



Europe Economics

# Pre-trade equities consolidated tape

## Final report

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# Executive Summary

1. Europe Economics was commissioned by the FCA to evaluate the potential impacts of implementing a pre-trade equities consolidated tape in the UK. The report examines existing access to pre-trade market data, possible use cases of a consolidated tape, associated costs, and expected benefits.<sup>1</sup> Our findings are drawn from stakeholder engagement with over 40 market participants and their trade bodies and desk-based research, supplemented by insights from our academic collaborators Professors Dion Bongaerts and Richard Payne.<sup>2</sup>

## Current access to pre-trade market data

2. There is a great variety in the level of access to pre-trade market data across market participants, both in terms of what participants view as necessary and what they are willing to pay for. This has important implications for the added value of a consolidated tape. The table below summarises the stakeholder evidence relating to data access.

**Table 1: Summary of access to pre-trade market data**

Market participant	Current data access	Sufficiency of pre-trade data
<b>Proprietary traders</b>	<ul style="list-style-type: none"> <li>• Heavily reliant on low-latency, direct feeds from exchanges for algorithmic and high-frequency trading.</li> <li>• Use proprietary systems to consolidate and normalise data for specific trading models.</li> <li>• Some risk management, compliance, and performance analysis functions use aggregated pre-trade non real time data.</li> </ul>	<ul style="list-style-type: none"> <li>• Have sufficient access to data from all relevant venues.</li> <li>• Costs are significant but viewed as a necessary expense for maintaining competitive speed and granularity.</li> </ul>
<b>Institutional focused brokers (including investment banks)</b>	<ul style="list-style-type: none"> <li>• Use a mix of low-latency direct feeds and vendor-consolidated data for trading and pre-and post-trade analysis.</li> <li>• Rely on terminal-based data for broader market insights and compliance functions.</li> </ul>	<ul style="list-style-type: none"> <li>• Larger brokers have sufficient access and consolidate data internally, but smaller brokers may face gaps in venue / instrument coverage due to high data costs.</li> </ul>
<b>RSP market makers</b>	<ul style="list-style-type: none"> <li>• Use low-latency direct feeds or vendor data.</li> <li>• Some in-house normalisation and consolidation of data.</li> </ul>	<ul style="list-style-type: none"> <li>• Generally considered to have sufficient access to data, albeit high costs are an issue.</li> </ul>

<sup>1</sup> FCA Consolidated Tape Study Terms of Reference [\[link\]](#)

<sup>2</sup> Dr Dion Bongaerts is Professor of Financial Technology and Data Analytics at RSM Erasmus University and Academic Director Fintech at the Erasmus Center for Data Analytics. Dr Rich Payne is Professor of Finance, City University London, specialising in financial market microstructure and empirical asset pricing.

<b>RSP brokers</b>	<ul style="list-style-type: none"> <li>• Consume live pricing (top of book) to display to end investors over their broker platforms.</li> <li>• A range of other real-time data use (e.g. through vendors) for their own pricing and order routing.</li> </ul>	<ul style="list-style-type: none"> <li>• High costs are an issue, in some cases limiting back-office data usage.</li> </ul>
<b>Retail investors</b>	<ul style="list-style-type: none"> <li>• Typically have access to only top-of-book data via brokers, often delayed and/or limited to primary venues.</li> <li>• Limited ability to view market depth or multiple venue quotes.</li> </ul>	<ul style="list-style-type: none"> <li>• Potentially significant gaps in data access in terms of coverage and speed. However, in the current RSP model there is uncertainty as to the benefits that additional data access could bring.</li> </ul>
<b>Asset managers</b>	<ul style="list-style-type: none"> <li>• Rely on vendor feeds (usually consolidated) integrated into Order Management Systems (OMS) and Execution Management Systems (EMS).</li> <li>• Higher latency data via vendor terminals for back office and analytical functions.</li> <li>• Prioritise breadth of coverage over ultra-low latency for compliance, liquidity analysis, and strategic decision-making.</li> </ul>	<ul style="list-style-type: none"> <li>• Rationalise data usage for middle- and back-office functions due to cost.</li> <li>• Consider current data speeds sufficient (not very latency sensitive, as rely on brokers' algorithms and order routing).</li> </ul>

## Use cases of a pre-trade equities consolidated tape

3. Our fieldwork explored at length likely use cases market participants might have for a consolidated tape.

### Cost reductions

4. The primary reason most parties would have for using a consolidated tape is to save money accessing pre-trade market data. In some cases, the tape could be a cheaper alternative to what they currently use to access the data, provided it was of sufficient quality and depth. In other cases, the tape could allow them access to market data that they currently choose not to consume (either at all, or as comprehensively as they might like) because it is too expensive. This would apply largely to middle- and back-office functions, potentially enabling compliance, risk, and operations teams to undertake new and enhanced tasks, including better trade monitoring and market analysis. Access to a greater breadth of pre-trade data may also improve buy-side firms' portfolio management capabilities (e.g. portfolio construction and valuation).
5. Stakeholders widely held that a consolidated tape would not affect direct trading decisions and that those responsible for executing trades would continue to rely on their current data arrangements.
6. Parties we spoke to assumed that cost savings would have to come from a fall in the licensing fees that they have to pay to consume the data, particularly the costs associated with display usage (in other words, there is no intrinsic reason for a consolidated tape to be cheaper than individual data feeds). These parties indicated that they either already had the in-house capabilities to consolidate the data if they chose or were already able to access third-party solutions, whether purchasing

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existing consolidated products from data vendors or IT solutions that would allow them to consolidate their own data feeds. Therefore, this primary use case for a consolidated tape centres on affordable access to pre-trade data in general, rather than specific benefits of consolidation.

### **Retail investors**

7. Over half of the respondents (both buy- and sell-side, plus some venues and data vendors) suggested that reduced costs for data access could also support more informed, value-seeking behaviour among retail investors. It was suggested that a consolidated tape could help retail investors access tighter spreads, potentially giving them greater leverage to challenge brokers on pricing and encouraging RSP liquidity providers to offer more competitive rates.
8. However, some respondents, particularly those with a closer relationship with or deeper understanding of the retail side, emphasised that while a consolidated tape may enhance market transparency, it would need to be supported by targeted publicity and investor education to effectively boost retail participation. Retail investors often lack knowledge of market structure and trading mechanics, relying heavily on brokers to make decisions on their behalf. Transparency alone may not be sufficient to attract new retail investors or to foster more active engagement in trading activities through their brokers. Moreover, the consolidated tape would not contain actionable data for retail investors using the RSP model if pre-trade data was limited to lit venues (as almost all participants we spoke with assumed would be the case).

### **Streamlining data consolidation**

9. A few stakeholders suggested that a consolidated tape could reduce the complexity and costs firms encounter managing multiple direct data feeds from diverse venues. This is a claim that was more typically made on behalf of other, often smaller, market participants, although we did meet a few stakeholders who thought a consolidated tape could help their own operations in this way. Similarly, some respondents said that a consolidated pre-trade tape in the form of a single feed would enable smaller market participants to access a greater amount of market data without having to invest heavily in IT systems for data integration, for example if they could replace a current single feed with the tape.
10. On the other hand, some parties queried how a consolidated tape would change the ability of market participants to process consolidated data. In practice, they anticipate that intermediaries, such as data vendors, will continue to have a role to play in permitting many end users to visualise and analyse the feed from the tape (i.e. that the tape would need to be in a suitable format to permit existing vendor and third-party IT firms to make the data available to IT-limited end users). Given the required universality of the consolidated tape, it is unrealistic to assume that a consolidated tape provider would produce the data in a visual form suitable for a range of end users.

### **Common reference**

11. A further rationale for a pre-trade data tape stemming from its consolidated nature is that it could serve as a shared reference point for all market participants. Stakeholders noted that it could act as an official “golden source” of information on pre-trade prices and volumes across venues. This could increase the ability of buy-side parties to monitor whether their broker executes trades efficiently. Brokers and asset managers would have a shared reference that would allow for more transparent order routing strategies. For some trades which are not conducted using algorithms, access to a consolidated tape may encourage the trader to consider venues that they currently have no visibility on. By having access to more comprehensive pre-trade data in the form of a shared reference, buy-side firms may be able to have more informed and transparent discussions with their brokers about best execution.



12. However, a minority of sell-side respondents voiced concerns about the consolidated tape's effectiveness in ensuring best execution. They were concerned that instead the consolidated tape may create confusion, requiring time and resources be spent explaining to clients the limits of what can be inferred from the consolidated tape. The tape may give a misleading impression about the available liquidity compared to the direct pre-trade data that brokers use in their algorithms and smart order routers.
13. From a broader perspective, many sell-side firms thought pre-trade data would be helpful in educating international investors about liquidity in the UK market.

### Market resilience

14. An oft-cited use of a consolidated tape is to aid market resilience in the event of an outage on the primary exchange, whereby the tape would act as a centralised and reliable data source, maintaining market confidence and enabling trading continuity.
15. However, a number of respondents thought that despite the presence of a consolidated tape, market participants might still hesitate to trade during an outage of a primary exchange, viewing the primary exchange as the key price discovery venue. There are also concerns that relying on the tape in this way introduces another point of potential failure into the system.

### Appetite for a consolidated tape

16. Views on the consolidated tape's value are shaped by existing data access, business models, and functional priorities. While some participants see potential benefits in terms of cost savings or enhanced transparency, others are sceptical of its practical utility or necessity. The table below summarises the views across market participants contributing to our study.

**Table 2: Appetite for adopting a pre-trade consolidated tape across market participants**

Market participant	Appetite for consolidated tape	Rationale
<b>Proprietary trader</b>	Most had no appetite for adopting a tape.	Reliance on low-latency, direct data feeds for algorithmic and high-frequency trading.
	Some larger, integrated firms see some potential value in a tape as a cheaper alternative to display data.	Already consolidate data internally and tailor it to their trading needs.
<b>Institutional broker</b>	No use for a tape for trading functions.	Trading functions rely on low-latency data normalised / consolidated to each firm's need.
	Widely perceived value of tape in increasing access to data for middle-to back-office functions.	Appetite reliant on the tape being substantially cheaper than current market data.
<b>Retail market maker</b>	Little to no interest among market makers, who rely on direct feeds for their trading operations.	The CT is not seen as adding value due to its slower speeds and lack of granularity compared to existing solutions.
<b>Retail broker</b>	Some appetite for a pre-trade consolidated tape.	Would depend on brokers' ability to display the data to retail investors over their platforms.

		Post-trade data considered by most to be more valuable in assessing trade execution.
<b>Retail investor</b>	Little insight from the fieldwork as to retail investor's actual appetite.	Would depend largely on the data being seamlessly integrated into the broker platforms the retail investors already use.
<b>Asset managers</b>	Largely supportive of a tape as a cheaper alternative to display data or increasing data access and usage, although unlikely to be first adopters.  Some concerns about the technical compatibility of a tape compared to current data.	Most view it as cheaper alternative data source, but some see benefits of expanding liquidity assessment of stocks.

## Specifications of a consolidated tape

17. The core feature of the consolidated tape that would make it useful across a range of cases is its cost. The tape would need to be at least cheaper than the sum of current individual data feeds from all relevant venues. In many cases respondents assumed it would be no more than the cost of a single data feed. The table below summarises the further specifications of a consolidated tape that would be needed for the majority of suggested use cases.

**Table 3: Specifications of a consolidated pre-trade equities tape**

Feature	Specification	Rationale
<b>Coverage</b>	Lit venues	Ensuring the tape contains fully actionable liquidity, rather than liquidity which may not be accessible by everyone (e.g. on dark pools). One exception was raised regarding retail investors, who cannot access lit book prices directly within the RSP model.
<b>Latency</b>	Around 50-100 milliseconds.	This is considered achievable and suitable for most use cases described.
<b>Venue attribution</b>	Full venue attribution.	Considered essential for the tape to realise its full potential.
<b>Depth and contents</b>	Variety of views, but majority consider depth of 5 levels sufficient.  Price and volume.  Equities and ETFs; possibly periodic auctions.	Top-of-book valuable for smaller trades / simpler trading strategies; greater depth needed to inform decisions on order routing, liquidity analysis or certain algorithmic strategies.  Price and volumes are both needed to enable liquidity assessment and other related use cases described.

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Inclusion of ETFs considered important by stakeholders engaged in this market. Varying views about the value of periodic auction data.

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## Costs of a consolidated tape

18. There is significant uncertainty about the potential costs of a consolidated tape that included pre-trade equities and post trade data. Drawing on existing estimates of an EU tape and making adjustments for the UK context, we estimate that set-up costs could range from £6 million to £26 million and running costs from £5 million to £21 million. These estimates represent upper bounds on what the standalone cost of a pre-trade equities consolidated tape might be or what the incremental cost of including pre-trade equity data in a consolidated tape that also contained post-trade data might be.
19. The costs of the tape are likely to vary according to its specifications. There is most disagreement among stakeholders about the cost implications of including different depths of book. Some have said that at least five levels of data would be required to calculate the best bid/offer, therefore streaming five levels of data would not add too much cost to a top-of-book offering. However, others have disputed this, arguing that, while it is the case that depth of data may be used to calculate the best bid/offer, the largest cost increase with depth of book will be due to storage and dissemination of more data. In addition, some noted that there would be significantly higher operational support and maintenance costs associated with five levels of depth versus top-of-book.
20. Developing a tape with adequate latency is not expected to entail significant cost trade-offs. While very low latency feeds are expensive, primarily due to the need for dedicated physical infrastructure, stakeholders do not see a tape requiring such low latency to realise the types of use cases envisaged for such a tape. Latency issues were in general considered to be more relevant to the EU and US contexts given the distances involved.

## Wider market impacts

21. We also assessed a range of wider impacts a pre-trade consolidated tape could have on the equities market, namely impacts on the market for data, competition between lit venues, the relative share of trading volumes between CLOBs and alternate venues, liquidity and price volatility, resilience, ancillary functions, market entry of new trading venues, different share types, retail investors and international competitiveness.
22. The extent of these wider impacts will depend on the adoption of a pre-trade consolidated tape by the market, and how it affects trading patterns and decisions. Given that a tape is unlikely to bring about a significant change in trade execution, as described above, any market impacts are likely to be weak.
23. We explored the likelihood that a pre-trade consolidated tape would exacerbate current trends in trading volumes away from CLOBs to alternative venues such as systematic internalisers and dark pools. The majority of stakeholders we spoke to were sceptical of this impact, given that the brokers and market makers responsible for the majority of trading are already connected to all lit venues and consuming their pre-trade data. Choice of venue is also affected by a range of factors including cost and immediacy of execution, which a consolidated tape will not change.
24. A common impact of a consolidated tape cited in our fieldwork was that a tape would make markets more resilient by allowing trading to continue when there is an outage at the primary market. It was argued that a pre-trade tape would act as a unified data source of prices and available liquidity across

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all lit venues, providing the market with sufficient confidence for trading to continue on alternative venues. However, several respondents did not think there would be a notable impact, as the major trading firms already have consolidated pre-trade data yet still do not switch trading to alternative venues when there is an outage at the primary market. In our view the more hopeful case for a pre-trade consolidated tape adding resiliency is one where it would serve as an alternative reference price, e.g. for SIs and dark pools, allowing relevant market participants to continue trading, even when the primary exchange is offline. This would require reference prices linked to multiple venues to be acceptable to both the regulator and relevant market participants.

25. In terms of competition between lit venues, stakeholders doubted that a pre-trade consolidated tape would impact venue competition meaningfully, given that the largest brokers and traders are already directly connected to all the lit venues and hence the consolidated tape would not alter order routing decisions. Competition between the primary and other lit venues could potentially be affected by a tape if it enabled the refinement of the best execution process, i.e. it could result in improved dialogue between sell-side and buy-side participants due to enhanced transparency around where the available (lit) liquidity is in a particular stock. This could in turn leading to better decision-making around the lit venues that are connected to and traded on by the sell-side and/or the selection of sell-side firms by the buy-side. But this potential impact is constrained by the fact that larger, more liquid stocks are generally very tightly priced already and trading of less liquid stocks may not occur on lit venues away from the primary exchange.

## Conclusions

26. The primary appeal of a pre-trade consolidated tape among market participants interviewed for this study is if it is accompanied by lower data licensing fees. This would apply primarily to pre-trade data used for middle- and back-office functions, or data feeding into the OMS and EMS software in buy-side firms. It would either simply enable cost savings among firms or increase the amount and spread of pre-trade data consumed within firms, enabling additional or extended functions such as risk analysis, portfolio valuation and construction, liquidity assessment, and monitoring.
27. A tape would be no substitute for low-latency direct feeds used by brokers and proprietary traders. Given that the brokers and traders accounting for most trade executions already consume low-latency pre-trade data from all lit venues, a consolidated tape is unlikely to affect trade execution, such as order routing, and thus the impacts on the wider market are likely to be muted. That said, some impacts could arise from increased investor confidence and improved execution—driven by smaller buy-side firms and retail investors—if uptake of the tape is sufficiently widespread and, for retail investors, is accompanied by necessary education and publicity, as well as suitable integration into broker platforms.
28. However, challenges and risks associated with a consolidated tape must also be considered. Introducing a tape is neither necessary nor sufficient to address concerns about high data licensing fees, which would require regulatory intervention to ensure lower costs. Furthermore, some market participants doubt that a tape will significantly enhance best execution discussions or market resilience. Additional risks include the potential for the tape to become a critical piece of infrastructure, introducing new vulnerabilities if disrupted, as well as the possibility of liquidity dilution if less competitive venues enter the market due to revenue redistribution (although this is currently a remote risk). Additionally, while the tape might make pre-trade data more accessible to smaller firms, it could inadvertently increase costs for other data feeds as venues seek to recover lost revenue. Despite these concerns, proponents argue that the tape could enhance transparency, improve liquidity in ETFs, and increase the UK's international competitiveness by attracting investors who prefer consolidated data.

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# 1 Introduction

1.1. This is Europe Economics' report to the FCA on the impacts of an equities pre-trade consolidated tape. The objectives of the study were to:

- assess whether market participants currently have sufficient access to pre-trade data and the likelihood different participants would adopt a tape,
- review the use cases for such a tape,
- describe the specifications of the tape for different uses in terms of e.g. latency and depth, and
- assess the costs of a tape and likely wider market impacts.<sup>3</sup>

1.2. Our work consisted of a mix of stakeholder engagement and desk-based research. At various stages in the project, we engaged with academic advisors to seek assistance on hypotheses to explore, relevant literature to review, and to sense check the emerging findings.

## 1.1 Stakeholder engagement

1.3. We met with a variety of stakeholders, including trade bodies as well as individual market participants, to discuss use cases and the wider implications of a consolidated tape. The table below provides a breakdown.

**Table 1.1: Individual market participants contributing to our fieldwork**

<b>Market participant group</b>	<b>Number of interviews</b>
<b>Proprietary traders</b>	8
<b>Investment banks and other brokers</b>	8
<b>Retail service providers and brokers</b>	5
<b>Asset managers and institutional investors</b>	7
<b>Trading venues and data vendors</b>	7
<b>Representative bodies and other</b>	7

1.4. Ahead of each meeting, stakeholders received an agenda and, in most cases, an indicative set of questions of interest to help them prepare (see Appendix 4). The meetings were conducted on the basis that views would not be attributed to individuals. We typically did not seek answers to all the questions in the appendix, but instead focussed the discussion on those topics where the party had the most to contribute.

1.5. The meetings were universally helpful, with each generating new insights. The meetings highlighted the heterogeneity of market participants, with each participant having slightly different perspectives on what pre-trade data are important, the extent to which a consolidated tape might help their business and the wider market impacts.

