

LiquidMetrix

Best Execution, Quantified



What Price for a Dark Pool?

White Paper WP0002

12 February 2011



What Price for a Dark Pool?

Key Points

- There has been a lot of discussion recently on how often '**adverse selection**' might be impacting resting orders on mid-point matching dark pools.
- There has also been discussion regarding the introduction of possible alternatives to the current practice of basing mid-point reference prices on the mid price of the **primary venue only**.
- We look at how often actual mid-price matching dark pool executions are occurring outside of EBBO. We examine over 100,000 UK trades, executed on three dark venues (CHID, BATD, TRQD) from a week in early February 2011.
- We find that around 3% of the time these dark trades appear to be occurring outside of European best bid and offer (EBBO).
- We then simulate what the effect would have been if these trades had instead been matched against single MTF BBO prices or a consolidated MTF BBO.
- We find that for the most liquid UK stocks, a mid-price match based on a consolidated MTF BBO would have lead to fewer (1.5%) price outliers than primary mid.
- However, for less liquid UK stocks this picture deteriorates rapidly, MTF consolidated mid prices of stocks outside the FTSE-100 lie outside EBBO over nearly 10% of the time.

Overview

Many of the dark pools that launched in Europe in recent years, particularly those operated by the larger MTFs such as BATS Europe, Chi-X Europe and Turquoise have been designed to use the mid price of the Primary Exchange as the external reference price at which to match buyers and sellers.

There has been a lot of interest recently in how suitable this primary market mid price is as a fair reflection of the current overall market price. For instance, there is some concern that when market prices move quickly and / or when order book volumes on the primary market are relatively thin, it might be possible to 'game' the primary mid price. Allied to this are suggestions from some market venues and participants that reference prices other than the simple primary mid price might also serve as a fair price to match buyers and sellers in a dark pool.

This paper presents a fairly detailed study into both how 'good' the primary market mid-price is as a fair reference price in a fragmented lit market and also, what the impact would be of using other potential reference prices for dark pool matches.

We have conducted this analysis by looking at actual mid-point dark trades that have occurred in UK stocks on 3 particular mid-price matching dark pools (CHID, BATD, TRQD) for a week in February 2011.

In particular, we have examined:

- How effective / robust is the currently used primary market mid price with respect to full market EBBO? Are there arbitrage opportunities between the primary mid price and EBBO liquidity? Is there evidence that some participants are exploiting this?
- What would the impact be of using any one individual lit MTF venue BBO mid price as a replacement for the primary market mid price?
- What would be the impact be of using a multi MTF consolidated EBBO mid price to replace the primary market mid price?
- For dark pools that do not use a full EBBO mid price as a reference price (currently all of them), what

- Quantifying the practical **effect of adverse selection** shows that the maximum arbitrageable benefit to any party 'gaming' Dark order flow by executing at primary mid and then exiting at EBBO is in fact very small, about **0.04BPS** in terms of total flow executed on dark pools. No one is getting rich by gaming the current arrangement.

additional price / volume checks could be added to dark pool matching logic to ensure that the reference prices used are 'fair' and don't lead to trades occurring at times that a market is not 'well formed'?

Our methodology for determining how 'good' different possible reference matching prices are relative to each other relies on the assertion that if a trade occurs on a dark pool then

- Ideally it should be at the EBBO mid price formed from all available lit liquidity in the market.
- Even if not exactly at EBBO mid price, then the reference price should at least lie within the EBBO spread. If a matched trade price lies outside the EBBO spread then this implies that one side of the matched trade had a **risk free arbitrage** opportunity by immediately executing an offsetting trade on any lit venue matching EBBO price. The other side had a **best execution outlier** as a better price would have been achieved sending their order aggressively to any lit venue matching EBBO.

Section 1 starts with a quick summary of the mechanics of mid-point matching dark pools. Those familiar with the microstructure of such dark pools can safely skip this section.

Section 2 describes in detail the methodology we use to measure the estimated impacts of using external price measures other than primary mid-point.

Section 3 presents the results of applying this methodology.

