBBO IMPROVEMENT		SIMPLE AVERAGE IN BPS (TURNOVER WEIGHTED)		
Period		Full period	Pre-Covid-19 pandemic	During Covid-19 pandemic
BoB (gross)	Trade avg.	+1.37	+0.79	+1.68
	Turnover avg.	(+1.34)	(+0.93)	(+1.62)
BoB (net)	Trade avg.	+0.62	+0.04	+0.93
	Turnover avg.	(+0.59)	(+0.18)	(+0.87)
Apex	Simple avg.	-0.80	-0.55	-0.95
	Turnover avg.	(-2.81)	(-1.92)	(-3.47)
BoB – Apex (net of fees)	Simple avg.	+1.42	+0.59	1.88
	Turnover avg.	(+3.40)	(+2.1)	(+4.34)

All BoB and Apex trades from Dec 2019 to Apr 2020
 Continuous phase, same stocks universe, 2.48m Apex trades & 3.71m BoB trades

CONTACTS

Paul Besson

Head of Quantitative Research

Email: pbesson@euronext.com

Tel: +33 1 70 48 26 36 /

+33 6 22 47 10 95

Théo Compérot

Quant Research Analyst

Email: tcomperot@euronext.com

Tel: +33 1 70 48 24 22 /

+33 7 88 29 80 54



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