1.6. While we sought to meet with a mix of participants, including smaller brokers and buy-side investors, we would caution that our final sample of interviewees was skewed towards the larger market

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<sup>3</sup> FCA Consolidated Tape Study Terms of Reference [\[link\]](#)

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participants. In particular, our buy-side sample is limited to seven larger asset managers, as well as inputs from the Investment Association. Whilst we contacted a number of smaller asset managers, and liaised with the Investment Association to do so too, none were forthcoming for interviews. This means that the direct input into our study from the buy-side is more limited than from the sell-side, although brokers offered views on the needs of their buy-side clients. In particular, smaller asset managers who might be expected to have less pre-trade data access than their larger counterparts and therefore potentially have a different perspective on the value of a consolidated tape did not directly feed into this study.

- 1.7. All interviewees faced the challenge of being asked to comment on the possible use cases of a consolidated tape in the abstract (the cost, coverage, depth, latency or details on how it might be distributed all remain to be determined). With more of those details resolved, it is possible that some parties would have been more (or less) positive about the potential use cases for a tape. Many of the parties generally sceptical about the value of a consolidated tape queried what problem(s) it was trying to solve and, in some cases, thought the absence of a clearly defined problem hindered their ability to comment.
- 1.8. Our focus concerned a pre-trade consolidated tape for UK equities. In some of the meetings, it became apparent that parties were identifying uses cases or impacts of a consolidated tape that included post-trade data or data from other European trading venues.
- 1.9. In addition to interviews, associations (notably AFME, UK Finance, and the IA) and some individual stakeholders also contributed views on the uses and impacts of a consolidated tape by way of position papers.

## 1.2 Desk-based research

- 1.10. Much of the desk-based research consisted of reviewing the literature, including position papers that parties have prepared discussing the merits of a consolidated tape and academic articles relating to market microstructure. We undertook two specific literature reviews, included as appendices, looking at
  - Trends in the UK equity market, and
  - The impact of the consolidated tape in the USA.
- 1.11. Our findings from desk-based research looking at possible metrics to assess market quality are also included as an appendix.
- 1.12. There were no primary data collected for the study. We did analyse data on the evolution of equity trading in the UK to inform our analysis of the impacts of a consolidated tape. To generate estimates of the likely costs of a consolidated tape, we relied on existing publications, feedback from stakeholders and simple calculations.

## 1.3 Structure of the report

- 1.13. The following two chapters describe the current access to and use of pre-trade market data across market participants, and the likely use cases for a tape. Chapter 4 assesses the costs of a tape, and Chapter 5 analyses the possible wider impacts of a tape. We summarise the findings in Chapter 6. There are also a number of appendices, including material describing our findings from reviewing the literature.

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## 2 Current Access to Pre-trade Equities Market Data

- 2.1. We begin with an overview from our fieldwork of how different market participants currently access pre-trade equities market data and what they use it for. We cover the following broad groups (noting that some may overlap, e.g. proprietary traders and investment banks):
- Proprietary traders.
  - Institutional-focused brokers and investment banks.
  - Asset managers and other buy-side firms.
  - Retail brokers, market makers and investors.
- 2.2. Pre-trade data are used across a broad range of functions in the financial markets, as various position papers and reports discussing a consolidated tape describe.<sup>4</sup> In front-office functions, such data can help with pre-trade analysis functions (e.g., display order books, liquidity analysis, trading opportunities, instrument pricing) and monitoring and analytical functions (e.g., best execution monitoring, adverse deviation tracking, continuous price control, and trading events analysis). For the buy side, it supports portfolio management (such as portfolio valuation and decisions on which stocks to hold and at what amounts) and order placement. In middle and back-office operations, pre-trade data aids in transaction cost analysis and performance review, enhancing tasks like liquidity risk management, credit assessment, and price reconciliation. It also supports regulatory, audit and control functions such as market abuse surveillance.

### 2.1 Proprietary traders

#### *Description*

- 2.3. Proprietary traders refer to firms (or divisions within wider organisations) which use their own capital to invest in markets for direct gain, as opposed to earning commission by trading on behalf of clients. They are often described as liquidity providers or market makers. Market participants from our fieldwork in this group are generally divided into two main categories based on their trading approaches:
- High-Frequency Traders (HFTs) – These rely on fully automated, latency-sensitive algorithms, often co-locating with exchanges and continuously optimising data processing to minimise delays. They use direct pre-trade data feeds from venues and may also implement proprietary data processing techniques to aggregate and normalise data for their trading models.
  - Multi-Strategy and Quantitative Traders – These employ a mix of high-frequency and slower, strategic trades, often using a combination of algorithmic and human oversight. They may leverage historical data and statistical models to inform longer-term positions while also participating in high-speed trading.
- 2.4. In terms of trading execution, proprietary traders interviewed stated that that over 90 per cent of trades are now handled by algorithmic systems, particularly in high-speed environments like equity and FX markets, where speed and precision are critical. This reliance on algorithmic trading amplifies

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<sup>4</sup> See for example Adamantia Research Institute (2022), “The case for a viable Consolidated Tape on Equity”, [[online](#)]; and UK Finance (2024), “The benefits of including pre-trade data within a UK equities consolidated tape”.



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the need for real-time pre-trade data feeds, allowing these systems to respond instantly to market changes, optimise execution, and maintain competitiveness in latency-sensitive markets. A smaller percentage involves manual trading, often in less liquid markets or during strategic adjustments where algorithms may not capture market nuances effectively. Human traders also monitor algorithmic outputs, stepping in as needed for risk management reasons or during unexpected market movements.

#### *Access to data and uses*

- 2.5. According to our fieldwork, proprietary traders acquire pre-trade equities data directly from trading venues (e.g., lit exchanges like the LSE, CBOE, Aquis, and other MTFs), focusing on low-latency direct feeds (in the microsecond range) to support high-frequency and algorithmic trading strategies. As speed and granularity of market data are critical to their business model, these firms will buy the best available data direct from all venues. Only one proprietary trading firm in our sample accesses low-latency data from a vendor.
- 2.6. Many respondents' business functions, such as risk management, compliance, and performance analysis, make use of aggregated pre-trade data<sup>5</sup> which is obtained from vendor feeds (some make use of display data through terminals) or internally processed raw data from venues. Some interview participants prefer to rely on their own consolidated data for these functions derived from the direct feeds rather than vendor data, as it allows them to classify and aggregate the data exactly as they wish for their purposes.
- 2.7. Data licensing and access costs are significant among the participants we interviewed, particularly for multi-venue trading, as these firms handle large volumes of trades daily and require expansive data coverage across asset classes and global markets. Interview participants noted that having to pay for each different use of pre-trade data (e.g. platform licenses, redistribution licenses, or back-office use) creates significant costs. However, respondents noted that they were fairly price-insensitive, given the critical role high-quality, low-latency data plays in their business models.

#### *Current consolidation*

- 2.8. All respondents from proprietary trading firms using direct data feeds indicated that they consolidate and process data internally, drawing direct feeds from all markets and MTFs to which they are connected, aiming for the lowest latency and ensuring the most accurate, timely information for decision-making. Certain teams within firms also process and normalise data independently, using either their direct feeds or an internally standardised version.

## 2.2 Institutional-focused brokers

### *Description*

- 2.9. This is a broad group of market participants that undertake brokerage activities in equities trading on behalf of clients. It includes investment banks and other institutional-focused brokers, covering a range of trading techniques. For example, in addition to algorithmic trading, some entities could provide high-touch brokerage services, involving direct engagement with clients through personal communication methods, such as phone calls, to facilitate large trade executions. Their clients primarily consist of institutional investors, such as hedge funds, mutual funds, pension funds, insurance companies, and other large entities that invest substantial amounts of capital.

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<sup>5</sup> For some, real-time market data are used for risk management, as the ability to readjust risk based on the latest data is crucial for their operations.

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#### *Access to data and uses*

- 2.10. Respondents from investment banks (five) access market data primarily through low-latency direct feeds from all trading venues (such as LSEG, CBOE, and Aquis), essential for supporting their algorithms and smart order routing systems, using advanced technology to process this data at ultra-low latency. These direct feeds provide data depth and minimal latency, crucial for some in competing in co-located trading environments. All investment bank respondents consolidate this direct data themselves, creating a basic bid/ask and trade dataset that is used consistently across both algorithmic trading and other internal systems.
- 2.11. Data use among other brokers for trading purposes is more varied, with some consuming direct feeds and others low-latency data solutions from market data vendors. These vendors can provide consolidated views across multiple venues, including UK and EU exchanges, allowing firms to monitor trades and price movements without negotiating separate data agreements. These services provide full book bid-offer spread and volume depth data and allow for real-time pricing and order matching.
- 2.12. For back-office and analytical functions, investment banks and other brokers employ terminal data from data vendors. These terminals support screen-based applications for general market observation, pre-trade analytics, and risk and compliance tasks. (These data are also used for post-trade analysis like price validation, transaction cost analysis, and liquidity analysis, where lower latency is less critical.) As mentioned by one respondent, these data are also communicated to their clients via the firm's website tools.
- 2.13. Three of the eight respondents find it frustrating to pay for similar data in multiple formats for both direct feeds and terminal usage. There is also a cost concern related to maintaining permissions across all exchanges.

#### *Latency and depth requirements of current use*

- 2.14. Latency is critical for algorithmic trading functions, where ultra-low latency direct feeds are necessary to stay competitive, particularly (for some respondents) against co-located high-frequency trading firms. These feeds provide real-time, non-displayed data, enabling algorithms to respond instantly to market shifts, assess liquidity, and execute trades with precision. One respondent emphasised the need for full book depth, order-by-order data with fast processing (e.g., FPGA technology) to support high-speed execution.
- 2.15. Manual or human-assisted trading has lower latency requirements, with some human traders also using terminal data to monitor broader market conditions and manage risk. Respondents noted that latency in the millisecond range is generally "fast enough" for human trading, as decision-making relies more on data breadth and reliability than microsecond precision.

#### *Current consolidation*

- 2.16. As mentioned above, all investment banks responding to our fieldwork consolidate data internally from direct feeds to suit their specific trading models and other functions' needs. This custom data aggregation integrates feeds from multiple venues, allowing algorithms to assess spreads, liquidity depth, and directional trends. Customised consolidation can also include auction prices and condition codes, defining which prices are addressable. This internally normalised data feeds into pre-trade tasks, like volume prediction and spread analysis, enhancing algorithmic strategies. Other brokers typically use low-latency vendor data which already has functionality for consolidation.

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## 2.3 Retail service providers, brokers and investors

### 2.3.1 RSP model in the UK

- 2.17. Around 95 per cent of retail orders for shares are executed through the Retail Service Provider (RSP) system in the UK. Investors place orders through a stockbroker or platform connected to the RSP network, who then send requests for quotes to RSP market makers. The market makers respond with a quote to the broker or platform. Depending on the configuration, the retail investor then has between 10 and 30 seconds to accept a quote and place an order.<sup>6</sup>
- 2.18. Within this framework, RSP market makers play a pivotal role by offering bid and ask quotes in response to requests from retail brokers. These market makers compete to provide the best available prices, often responding within milliseconds. These market makers are LSE members who provide pre-trade transparency by making public two-way quotes in shares. When asked for a quote through the RSP system they may improve on the prices they make public. This is because liquidity providers face less risk of the market moving against them when dealing with retail investors who are generally considered uninformed traders.<sup>7</sup>
- 2.19. Retail brokers in the UK typically connect directly to RSP networks as part of their direct-to-consumer (D2C) trading services, enabling customers to view their portfolios and place orders through online platforms. According to interview feedback, when a customer places a trade, the order is routed to a central execution desk within the retail broker's system, which manages the execution via the RSP network. Respondents noted that, in this model, the retail broker's execution desk efficiently handles trades through automated processes, supporting a high rate of straight-through processing.
- 2.20. From the retail investor's perspective, respondents indicated that the RSP model is designed for simplicity and accessibility. Many investors use retail platforms provided by brokers where they can view prices and place trades through a straightforward "click to trade" interface via smartphone or computer.

### 2.3.2 Access to data and uses – retail service providers

- 2.21. According to our fieldwork, RSP market makers in the UK use various data sources to manage trading, liquidity, and risk. Low-latency data and high-speed connections allow them to offer optimal prices and respond quickly to market shifts. Some market makers rely on vendors to access both displayed and non-displayed data for their trading purposes. These vendor feeds provide a consolidated view that integrates data from multiple European and US markets, simplifying access to a broad spectrum of market information. Other market makers source data directly from primary exchanges and Multilateral Trading Facilities (MTFs), creating a more granular and customisable view of liquidity. According to one respondent, it uses proprietary systems to normalise and consolidate this data in-house, integrating real-time information from multiple venues to support their Request for Quote (RFQ) systems.
- 2.22. Data costs were raised as an issue in our fieldwork, with the view that building an internal consolidated tape from all UK lit venues would be prohibitively expensive.

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<sup>6</sup> FCA (2022), "Improving Equity Secondary Markets – CP22/12" [[online](#)]

<sup>7</sup> FCA (2022), "Improving Equity Secondary Markets – CP22/12" [[online](#)]

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### 2.3.3 Access to data and uses – retail brokers

- 2.23. According to respondents, retail brokers primarily use live UK pricing to support their customers in viewing portfolios and placing trades. Customers typically access these services through a direct-to-consumer (D2C) platform, where they can see a basic bid-offer price on the LSE without details on volume or order book depth.
- 2.24. In terms of execution, as mentioned by some participants, retail brokers' desks receive live prices from UK markets, including access to order book depth, along with real-time data from major European venues and US exchanges. One respondent noted that retail brokers often work with data vendors and direct market access (DMA) providers, which facilitate connectivity to numerous exchanges, dark pools, and other execution venues. This setup allows brokers to use algorithmic routing to optimise pricing and order execution across a range of venues.
- 2.25. For post-trade analysis and benchmarking, for example, one retail broker utilises a data analytics service which allows them to benchmark trades against primary exchanges, typically the LSE for UK equities. Pre-trade and post-trade data integration helps retail brokers to comply with regulatory requirements and enhance execution quality.

### 2.3.4 Access to data and uses – retail investors

- 2.26. Insights from our fieldwork indicate that for most retail investors, market data usage is limited to the basic bid and ask prices displayed on their trading platforms. Respondents noted that these investors are generally unaware of market depth or RSP-specific data, relying solely on top-level prices to make trading decisions without understanding the underlying market structure. While a more detailed view of market data could potentially benefit some retail investors, respondents suggested that the majority do not actively seek or utilise additional data due to limited familiarity with complex market mechanics.
- 2.27. Retail-focused respondents to our fieldwork suggest that experienced investors may engage with market data more deeply, and fuller-depth data could provide valuable insights into price direction and liquidity. These data-savvy investors often turn to specialised tools which display additional details like RSP volumes. By checking this data, they can better gauge potential execution prices before placing trades on their main platform, allowing them to make more informed trading decisions.
- 2.28. Retail investors generally fall into two groups: those who trade independently using basic platform-displayed prices who typically focus on convenience and simplicity, preferring to rely on familiar platforms that display only essential pricing information; and those who rely on brokers to handle trades on their behalf. Respondents to our fieldwork thought that investors rarely change brokers unless there is a significant incentive to do so, as in their view switching brokers remains a hassle despite FCA efforts to make it as straightforward as switching a bank account. For many, the convenience of staying with a familiar broker outweighs any potential benefits from switching, even if improved execution quality or access to more detailed data might be available elsewhere.
- 2.29. A key issue for retail investors is the visibility of real-time RSP quotes on trading platforms. The wide spreads on smaller-cap stocks can be off-putting, as investors often see only the top-level market quotes on venues before placing an order, which may not reflect the best available prices available from the RSP market makers. The actual RSP quotes are often better than these initial market prices, but they are not always displayed upfront. For example, while a stock might show a 15-point spread with a market quote of 280, the real RSP quote could be closer, such as 273, making the stock a more attractive trading opportunity than it initially appears.

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- 2.30. Many retail investors are unaware of this discrepancy, as they only see the wide market spreads displayed on their platform before placing an order. This can be discouraging, particularly for less liquid, smaller-cap stocks. If retail investors could see these more accurate RSP quotes immediately, rather than just the initial market-venue quotes, it would likely make smaller stocks more appealing for trading.

## 2.4 Buy-side

### *Description*

- 2.31. This group of market participants includes asset managers, insurers, and pension funds, who typically rely on brokers to execute their equities trades on exchanges. From our fieldwork, these buy-side firms frequently utilise Execution Management Systems (EMS) to manage and execute orders efficiently across multiple trading venues. An EMS is a software platform that not only facilitates order management but also enables real-time handling of live market data, providing users with execution options, liquidity management tools, and transaction cost analysis.<sup>8</sup> These systems integrate with Order Management Systems (OMS) to streamline trading workflows and support portfolio management (such as constructing and valuing portfolios). Respondents rely on their brokers' SOR and algorithms for market execution, as brokers have the infrastructure to manage latency and access various liquidity sources across a range of venues. This approach allows buy-side firms to focus on strategic decisions about their portfolio composition and level of risk they can accept, while leveraging brokers' capabilities for efficient trade execution.

### *Access to data and uses*

- 2.32. Respondents to our fieldwork primarily source pre-trade market data from vendors rather than direct exchange feeds. This data, typically full book (i.e. all levels of bid and offer prices and volumes), is integrated into OMS/EMS to support pre-trade and post-trade analysis, allowing firms to monitor market depth, bid-offer spreads, and liquidity across fragmented markets. They rely heavily on vendor-provided consolidated feeds to gain a comprehensive market view, often covering multiple exchanges and MTFs.
- 2.33. Although latency is important, buy-side firms generally prioritise data coverage and cost-efficiency, focusing on tools that support broader market insights and compliance. Latency measured in milliseconds is generally acceptable, as many buy-side trading strategies do not require sub-millisecond speeds (i.e. for large block trades), and where speed is essential this is the responsibility of the brokers to whom buy-side firms contract out their trade executions.
- 2.34. The pre-trade data flows into internal analytics systems for liquidity assessment, transaction cost analysis, and compliance monitoring, which helps inform portfolio construction, order management, and execution strategies. These data are also used by risk management teams to assess execution quality and the risks the firms are exposed to during trading. Buy-side firms can aggregate this data to assess available liquidity across venues, using metrics like volume-weighted average price (VWAP), best bid/offer, and full order book depth to aid decision-making and manage large orders. Some firms also leverage analytics to track price impact, trading costs, and fill rates on block trades, enhancing trade efficiency and cost optimisation.
- 2.35. To manage data costs, respondents reported regularly reviewing their data subscriptions, ensuring traders have access to necessary feeds without redundant expenses.
- 2.36. One respondent specialising in ETF trading highlighted the pre-trade and intra-day data requirements necessary for managing ETF liquidity and spreads in both primary and secondary markets. They

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<sup>8</sup> Philippe Ramkvist-Henry, "Guide to Execution Management System (EMS)." [\[online\]](#)

employ a spread analytics function which sources top of book data from major exchanges like the LSE and Euronext, enabling precise monitoring of ETF positions across fragmented EU and UK markets. Intra-day monitoring occurs with a 30-second to 1-minute delayed data, which this ETF-focused participant finds sufficient for their needs.

## 2.5 Summary of current pre-trade data access and use

- 2.37. The table below summarises our fieldwork results on the current access to and use of pre-trade market data by different market participant groups. The overall finding is that parties consume data in accordance with their business models, with quicker and more extensive (and costly) data being consumed by those for whom it is most critical.
- 2.38. Many parties can and do already create consolidated versions of pre-trade data from the raw data they consume from venues or purchase consolidated products from vendors.
- 2.39. The key factor governing pre-trade data usage is cost, with parties purchasing different speeds and depth of data for use across multiple functions based on the relative value of the data for that use, as part of commercial decision-making.