Section 4 summarises the main findings.

Section 1 Background / Explanation

This section gives a brief introduction to the mechanics of mid-point matching dark pools. Those familiar with the basic structure of mid-point matching Dark Pools may wish to skim / skip this section.

A significant amount of trading in liquid European stocks currently occurs on what are loosely called 'Mid Point Matching Dark Pools'. In terms of value traded, about 2-3% of overall trading in FTSE-100 shares occurred on such venues in the 2nd week of February 2011.

About Dark Pools

- Buyers and sellers submit orders into a dark pool. All orders are hidden until after execution.
- Orders can optionally be assigned a minimum execution size and/or a limit price.
- When buy/sell orders can be matched, the execution price is the mid-point price of the primary (reference) venue.
- Dark pool orders can be used to minimise the 'price impact' of trading.
- Dark pool trades occur at a better price than aggressive orders sent to the primary venue. (Improvement of half the spread).
- Since resting dark pool orders are hidden, there is no way of knowing if an aggressive order will execute until it is sent.
- At times, the reference price may be unreliable and out of synch with other venues creating the potential for adverse selection.
- Fees for using a Dark Pool are generally higher than for lit order books

The top 3 mid-point matching venues by value traded (February 2011) are:

- CHI-Delta
- Turquoise Dark
- BATS Dark.

The trading/matching mechanics of these venues are all fairly similar. Essentially, buyers and sellers submit orders into the Pool. The main conditions that buyers and sellers attach to their orders are a limit price, minimum execution size (both these are generally optional) and importantly, whether they wish their order to remain on the Dark Pool as a resting order if their order cannot be immediately satisfied (DAY), or to cancel the order if it cannot be filled (IOC).

Any buyers and sellers in the Dark Pool that can be matched based on the conditions they have attached to their orders are matched immediately. The price at which the deal takes place is then set using an **external** reference price. In the case of mid-point matching venues this is currently the **mid price of the market of listing**.

These venues are considered 'dark', in that there is no public feed giving details of orders entering the venue and no means of seeing any resting liquidity on the venue. The only way to find out if there is a buyer/seller with resting liquidity on a dark venue is to send an order into the venue and see if a match occurs.

Why Use a Dark Pool?

Why would a trader use a Mid Point Matching Dark Pool rather than a lit book?

Some of the main advantages/disadvantages of using a Dark Pool are summarised below split by whether the user is the aggressive or passive side of the trade.

Aggressive Side

- Advantages
 - Matching at primary market mid-price means that a price improvement of **half the spread** is automatically achieved compared to sending an aggressive order to the primary lit venue.

Discovering liquidity

Dark pool orders are theoretically hidden until after execution. However, a large resting order can execute as a series of small trades over time and the reports of these trades to the market can reveal the (potential) presence of the large order.

'Pinging' is the practice of sending a series of small immediate-or-cancel (IOC) orders into the pool in order to detect liquidity.

A party placing an order may wish to prevent it from being discovered by pinging by setting a minimum execution size. However, since average trade sizes on many dark pools are relatively low, trading opportunities may be missed by using this approach.

- A large aggressive trade match on a dark pool might have delayed public trade reporting, reducing immediate market impact. Even if the public trade report is not delayed, it is not possible, from the trade price itself, to publicly determine the *side* (buy/sell) of the aggressor. So even with immediate trade reporting, the **market price impact** will theoretically be **smaller** on a Dark Pool than the impact of a similar aggressive trade sent to a lit venue where the side of the aggressor is almost always inferable from the lit book and the market can and will react to this information.
- Disadvantages
 - Until the order is sent to the venue and an execution report is received, there is no way of knowing if execution will occur. If many dark pools are to be 'scanned' as part of an execution strategy then the delay in waiting for replies to IOC orders sent to all these venues (one at a time) can cause a significant delay and potential opportunity cost if ultimately the order has to finally be sent to a lit venue and the liquidity in that lit venue is no longer what it was when the process started.
 - Exchange Fees for using a Dark Pool are generally higher than those for lit order books.