**Table 2.1: Summary of pre-trade data access**

<b>Market participant group</b>	<b>Current data access and use</b>
<b>Proprietary traders</b>	<p>Low-latency direct feeds from all relevant trading venues which feed into electronic trading infrastructure. Critical to business models.</p> <p>In-house consolidation of data.</p> <p>Some vendor (displayed) or in-house consolidated data for non-trade execution functions.</p>
<b>Investment banks and other brokers</b>	<p>Low-latency direct feeds or non-display vendor data from all relevant trading venues which feed into electronic trading infrastructure.</p> <p>Some slower data usage (e.g. terminal based) for manual trading.</p> <p>Wide use of vendor display data for back-office and analytical functions. Varying levels of depth and speed.</p> <p>Some in-house consolidation of raw data.</p>
<b>Retail service providers</b>	<p>Low-latency direct feeds or non-display vendor data, mainly from primary venue, which feed into electronic trading infrastructure.</p> <p>Some in-house consolidation of raw data.</p>
<b>Retail brokers</b>	<p>Live data from primary venue for internal use.</p>
<b>Retail investors</b>	<p>Top-of-book data from primary market via their retail broker platforms.</p> <p>Mid-market data from external suppliers like Google Finance.</p>
<b>Asset managers and other institutional investors</b>	<p>Vendor data that feeds into OMS and EMS functions (often 'real time').</p>

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Higher latency data via vendor terminals for back office and analytical functions.

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## 3 Uses of an Equities Pre-trade Consolidated Tape

### 3.1 Introduction

- 3.1. This section reports findings from our fieldwork and published sources on the potential use cases for a pre-trade consolidated tape. It covers how different market participants would likely use such a tape and comments on the specifications required for these uses. In some areas respondents to our fieldwork commented on the value of post-trade data. We make this clear in our reporting and note that, unless otherwise specified, respondents' views refer to pre-trade data.

#### **Greater access to pre-trade market data**

- 3.2. The primary reason most parties would have for using a consolidated tape is to save money accessing pre-trade market data. In some cases, the tape could be a cheaper alternative to what they currently use to access the data. In other cases, the tape could allow them access to market data that they currently choose not to consume (either at all, or as comprehensively as they might like) because it is too expensive. For example, this could include consuming data from the primary exchange only; only the best bid and offer rather than any depth; or consuming delayed rather than real-time data; and some business functions may not consumer any pre-trade data at all. For most parties we spoke to, the cost savings would have to come from a fall in the licensing fees that they have to pay to consume the data, particularly the costs associated with display usage (in other words, there is no intrinsic reason for a consolidated tape to be cheaper than individual data feeds). These parties indicated that they either already had the in-house capabilities to consolidate the data if they chose or were already able to access third-party solutions, whether purchasing existing consolidated products from data vendors or IT solutions that would allow them to consolidate their own data feeds. Therefore, this primary use case for a consolidated tape based on our stakeholder feedback centres on affordable access to pre-trade data in general, rather than specific benefits of consolidation.

#### **Benefits specifically from consolidation**

- 3.3. Possible use cases described in this section for a consolidated tape parties identified over and above a fall in the data licensing costs include as a shared price/volume reference and as a potential marketing tool to attract interest in the UK equity market. These uses stem from the consolidated nature of the tape, but most respondents noted that there would also need to be an accompanying fall in price for the tape to be adopted. Some parties queried whether these claimed benefits would materialise in practice, at least absent additional regulatory measures such as requiring use of the consolidated tape to demonstrate best execution.

#### **Direct uses versus wider market impacts**

- 3.4. Many of the parties did not see an immediate significant use for a consolidated tape for them (for example, six of the eight proprietary traders and three RSP market makers would have no use, and a couple more buy- and sell-side firms were very uncertain as to whether a consolidated tape would add value for them). They suggested that the main benefits of a tape would accrue more to others, although this could lead to wider market impacts which would benefit them indirectly. Often the suggestion was that smaller firms and retail investors would be the main beneficiaries. However,



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feedback in some of our meetings with smaller firms and parties with a more direct connection to retail investors was that they saw no use case for themselves from a tape and suspected it was probably more relevant for larger firms.

- 3.5. We elaborate on these findings in the material that follows. We start by discussing the possible reasons why parties might choose to adopt a consolidated tape. Then we discuss the extent to which choices about different aspects of a pre-trade tape specification may matter for the use cases identified, before describing how the appetite for a use case might vary for different market participant types.

## 3.2 Use cases

### 3.2.1 Cost reduction and data accessibility

- 3.6. A key potential use case for a consolidated tape is its ability to lower market data costs and provide access to data that many market participants consider too expensive and/or currently cannot afford. Many respondents to our fieldwork (six buy-side and 14 sell-side firms, as well as the associations and some venues) assumed the underlying data cost would be cheaper if there was a consolidated tape, primarily because data licencing fees would be reduced. They assumed the need to pay for separate data licenses to each of the venues contributing to the tape would fall away or, at the very least, the fees that the venues could levy would be capped. Some parties mentioned that the potential cost savings could include reducing some of the administrative costs they currently incur understanding, putting in place and complying with the different terms and conditions each venue places on using the data, costs that they can incur even when taking their feed from a data vendor. Their views align with those expressed in position papers by trade associations such as AFME, the Investment Association, and UK Finance, which suggest that a consolidated tape would offer market data users a cost-effective alternative source of display data, reducing reliance on direct feeds and lowering operating costs.

#### Uses of pre-trade data within a consolidated tape

- 3.7. As described in Section 2, there are multiple uses of pre-trade market data across traders, investors, asset managers and brokers. According to our fieldwork, the majority of these uses could in principle be replicated by a consolidated tape (depending on details such as the depth of the data, venue attribution, and latency).
- 3.8. Questions of latency are discussed further in Section 3.3, but the consensus from our fieldwork and published material is that a tape would not be used as a substitute for non-display data used for latency-sensitive algorithmic trading, and that traders would continue to consume direct feeds for these purposes. This is due to the inevitably higher latency of a tape compared to a direct feed (even though the tape could potentially achieve latency of microseconds it would still be slower). Also, users of direct feeds tend to prefer to work with the raw data which they can compress, consolidate and configure to their exact purposes.
- 3.9. However, where trading currently is informed by or undertaken based on displayed data (e.g. high touch and screen-based trading), then a tape could be a realistic substitute as the latency would be comparable to displayed data.
- 3.10. The effects of parties being able to use a pre-trade equities consolidated tape to get cheaper access to these data will vary. In some instances, the cheaper data may just permit the party to realise a cost saving for accessing the same data that they are already using. In other cases, the cheaper data may allow a party to increase the volume of data that they have access to when performing a particular

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activity. Typically, this might cover cases where currently the party only accesses pre-trade data from the primary exchange or at a limited granularity or depth. Finally, there may be some instances where the tape, if it is associated with a sufficiently large accompanying reduction in the licensing costs, could result in firms using such data to perform activities that they either previously did not do or conducted without the benefit of access to any pre-trade data.

### **Cost Savings without Behavioural Change**

- 3.11. A commonly cited need for a pre-trade equity consolidated tape from parties that felt such a tape was necessary was that it had the potential to deliver cost-effective display data.
- 3.12. Most sell-side respondents to our fieldwork (17 of the 21) said that a tape would have no impact on their consumption of direct data feeds for trading purposes, but four said that it could replace current display data used across other functions such as risk management, central trading desks for oversight purposes and sales teams, thus generating cost savings. One broker which does not use direct data feeds but rather vendor data in its algorithmic trading stack thought that a tape could conceivably replace some of these feeds if it was comparable in depth and quality.
- 3.13. Similarly, the majority of buy-side participants (five) thought that a consolidated tape could replace some or all of their existing display data. Buy-side participants said that cost reduction would be the primary reason for adopting a consolidated tape over current data subscriptions. These respondents already have sufficient pre-trade data coverage for tasks like order book construction and viewing UK Best Bid and Offer (BBO). In this case, the tape would need to be able to support current OMS and EMS.
- 3.14. The value to users of this use case is the direct cost saving that the consolidated tape would allow them to realise. Since the cost saving is due to lower licensing costs, there would be an offsetting loss in revenues to the data providers. In welfare terms, the first-order effect is a straight transfer from data providers to end users of the data.

### **Cost Savings leading to Behaviour Change because of Enhanced/New Data**

- 3.15. There are also several parties who anticipated a pre-trade equity consolidated tape, assuming it lowered the data licensing costs, would allow them more access to pre-trade data than they currently have. Functions that currently make do with using just data from the primary exchange or pre-trade data with a 15-minute delay would now have access to pre-trade data from all lit venues in close to real time.
- 3.16. This finding is supported by the position papers from the Investment Association, UK Finance and AFME, which noted that the CT serves as an affordable alternative to direct feeds, particularly benefiting retail and professional investors without current access to real-time data.
- 3.17. Many sell-side firms (a further seven in addition to the four mentioned above) said that a consolidated tape could provide greater pre-trade data visibility to enable their compliance, risk, and operations teams to undertake new and enhanced tasks, including better trade monitoring and market analysis. More employees and departments would be able to access real-time pre-trade data and thus enhance their decision-making capabilities. Some of these respondents highlighted that operations, compliance, and other support functions could use the data from a pre-trade consolidated tape to understand market patterns and facilitate collaboration across teams. Buy-side respondents tended to focus on the value of a tape in replacing their existing data consumption (as described above), with only two directly stating that a cheaper tape could lead to a behaviour change with additional functions making use of more pre-trade data. AFME claimed that a consolidated tape would equip investment firms with a versatile tool to support risk management, regulatory compliance, and middle- and back-office operations. The Investment Association's position paper also noted that a pre-trade tape could enable investment managers to better serve their clients by supporting key

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functions such as transaction cost analysis, portfolio construction, and fund liquidity analysis, as well as enhancing risk management, regulatory compliance, and operational processes.

- 3.18. On the sell side, two large brokers suggested that their compliance and risk teams might adopt a consolidated tape immediately as it would provide sufficiently low latency to permit ongoing visibility of the market even though it was slower than a direct feed. Access to market data across all lit venues could also help with analytics, e.g. assessing whether the broker ought to connect to additional venues for the trading of particular stocks. One other trader mentioned that a tape could provide new access to delayed pre-trade data to the trading floor to assist in liquidity assessment across venues. Contrary to the views of most sell-side participants, one small broker (engaged in high touch relationship trading) thought that a consolidated tape would make a material difference to its business model, allowing it to see real time data from venues to which it is not currently connected and enable it to potentially broaden the range of stocks it trades.
- 3.19. In cases where cost savings from a consolidated tape prompt behavioural change, it is possible that the new or enhanced data realises benefits without necessarily resulting in equal and offsetting revenue losses for data providers. By revealed preference, we can infer that the scale of the private benefit associated with an individual use case would be no greater than the cost saving the consolidated tape permits, i.e. lower than the benefit to an individual user able to use the tape as a perfect substitute to an existing data feed.

#### *Trade Identification and Liquidity Assessment*

- 3.20. If the consolidated tape results in pre-trade data becoming more affordable, some parties think that the resulting consolidated view of the UK's fragmented market would support better trading, portfolio composition and investment decisions. For example, AFME argued in its position paper that a consolidated tape could help investors and issuers assess liquidity depth in less frequently traded instruments, fostering investment in smaller-cap firms.
- 3.21. A small number of parties (one venue, one sell-side association and one buy-side firm) suggested that brokers could use the tape to make better informed routing decisions, considering both price and liquidity to achieve the best execution for their clients. Other respondents claim that brokers already have, or should have, access to pricing data from all the main venues and do not see how a consolidated tape will influence routing decisions (four sell-side firms explicitly said that a tape should make no difference to order routing).
- 3.22. For buy-side participants, particularly those managing large orders, a pre-trade consolidated tape could provide insights into market liquidity and available quantities across exchanges. This is especially pertinent for block trades, where understanding both price and actual quantities available at each venue is critical. Some sell-side brokers noted that their clients, particularly asset managers, are concerned about the overall liquidity in the UK market and would benefit from pre-trade visibility through a tape. According to these respondents, many asset managers currently rely only on data from the primary market, but a pre-trade consolidated tape would provide a consolidated view of liquidity across all lit venues, helping them see the true availability of liquidity. Some interviewees suggested that the buy-side, particularly mid-sized wealth managers and retail investors, would benefit from having a more complete picture of the market. It would allow them to have more informed conversations with brokers. One consequence might be that buy-side investors may be more willing to trade on venues other than the primary exchange.<sup>9</sup>
- 3.23. A contrary view expressed by some respondents is that the primary exchange already accounts for a large share of trading on lit venues, a pre-trade consolidated tape would still omit information on

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<sup>9</sup> Four buy-side and eight sell-side firms mentioned the positive impact of a tape on the buy-side's ability to assess liquidity of stocks across venues.

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the liquidity available on unlit venues, and a post-trade tape would provide most, or all, of the information parties might need to assess whether there was sufficient liquidity to warrant trading a given UK equity.

- 3.24. The users unlikely to adopt a consolidated tape even if it allows lower data licensing costs are at two extremes in terms of their current use of pre-trade data. First, several respondents emphasised that any consolidated tape would be unsuitable for roles requiring ultra-low-latency, high-depth data, so they would continue to rely on the direct feed from exchanges even if the consolidated tape is cheaper (17 of the 21 sell-side firms said they would not replace their direct feeds, and 9 of these (six proprietary traders and three RSP market makers) also said they could see little direct use at all for a tape, given their reliance on low-latency direct feeds and/or their business models). At the other end of the spectrum, one high-touch market maker in small- to mid-caps saw no value to them in having access to pre-trade data from a consolidated tape. They view such data as of more value to firms with the in-house IT skills to interrogate and utilise the data, such as high-frequency and algorithmic trading houses. Their own business model does not depend critically on access to real-time pre-trade data and they do not see that changing should there be a consolidated tape.

### **Retail investors**

- 3.25. More than half of respondents highlighted that, while they may not use a consolidated tape for their own purposes, they still see significant value in it for retail investors.
- 3.26. Many suggested that reduced costs for data access could support more informed, value-seeking behaviour among retail investors. It was suggested that a consolidated tape could help retail investors access tighter spreads, potentially giving them greater leverage to challenge brokers on pricing and encouraging RSP liquidity providers to offer more competitive rates. A couple of stakeholders mentioned that as present, RSPs may offer the best price but not necessarily the best overall execution cost—a gap that a consolidated tape could fill by providing transparency on both fronts.
- 3.27. Some thought that a consolidated tape could foster retail engagement by consolidating price and liquidity data, enhancing confidence in the market. Retail investors, often limited to delayed data, would gain access to real-time information, empowering them to make more active trading decisions throughout the day. Some respondents caution, however, that a pre-trade tape could risk undermining confidence if it displays fleeting or inaccessible liquidity—prices that appear available but cannot actually be executed, especially for less liquid venues. The effectiveness of a consolidated tape may also depend on whether brokers provide access to these exchanges, which is sometimes limited by technical or cost barriers, particularly in wider EU markets with high connection costs.
- 3.28. Some respondents believed a consolidated tape could stimulate new trading models through innovation and by affecting the market structure in the UK, potentially moving more retail activity onto exchanges away from the RSP model and improving visibility for smaller and mid-cap stocks. Some participants agreed that, over time, greater transparency from a consolidated tape could encourage a shift of retail flow to lit venues, potentially boosting on-screen liquidity and reducing reliance on dark liquidity pools.
- 3.29. However, there is concern that only more sophisticated investors might fully benefit from a consolidated tape, and that current RSP models already deliver competitive pricing for most retail orders. Additionally, some respondents, particularly those with a closer relationship with or deeper understanding of the retail side, emphasised that while a consolidated tape may enhance market transparency, it would need to be supported by targeted publicity and investor education to effectively boost retail participation. Retail investors often lack knowledge of market structure and trading mechanics, relying heavily on brokers to make decisions on their behalf. Transparency alone may not be sufficient to attract new retail investors or to foster more active engagement in trading

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activities through their brokers. Moreover, the consolidated tape would not contain actionable data for retail investors using the RSP model if pre-trade data was limited to lit venues (as almost all participants we spoke with assumed would be the case).

### 3.2.2 Streamlining data consolidation

- 3.30. In addition to the use cases stemming from a general increase in access to pre-trade market data due to lower data costs, there are potential benefits specifically related to a consolidated tape. These include reduced costs from streamlining data consolidation (discussed in this section) and having a common market reference point and market resilience, discussed in the following sections.
- 3.31. A few stakeholders suggested that a consolidated tape could reduce the complexity and costs firms encounter managing multiple direct data feeds from diverse venues. This is a claim that was more typically made on behalf of other, often smaller, market participants, although we did meet a few stakeholders who thought a consolidated tape could help their own operations in this way. The perceived problem is that some market participants, especially smaller firms, lack the IT infrastructure and resources required to consolidate data in-house. A consolidated tape would create a unified source for market data, simplifying processes and reducing the need for firms to manage and integrate multiple feeds individually. This, they noted, could enhance data accessibility, particularly for trade monitoring and risk management activities. This would be an additional benefit of having a ready-consolidated tape in addition to the lower market data costs implied by such a tape (as opposed to say only having cheaper data from individual venues).
- 3.32. Similarly, some respondents said that a consolidated pre-trade tape in the form of a single feed would enable smaller market participants to access a greater amount of market data without having to invest heavily in IT systems for data integration, for example if they could replace a current single feed with the tape.
- 3.33. On the other hand, some parties (including data providers and brokers) queried how a consolidated tape would change the ability of market participants to process consolidated data. In practice, they anticipate that intermediaries, such as data vendors, will continue to have a role to play in permitting many end users to visualise and analyse the feed from the tape (i.e. that the tape would need to be in a suitable format to permit existing vendor and third-party IT firms to make the data available to IT-limited end users). If there are some parties currently unable to find a third-party offering that permits them to ingest data in a suitable manner, then that problem will persist even after a consolidated tape becomes available. Given the required universality of the consolidated tape, it is unrealistic to assume that a consolidated tape provider would produce the data in a visual form suitable for a range of end users: the tape would most likely be distributed as a machine-readable feed, which users would need to either feed into their own visualisation and analytics systems, or access from a third-party vendor.

### 3.2.3 Common reference

- 3.34. A further rationale for a pre-trade data tape stemming from its consolidated nature is that it could serve as a shared reference point for all market participants. (Although this use case does not solely rely on cost savings, our fieldwork implies the tape would need to be sufficiently cheaper than current data for it to be widely adopted and thus confer the benefits of a common reference point.) It could act as an official “golden source” of information on pre-trade prices and volumes across venues. Whilst there are currently consolidated data products available from vendors – as well as the data consolidation that some sell-side firms do themselves – each will have differences in the venues included, the level of depth, what constitutes ‘addressable’ liquidity, and so on.

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- 3.35. Some supporters of a consolidated tape we interviewed argued that with a single, standardised reference, both buy-side and sell-side participants could make informed pre-trade decisions based on the same data. This was raised by four buy-side and 12 sell-side firms, as well as trade associations. This shared data source could support not only risk management and transaction cost analysis but also improve communication and transparency between firms, helping them to align on key market information before executing trades. This also could help with best execution, as described below.
- 3.36. However, some institutional and retail-focused brokers see little value in a consolidated tape as a benchmark. Some argue that the ultimate source of truth is the matching engine of the relevant venue, and that brokers would continue to use their direct data feeds to drive trading decisions rather than what appeared on the tape. They saw the consolidated tape just adding to confusion, as it would be one more data source against which they might have to explain why what is available to the trader at the point of execution may not correspond with what other information sources suggest is available. One example given, although queried by other parties, is the possibility that different venues each show available liquidity of 500, but in practice as soon as trades take place on the first venue the available liquidity on the other venues would disappear.
- 3.37. Another concern some parties raised is the possibility of market fragmentation if there are multiple versions of a consolidated tape. If there are different consolidated tape providers, they are likely to develop tapes that do not always perfectly align, creating costs for parties as they attempt to reconcile the different outputs from different consolidated tapes. A consolidated tape's ability to serve as a universal source of truth would be undermined if there were competing consolidated tapes. It is the FCA's stated intention for there to be a single consolidated tape provider per asset class, and the views expressed concerning the pitfalls of tape fragmentation support the value of a dedicated consolidated tape provider, rather than relying on consolidated products from different vendors (even if these were cheaper than they currently are).
- 3.38. One possible use of a consolidated tape as a common reference would be in determining the BBO price to apply. For example, a couple of respondents thought it might replace the primary exchange as the reference source used when determining the price for transactions on certain dark pools (although existing regulations currently restrict the flexibility to use alternatives to the primary exchanges).
- 3.39. Another example parties cited is that having a consolidated tape to serve as a common reference may improve transparency in certain marketing activities. Exchanges extolling the frequency with which quotes on their venue represent the best bid or offer or brokers wanting to benchmark how good their execution prices are might use the consolidated tape as the reference. Some parties generally sceptical about the value of a consolidated tape thought that there may be some value to exchanges in being able to present their claims with reference to an agreed reference source, such as a consolidated tape.

### **Best Execution**

- 3.40. A commonly cited use case for a consolidated tape from parties who support such a tape relates to how it could help with best execution (four buy-side and 12 sell-side respondents, as well as the trade associations). According to the feedback we received, the cheaper access to pre-trade data from various venues and the possibility that the consolidated tape can serve as a shared reference could both help with increasing the ability of parties to monitor whether their broker executes trades efficiently. Brokers and asset managers would have a shared reference that would allow for more transparent order routing strategies. For some trades which are not conducted using algorithms, access to a consolidated tape may encourage the trader to consider venues that they currently have no visibility on. By having access to more comprehensive pre-trade data in the form of a shared reference, buy-side firms may be able to have more informed and transparent discussions with their



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brokers about best execution. This idea is supported in UK Finance’s position paper which highlighted that pre-trade data enables investors to monitor execution quality, detect inefficiencies, and take corrective action where needed, aligning with investor protection goals.

- 3.41. However, some respondents (eight sell-side firms) voiced concerns about the consolidated tape's effectiveness in ensuring best execution. They were concerned that instead the consolidated tape may create confusion, requiring time and resources be spent explaining to clients the limits of what can be inferred from the consolidated tape. The tape may give a misleading impression about the available liquidity compared to the direct pre-trade data that brokers use in their algorithms and smart order routers. For example, if a client orders 20,000 shares based on consolidated tape data showing 50,000 available at the best offer price but only 10,000 shares are secured at that price, the client might feel that best execution was not achieved. The extent of this problem will be influenced by the design of the tape (if it includes auction data or does not disaggregate the liquidity by venue, the concerns may be more acute). In addition, some sell-side respondents consider – in line with the overarching FCA rules<sup>10</sup> – best execution to be more about overall performance and strategy and securing the required volume of a client’s trade, than trade-by-trade scrutiny of whether a best price was achieved or not. Several sell-side respondents felt that if a consolidated tape were adopted widely by the buy-side as a reference source then they would be obliged to adopt it too to facilitate these discussions, but that it would serve little benefit and merely be an additional cost.
- 3.42. Some parties from the sell-side challenged these concerns. One argument is that the consolidated tape should not be seen as confusing simply because buy-side firms observe liquidity at exchanges their broker may not be connected to. Instead, they see it as an incentive for brokers to ensure connectivity to all relevant exchanges, thereby supporting true best execution for clients. Another argument is that if it is quoted on lit venues, it is actionable and a well-designed smart order routing algorithm would allow the trader to access the quoted volumes and not succumb to ‘phantom liquidity’. Further, although best execution may be more than simply chasing tiny changes in prices (unlike the US, best execution in the UK is not based solely on price), a tape would be valuable if it allowed clients to assess the proportion of trades where their brokers achieved the best price (as seen on the tape), and to challenge them when this proportion appeared low or fell.
- 3.43. Respondents who commented generally consider there to be very limited scope for a best execution role for a consolidated tape in the retail market. As the market is largely a quote-drive market, prices and volumes made available by market makers are influenced by prices on trading venues as well as competition considerations vis a vis other market makers in the network. In many cases, the prices quoted are better than those displayed on the exchanges. It is also possible that the brokers used by retail investors are not connected to all trading venues, and that a consolidated tape would show a misleading view of actionable prices.
- 3.44. For post-trade analysis, some respondents noted that real-time data from the consolidated tape might not be essential, as post-trade transaction cost analysis is often conducted on a T+1 basis. They suggested that real-time post-trade data might not significantly enhance these evaluations.

#### 3.2.4 Market resilience

- 3.45. A further use case suggested for a consolidated tape during our fieldwork is its potential to enhance resilience for both individual participants and the market, particularly during exchange outages. For instance, if a major exchange like the London Stock Exchange (LSE) were to experience an outage, the consolidated tape could act as a unified data source of prices and available liquidity, providing the market with sufficient confidence for trading to continue on alternative venues. This would be

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<sup>10</sup> FCA Handbook COBS 11.2A [[link](#)]

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especially beneficial for smaller firms or companies that cannot access market data directly from multiple venues. (This would be subject to some conditions, as discussed in Section 5.2.5.) Respondents referred to the impacts of recent venue outages on trading volumes and spreads. Trade associations such as Investment Association, AFME and UK Finance also highlighted that a pre-trade tape could mitigate the risks of market outages by providing reliable reference prices, ensuring market stability and seamless trading, enabling smoother transitions between trading venues and enhancing investor confidence.

- 3.46. However, some respondents argue that, despite the presence of a consolidated tape, market participants might still hesitate to trade during an outage of a primary exchange. Many view the primary exchange as the central benchmark for price discovery, and they may prefer to await its return rather than rely on data from secondary venues. This dependency on the primary venue could, as respondents noted, limit the consolidated tape's immediate impact during an outage.
- 3.47. The structure of the consolidated tape itself would need to facilitate market continuity during outages. Respondents stressed that it would be critical for the consolidated tape to incorporate safeguards, such as alerts to flag potential data irregularities during these periods. Given its position in the data chain, the consolidated tape itself must be resilient, maintaining data access for clients even if it encounters technical issues. This would require a robust design to ensure data flow during periods of stress, with transparency around its resilience measures. As respondents highlighted, the consolidated tape provider's responsibility is substantial, as the integrity of market operations could heavily rely on the consolidated tape's ability to withstand outages.
- 3.48. Sell-side respondents generally questioned whether the consolidated tape could fully mitigate the impact of outages, noting that traders might still wait for the primary exchange's return, given its role as a price benchmark. In contrast, the buy-side was more supportive, viewing the consolidated tape as a valuable tool for maintaining market confidence and operational continuity during disruptions. Trading venues underscored the technical capabilities of the consolidated tape in providing alternative price discovery but stressed the importance of building the consolidated tape with strong resilience and continuity features to avoid disruptions in its own data delivery.
- 3.49. The value of a consolidated tape in providing trading resilience for individual firms is a further example of how access to cheaper market data may lead to its increased use, allowing firms to have visibility of prices and liquidity on more venues than they did previously. This would not necessarily require a consolidated tape, so long as market data were cheaper. Indeed, many sell-side firms already have access to comprehensive trading venue data and thus would not benefit from any additional resilience from a tape.
- 3.50. For such resilience in the face of a trading venue outage to benefit the market as a whole, a sufficiently large proportion of the market would need to have access to the same comprehensive data such that everyone feels more confident in continuing trading. While it is possible that a consolidated tape on its own could serve as the trigger that moves the market to an equilibrium where all market participants have an incentive to purchase and use the data from all venues such that market resilience is improved, it seems intuitively more likely that this would happen if the data licensing fees were cheaper.

### 3.2.5 Future regulatory guidance

- 3.51. For some of the respondents, a consolidated tape could offer potential to enhance the FCA's ability to shape future regulatory guidance, particularly in measuring best execution and evaluating market efficiency. With access to real-time data, the consolidated tape could provide a clearer basis for assessing best execution by offering insights beyond traditional post-trade analysis, thereby allowing



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the FCA to offer more precise and informed guidance to the market. It also addresses current limitations in market analysis that rely solely on post-trade data. AFME also highlighted the importance of real-time data for improved supervision and policymaking. They also suggested a consolidated tape could strengthen the UK's position as a global trading hub, aligning with the FCA's objectives of promoting competition and driving positive market change.

- 3.52. In terms of data handling, respondents noted that the provided consolidated tape and distributed consolidated tape do not need to be the same. For example, even if only the top of book data was publicly available, access to a complete data set could be made available to the FCA, including multiple levels of order book data, allowing it to conduct more comprehensive regulatory studies (including commissioning academic market studies). Storing this more extensive data set solely for regulatory purposes could bring long-term benefits, as data from past years could be published periodically—potentially at a two-year interval—without the need for frequent updates to the framework and with only a minor increase in administrative fees.
- 3.53. The consolidated tape may also have an option value for the regulator, allowing it to adopt future regulatory reforms more easily, either where a consolidated tape would provide better data to assess policy implications, or where a tape was seen as a necessary pre-condition for a reform.

### 3.3 Specifications of the tape for the use cases

- 3.54. The actual specifications of any consolidated tape as well as its cost will clearly be important in determining whether parties ultimately decide to adopt the tape. During our meetings, we discussed various features relating to the design of the consolidated tape that may be important. There were competing views as to what the key features of a tape were. In a few cases, mostly around the extent to which the distributed consolidated tape should aggregate the data, what would be desirable to one stakeholder would undermine another stakeholder's use case for a tape.
- 3.55. Some parties thought that it should be for the consolidated tape provider to decide on the ultimate design of the tape, as it was the consolidated tape provider that bore the risk of a low take-up rate if they failed to develop a consolidated tape that met users' needs. However, some regulatory oversight may still be necessary. Most obviously, the possibility of certain venues not providing useable data would need to be avoided. There are also some concerns that the consolidated tape provider will itself assume a privileged position and, absent constraint, enjoy a competitive advantage that it could exploit to the detriment of other parties, such as data providers and vendors. Regulatory engagement concerning the design of the consolidated tape will need to be ongoing, since over time there are likely to be issues that arise for which there is no consensus on the best way for the tape provider to proceed.

#### 3.3.1 Coverage of the tape

- 3.56. The majority of parties that expressed a view thought that a pre-trade consolidated tape should be limited to feeds from lit venues. One reason offered in support of this view was that the tape should be limited to actionable trades. Not everyone has access to systematic internalisers or dark pools, so including information from these sources would potentially present a misleading picture of what prices and volumes were achievable in the market. There are also questions about how practical it would be to include such feeds, and whether it would make sense to talk about unlit venues if they were having to publish pre-trade pricing data.
- 3.57. One dissenting view was that a pre-trade tape limited to just the lit venues would be of little value to retail investors, the very group for which many parties thought that a consolidated tape could be of most value. Data from lit venues would not be actionable for retail investors trading on the UK

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RSP model. Instead, what they really needed to see was quotes (at least indicative) from the RSP market. This was of most concern for smaller stocks, where the bid-ask spread on the lit venues can be large. With a large spread, the retail investor will be uncertain what price they are likely to be quoted should they seek a quote to buy or sell stock. Just adding prices from additional lit venues to a feed from the primary exchange may not reduce the bid-ask spread sufficiently to be of any additional value to the retail investor.

- 3.58. The possible inclusion of auctions in the consolidated tape was raised by some parties. While these might take place on lit venues, there was a concern that including pricing data associated with these auctions on the consolidated tape would provide a distorted view of the market. The prices were not really indicative of what liquidity available on the order book and would needlessly complicate discussions around best execution based on the consolidated tape.
- 3.59. Some respondents to our fieldwork observed that the limited number of lit venues meant that added value of a consolidated tape for equities would be less than for bonds. In equity markets, prices are generally accessible through linked exchanges, making price formation straightforward. In contrast, bond prices are fragmented across multiple venues, with access often dependent on bilateral agreements with counterparties, leading to limited visibility. Traders may receive incomplete or inaccurate information, as they cannot always see counterparties or trade details. The bond market's disaggregated structure requires participants to request quotes from various sources, often resulting in significant price disparities. A consolidated tape for bonds would address this fragmentation, enhancing transparency, improving price formation, and broadening access for participants. A consolidated tape may not be as critical for equities, where data are widely available – albeit at cost.

### 3.3.2 Latency

- 3.60. Latency requirements for pre-trade data vary among market participants and uses.
- 3.61. High-frequency trading (HFT) and smart order routing strategies rely heavily on real-time data, requiring latency in the microsecond (or even nanosecond) range to react instantly to market changes. For example, direct data feeds (not co-located) and non-display data provided by vendors are in the range of 10 – 100 microseconds depending on the location of the venue. Even minor delays introduced by a consolidated tape—such as additional "hops" in data processing—could lead to missed opportunities or expose latency-sensitive traders to risks like latency arbitrage. Consequently, these traders would continue to rely on direct market feeds rather than switch to a consolidated tape, regardless of how low the consolidated tape latency was. The consolidated tape can never be fast enough for such use cases.
- 3.62. For most other trading applications, a latency of 10-20 milliseconds is generally considered adequate, especially for strategies where real-time algorithmic speed is not a primary focus. Manual traders and those displaying market data typically find that latency up to 100 milliseconds meets their needs, as they prioritize clear visibility of market depth and liquidity over ultra-low latency. In these cases, vendor-provided latency, or "the speed of a human eye" would suffice. Participants focused on post-trade analysis, relationship-based trading, or long-term strategies (often from the buy-side) have more relaxed latency requirements. For these groups, delays of 100-500 milliseconds are usually acceptable. These participants prioritize data quality and comprehensive market depth over ultra-low latency. Certain vendor feeds or websites with refresh rates as slow as once per minute represent the higher end of latency currently available. While this is generally unsuitable for real-time trading decisions, it may be acceptable for applications like portfolio valuation or product structuring.
- 3.63. The consensus from our meetings was that a well-designed consolidated tape could easily achieve the latency requirements for all these use cases, and there were no material cost implications of

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aiming for a latency that was at least as fast as blink of an eye versus something slower. One user commented that a consolidated tape provider who chose to rely on a cloud-based solution rather than building their own infrastructure could generate a tape that failed to meet this latency by a significant margin as there would be the extra hop of accessing the data from the cloud. Some parties also commented that it would be possible to put in speed bumps to delay the feed, but the consensus is that absent a deliberate decision to have a high-latency tape it would be possible to have a tape that meets the latency requirements of all the candidate users of such a tape.

- 3.64. Some parties observed that the debates about latency seen in other jurisdictions do not apply in the UK. In contrast to an EU consolidated tape, the UK trading venues are much more centralised. An EU tape needs to be designed having regard to the fact that it is taking feeds from venues more than a thousand miles apart, such that there will inevitably be differences in the time taken for a feed to arrive from a given venue. Currently, all the feeds for a pre-tape equity feed in the UK are in the South-East. Some parties thought there may be minor complications with latency if an exchange was to locate elsewhere in the UK, although the challenges would still not compare with those facing an EU consolidated tape. Similarly, as discussed in Appendix I, the efforts made in the US to address latency variations between the consolidated tape and other sources of pre-trade data would not likely be relevant in the UK. Unlike in the UK, the SIP in the US is used by many market participants as the basis for trading, and thus speed bumps and other mechanisms are used to slow down other price information so as not to subject those trading with the SIP to excessive latency arbitrage.

### 3.3.3 Venue attribution

- 3.65. For most use cases identified, parties felt that venue attribution was essential if the consolidated tape was to realise its full potential. Many respondents highlighted the importance of venue attribution for accurately assessing liquidity at various price levels across venues, making informed routing decisions based on venue-specific data, and correctly interpreting data by identifying whether it originates from continuous trading or periodic auctions. Venue attribution is also necessary for effective post-trade analysis, allowing for evaluation of execution quality and market dynamics.
- 3.66. There is also a concern that without venue attribution the consolidated tape may make it easier for parties to engage in unhelpful trading strategies, posting minimal prices and volumes on less popular exchanges to influence market perceptions and, consequently, prices across all venues.
- 3.67. Many parties felt that a UK pre-trade tape should not copy the design of the proposed EU tape and limit itself to providing top-of-book quotes without venue attribution. Some felt that absent venue attribution, the tape would be of no value. Others thought that there might still be some limited value in such a tape, but that it would clearly be a second-best solution.
- 3.68. Venue attribution is seen as essential if the consolidated tape is to realise its use cases relating to best execution and supporting informed trading decisions. Without it, users cannot identify where the best bid and offers are available nor what liquidity is available at a given venue. The additional transparency venue attribution would provide would allow buy-side parties to challenge their brokers more effectively when discussing whether best execution was achieved (as noted previously, other parties had reservations about relying on pre-trade data to discuss best execution). The conversation might cover why a given trade was not routed to a given venue or, in some instances, why a broker does not currently trade on certain venues.
- 3.69. Having a consolidated tape with venue attribution may help the buy side assess broker performance when deciding which brokers to use. For example, it may cease to be tenable for a broker to only trade on the primary exchange if their would-be clients can see that for the stocks of most interest to them other lit venues offer the best BBO for a large fraction of the day.

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3.70. A small number of respondents thought that RSPs and smart order routers are well-positioned to benefit from venue attribution. RSPs, who face ongoing scrutiny regarding their ability to consistently offer the best prices, could leverage a venue-attributed tape for transparent price matching and improved execution quality. For smart order routers, knowing which venue holds specific liquidity at a given price level is crucial, especially in scenarios where different venues offer different volumes at similar prices.

### 3.3.4 Depth and contents

3.71. The depth requirements for a consolidated tape vary across market participants based on their specific use cases. For parties only placing small orders and with simpler trading strategies, including many retail investors and smaller institutional traders, top-of-book data might suffice. It provides basic liquidity information. Such data might also suffice for some risk monitoring. Another attraction of top-of-book data was that it would be easily understood by all market participants, whereas a consolidated tape with more depth might confuse some users absent training.

3.72. However, top-of-book may not meet the needs of more advanced trading strategies, from both sell-side and buy-side participants. For strategies like order routing, liquidity analysis, or algorithmic trading, access to deeper market data is essential. Many participants agree that a minimum of five levels of depth is ideal for a consolidated tape, as it provides a fuller view of liquidity beyond just the best price, supporting more granular trading. Some advocate for up to 10 levels or more for greater insights, though there is concern that deeper data may significantly increase costs (we discuss the possible costs of a tape, including the implications of extra depth, later in the report).

3.73. Quite a few parties are critical of only having a top-of-book EU consolidated tape. Some claimed that the complexity and cost of offering a deeper consolidated tape was more of a concern for an EU consolidated tape. However, in the UK, as in the US, exchanges often provide more levels of depth. Parties already accessing sometimes as many as 10 levels of depth would expect a consolidated tape to provide a similar level of granularity if they were to contemplate adopting it.

3.74. For small-cap stocks and ETFs, top-of-book may not offer sufficient depth, and a depth-of-book view with at least three to five levels of data, along with venue attribution, would provide more comprehensive information. More generally, even parties that think a top-of-book will generally suffice caution that this is conditional on the top-of-book quotes having some minimum level of volume available at the prevailing bid or offer.

3.75. For the UK ETF market, which is still developing, a pre-trade consolidated tape could drive growth and innovation, providing clearer insights and making the market more competitive, especially as cross-border trading with the EU becomes more seamless. Including ETFs in a consolidated tape or producing a separate ETF Tape for day-to-day monitoring could provide potential benefits, especially given that much of the ETF trading currently occurs off the order book due to the creation and redemption process. Smaller ETF trades do take place on the order book, and adding ETFs to a consolidated tape could improve observable liquidity, particularly for mid- and small-cap ETFs. This would enable better trading decisions and reduce costs for market makers by consolidating liquidity data across venues. While direct access to liquidity providers via RFQ systems is an alternative, a consolidated tape would offer a more transparent, consistent view of the market, enhancing pricing and supporting best execution.

3.76. Post-trade data are generally seen by participants as more crucial for enhancing transparency and oversight compared to a pre-trade tape, particularly in the fragmented OTC markets. Even a T+1 post-trade tape would provide significant benefits by serving as a "golden source of truth" for post-trade data, helping to police OTC trades and improve liquidity discovery. The fragmentation created

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by MiFID II has made tracking trades across multiple venues difficult, with hidden off-exchange activity complicating transparency. A post-trade consolidated tape would aid in benchmarking, broker performance evaluation, and ensuring market participants have a consolidated view of activity, particularly in non-lit venues.