Passive Side

- Advantages
 - A large order can be sent that is 'hidden' in the sense that the outside world is unaware of the size of the order resting on the book. Indeed, even knowing an order is resting on a dark book at all is difficult to gauge without repeatedly 'pinging' the venue, although 'heat maps' formed from public trade reports can help detect venues where larger resting orders are likely to be located.
 - By setting a minimum execution size, the order can be further 'hidden' from high frequency arbitrageurs who will generally not wish to ping using a large trade size and will therefore not 'see' or interact with orders set with large minimum execution sizes.
 - The order 'limit price' does not need to be constantly 'managed' during the day as the price that is executed is always the mid-point of the primary venue which would usually be considered 'fair'. [This particular advantage is also achievable via pegged orders on lit books however].

- Disadvantages
 - Rather than receiving the full price improvement of the lit bid/offer spread, the passive side in a dark pool only gets compensated by half of the spread for providing liquidity. In fact they get no more improvement than the aggressive side.
 - At times when overall market prices move quickly, there is a danger of adverse selection, especially if the mid price on the primary market is even momentarily 'out of synch' with other venues. [Much of the rest of this paper is devoted to this potential problem].
 - Being hidden does of course mean that potential trading partners might simply not see your order and so you reduce the overall chance of execution. This effect is increased if a large minimum execution size is also used.
 - Exchange fees for using a Dark Pool are generally higher than for lit order books (in some cases this means simply that there is no 'rebate' for providing liquidity as there would be on a lit venue).

It's interesting to note that although Dark venues using external reference prices were originally principally designed to allow trading in **large sizes** between Buy Sides, the actual average trade size on many mid-point matching dark venues is, in reality, currently not much bigger than trade sizes on the lit primary venues.

This suggests that users of Dark Pools are probably quite diverse and the aggressive sides of matched trades in particular, want to execute relatively small order sizes at a time. This would imply that it is potential **price improvement** of half of the primary spread that might be a stronger motive for sending aggressive orders to some mid-point matching Dark Pools than hiding trading intentions.

Section 2

Measuring the Effectiveness of Different Reference Prices

As described in the previous section, most Dark Pools currently use the mid price of the primary market at the exact instant of trade as the reference price at which the buyer and seller are matched.



Unilever order book and bid/offer chart on LSE



Lamprell order book and best bid/offer chart on LSE

We'll start our analysis by considering how robust this current arrangement is and what potential weaknesses it might have. From this we define a methodology to measure how effective different external reference price measure might be.

Potential Problems with Primary Mid Prices

For stocks with deep lit order books and tight spreads, the mid price of the primary market is a fairly stable measure of the 'fair price' of an instrument at a given point in time. An example is shown to the left, namely the LSE order book for **Unilever PLC**, a stock with an average spread leeway¹ of just 0.23.

This order book has tens of thousands of shares available at the top five price levels for bids and offers. The best bid and offer are separated by around 10BPS (0.10%). Successive price levels up the book are separated by similar very small price increments. The evolution of the mid price tends to jump by just a small number of 'ticks' at a time as can be seen by the best bid /offer chart below the order book.

However, for less liquid stocks, or stocks that are experiencing large trading volumes, high volatility or thin order books, the simple mid prices can be misleading. Take the example to the left for **Lamprell ORD**, a FTSE 250 stock.

In this case, an aggressive buy order of just 1000 shares will change the mid price of the stock by around 85BPS (from 299.15p to 301.7p). Indeed exactly this scenario happens a few seconds later, the resulting rapid widening in the best bid and offer is seen in the ask/bid graph below the order book. A few seconds after the 'blip' new offer prices are inserted at close to the price at which the original was lifted and the spread reverts to pretty much its original value. However, for a time there was a wide spread and significantly changed mid price on the primary market.

If at the same time the best bid/offer prices on **other trading venues** had all exhibited the same behaviour, the price on the primary market might still be considered to represent a 'fair' matching price. However, if we look at the consolidation of all lit liquidity from Europe at the time of the wide LSE spread we see that in fact the mid prices and spread on this EBOO 'consolidated' book remained tighter. Indeed it can be seen that a seller at the LSE mid price of 301.7p would have a very easy arbitrage as they could immediately buy the stock back

¹ Spread leeway is a measure of how many price ticks (on average) there are between the best bid and the best offer. A spread leeway of 1 means that on average there is 1 unused price tick between the best bid and offer.

Methodology

- We assume that a 'fair' reference price for a dark pool match is a price at which neither party can get a better price for an aggressive order on any lit venue.
- So the price for each matched trade should always occur within EBBO.
- We compare this measure of price 'fairness' against 3 different types of reference prices.
- The first reference price is the primary midpoint price.
- The second set of reference prices is the midpoint price of an individual MTF.
- The third reference price is the combined MTF EBBO mid price.

from CHIX for a price of 299.9 giving an instant risk-free 75BPS profit.

[In fact, precisely this appears to have happened, at this instant there was a trade on an MTF dark pool matched at the LSE mid price]

In general, the mid price taken from any market might be considered 'unreliable' if

- There is a markedly wider spread than is normal especially if the wider spread only occurs for a short period of time before reverting.
- The volumes relating to the best bid or offer are particularly low especially if the next best bid/offer is at a significantly worse price.
- If the mid-price at a given instant is actually **outside of the BBO spreads** from any other market (or combination of other markets).

Of course these potential problems are not related specifically to using a Primary market for a mid-price reference. Indeed, the Primary market may often be expected to be the single market least likely to suffer such anomalies (results surrounding this are shown later).

Benchmarking Methodology

We will now describe our methodology for measuring the effectiveness of different potential reference prices from different exchanges / combinations of exchanges. Our analysis will largely focus on how often a given reference price might lead to a straightforward arbitrage opportunity (as described above). Our assumption throughout is that a 'fair' reference price for a dark pool match should be one where an aggressive order to any other lit venue cannot be performed at a better price for one or other party to the trade.

In other words each matched trade **should always occur within the (trade volume adjusted) EBBO**. Where this is not the case, an instant deterministic arbitrage opportunity existed for one side of the trade and the other side did not achieve Best Execution (assuming they had access to the all public lit markets).

We will measure and compare the 'fairness' of three different reference prices that might be used as the basis to match dark pool trades.

- **Primary Mid Point** – i.e. what is used currently by the market. Our figures here will give an indication of how

Data Sample

- The data set analysed consists of around 120,000 trades.
- These trades were executed during the week of 7-11 February 2011 on three midpoint matching dark pools, BATS Dark, Chi Delta and Turquoise Dark.
- All dark trades for FTSE 350 stocks were considered.

For each trade we measured:

- How different is the reference price to the EBBO price?
- Is the (reference) price achieved inside the EBBO bid and offer prices?
- The reference price was taken to be
 - a) the actual price achieved (= primary mid),
 - b) the mid price from each MTF and
 - c) the mid price based on a consolidated MTF EBBO.

effective current arrangements are.

- **Single MTF Mid Point** - Where the dark pool trade considered is on an MTF dark pool that has its own corresponding lit order book we will imagine that the dark pool trade was not matched at the primary mid price but instead was matched at the mid price of the MTF's own BBO. So for instance Chi-Delta trades would be matched on Chi-X lit mid price.
- **MTF (BATE, CHIX, TRQX) EBBO Mid Price** - Here we will imagine that the price was matched at the mid-point of the consolidated order books of the three most liquid lit MTFs (Chi-X, Turquoise and BATS).

In each case we are measuring the reference price against the 'most fair possible price' that being the consolidated EBBO mid price (by definition it is impossible to arbitrage between the EBBO mid price and any lit venue).