- 3.77. Even for parties that wanted a pre-trade consolidated tape, focusing only on post-trade transparency would still fill major gaps, increasing confidence and driving more liquidity into the markets. The key considerations will be the cost and accessibility of this tape, but its value in improving execution quality and harmonising data across venues is widely recognised. Respondents were concerned that extensive deliberations about the inclusion of pre-trade data should not delay the provision of a post-trade tape.
- 3.78. That said, the additional benefits of including pre-trade data into a post-trade tape are raised by a few market participants contributing to this study and in published reports and statements.

### 3.4 Appetite across market participants for a consolidated tape

- 3.79. In this section we summarise the results of our fieldwork as to the likely appetite of different market participant groups to adopt a consolidated tape, considering respondents' current access to pre-trade market data and the additional benefits a tape could bring to them. We focus on direct uses that the firms would make of a tape, rather than wider benefits that may accrue to the market if others adopted it (these are discussed in Section 5).

#### 3.4.1 Proprietary traders

- 3.80. Most proprietary traders (six of the eight interviewed) are sceptical about adopting a pre-trade equity consolidated tape due to their reliance on existing direct pre-trade data feeds that already meet their needs. Speed and data depth are crucial for their trading strategies, and firms say a consolidated tape will be too slow, lack the full order book information required, and only cover a fraction of the trading venues on which they trade (on the assumption that the tape will not include quotes from systematic internalisers or dark pools). They also express concerns about the costs of incorporating a consolidated tape without seeing significant additional benefits.
- 3.81. Many firms in our sample see no use for a consolidated tape within their current business, viewing it as redundant given the direct data they receive from exchanges, which they consider sufficient for all their uses. These firms also consolidate the data themselves in ways most useful to their needs, and they would not wish to adopt data consolidated to a different set of specifications or criteria. They are not inclined to change their data processes and see no advantage in adopting a consolidated tape. Some parties stated that the consolidated tape use case was valid a decade ago, but the market has since developed alternative solutions that meet the needs of investors.
- 3.82. The larger and more integrated proprietary trading firms see some use for a consolidated tape to provide a cheaper alternative to display data. In addition, some might consider using a consolidated tape as an additional data source if it becomes widely adopted as a benchmark or is mandated by regulation, particularly for measuring best execution or serving as a reference for price trading. However, this would only happen if the consolidated tape shows clear value beyond what they currently access.

#### 3.4.2 Institutional-focused brokers

- 3.83. Most investment banks and other brokers in our fieldwork do not see any use for a consolidated tape in their trading operations. They rely on direct, high-speed data feeds from exchanges, which

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are critical for their algorithms and smart order routing. As a result, the introduction of a consolidated tape would not change their trading behaviour or existing infrastructure. The exception here was a broker engaged in high touch trading, who considered that a consolidated tape could enable it to expand its brokerage capacity into a wider range of stocks, as visibility of a greater number of venues could enable it to build an investment portfolio around stocks traded on these venues.

- 3.84. However, all but one broker in our sample acknowledge that a consolidated tape could have value in functions that do not rely on latency-sensitive market data, by replacing current display data with a cheaper alternative and/or enabling further uses in sales, compliance, risk management, or middle and back-office functions. Respondents who commented on the issue considered that adopting a consolidated tape feed should be technically feasible without significant infrastructure investment. The initial ingestion point would need to be configured to accept the tape which would then flow into end applications. There may be some timing delay whilst existing data contracts expired (to the extent that these were to be replaced – a number of participants thought that the tape would be an additional source of data), but that adoption within two years would be feasible, if the commercial case was met.
- 3.85. Brokers were also largely supportive of a consolidated tape for other users such as investment managers and retail investors, for uses described in section 3.2, namely enhanced liquidity assessment and greater confidence in trading decision making.

### 3.4.3 Buy-side firms

- 3.86. Buy-side firms we interviewed support the implementation of a consolidated tape and are open to adopting it (six out of seven explicitly said this). They see the main benefit as a cheaper source of market data they already use, such that a tape would not generate significant behavioural changes. A few however did think a tape would enhance their ability to see and access a broader pool of liquidity and give a clearer picture of market activity, and thus have an impact on their trading decisions. Several other respondents – such as sell-side firms and buy-side trade associations – were of the view that buy-side firms in general would benefit greatly from a consolidated tape, for the reasons described in Section 3.2 (i.e. greater visibility of liquidity across all lit venues and more confidence in making trading decisions). That this was not clearly identified in our buy-side sample could be due to the nature of the firms we met (typically large and sophisticated).
- 3.87. While most firms stated they would initially maintain their current data feeds, they see the potential for a consolidated tape to eventually replace some of these display data feeds if it proves reliable and cost-effective. Many respondents said they would be unlikely to be early adopters but are open to transitioning once they can evaluate the tape's performance. One smaller firm considered it would not require a substantial change or investment (perhaps a few months' programming to incorporate it into the OMS and EMS) provided the feed was similar to their existing vendor feeds. Adopting within two years was definitely possible. A larger firm however thought that more work would need to be done by their data architects to understand the tape's scope and configuration and to assess how to integrate it into their existing feeds. They would likely begin this process in advance of the tape being ready so that they could purchase it as soon as possible.
- 3.88. Concerns remain about the commercial viability and quality of the consolidated tape, particularly whether it can serve as a substitute for current data. There are also technical issues that need clarification, such as the scope and features of the consolidated tape and how it will integrate with existing data systems. Additionally, some firms are concerned about the costs and complexity of switching to the consolidated tape. While some believe the process could be straightforward, similar to switching feeds from another exchange, others anticipate that infrastructure investment would be



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necessary to fully integrate a consolidated tape, and firms with more complex data management processes would need to modify their feeds and linkages. There is concern about losing flexibility in choosing data sources if the consolidated tape only provides a single option.

#### 3.4.4 Retail market

- 3.89. Most parties in our fieldwork, including buy- and sell-side firms and trade associations, emphasise the potential benefit of a consolidated tape for retail investors. A consolidated tape would likely improve transparency in the market by consolidating data across venues, providing retail investors with access to a broader and clearer picture of market activity. This could lead to better price discovery and allow retail investors to challenge quotes obtained through brokers – as well as brokers’ fees – more effectively. The greater availability of data could also increase retail investor confidence as they see prices across more venues, potentially increasing participation in the market. Some also think that a consolidated tape would enable regulators to better monitor the RSP broker and market maker model and interrogate where retail investors are not receiving the best price. In addition, some respondents were of the view that a consolidate tape could encourage a change in the market towards more direct participation by retail investors, away from the RSP model.
- 3.90. However, a number of parties mentioned that due to the dominance of the RSP model in the UK – where retail investors access quotes from RSP network market makers via retail brokers – the impact of a consolidated tape on retail behaviour is less clear. While a consolidated tape could encourage a shift towards more direct engagement with lit venues, some argue that the current system already ensures competitive pricing. The introduction of a consolidated tape could still promote further transparency and encourage retail investors to become more actively engaged, but its success would depend on factors such as how accessible and affordable the data are, and how is it presented for retail participants. In addition, some respondents had concerns about the ability of retail investors to interpret the large volume of market data on a tape and thought that current data available to retail investors was sufficient for their needs.
- 3.91. The LSE has announced plans to make pre-trade equities data free to retail investors from January 2025.<sup>11</sup> Respondents to our fieldwork think this would positively impact the retail investor market, although it would not include the same breadth of data that a consolidated tape would.
- 3.92. From the retail investors' direct perspective, the introduction of a consolidated tape could provide benefits if it includes RSP market maker quotes. Retail investors often face wide spreads on smaller stocks, which can deter trading, but the actual RSP quotes are typically more favourable. If these quotes were integrated into the consolidated tape and displayed in real-time, it could encourage more trading by retail investors in less liquid stocks by providing better price transparency and improving liquidity. This would make smaller and mid-cap stocks appear more attractive and less risky to trade, while the impact on larger stocks would likely be minimal, as price differences between venues are smaller.
- 3.93. For a consolidated tape to be truly useful to retail investors, it would need to be seamlessly integrated into the broker platforms they already use. Without this integration and clear access, the benefits of a consolidated tape might not be fully realised. Publicity and education would also be critical to ensure retail investors understand how the consolidated tape can enhance their trading decisions and provide better price visibility, as most will be unfamiliar with more detailed pre-trade data more complex market data.
- 3.94. Retail-focused brokers also see the potential value in a consolidated tape, particularly for post-trade analysis and improving execution monitoring. A consolidated tape could help benchmark trades

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<sup>11</sup> LSE (2024) “Retail investors – democratising access to UK capital markets” [[online](#)]

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against the best available prices across multiple venues, especially when dealing with RSPs, driving better price transparency and ensuring competitive execution for retail clients. While pre-trade data are less critical for some brokers, they acknowledge that as they expand, a pre-trade consolidated tape could inform liquidity decisions and help optimise execution strategies. However, the cost of accessing a consolidated tape is a key concern, as data licensing fees are already high, and any increase could negate its benefits. Integrating the consolidated tape seamlessly into existing systems without overwhelming retail clients with too much data, while still offering market depth to internal desks, will be essential for its success.

- 3.95. On the other hand, RSP market makers have little appetite to adopt a consolidate tape, with none in our sample identifying a use case. They currently obtain all the pre-trade data they need through direct feeds, and do not think the tape would be comparable in terms of speed or granularity of information.



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## 4 Costs of a Consolidated Tape

4.1. In this section, we review existing papers that provide commentary on the likely cost of a consolidated tape. We also feed in views picked up from fieldwork on possible cost drivers for such a tape, although most of the meetings focussed primarily on possible use cases and impacts of a consolidated tape. Often attendees did not feel qualified to comment on matters relating to the costs of a tape. Those that did comment on the costs did not always agree on what the costs of such a tape might be. The differences did not necessarily align with interviewees' overall views on the desirability of a UK pre-trade consolidated tape, with instances where a party very supportive of the tape suggesting costs would be more significant than parties more neutral or negative on the need for a consolidated tape.

### 4.1 Existing cost estimates

4.2. We are aware of three main studies that are relevant to costing an equities consolidated tape. These all focused on a potential EU tape.

- Market Structure Partners (MSP) was commissioned by the European Commission (EC) to estimate the cost of introducing a consolidated tape across 11 countries largely in Western Europe, including the UK; this tape would consolidate from 482 data contributors.<sup>12</sup> A single tape would cover post-trade data for bonds and both pre- and post-trade data for equities.
- Oliver Wyman was commissioned by the Federation of European Exchanges (FESE) to cost a consolidated tape including post-trade data for bonds as well as both pre-trade and post-trade data for equities.<sup>13</sup> This estimated the cost separately for a pre- and post-trade tape at different latencies, covering the 30 European Economic Area (EEA) jurisdictions alongside the UK and Switzerland, with over 600 contributors. The pre-trade option is not broken down by speed, with only pricing for real-time pre-trade data. The study does not provide an exact definition for what constitutes real time.
- A group of European buy-side and sell-side institutions commissioned Adamantia to estimate the costs of setting up a pre- and post-trade equities consolidated tape covering all European Economic Area (EEA) venues.<sup>14</sup>

#### 4.1.1 Specification and set-up costs

4.3. The cost models for a consolidated tape establish a preferred specification with limited flexibility in terms of key variables such as latency, depth of book offering, and geographical scope. Despite these constraints, these models provide valuable estimates for assessing the likely cost ranges for a tape in the UK. None of the studies directly estimates the cost of a standalone pre-trade equity consolidated tape. Some of them provide separate estimates of a consolidated tape for post-trade financial data (including fixed income) with and without pre-trade equity data. This potentially offers clues about what the incremental costs of including pre-trade equity data on a consolidated tape might be, assuming that the decision to include such data was made at the time of set up (the incremental costs of adding pre-trade data to an existing tape might be very different).

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<sup>12</sup> Market Structure Partners (2020) "The Study on the Creation of an EU Consolidated Tape" [\[link\]](#).

<sup>13</sup> Oliver Wyman (2021) "Caught on Tape — A Consolidated Tape for Europe" [\[link\]](#).

<sup>14</sup> Adamantia (2022) "The case for a viable Consolidated Tape on Equity" [\[link\]](#).

4.4. MSP model the costs of a consolidated tape system operated by a single provider across Europe, including the UK. Table 4.1 sets out the number of data providers by venue type used as inputs to this consolidated tape specification. Their model includes two data centres, with one serving as a backup to ensure continuity in the event of an outage. The tape’s data offering would encompass five levels of depth, detailed auction data, and the calculation of the volume-weighted Best Bid and Offer (BBO). The latency for disseminating this data would be in the range of tens of milliseconds. MSP estimates that a post-trade bond and equities consolidated tape with this specification would cost €9 million. They find that the largest cost would be the hardware involved in connecting to the data providers and the storage costs required to handle the quantities of data involved. The incremental set-up costs of including pre-trade equities data is €2 million in the MSP model.

**Table 4.1: Data inputs to MSP consolidated tape specification**

	RM	MTF	OTF	APA	SIs, OTC	Total
<b>EU</b>	121	139	25	16	15	316
<b>UK</b>	15	81	49	6	15	166
<b>Total</b>	136	220	74	22	30	482

Source: MSP: The Study on the Creation of an EU Consolidated Tape

4.5. Oliver Wyman has larger estimates for the set-up costs relative to the MSP report. This partially reflects the larger scope of the tape, which would cover over 400 trading venues and 200 SIs across Europe, so that 650 venues would connect to the tape’s feed. The cost of the tape depends on the data offering, detailed in Table 4.2: a pre-trade equities and post-trade bond tape would cost almost €100 million to set up, compared to €77 million for post-trade only at real time and €50 million for a post-trade tape with a 15-minute delay.

4.6. The incremental set-up cost of including pre-trade data on a tape with close-to-real-time post-trade data is over €20m, ten-times larger than the incremental set-up costs implied by MSP. The incremental costs of including pre-trade data would be even greater if the increment related to the costs of going from a post-trade consolidated tape that was not close to real time.

**Table 4.2: Set-up Costs**

	Oliver Wyman				MSP	
Consolidated tape design options	Pre/post-trade (Real-time)	Post-trade (Close to real-time)	Post-trade (15-minute delay)	Post-trade (End of day)	Pre-trade (Real-time)	Post-trade (Real-time)
<b>Leadership &amp; project mgmt.</b> (5 functional managers)	€1 MN	€1 MN	€1 MN	€1 MN		
<b>Proposition design</b>	€0.6 MN (3 architects & design leads)	€0.6 MN (3 architects & design leads)	€0.4 MN (2 architects & design leads)	€0.4 MN (2 architects & design leads)		
<b>Business Developer</b> (1 representative per country)	€6 MN	€6 MN	€6 MN	€6 MN		
<b>Technology implementation</b> (Outsourced vendor support)	€25 MN	€20 MN	€10 MN	€5 MN		
<b>Connectivity</b>	€65 MN (€100k per venue)	€49 MN (€75k per venue)	€33 MN (€50k per venue)	€7 MN (€10k per venue)		
<b>Total build cost</b>	~€98 MN	~€77 MN	~€50 MN	~€19 MN	~€11 MN	~€9 MN

- 4.7. The two reports agree that the largest component is the cost of providing physical infrastructure, including the connections to each data provider. Oliver Wyman estimates these connection costs to be €100,000 per venue for real time pre-trade data, reaching costs of €65 million. For technology costs, rather than build up the costs by first determining the staffing complement that would be required for the task, both MSP and Oliver Wyman assume that the technology implementation would be outsourced. MSP notes that there are readily available technology solutions. Oliver Wyman estimates these technology costs would be €25 million for a real time pre- and post-trade equities tape with post-trade bonds, while MSP have a total set-up cost of €11 million for a tape covering pre-trade equities and post-trade bond data.
- 4.8. Adamantia propose a pre-trade equities tape at near real time latency, which they define as roughly 100 milliseconds, covering all trading venues and APAs in the EEA. This specification would disseminate individual BBO data from each execution venue, with the calculation of a European-wide BBO left to the users of this data. Despite having a similar scope and specification to the Oliver Wyman study, their estimate for the set-up cost of this tape is €17 million.

## 4.1.2 Running costs

- 4.9. There is also a divergence in the running cost estimates between the studies, particularly in the cost of technology and software, set out in table 4.3. Again, the studies allow inferences to be made about the incremental costs of running a consolidated tape that includes pre-trade equity data, but they do not offer estimates on the cost of building a standalone pre-trade equity consolidated tape.

**Table 4.3: Ongoing Costs**

	Oliver Wyman				MSP
Consolidated tape design options	Pre/post-trade (Real-time)	Post-trade (Close to real-time)	Post-trade (15-minute delay)	Post-trade (End of day)	Pre/post-trade (Real-time)
<b>Technology</b>	€12 MN	€10 MN	€8 MN	€2 MN	
<b>Tech. operations</b>	€3 MN (25 operations specialists)	€2 MN (15 operations specialists)	€1 MN (5 operations specialists)	€1 MN (5 operations specialists)	~€5 MN
<b>Real estate and other</b>	€3 MN	€3 MN	€3 MN	€3 MN	
<b>Staff costs</b>					
<b>Venue managers</b> (1 representative per country)	€3 MN	€3 MN	€3 MN	€3 MN	~€2 MN
<b>User managers</b>	€15 MN (One manager per 100 users)	€15 MN (One manager per 100 users)	€10 MN (One manager per 150 users)	€5 MN (One manager per 300 users)	
<b>Corporate functions</b>	€3 MN	€3 MN	€3 MN	€3 MN	
<b>Total run cost</b>	~€38 MN	~€35 MN	~€27 MN	~€16 MN	€6-7 MN

- 4.10. MSP estimates that the total costs for operating a consolidated tape would amount to €6 to €7 million annually, with the largest cost components being staffing and ongoing technology costs. The permanent staff requirement is estimated to consist of 22 individuals, with the core technology outsourced; the costs associated with personnel responsible for the development and maintenance of the technology are incorporated within the overall technological expenses. Of the total estimated running costs, staff expenses are projected to account for approximately €2 million out of the total, with staff to deal with legal compliance, operational support and a liaison with the technology provider. This falls to €1.4 million for a tape covering only post-trade bonds and equities.
- 4.11. Oliver Wyman estimates a yearly cost of €38 million, with the largest component being staff salaries and a software cost up to €12 million. This specification, focusing on the whole of the EU, budgets one manager per member country and one manager per 100 users, in both cases at an annual cost of €100,000 per manager.

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- 4.12. The Adamantia report does not provide specific breakdowns of running cost components and reports an annual cost of €16 million to run a tape covering pre- and post-trade data for equities.