Trades Data Used in the Analysis

For our analysis we will consider **all** mid-point matched trades that occurred on the following mid-point matching Dark Pools [BATS, Chi-X, Turquoise] during of the week of 7 - 11 February 2011. For each dark pool trade, we will do the following analysis:

- Taking the actual price that the trade was executed at (which is assumed to be the primary mid-price), we will match that executed price against the consolidated EBBO mid price. Specifically we will measure two things:
 - How different the executed primary midpoint price is to the EBBO mid price. This difference will be measured in both basis points (0.01%) and as a fraction of the EBBO spread at the time of the trade.
 - Whether or not the price is 'inside' the EBBO bid and offer prices.
- We will then perform the same analysis, but instead of using the actual prices executed (i.e. primary mid prices), we will substitute each of the following two alternate reference prices
 - **Single MTF Mid Price**
 - **MTF (BATE, CHIX, TRQX) EBBO Mid Price**

Section 4 Results

The table below gives the summary results for BATS, Chi-X and Turquoise in FTSE 100 stocks and separately for FTSE 250 stocks.

Results for dark pool trades for FTSE 100 stocks
Number of trades: 101,082, Valued traded: £759,679,986.

	Primary	BATS	CHIX	TRQX	MTF
% at EBBO Mid	57.79%	55.45%	71.60%	44.17%	86.28%
% inside EBBO	96.87%	94.92%	96.88%	91.55%	98.49%
% outside EBBO	3.13%	5.08%	3.12%	8.45%	1.51%
Avg difference (BPS)	0.9074	1.0692	0.7229	1.5659	0.3076
Arbitrage value (BPS)	0.0480	0.1353	0.1454	0.2688	0.0434

Results for dark pool trades for FTSE 250 stocks
Number of trades: 28,306, Value traded: £96,602,555.

	Primary	BATS	CHIX	TRQX	MTF
% at EBBO Mid	73.91%	36.66%	55.60%	30.84%	68.54%
% inside EBBO	97.31%	79.31%	86.32%	74.19%	90.95%
% outside EBBO	2.69%	20.69%	13.68%	25.81%	9.05%
Avg difference (BPS)	1.3401	15.3379	7.7999	12.8476	4.0418
Arbitrage value (BPS)	0.1959	13.5785	4.5198	8.8940	1.1071

Key points from these results:

- For **FTSE-100** stocks both Primary (LSE) and CHIX mid points lie outside EBBO approximately **3%** of the time. Mid points from BATS and TRQX lie outside EBBO more frequently (5% and 8.5% respectively).
- For FTSE-100 stocks, the MTF consolidated BBO mid price is outside EBBO just **1.5%** of the time, considerably better than the primary market mid price on its own.
- The arbitrageable value from dark trades occurring outside of EBBO based on an MTF BBO mid price is very similar to that based on primary midpoint (0.43 BPS versus 0.48BPS). So although the consolidated MTF BBO mid price leads to less EBBO exceptions by percentage of trades, the size of these exceptions is presumably larger.
- For FTSE-250 stocks the viability of using BBO mid prices as reference prices for any single MTF venue or even consolidated MTF order books, is dubious. On

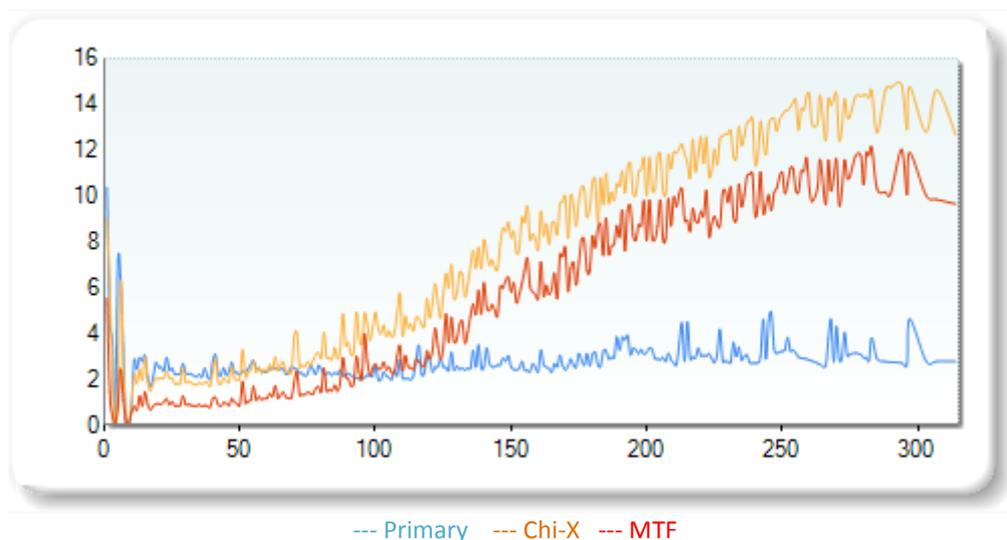
average mid prices based on any of these measures lie outside EBBO nearly 10% of the time. Primary BBO mid price is outside EBBO less frequently than for FTSE-100 stocks

Analysis Based on Individual Stocks

The results above seem to indicate that the less liquidly traded stocks (i.e. FTSE-250) appear to have far less stable mid prices formed on single or even combined MTFs. To help further illustrate this, the graph below shows the % of time mid points are outside EBBO for individual stocks, ordered by the volume traded in each stock. To make things clearer we are showing a 10 point moving average of these numbers.

So looking at the first 50 most liquid stocks in the FTSE 350 (FTSE 100 + FTSE 250), we see that CHIX BBO and the consolidated MTF BBO mid prices both 'beat' the primary market in terms of the mid prices not falling outside EBBO. After about stock 50 there is then a marked deterioration in both CHIX on its own and consolidated MTF (CHIX,BATS,TRQX) mid prices. After stock 130 the outside EBBO percentages of mid prices are approximately double those of the mid prices of the primary venue. This trend continues until for the less liquid stocks the midpoint of even the consolidated MTF BBOs lies outside the EBBO more than 10% of the time.

Results by stock traded for all FTSE-350 stocks



Potential Bias Due To Sampling Actual Dark Pool Trades

We chose to base our analysis by measuring the market at the precise times that dark pool trades actually occurred rather than simply sampling potential reference prices and EBBO at random times of the day. This is because we believe that, in fact, the times at which dark trades are more likely to execute might be more likely to be somewhat different to 'average' market conditions. So we wanted to sample specifically those times when dark trades are likely to occur.

However, this does bring a potential bias into our study. As we have stated, if the mid price of the primary market lies outside EBBO at a given instant then there is a potential arbitrage opportunity to hit a resting dark pool order on a venue such as CHID, BATD, or TRQD and to then immediately exit for a risk free arbitrage at EBBO. As such, it is likely that when such opportunities exist **trades on mid-point matching dark pools are more likely to happen**. In other words, our analysis might be biased against primary mid-point measures because, as they are the ones currently being used, trades are more likely at times when the primary mid price is out of synch and so we are sampling these 'failures' disproportionately.

To test this, we ran an identical study over the same trading week, but instead of measuring reference prices and EBBO at times of actual dark pool trades, we sampled theoretical prices at fixed 1 minute intervals during the complete trading day (excluding the first and last 30 minutes of lit book trading). The results are shown below.

Results for FTSE 100 stocks (evenly sampled points)

	<i>Primary</i>	<i>BATS</i>	<i>CHIX</i>	<i>TRQX</i>	<i>MTF</i>
<i>% at EBBO Mid</i>	<i>78.06%</i>	<i>60.51%</i>	<i>77.81%</i>	<i>53.25%</i>	<i>87.46%</i>
<i>% inside EBBO</i>	<i>99.31%</i>	<i>97.51%</i>	<i>98.94%</i>	<i>96.07%</i>	<i>99.40%</i>
<i>% outside EBBO</i>	<i>0.69%</i>	<i>2.49%</i>	<i>1.06%</i>	<i>3.93%</i>	<i>0.60%</i>
<i>Avg difference (BPS)</i>	<i>0.5036</i>	<i>1.0415</i>	<i>0.5641</i>	<i>1.6595</i>	<i>0.3053</i>
<i>Arbitrage value (BPS)</i>	<i>0.0106</i>	<i>0.0452</i>	<i>0.0195</i>	<i>0.1809</i>	<i>0.0110</i>

The key conclusions to note are:

- Evenly sampled results show much lower frequencies of mid prices lying outside of EBBO for all potential reference prices. The percentages outside EBBO are lower by a factor of 4.
- In the case of even samples LSE's mid price is as good as

the consolidated MTF BBO for FTSE 100 stocks.