## 4.2 Likely costs of a UK pre-trade tape

- 4.13. In this section, we attempt to generate an estimate of what a UK consolidated tape that included pre-trade equity data and post trade data might cost. These cost estimates will be larger than either the standalone cost of a pre-trade equity consolidated tape or the incremental cost of including pre-trade equity data on a consolidated tape. Our calculations have regard to the Oliver Wyman and MSP studies. While the studies focus on the creation of an EU consolidated tape, both include the UK as a data provider. Oliver Wyman provides a specific cost breakdown but does not indicate the number of UK venues or users, while the MSP study includes the number of UK venues but does not provide cost breakdowns. We do not attempt to scale the Adamantia estimate given that cost breakdowns by component are not provided in that report, although we note that any scaling would result in lower costs so the study's published estimate can be treated as an upper bound on what the implied costs of a UK consolidated tape are using Adamantia's estimate.
- 4.14. Oliver Wyman's greater connection costs reflect the greater scope of their study, looking at a tape for the whole of Europe. In the UK there are 5 firms operating as an RM<sup>15</sup> and 38 firms operating as an MTF.<sup>16</sup> If we assume that the only set-up costs that would vary according to the number of venues relate to business development and connectivity, then the total set up cost for a tape including these 43 venues would be £26 million.<sup>17</sup> A more detailed breakdown of the calculations can be found in Appendix 5. Several stakeholders have noted that they would expect five lit venues to be the total coverage of a UK pre-trade equities consolidated tape. A consolidated tape with just five venues would cost £23 million to set-up if scaling the Oliver Wyman cost estimates.
- 4.15. The annual running costs for a UK tape might be of a similar magnitude if scaling the running cost estimates from Oliver Wyman. We assume a single venue manager. Trading volumes on UK trading venues in 2019 accounted for 50 per cent of equity share volumes traded on exchanges in the EEA and UK in 2019.<sup>18</sup> We use this ratio to scale down by one half the running costs associated with tech operations, user managers and real estate & other, to reflect the fact that a UK tape is likely to attract considerably more activity and work than would be implied if scaling by the share of venues. Our calculations use the 2019 share rather than the 2020 share (69 per cent) to avoid any distortions associated with Covid. We have not attempted a further adjustment to control for the fact that the OW estimates include fixed income, since the share of transaction that are fixed income is small (in 2023 1.9 billion equity transactions and only 16 million bond transactions)<sup>19</sup>. Other running costs, including software costs, are assumed to be unchanged. This gives a running cost estimate of £21 million.
- 4.16. There is considerable scope to argue for adjustments (up or down) to this point estimate. For example, maybe trading activity should be assumed to have some effect on corporate costs but be less correlated with real estate costs. There is also the question of how to scale having regard to the scale of activity on a UK tape. Such a tape may not account for half of all users (or trading venues) in Europe, although it would be wrong to limit attention to UK-based investors given one suggested source of demand for a UK consolidated tape is from non-UK investors wanting better visibility on the UK equity market.

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<sup>15</sup> FCA (2024) Financial Services Register [\[link\]](#)

<sup>16</sup> FCA (2024) DRSP, MTF, OTF, SI and DR Register [\[link\]](#)

<sup>17</sup> We have assumed a €: £ exchange rate of 0.83.

<sup>18</sup> ESMA (2022) "Evolution of EEA share market structure since MiFID II" [\[link\]](#)

<sup>19</sup> ESMA (2024), EU Securities Markets 2023 [\[link\]](#)

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- 4.17. UK estimates of set-up costs inferred from the MSP study would necessarily be less than £10 million, given the UK is within the scope of its study. Absent details on how the costs were built up, we assume MSP estimates of set-up and ongoing costs to scale having regard to the same ratios of fixed and variable costs as used when adjusting the corresponding Oliver Wyman estimates. This method provides estimates of £6 million in set-up costs and £5 million in ongoing costs to run the consolidated tape.
- 4.18. Overall, the estimates to a potential pre-trade equities tape in the UK provides estimates in the region of £6 million to £26 million and a running cost from £5 million to £21 million. This wide range highlights the disagreement between Oliver Wyman, MSP and Adamantia around the overall cost of setting up a pre-trade consolidated tape, particularly how much it would cost to outsource the technology to achieve real-time latency.

### 4.3 Cost drivers

- 4.19. Stakeholders tend to agree on the cost components of a consolidated tape, while there were conflicting views over their relative magnitude. Only one stakeholder provided a specific monetary estimate of £11-14 million in set-up costs and £5-7 million ongoing costs for a consolidated tape offering top of book BBO. Another agreed with the general scale of the cost estimates put forward by MSP.
- 4.20. The setup costs would encompass physical infrastructure, such as space in data centres, servers, firewalls, switches, electricity, and staffing, as well as the software development required to consolidate market data. This software development would include standardising data feeds; once the data has been received from the exchanges the data would need to be cleaned and standardised before it is disseminated onto the consolidated feed. One respondent mentioned that this may be less of an issue for a UK-only tape, as there are fewer trading venues, and these tend to have similar reporting standards. Another stakeholder also mentioned that there may be additional cost in having different distribution channels. For example, algorithmic users of the data would require a direct data feed by API for raw data, while retail consumers would require visual access to the data, potentially through a web-based platform. The ongoing costs would be for data storage, the monitoring of data issues, licencing and legal compliance. One stakeholder mentioned that regulatory capital may also be a relevant cost beyond the operational cost of the tape.
- 4.21. The cost of tendering for the consolidated tape provider would also have to be considered: one stakeholder estimated this to cost £1-2 million per tender preparation. The frequency of any tenders will affect how often these costs are incurred. Auctions will also give rise to set-up costs should the incumbent not win the auction (or the auction design, perhaps to overcome incumbency advantage, denies the incumbent the opportunity to continue with its existing infrastructure after the auction).

#### 4.3.1 Costs drivers mentioned by the stakeholders

##### Set-up costs

- **Network Costs:** Infrastructure costs to support the high data volume.
- **Consolidated Tape Enablement:** Making consolidated tape available to all users, considering time differences and consumer needs.
- **Physical Infrastructure:** Datacentre space, servers, firewalls, switches, electricity, and personnel.
- **Data Collection Infrastructure:** Systems for collecting data from multiple venues.
- **Distribution Formats:** Providing API access for professional users and web access for retail investors.

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- **Marketing and Publishing Infrastructure:** Setting up licensing, compliance, legal, risk, and salesforce structures.

#### Ongoing costs

- **Fee Handling:** Managing fees paid to trading venues for data access.
- **Data Formatting:** Normalising data across different trading venues for consistency.
- **Network Costs:** Infrastructure costs to support the high data volume.
- **Data Cleaning:** Ensuring data accuracy and usability through thorough cleaning processes.
- **Operations Monitoring:** Identifying and addressing operational issues.
- **Centralised Data Lake:** Storing and accessing data centrally for reliability.
- **IT and Support Team:** Monitoring data quality and IT support for operational continuity, as well as cyber security.
- **Development Costs:** Development work will be required to support new equity products
- **Regulatory Capital:** Maintaining required regulatory capital as a regulated entity.

### 4.3.2 The impact of technical specifications on costs

#### Depth of book offering

- 4.22. There is most disagreement among stakeholders around the cost sensitivity of increased depth of book data. Some stakeholders do not believe that the depth of book offering of the tape would have a notable effect on the cost. Some stakeholders have said that at least five levels of data would be required to calculate the best bid/offer, therefore the consolidated tape provider would already be receiving and processing such volumes of data that including five levels of data on the tape would not add too much cost. Another disputed this claim, arguing that, while it is the case that depth of data may be used to calculate the BBO, the largest cost increase with depth of book will be due to storage and dissemination of more data.
- 4.23. Others cite the increased bandwidth required, with one stakeholder mentioning that it would require around ten times more updates with more depth offering. Greater bandwidth for receiving and sending this information would be required, as well greater software and storage costs. One party claimed that, relative to a post-trade consolidated tape, the data costs would be 10 times larger for a top of book pre-trade feed and 100 times larger for one with depth of book offering. Another also mentioned the increased operational support and maintenance costs associated with the larger quantity of data and mentioned that they thought depth of book offering in consolidated data feeds are not commercially viable in the current environment.

#### Data coverage

- 4.24. Beyond the depth of book offering one stakeholder argued that there may be notable cost differences with the coverage of different message types. They argued that the inclusion of auction data would represent an additional computing challenge to categorise, since they would have to be standardised with other forms of data. This is particularly challenging for frequent batch auctions rather than scheduled auctions, which occur regularly at microsecond speed and add the greatest deal of complexity.

#### Latency

- 4.25. Stakeholders identified technology requirements for ensuring low latency as a significant driver of consolidated tape costs. However, within the bounds of a likely or useful tape specification these are less relevant. For example, one stakeholder highlighted that costs only escalate when transitioning from a latency measured in seconds to one measured in milliseconds, primarily due to the need for dedicated physical infrastructure to enable high-speed data transfer. For a system with a latency of



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seconds, it would be possible to rely on cloud-based infrastructure, which could result in significant cost savings by eliminating the need for extensive physical storage infrastructure. In this case, software costs would remain relatively unchanged compared to a direct feed system. Achieving latency in the millisecond range would necessitate more sophisticated code optimisation and high-performance data centres to handle the increased demands on speed and efficiency. However, as most of the respondents agreed that a tape would need to have a latency at least at 'human eye speed' of around 100 milliseconds, the cost differential with a tape with a latency of a few seconds is largely moot.

- 4.26. There were some parties that commented that latency is a bigger issue in Europe, given connections would come from much further apart than a UK only tape. A few parties commented that latency issues might become slightly more important if at some point there was a UK exchange operating from outside the South East, but even then it would not compare with the challenges for an EU consolidated tape.

#### Operational support

- 4.27. The stakeholders tended to differ from the cost estimate studies in their focus on maintenance operations as a large cost driver in setting up the tape. One stakeholder mentioned that this issue is a factor in why there is not a current provider interested in running the tape. The consolidated tape provider would need a large operational and support mechanism to respond to all the queries about issues with venue latency and small mistakes or glitches. Those concerned about the depth of book offering highlighted that these support costs would escalate significantly if publishing depth of book data. In the scenario of an outage, the costs associated with restoring historical data would be significantly more for a tape with depth of book offering rather than one only including top-of-book data. Another stakeholder argued that historical data could be stored on a separate, cloud-based, system at much lower cost. Stakeholders have noted the importance of including historical data within the feed, since it is a key component of venue routing algorithms and portfolio risk analysis.
- 4.28. One stakeholder noted that the resiliency standards for a consolidated tape would need to be significantly higher than those for individual exchange feeds. A consolidated tape involves more data inputs, which increases the risk that an issue with a single feed could disrupt the entire system. Measures to ensure that each venue data reporting feed is separate and secure would add to costs. Monitoring of the feed and having the resources available to take prompt remedial action would be important, as a venue providing delayed or corrupt data could affect the accuracy of the BBO signals across the market.
- 4.29. Separate to the increased risk of outage, if the consolidated tape serves as the sole reference point for market data, it may be more important to prevent an outage of the consolidated tape than a single vendor. In cases where participants rely exclusively on the consolidated tape rather than individual exchange feeds, an outage could halt trading altogether (e.g. if regulations were changed and the consolidated tape was being used by SIs or dark pools as the reference price). The reliability and perceived value of the consolidated tape as a central data source would suffer, which may lead some users to question its suitability as a sole reference point. Consequently, additional spending on resilience measures may be required to mitigate these risks and ensure continuous operation.

#### Data standardisation and distribution

- 4.30. Most stakeholders that commented on costs did not think that there was any case for imposing data standards that either data providers would have to use when sending feeds to the consolidated tape provider, or that the consolidated tape provider would use when distributing the data.<sup>20</sup> For distributing the data to end-users, they felt that the existing infrastructure would suffice. They thought that the data would best be sent via existing channels, including via data vendors, and that introducing

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<sup>20</sup> Some stakeholders commenting on costs did not specifically comment about the need for data standards.

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new data standards and distribution channels would add unnecessary costs to both venues and the consolidated tape provider. For any market participants who currently do not use pre-trade data or significantly enhance their consumption of pre-trade data after a consolidated tape, there may be some onboarding costs.

- 4.31. For the data feeds from the venues to the consolidated tape, no-one saw any reason for not using the existing data feeds that the venues provide. There are only a few UK venues and they have already developed data formats that data vendors and traders receiving direct feeds are comfortable operating with. One stakeholder suggested that it may cost each venue an additional £1 million if they were required to set up new distribution and standardisation infrastructure to send data to a consolidated tape feed separate to existing channels. Not only did they not consider this necessary but warned that it might introduce new risks to market resilience given the degree to which the current distribution system is merged with trading systems and strategies. Either all these participants would have to incur costs themselves to accept the new feed, or the venues would be operating with two separate feeds with potential consequences for market integrity if either of those feeds went down.

### 4.3.3 Likely business case

- 4.32. A significant barrier to a consolidated tape currently is the data licensing costs, as there is currently no requirement for venues to provide a potential consolidated tape with data. For a consolidated tape to have a sufficient take-up to be commercially viable, it would almost surely need to be able to offer users access to data with a significant discount on the licensing fees. Current consolidated pre-trade products are available from data vendors. Real-time consolidated feeds drawing from all venues are available for the top of book. Application-based products can be tailored by users to only include data from venues with which they have underlying data licences and can provide consolidated market data to full market depth. Given the cost of market data, this flexibility is considered essential to enable users to tailor the data and analytics they receive from their vendors to their needs. Without a reduction in data licencing, the economic viability of providing a consolidated tape may be undermined as a more general specification must be used.
- 4.33. The EU tape involves what many see as a compromise, whereby exchanges offer only top-of-book at no cost to the consolidated tape. In comparison to the business case for an EU consolidated tape, a UK tape provider has the disadvantage that it would be consolidating data from fewer venues, reducing the potential value of additional information from the tape. On the other hand, some of the practical challenges facing an EU consolidated tape provider may not arise for a UK provider. The EU market includes many regional exchanges, each with its own reporting and resilience standards. This may create challenges for the tape provider standardising the incoming data. The risks of corrupt or lagged data disrupting the entire feed, leading to an incorrect BBO, may be greater. Such concerns may be less pronounced in the UK market, given it has fewer exchanges, with more uniform data reporting standards across them.
- 4.34. Respondents to our fieldwork have also noted that the fact the consolidated tape would be a regulated service may reduce the attractiveness of the business case for data vendors, given the regulatory controls they would face and the lack of flexibility in the design of the tape.

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# 5 Impacts of an Equities Pre-trade Consolidated Tape

5.1. We have discussed at 3.2 the potential use cases for a pre-trade tape. As we describe at Appendix 2, this has fragmented significantly since MiFID but the market has also adapted to this fragmentation in ways that may limit the impact of a pre-trade tape. For example, market participants have exploited how the varying trading models offer different options in terms of cost (explicit and implicit), immediacy and implementation risk — and made their choices accordingly. These choices are dynamic, as suggested by the pecking order approach to order execution (again, see our literature review at Appendix 2). With this in mind, we now turn to how the identified use cases could impact the UK equity market.

## 5.1 Impacts on the market for data

5.2. Whilst the location of trading venues and most market participants is relatively tightly clustered in London, we do not believe that a pre-trade consolidated tape would be an effective substitute for non-display direct feeds underpinning algorithmic or high-frequency trading, even if it contained five levels of order data. This was also the view of the vast majority of stakeholders. However, as we have described in our analysis above, there are potential use cases in display-based trading and in roles ancillary to trading activity.

5.3. Nearly all stakeholders assumed that for the tape to be commercially viable it would need to be disseminated at a lower price than competing data products (which, given the use cases identified, would be the likes of display data). As such, a consolidated tape could provide additional market discipline to the display market segment, creating pressure for data providers to lower costs — or to adjust business models to raise revenues elsewhere. Whilst most stakeholders did not foresee significant scope for the exchanges to recoup any revenue lost on selling display and delayed data by increasing non-display data fees — nor in increasing trading or issuance fees — this was a concern raised by some stakeholders and we discuss the potential for such effects here.

5.4. The stakeholders most concerned about having to pay higher fees for direct access and/or for trading were algorithmic and high-frequency traders, i.e. those which any such cost increases would most heavily impact. We note that there is little real substitutability between venues' own low-latency direct feeds. Whilst compliance with MiFID II requires the pricing of continuous trade data to be on a non-discriminatory, reasonable commercial basis, the FCA noted recently that this requirement does not “appear to be a significant constraint on pricing”.<sup>21</sup> The scope for additional price increases is thus unclear.

5.5. The compensation arrangements for any consolidated tape would likely to be a necessary element in reaching a definitive conclusion on its implementation. Various parties characterised the current equity market as one where trading costs are kept low to persuade people to trade on your exchange — and that trading activity re-values the venue's trading data allowing it profit through data revenues. If the nature of that competitive game were to change, then following the argument through it is possible to see a waterbed effect whereby trading costs go up. As we discuss at Appendix 2, there

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<sup>21</sup> FCA (2023) “Wholesale Trade Data – Findings Report”.

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are multiple alternative trading models catering to different investor preferences on cost, immediacy, execution risk and so on. Increased trading costs on a venue's CLOB and call auctions would change this mix and this should have some limiting effects. In addition, to the extent there is international competition in secondary trading, such a move could trigger migration of trades outside of the UK (i.e. it would be a self-defeating move by the trading venue). In the worst case, though, increased trading costs would marginally increase the UK's cost of equity capital.

- 5.6. The other area where a venue (or at least the primary exchange) could seek compensating revenue would be from new listings. The incentive to promote new listings falls if the profits from data sales reduce (assuming there is no offsetting waterbed effect affecting data revenues). On the other hand, IPOs are effective marketing tools for primary exchanges (certainly in contrast to an absence of IPOs). As such, it could be that the primary venue would need to make more effort to attract new listings.
- 5.7. It is not clear at present whether the provider of the consolidated tape would provide the feed directly to end users or through the existing data vendors. We would expect the existing data vendors to continue to play the main role in packaging the feed with additional functionality and data within the GUI and format that market participants currently use. Substitutability would be a function of the data contained within the pre-trade tape (e.g. top of book, level 3 or level 5 depth), the consolidated tape's cost and the particulars of the users' use cases. Away from trading, ancillary activities often rely on primary venue data only — on cost grounds — and from our interviews we found that this applied even in some of the largest sell-side firms.

## 5.2 Impacts on the UK equity market

### 5.2.1 Competition between lit venues

- 5.8. A pre-trade consolidated tape could have real impacts encouraging competition between lit venues, as suggested by some trade associations and interviewees. A consolidated tape available at an economic cost — by contrast to the cost of existing “composite” products that currently combine order data characterised by many stakeholders as “prohibitive” — would potentially democratise access to lit market data (with the benefit focused upon the buy-side and smaller sell-side firms) and even foster competition across the UK's lit exchanges. Many sell-side firms take direct feeds from all the relevant trading venues (even consolidating and normalising that data to facilitate trading activity). This was confirmed through our interviews, particularly for the larger sell-side firms that are the main dealers and liquidity providers in lit markets. But our engagement with stakeholders also made it clear that there are also sell-side firms that are not directly connected to all the lit venues (indeed, a review of the membership of these venues also makes this apparent). In some cases, this is understandable in that the firm's business model might be to specialise in stocks where the primary venue is dominant or even the exclusive trading location — but this is not always the case.
- 5.9. Algorithmic and high-frequency market makers would not use the consolidated tape for trading. The incremental latency and restricted data set (i.e. not the full order book) in any design of tape relative to existing direct feeds would mean that it would not be used by algorithm-based trading in the moment — at most, its existence would impact upon the design of smart order routing processes. Algorithmic and high-frequency traders interviewed by us already have direct feeds from all the venues but whilst algorithmic trading dominates lit trading (see our review of the literature at Appendix 2 that suggests 80+ per cent of trading on lit venues is algo-based, and feedback from interviews indicating 90+ per cent), display-based trading remains an element in the market. The latency in a consolidated tape would not in itself affect human reaction times. Consequently, many stakeholders doubted that the consolidated tape would impact venue competition meaningfully, given

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that the largest brokers and traders are already directly connected to all the lit venues and hence the consolidated tape would not alter order routing decisions. There is a strong trend towards algorithmic and high-frequency trading, particularly in market-making activity. Venue selection by sophisticated participants would remain driven by direct non-display data feeds (offering more than 20 levels of order depth) and a full historical tick database.

- 5.10. Even so, we can identify two potential mechanisms that could work to impact competition between lit venues. First, the consolidated tape would deliver additional data to those display-based brokers and traders currently reliant on primary venue data only, which could encourage them to connect to and execute trades with trading venues other than on the primary exchange. An analysis by OXERA (2024) suggests that 50 per cent of sell-side firms active on LSE's CLOB are connected to CBOE and/or Aquis.<sup>22</sup> Our fieldwork strongly indicates that the larger sell-side firms are connected to all possible data — at least for trading purposes — and such firms are, by definition, responsible for a disproportionate share of trading activity. This does not negate this effect but clearly does diminish the likely scale of its impact.
- 5.11. Smaller cap stocks are less likely to be traded currently on any lit venues relative to large and medium cap ones (lit trading within small caps is more concentrated on the primary venue than medium and larger caps) and tend to trade on CLOBs with a broader bid-ask spread. In our fieldwork it was claimed that RSP quotes would typically generate a better price than that offered on the CLOB for such smaller cap stocks. This suggests that display-based traders would be unlikely to place complete reliance on a consolidated tape to drive trading decisions in such stocks. A pre-trade tape could, perhaps, aid decision-making between the sell- and buy-side as to where to trade, but only if such smaller cap stocks are meaningfully traded on lit venues other than the primary exchange.
- 5.12. The second mechanism would be the refinement of the best execution process, i.e. that it could result in improved dialogue between sell-side and buy-side participants due to enhanced transparency around where the available (lit) liquidity is (was) in a particular stock, in turn leading to better decision-making around the lit venues that are connected to and traded on by the sell-side — and/or the selection of sell-side firms by the buy-side. It could simultaneously act as a “golden copy” for all parties giving rise to a network effect such that should allow for more efficient discussion and comprehension around the routing of order flow.
- 5.13. The buy-side, such as hedge funds and larger institutional investors, execute order flow through smart order routing algorithms at bank and brokers. High trade data costs — especially those related to algorithmic trading, i.e. non-display — could impact such institutions by limiting their ability to assess the order execution strategies adopted by the sell-side. This could again drive a separation in the market whereby those able to purchase fuller data sets (and successfully manipulate it) can better assess where liquidity is and where, preferably, execution should occur. Such participants can better utilise the availability of different trading models available for their own benefit and the benefit of their ultimate clients (if any) or end investors. Those less able to use data to drive their execution strategies — again, likelier smaller buy-side institutions — consequently might do less well as potentially superior pricing opportunities are not seen and so not acted upon because they are less able to hold the sell-side's feet to the fire. In addition, there would be a risk of growing non-display data costs sharpening a split in the sell-side with some — likely smaller — firms opting to focus on the (still robust) bilateral, discontinuous market models such as OTC trading.
- 5.14. This could drive additional routing of orders through CBOE or Aquis. Many participants highlighted that the LSE (and CBOE) had the best prices “most of the time” (trading at the BBO 70–80 per cent

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<sup>22</sup> OXERA (2024) “The functioning of equity markets in the UK: Implications for an equity Consolidated Tape” on behalf of the London Stock Exchange Group. The analysis is based on examination of the firms' best execution policies and is heavily caveated by OXERA.

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of the time, at least for FTSE100, i.e. large cap, stocks). However, it is not clear that “most of the time” fulfils firms’ best execution obligations — this would depend also on the available depth at the BBO and this is less apparent. Even so, connectivity to more if not all lit markets should be encouraged, but the cost of data was cited by stakeholders as an issue here along with connectivity costs.

- 5.15. This mechanism could see immediate effects in larger, more liquid stocks — albeit that these are generally very tightly priced already — and in less liquid stocks, but only if these are traded on a lit venue away from the primary exchange. Smaller cap stocks are relatively less likely to be traded currently on any lit venues with the primary exchange’s role more substantial than in more liquid stocks.<sup>23</sup> As such any benefit for smaller cap stocks may take time to eventuate, as trading in such shares on other trading venues would need to increase first. An economically priced pre-trade tape could then fully democratise realised access to lit venues other than the primary. (One could even argue that an inventory imbalance on a venue less active in any given stock could more likely result in more competitive prices in a stock, even if only transiently.) The main immediate benefit here would perhaps be improved market quality in trading in mid-cap stocks. There would also be potential redistributive consequences, i.e. the buy-side would gain at the expense of the less well-connected, less technologically adept buy-side.

## 5.2.2 Switching volumes across CLOB and alternative trading mechanisms

- 5.16. Over the last several years trading on Central Limit Order Books (CLOBs) has reduced with more activity being executed on alternative trading models such as dark pools, call and periodic auctions and through systematic internalisation systems. The vast majority of stakeholders did not see how the introduction of a tape — particularly one incorporating only pre-trade data from lit markets — could have any impact on this, either positive or negative. There are, however, potential mechanisms for how it could.
- 5.17. One potential argument for how a consolidated tape could help reverse this trend away from the CLOB would be by making lit markets more attractive through improved visibility and aggregation. This idea is highlighted by the Investment Association, suggesting a pre-trade equity consolidated tape encourages trading on public venues by providing aggregated price information from lit markets, improving transparency. A few stakeholders from our fieldwork also made this case, arguing that the provision of more clarity on what lit liquidity is available in aggregate and having more confidence in decision-making around order-routing.
- 5.18. We have described in our review of existing trends in UK equity markets that important drivers of activity away from lit markets include: the dominance of algorithmic and HFT, the consequent scope for those uninformed traders that remain on lit markets suffering from adverse selection and latency arbitrage, and the existence of dark market infrastructure that is a potential safe haven for uninformed investors and well-suited to the needs of particular investors (e.g. those making large, block trades whilst minimising adverse market impact). Given that a pre-trade tape would not change these aspects of the market, it is difficult to see how it would drive liquidity returning to lit markets from alternative trading mechanisms in the short- to medium-term, if not beyond.

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<sup>23</sup> We analysed trading in a sample of 50 small cap stocks over the period 1 October–5 November 2024. The LSE’s share typically 80+ per cent (being below this for just two shares in the sample), with an unweighted average share of 93 per cent of trading. For about 20 per cent of the sample, trading on the primary exchange was 99 per cent or more of the total.



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- 5.19. OXERA (2024) put forward the argument that a pre-trade consolidated tape could reduce lit activity and instead result in an enhanced role for SIs and dark pools.<sup>24</sup> The thought is that a sell-side firm considering expanding the trading mechanisms it is connected to (in order to deliver best execution) might opt for an SI offering to match the BBO generated by the consolidated tape rather than establishing connections with more lit venues.
- 5.20. OXERA's hypothesis implicitly assumes that at least some sell-side firms — specifically amongst those not connected to all lit venues — are not delivering on best execution currently. For increased use of SIs to be the preferred mechanism for resolving this, a reference price linked to the consolidated tape would need to be both allowed by the regulator and acceptable to the participants in the alternative trading mechanism. This may not be the case as this would introduce scope for additional staleness in the reference price. At least some stakeholders (including an operator of a dark pool) thought this would be unattractive to market participants. That said, there might be scope — as and when having a reference price linked to multiple venues were to be permissible — for the reference price to draw on direct feeds from multiple venues, rather than the consolidated tape.
- 5.21. If there was to be such a shift in volume, it would apply only to that volume of trading handled by sell-side that are not fully connected now. Those sell-side players already consuming all available lit pre-trade data already have the big picture so there would not be any additional information from the tape to influence order routing decisions.
- 5.22. More generally, routing through an SI offers a different trade-off in terms of cost, immediacy and order implementation risk than trading on a CLOB. These relative preferences do not change due to a consolidated tape. Large caps are at BBO 70–80 per cent of the time on the primary venue (or on CBOE) and, as we have noted in the previous section, routing trade in smaller caps to an SI to achieve the BBO generated by the consolidated tape may likely not be better execution than existing market models. These do not fully negate OXERA's hypothesis but do significantly affect its potential impact.
- 5.23. We discuss at 5.1 why we consider it unlikely (albeit not impossible) that there would be a waterbed effect due to trading venues seeking compensating adjustments in raised trading fees to replace lost data revenues. For completeness, though, such a move could also result in a shift in trading volume away from the CLOB to cheaper alternative trading mechanisms.

### 5.2.3 Impacts on liquidity

- 5.24. Stakeholders are divided on whether a pre-trade consolidated tape would positively impact liquidity on lit venues or have no effect. Some argue that a pre-trade consolidated tape would enhance transparency, increasing investor confidence and eventually participation. By consolidating data, a consolidated tape could make previously fragmented liquidity pools more accessible, especially for less liquid stocks. This accessibility would allow market participants to locate opportunities more easily, assess exit strategies more confidently and foster better market engagement. UK Finance also argued that a tape with pre-trade data could enhance liquidity, particularly for less liquid assets, and strengthen the international competitiveness of UK capital markets.
- 5.25. There are several counterarguments to this rosy scene. First, equity market fragmentation has been a fact for over 15 years. Data provision and market participant behaviour have adjusted to this reality — e.g. algo and high-frequency trading firms take direct proprietary feeds from trading venues and consolidate them in-house in ways that suit their purposes. Such firms are already responsible for a

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<sup>24</sup> OXERA (2024) "The functioning of equity markets in the UK: Implications for an equity Consolidated Tape" on behalf of the London Stock Exchange Group.



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very significant fraction of liquidity provision in today's lit markets. The introduction of a tape would have no effect here.

- 5.26. Second, an order may be posted on multiple venues such that it may over-state the true scale of actionable liquidity at any one point. Once one order is executed on one venue, its mirroring orders elsewhere may be cancelled. Market participants have systems in place to adjust for such phantom liquidity in setting their price points. Third, less liquid stocks may not be — currently at least — actively traded beyond the primary venue, as we discuss above. All these factors would limit any de-fragmenting benefits to existing liquidity arising through a pre-trade tape.
- 5.27. We have discussed how a tape could mean reduced data costs for some market participants. However, we do not expect such reduced indirect costs of trading to translate to additional trading activity, even ignoring any potential compensating adjustments to trading fees by the venues (if they have lost data revenue). If trading fees did increase — see the discussion at 5.1 — this itself could adversely affect CLOB liquidity.
- 5.28. A common theme raised particularly by sell-side stakeholders was that a consolidated tape (even one restricted to limit order trading) would be helpful in educating potential international investors about UK markets by highlighting previously hidden pockets of liquidity. US investors may simply see a consolidated tape as a necessary part of the package for a modern, fragmented equity market. As such, a tape could help attract new participants to the UK equity market. However, no investor will come to a market simply because of its market infrastructure — there must also be a stock of companies the investor wishes to invest in. The divergence between US and European capital markets seen in the past several years is partly a function of the investor value proposition offered by trillion-dollar companies such as Apple, Nvidia and Microsoft, and currently there is no prospect of an equivalent UK entity.
- 5.29. Several stakeholders in the ETF market believed that ETFs could benefit significantly from a pre-trade consolidated tape in the UK market by making ETF liquidity more transparent, narrowing the gap with the highly liquid US ETF market. This would make it easier for foreign investors to justify investing in UK ETFs, which are currently seen as illiquid, making it difficult for risk managers to approve investments. In this view, a consolidated tape would allow investors to assess the real liquidity of ETFs, bringing more confidence and, eventually, liquidity into the market. This was seen as likely to be especially beneficial for mid- and small-cap ETFs.

#### 5.2.4 Impacts on price volatility and price formation on CLOBs

- 5.30. Informed traders promote an enhanced price formation process. Informed traders (particularly algo and high-frequency traders) increasingly dominate CLOBs. The result — at least in normal market conditions — is improved price formation and less noisy pricing. The cost is largely borne by uninformed traders remaining on the CLOB through adverse selection and latency arbitrage. As we describe at Appendix 2 algo and especially high-frequency trading have incentivised uninformed traders to migrate from the CLOB to less well-lit trading models (e.g. SIs, where the operator can also choose to deny access to informed traders, and can even compete based on such restrictions) or fully unlit ones (e.g. dark pools).
- 5.31. We have not identified mechanisms that could cause a meaningful further shift in uninformed order flow away from lit venues that could be attributable to a pre-trade tape. We would add that were there to be such additional segmentation of order flow by venue (i.e. informed on lit venues versus the uninformed elsewhere), we would not expect price formation to suffer (although it is conceivable that there could be consequent consolidation amongst market makers as the relative economic appeal of being ELP could reduce).

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### 5.2.5 Impact on resiliency

- 5.32. In a fragmented equity market resilience relates to the ability of the market to better adapt to an outage at a significant trading venue. Whilst a consolidated tape could increase resiliency, there is also a concern that a consolidated tape would introduce an additional point of failure. Clearly, the consolidated tape would need to incorporate safeguards such as warnings for market participants to flag potential irregularities in the data during outages. The consolidated tape itself would also need a highly resilient design. The responsibility of the consolidated tape provider is significant, as the integrity of market operations may rely heavily on the consolidated tape's ability to withstand outages.
- 5.33. In the current UK scene, the primary venue remains the most significant one — being the location of the largest single share of activity (CLOB and auction combined). It is the source of the reference price for SIs and dark pools and some fraction of display-based trading relies solely on data from the primary venue. Away from trading, many market participants only consume data from the primary venue (with data cost being cited as a key factor).
- 5.34. The resiliency of lit trading would likely be unchanged from what it is now. We do not expect algorithmic and high-frequency trading on lit venues to be reliant on the tape and these account for the bulk of trading on CLOBs — so it is hard to see how a pre-trade consolidated tape would affect meaningful change relative to the current position if there was an outage on the LSE. The more hopeful case for a pre-trade consolidated tape adding resiliency is one where it would serve as an alternative reference price, e.g. for SIs and dark pools, allowing relevant market participants to continue trading, even when the primary exchange is offline. As above, this would require reference prices to relate to multiple venues to be acceptable to both the regulator and relevant market participants.
- 5.35. However, various sell-side stakeholders argued that even with a consolidated tape, market participants would still be hesitant to trade during an outage. In this view, the primary exchange is taken as the benchmark for price discovery and would prefer to wait for its return than rely on data from other venues. The LSE was at BBO about 70-80 per cent of the time for FTSE100 stocks at the close of 2023<sup>25</sup> — but so was CBOE. As such, there appears to be some disconnect between this view and current market structure, at least for large cap stocks (the primary venue is more important in lit trading for smaller caps, but trading in such stocks is less likely to be lit). The buy-side generally supports the consolidated tape as a potentially valuable tool for maintaining market confidence and operational continuity during disruptions.

### 5.2.6 Impacts on ancillary functions

- 5.36. In Chapter 3 we set out the use cases for a pre-trade consolidated tape that extend beyond trading. This covers activity that directly supports trading (e.g. liquidity management) to more middle- and back-office functions (e.g. risk management, analysis relating to best execution). These activities are economically useful. Access to an additional information tool cannot make them less useful but individual market participants would make their own informed choices as to whether the acquisition of the tape makes economic sense (i.e. either same information at reduced cost or more information at an attractive cost).
- 5.37. In passing we also note that a consolidated tape (both pre- and post-trade) would result in ready access to an improved dataset for the supervisor (e.g. to make market-wide assessments of best execution, etc.)

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<sup>25</sup> OXERA (2024) “The functioning of equity markets in the UK: Implications for an equity Consolidated Tape” on behalf of the London Stock Exchange Group.

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### 5.2.7 Market entry of new trading venues

- 5.38. Some stakeholders identified the possibility of a consolidated tape encouraging new entrants to the exchange market. The argument is that a consolidated tape would provide visibility from the inception of the new venue and that there would be an immediate data revenue stream derived from the tape, removing a barrier to entry. The current biggest hurdle for new entrant is that new market venues need a certain critical mass to be considered enough of a player that it would be worth subscribing to their data feed. The sale of market data is a significant source of revenue for lit trading venues.
- 5.39. The counterpoint to this is that a pre-trade consolidated tape could instead encourage inefficient entry. A concern expressed by some stakeholders is that a flawed revenue allocation model for the consolidated tape could mean that a (new) venue would receive payments for data provided, even if that data does not provide economic value (e.g. out of touch pricing that is not executed). In a regulated consolidated tape structure, the argument goes, a badly designed revenue allocation mechanism could potentially discourage competition based on data quality and trading technology, undermining effective competition. By offering new venues a guaranteed user base, the consolidated tape could inadvertently incentivise uneconomic market fragmentation, as new entrants might join without delivering unique advantages. It is worth noting that the USA's consolidated tape has been in place in parallel with considerable innovation and entry into equity trading. Other stakeholders did not feel that the consolidated tape would encourage entry at all, with barriers to entry still high for exchanges. Given that the UK's equity market currently exhibits a lack of lit liquidity, we believe that someone would need a very compelling proposition to consider entry. However, a consolidated tape could, as described above, provide additional transparency to those opportunities on existing trading venues other than the primary one. Market participants would avoid incremental development or data costs to access data from additional venues if it is bundled into the consolidated tape that they are already consuming.

### 5.2.8 Impacts across share types

- 5.40. We have discussed the potential for differential impacts on small, medium and large cap stocks where relevant above, especially in the sections considering competition between lit venues and between lit markets and alternative trading systems, and do not recap it here.

### 5.2.9 Impacts upon retail investors

- 5.41. Retail investors are a particular case. Many stakeholders identified a role for the tape in increasing retail participation in UK equity markets thereby being a source of potential additive liquidity. Various stakeholders noted that retail investors play a valuable role in providing liquidity for smaller cap stocks.
- 5.42. The UK's default retail trading model in cash equities is the Retail Service Provider (RSP) model, where the investor's order is circulated by her broker to a pre-determined subset of market makers, which compete to fulfil the order by providing quotes with the order routed to the best offer. There is then no direct access to the CLOB, although RSP trades are recorded on-exchange. Since the quotes are held for 15+ seconds, the chosen market makers' quotes will factor in the risk of an adverse price move. Even so, stakeholders involved in the RSP model noted that the broad spreads in smaller cap stocks allowed quote providers to price in such a margin and still beat the spread.
- 5.43. A retail investor does not have access to affordable real-time data to directly assess such quotes either within the share-dealing application (the data are typically only from the primary venue and may have some delay as well) or externally to it (e.g. Google Finance provides mid-market data with an apparent one-minute delay). If a tape is implemented, stakeholders were unclear as to how much

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of its information set would be shared with retail investors. If it was simply the BBO without depth information, it is unclear to us how this would promote additional retail investment. Equally, the inclusion of depth could confuse all but the most sophisticated retail investors.

- 5.44. Data availability is not the main driver of low retail engagement in UK cash equity markets. There are other factors that can be used to rationalise the low level of retail trading in the UK relative to say the USA. For example, any day traders are more likely to use platforms offering spread betting and contract for difference (CFD) platforms because avoiding direct ownership of the underlying asset means that no stamp duty reserve tax is paid.

### 5.2.10 Impacts on IPOs and international competitiveness

- 5.45. One concern raised is that if trading venues lose data revenue due to the introduction of a pre-trade consolidated tape then there could be compensating adjustments in the venue's business model. The main candidates identified were: non-display data costs, trading costs and IPO issuance costs. Whilst many sell-side firms did not view increases in non-display data costs or in trading costs as achievable strategies by the venues, there are possible scenarios for this that we have already discussed at 5.1. The primary venue has an effective monopoly on IPOs. Whilst increasing issuance costs would be unattractive to the UK economy (as all else being equal it would increase the cost of equity capital) it would also be somewhat self-defeating for the primary venue. Even so, this may be an area that the supervisor should monitor.
- 5.46. Stakeholders frequently identified that implementation of a consolidated tape could make the UK market more attractive by offering a comprehensive view of total lit market liquidity. The idea is that this would enhance the UK's position as a competitive financial hub and draw more international participants, particularly from the USA. It is also supported by trade associations such as AFMe, suggesting a consolidated tape will attract domestic and international investors by making markets more appealing through improved visibility of liquidity and pricing.
- 5.47. Many stakeholders were mindful that, in designing a UK-based consolidated tape, the EU consolidated tape initiative should be considered. However, whilst some alignment with European developments was considered advantageous various stakeholders also argued that the UK's design should not be identical to that being proposed by the EU (e.g. the absence of venue attribution, mandated transmission protocols were seen as flaws in the EU's design that the UK could learn from). A few stakeholders expressed the concern that if the EU adopts a pre-trade tape, but the UK does not, then there would be a risk of losing liquidity to EU markets.