This appears to suggest that the times at which dark pool trades execute are not 'typical'. That is, dark pool trades appear to correlate to times at which mid prices from one or more venues are likely to be out of synch of EBBO. When deciding on an appropriate reference price measure to use, this is an important consideration, a reference price that appears to work under 'average' market conditions may not perform so well at times when dark pool trades are more likely to occur.

Section 5 Conclusions

The rationale behind a midpoint matching dark pool is to allow buyers and sellers to be matched at a fair reference price in a 'dark' venue where both parties are able to limit any signalling information that leaks out due to their trading and agree to split the bid/offer spread.

For UK stocks, we have looked at how 'fair' different possible reference prices would be in the context of actual trades executed on three of the more popular dark pools. Our analysis has included the current benchmark, namely the mid price on primary market (LSE) and also alternative benchmarks based on individual and consolidated MTF order books.

We have measured 'fairness' using two key metrics:

- How often a given reference price lies outside EBBO, presenting one side of the dark trade with a risk free arbitrage.
- The total profitability (losses) that parties might obtain (suffer) as a result of such arbitrages.

Ideally, both measures should be as low as possible.

Our main findings are:

- The current arrangement of using the mid price of primary market implies about 3% of the time this mid price is outside EBBO.
- However this 3% equates to just 0.04 BPS of total arbitrageable value. So, for the £0.75BN traded in the week of this study, the total arbitrageable potential is about £3,500, excluding trading / clearing fees and assuming that the would-be arbitrage had zero latency

Findings and conclusions

- For FTSE-100 stocks, the LSE mid price falls outside EBBO approximately 3% of the time.
- CHIX mid points fall outside EBBO about 3% of the time For FTSE-100 stocks. The magnitude by which these exceptions lie outside EBBO is much larger than for LSE mid prices.
- BATS and TRQX mid points fall outside EBBO 5% and 8.5% of the time respectively for FTSE-100 stocks.
- The MTF consolidated BBO mid price for FTSE-100 stocks is outside EBBO just 1.5% of the time suggesting this would be a viable alternative reference price to the primary BBO mid price.
- For FTSE-250 stocks the LSE mid price is the only viable reference price, any other combination of MTF prices leads to three times the number of EBBO exceptions.

market data / trading connections etc. In other words, no-one is likely to be getting rich exploiting this strategy.

- For FTSE-100 stocks, using a consolidated MTF BBO mid price would provide a better (lower) number of exceptions than using the LSE liquidity alone. The 'size' of the exceptions using the MTF BBO mid price, in terms of arbitrage is, however, about the same (0.04BPS) indicating individual exceptions must be larger.
- For FTSE-100 stocks, **using CHIX BBO mid price alone would provide about the same number of EBBO exceptions** as using LSE as a midpoint reference price but would provide a larger arbitrage potential (0.14bps).
- TRQX and BATS single venue BBO mid prices perform worse than CHIX.
- For FTSE-250 stocks, all combinations of MTF mid prices perform markedly worse than the LSE. LSE mid prices are outside EBBO 2.5% of the time a consolidated TRQX, BATS, CHIX mid price is outside EBBO over 9% of the time.

In conclusion

- For FTSE-100 stocks, an MTF consolidated mid price would appear to be a viable substitute for primary BBO mid price.
- Any 'single venue' MTF mid price is less viable. CHIX does appear to offer a similar rate of mid prices lying inside EBBO (97%), but the magnitude by which the 3% of exceptions lie outside EBBO is much larger than the LSE mid price leading to larger arbitrage potentials.
- For FTSE-250 stocks the LSE mid price is the only viable price, any other combination of MTF prices leads to three times the number of EBBO exceptions.

Further work

In an upcoming LiquidMetrix White Paper we will extend this analysis to other European markets.