## 5.3 Monitoring the impact of a consolidated tape

- 5.48. It seems unlikely that the consolidated tape in isolation will have a major impact on the UK equity market. Assuming this assessment is correct, it will be difficult to observe changes in the market that can be attributed to the consolidated tape. Consequently, we would caution against placing much weight on monitoring possible metrics to assess the impact of the consolidated tape on market quality
- 5.49. Appendix 3 outlines metrics that are sometimes suggested to assess market quality and discusses some of their pros and cons. Which of these metrics are most appropriate for attempting to monitor the impact of a consolidated tape will depend on exactly what the underlying policy goals are. For example, if the primary goal is to improve liquidity such that large investors are better able to execute block trades with minimal implications on the price, that may suggest looking at a very different set of metrics than if the goal is to reduce the spreads that small retail investors face when trading.

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5.50. Even the concept of the market may require careful thought. As with debates about what venues should be included in a consolidated tape, there is a question whether market quality assessment should be limited to trades that are actionable to all or should also include dark pools. If the interest is in how the retail investor has been affected by the consolidated tape, the focus should perhaps be on changes in the RSP market and even metrics relying on data from lit venues will be of no value in assessing changes in market quality.

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## 6 Conclusions

- 6.1. Perhaps our main finding is to caution against assuming that a consolidated tape in isolation is going to have a significant impact, positive or negative.
- 6.2. Many participants can already consolidate data independently or use vendor services, but costs vary based on the level of data speed and depth required. There can be significant costs involved in acquiring data across venues, with different strategies employed by firms depending on how critical they consider such data are to their operations. At one extreme are market participants who claim to have almost no need for pre-trade data; at the other are market participants engaged in high-frequency trading for whom low-latency, comprehensive pre-trade data feeds from multiple venues are fundamental to their business model. Segmenting the participants into various groupings, the following list attempts to summarise the typical data uses of different groups, although we stress that there can be significant differences within the groups given different business models (e.g. brokers only trading smaller stocks may attach less importance to having access to data from multiple venues or even the need for low latency).
  - Proprietary Traders: Use low-latency direct feeds, critical for high-frequency and other algorithmic trading. They often consolidate data in-house to maintain speed and customisation.
  - Institutional Brokers: Access low-latency feeds (direct or via vendors) for trading, and vendor-provided display data for compliance and analysis, sometimes creating consolidated feeds internally for their needs.
  - Asset Managers: Use vendor data integrated into Order and Execution Management Systems for compliance, trading strategies, and liquidity analysis. While latency is important, their primary focus is data coverage and cost-efficiency.
  - RSP market makers: Use low-latency direct feeds or vendor data. They may undertake some in-house normalisation and consolidation of data. Generally considered to have sufficient access to data, albeit high costs are an issue.
  - RSP brokers: Consume live pricing (top of book) to display to end investors over their broker platforms. A range of other real-time data use (e.g. through vendors) for their own pricing and order routing. High costs are an issue, in some cases limiting back-office data usage.
  - Retail Investors: Access only top-of-book data, usually via brokers or online platforms, with limited depth and timeliness. The feed typically comes from the primary exchange. Many retail investors may struggle to meaningfully interpret additional data showing market depth or prices from other venues, given their trades are relatively small and typically executed through the RSP mechanism.
- 6.3. **The primary appeal of a consolidated tape for most participants is the potential to lower data licensing costs.** Many parties currently rationalise their data subscriptions due to high fees, and a consolidated tape could democratise data access across participants. Some firms indicate they could replace or supplement their current data sources if the consolidated tape proves reliable and cost-effective for non-trading functions like compliance and risk management. Many advocates of a consolidated tape thought it would lower costs (via lower data licensing fees), thereby making pre-trade data more accessible to smaller firms and reducing administrative overheads associated with obtaining data from multiple sources. However, some smaller market participants thought that a consolidated tape would be of limited or no value to them, but instead primarily help larger firms.

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- 6.4. Other potential positives offered in support of a consolidated pre-trade equities tape are that it would provide a shared reference for market participants, it would help increase the UK's international competitiveness by appealing to potential investors that wanted to see a consolidated tape to assess available liquidity in the UK before committing to the market, and as a potential tool for future regulatory actions (e.g. it would permit the FCA to undertake more detailed studies on how the equity market was functioning). Assuming the consolidated tape is widely adopted (which may depend critically on an associated fall in data licensing costs), it could facilitate more discussions around best execution between the buy-side and sell-side, and it may enhance transparency about which venues to trade on and which brokers to use. There are also claims that the consolidated tape could enhance market resilience by providing parties with more confidence to trade on other venues if the primary exchange ceases to operate. Additionally, stakeholders in the ETF market believe that improved liquidity transparency through a pre-trade consolidated tape could stimulate greater investment in UK ETFs, making them more appealing to foreign investors.
- 6.5. A pre-trade consolidated tape is neither a necessary nor sufficient condition for addressing concerns about high data licensing costs. Several parties indicated that their current concerns about access to data would be addressed if the data licensing fees were reduced (with or without a consolidated tape). Support for a tape was typically conditional on the (often implicit) assumption that it would be accompanied by regulatory action to make sure that licensing fees for data on the tape would be lower than the current costs.
- 6.6. More generally, most of the reservations about a consolidated tape relate to questions about whether it will realise any benefits, rather than a concern that it will have major negative impacts. Aside from not tackling the concerns about data licensing costs, there are doubts about whether the tape would realise other claimed benefits. Not all parties accept best execution discussions will be helped by a consolidated tape, arguing that: post-trade data are more relevant; market participants can already access pre-trade data; and the consolidated tape will never reflect exactly what the trader could achieve. And there remain doubts whether the general reluctance to trade if the primary exchange is down will change because of a consolidated tape. Some parties feel that if there was a case for a consolidated tape, it was over a decade ago, and that today there is no need as it is already possible to access consolidated, pre-trade data.
- 6.7. If these doubts are warranted, then one potential negative is that real costs will be incurred building a consolidated tape for which there is no demand, but that should not be a concern for policy makers provided the tape provider is willing and able to assume these risks. Other potential negatives identified by some parties are that: it creates new risks relating to market resilience, since the consolidated tape itself will now be a critical piece of infrastructure and problems with feeds to or from the consolidated tape could disrupt the entire market; if the revenue distribution model is not carefully implemented, a tape may dilute liquidity across many venues by encouraging less competitive venues to enter the market; and it may result in increases in trading costs or licensing fees for other data feeds as venues seek to compensate for lost revenues from customers who switch to using the consolidated tape.



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# Appendix 1: Consolidated Tape in the USA

## Objectives

AI.1. This chapter reviews the relevant academic literature from the US on whether and how a consolidated tape for the equity market with pre-trade transparency has affected market quality. The findings may have lessons for the potential introduction and design of similar consolidated tape in the UK. The tape has been a feature of US markets for 50 years. Given the relatively limited data availability and limited available computing capacity at the time, there are only a few articles that directly assess the impact of a consolidated tape with pre-trade transparency in the US around the time of its introduction. Therefore, our review:

- Describes the key aspects of the equities consolidated tape in the US.
- Seeks to infer lessons about the possible impact of the consolidated tape on equities from studies that have looked at changes in pre-trade transparency in the US market.
- Discusses relevant articles looking at issues relating to the implementation of the consolidated tape.

AI.2. From this analysis, we would caution against drawing strong conclusions from the US experience about whether a pre-trade equity consolidated tape would be beneficial for the UK market or not. It is far from straightforward to isolate the effects of the introduction of the tape from other features and developments in the US market. It is also possible that some of those other features are a necessary complement to realising some of the effects that might be associated with a tape.

## Methodology

AI.3. We reviewed the relevant literature on developments in pre-trade transparency in the US, with a further consideration of who benefits from the consolidated tape, and what place it holds within the market for pre-trade data. Our academic partner, Professor Dion Bongaerts, provided an initial set of academic literature, which was subsequently expanded through additional searches, with search terms provided below.

### Box 0.1: Search terms for academic and pseudo-academic literature

“Consolidated tape equities” combined with “fragmentation”, US  
“Consolidated tape equities” combined with “market quality”, US  
“Consolidated tape equities” combined with “liquidity”, US  
“Securities Information Processors (SIP)” combined with “market quality”  
“Securities Information Processors (SIP)” combined with “price discovery”  
“Pre-trade transparency” combined with “equity market quality”  
“Quote rule” combined with “Securities Information Processors (SIP)”  
“Rule 11Ac1-1”

“Rule 605”

“Securities Information Processors (SIP) combined with “latency arbitrage”

“Consolidated tape equities” combined with “best execution”, US

“Securities Information Processors (SIP)” combined with “retail investors”

“Retail Investors” combined with “latency”

“RegNMS” combined with "fragmentation”

“Competition fragmentation equities”

## Key aspects of the specification of the equities consolidated tape

### Volume and nature of included data

AI.4. The US Consolidated Tape (consolidated tape) collects and aggregates real-time data on securities trading across various exchanges and releases this as singular data feeds via the Securities Information Processor (SIP). This system consists of three distinct feeds, each of which requires a separate subscription:

- **Tape A:** Covers securities listed on the New York Stock Exchange (NYSE) and is managed by the Consolidated Tape Association (consolidated tapeA).
- **Tape B:** Covers securities listed on regional exchanges such as the NYSE American and other regional exchanges that are not the Nasdaq or NYSE, also managed by the consolidated tapeA.<sup>26</sup>
- **Tape C:** Covers securities listed on the Nasdaq and is operated by the Unlisted Trading Privileges (UTP) Plan.<sup>27</sup>

AI.5. The SIP includes pre-trade data, of which the National Best Bid and Offer (NBBO) is most important. The NBBO aims to provide investors with a clear view of the current best price of a security and to encourage competition between exchanges. It represents the single highest bid price and the lowest ask price available for a security across all exchanges and trading venues at any given moment. Market makers and Alternative Trading Systems (ATSs) that account for more than five per cent of the average trading volume in an NMS stock over the past six months are required to provide their best-priced orders; these are aggregated and contribute to NBBO calculations. This pre-trade data are found on the quote feed, which updates with each new top-of-book best bid or offer (BBO) from each exchange; a BBO on an ATS that fits the requirement is indicated as a part of FINRA trade reporting facility (TRF) but not specified.<sup>28</sup> The quote feed provides information such as the size and price of the bid and ask, and the market centre from which the quote originates. Whether the quote affects the NBBO is included as an indicator on the tape; the NBBO is embedded within the quote feed and not disseminated as an independent stream. There is also a Limit Up Limit Down indicator; this indicates if the quote or NBBO is outside a percentage range of the average price seen in the previous five minutes. This is designed to prevent feedback loops in the algorithmic trading environment.

AI.6. Post-trade information on the tape includes the company or asset traded, the volume of the trade, the price per share, and the difference between the trade price and the previous day's closing price.<sup>29</sup>

<sup>26</sup> Consolidated Tape Association (2024) [\[link\]](#).

<sup>27</sup> UTP Plan (2024) [\[link\]](#).

<sup>28</sup> UTP Data Feed Services Specification (2024) [\[link\]](#).

<sup>29</sup> Buttigieg and Fenech (2024), “Unifying Market Data: Consolidated Tape Providers in the EU and US” [\[link\]](#).

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This is disseminated through the price feed, a separate data stream which provides the price data for each trade.

- AI.7. The SIP has significantly improved its performance over the last 15 years, now offering median latencies of 12 microseconds for quote feeds and 14 microseconds for trade feeds under the UTP plan tape.<sup>30</sup> The consolidated tapeA achieves latencies under 17 microseconds for quotes and under 18 microseconds for trades for its tapes, supporting up to 950,000 quote messages and 350,000 trade messages every 100 milliseconds.<sup>31</sup> This compares to a median 1-4 millisecond latency achieved in 2011.
- AI.8. Currently, no order book depth information is provided, just the best prices for each exchange. Unlit venues only have to provide post-trade data with a significant delay. The Securities and Exchange Commission (SEC) has looked to expand the scope of what must be collected and disseminated under the consolidated tape; in 2021, the SEC confirmed plans to introduce the Market Data Infrastructure Rule.<sup>32</sup> This expansion includes depth-of-book data, odd-lot quotations, and auction information, aiming to improve market transparency and access to data. This rule survived a legal challenge from Nasdaq, NYSE, and Cboe in 2022 but has yet to be introduced, with the pricing of this added data offering to be negotiated.<sup>33</sup> In September 2024, the SEC announced that odd-lot information will be added to the tape in 2026.<sup>34</sup>

## Pricing and compensation

- AI.9. The pricing of the SIP differs by the value that various participants derive from the data, as well as the costs associated with providing this service. Angel (2018) notes that the SIP provides essential market data at an extremely low cost to individual investors, while professional investors and brokerage firms absorb most of the costs. Retail investors benefit from this: a low price for non-professional users is intended to make market data widely available, allowing individual investors to participate in the market without significant asymmetry of information. They pay either \$0.0075 per query or a flat rate of \$1 per month per tape, which is often absorbed by their brokers. Since 1987, the inflation-adjusted price for real-time non-professional data has dropped by approximately 96 per cent.<sup>35</sup>
- AI.10. The value of retail investors is highlighted in the literature. For example, Boehmer et al (2021) find trades by retail investors have positive predictive power for stock prices, suggesting that some retail investors may have access to valuable private information.<sup>36</sup> Retail traders also provide liquidity to the market by buying stocks when institutional demand pushes prices down and selling when prices rise.<sup>37</sup>
- AI.11. Professional traders, including broker-dealers and investment advisors, pay a significantly higher fee of \$90 per month per user. This reflects their more intensive use of real-time data, along with a contribution to subsidising the lower costs for retail investors, ensuring the SIP remains financially viable. Algorithmic trading firms and other entities that engage in high-frequency trading are charged the highest fees, around \$9,500 per month. This is broken down into pre- and post-trade feeds, with

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<sup>30</sup> UTP Plan Metrics (2024) [\[link\]](#).

<sup>31</sup> Consolidated tapeA Plan Metrics (2024) [\[link\]](#).

<sup>32</sup> Market Data Infrastructure Rule, SEC (2020) [\[link\]](#).

<sup>33</sup> United States Court of Appeals (2022) The Nasdaq Stock Market LLC v. SEC [\[link\]](#).

<sup>34</sup> SEC (2024) "SEC Adopts Rules to Amend Minimum Pricing Increments and Access Fee Caps and to Enhance the Transparency of Better Priced Orders" [\[link\]](#).

<sup>35</sup> Angel (2018) "Retail Investors Get a Sweet Deal: The Cost of a SIP of Stock Market Data" [\[link\]](#).

<sup>36</sup> Boehmer et al. (2021) "Tracking Retail Investor Activity" [\[link\]](#).

<sup>37</sup> Kaniel, Saar and Titman (2008) "Individual Investor Trading and Stock Returns" [\[link\]](#).

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direct trade feeds providing post-trade data, at \$1,250 per tape per month for tape A. The quote feed provides pre-trade data at \$1,750 per tape per month for the same tape.<sup>38</sup> These firms rely on rapid access to data to execute large volumes of trades in microseconds, or faster; many of them will have access to separate direct feeds as well. Media outlets, which disseminate market data to the public, pay 0.5 cents per user per month. The pricing of the SIP reflects the ultimate aim of the consolidated tape to reduce information asymmetries and increase participation in the market, subsidised by higher frequency traders.

### Compensation for exchanges

- AI.12. Exchanges are compensated for providing data to the consolidated feed. The tape providers first deduct their operating expenses before sharing the remaining market data revenue based on the trading volume and quoting activity.
- AI.13. First, the Security Income Allocation (SIA) calculates the income attributable to each security.<sup>39</sup> The square root of each security's dollar value traded across the day is divided by the sum of the square roots of all traded securities' values to find the share of trading volume attributable to each security. This formula allocates a larger proportion of income to rarely traded securities due to the nature of the square root method, which narrows the income disparity between high- and low-volume securities. A cap is then introduced to restrict the amount of income that can be allocated to infrequently traded securities.
- AI.14. Once the SIA is determined, it is evenly divided between the Trading Share and Quoting Share. The Trading Share is allocated based on the proportion of qualified trades in a security by dollar volume that a participant has, with larger trades receiving more credits and thus a larger share of the income. The Quoting Share is based on the duration and size of the best bid or offer provided by each participant. Participants earn "Quote Credits" depending on how long their bid or offer remains the best and the size of the quote, with revenue apportioned based on these credits. Ultimately revenue is allocated by first calculating the income for each security and then dividing that income among participants based on their trading and quoting activities. In 2023 the consolidated tapeA paid out \$270 million to exchanges for data provision.
- AI.15. Caglio and Mayhew (2012) investigate how the revenue allocation mechanism can influence trading behaviour.<sup>40</sup> The previous revenue allocation mechanism, which prioritised the number of trades over their trading value, incentivised trade-splitting practices. Exchanges encouraged this practice by offering rebates to participants who reduced the size of their orders, further encouraging the fragmentation of trades. This led to artificial increases in trading volume, particularly in smaller trade sizes, which in turn inflated reported trading activity without accurately reflecting true market liquidity or price discovery. The distortion of trading data potentially reduced transparency, undermining the quality of market information. In 2007, the formula changed to that described in this section, with a reduction in splitting seen after contribution to the NBBO helped inform revenue allocation. A degree of splitting remained, which the authors hypothesise is due to the rise in high frequency traders (HFTs) who use this strategy for profit, further described in sections 1.2.3 and 1.3.1, separate to the revenue allocation incentives.

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<sup>38</sup> Schedule of Market Data Charges, consolidated tapeA (2015) [\[link\]](#).

<sup>39</sup> Revenue Allocation Formula, consolidated tapeA [\[link\]](#).

<sup>40</sup> Caglio and Mayhew (2012) "Equity Trading and the Allocation of Market Data Revenue" [\[link\]](#).

## Effect of a consolidated tape on market quality

AI.16. The initial post-trade consolidated tape was introduced in 1975, with pre-trade transparency being introduced later, in stages.<sup>41</sup> There has historically been no introduction of pre-trade transparency within the consolidated tape without other changes in the market system occurring at the same time. This has limited direct empirical study of the effects of pre-trade transparency on the consolidated tape, including research on the impacts of introducing the tape. This section of the review therefore focuses on the US experience of increasing pre-trade transparency, and its effects on the market for equities.

**Table A0.1: Equities transparency regulation in the US**

Rule	Year	Description
<b>Rule 17a-15</b>	1975	Required all equity transactions to be reported on the Consolidated Tape within 90 seconds of execution (post-trade transparency).
<b>Rule 11Ac1-1</b>	1978	Mandated exchanges and market makers to provide best bid and offer information throughout the trading day (pre-trade transparency).
<b>11Ac1-5 (later Rule 605, RegNMS)</b>	2000	Requires market centres to make monthly public disclosure of execution quality.
<b>Rule 603 (RegNMS)</b>	2005	The SIP calculates and disseminates the NBBO.
<b>Rule 610 (Reg NMS)</b>	2005	A requirement that market centres avoid locking or crossing quotations and limit access fees.
<b>Rule 611 (Order Protection Rule, Reg NMS)</b>	2005	Requires trading centres to implement policies to ensure that trades do not occur at worse prices than the best available quotes (best price execution). This rule includes an exemption, permitting trades at inferior prices if the superior price is not "immediately accessible", for example when the NBBO is found on an ATS.
<b>Market Data Infrastructure Rule</b>	2021	Adds to the pre-trade data provision of the tape, providing depth-of-book data to the quote feed, odd-lot quotations, and auction information.

Source: SEC Historical Society, US Securities and Exchange Commission

AI.17. Beyond the introduction of the pre-trade tape, RegNMS is seen as a key piece of legislation which increased the availability of pre-trade data. However, studies examining RegNMS will not solely capture the effects of increased pre-trade transparency but also the impact of other significant rule changes implemented concurrently. While it did introduce pre-trade elements, such as the NBBO being integrated into SIP data feeds, there were other rules introduced at the same time. For instance, the Order Protection Rule (Rule 611) prohibits "trade-throughs," which occur when an order is executed at a price inferior to the best available price across multiple trading venues. We should therefore caution our conclusions using the literature focusing on RegNMS as an example of increasing pre-trade transparency.

<sup>41</sup> Transformation & Regulation: Equities Market Structure, 1934 to 2018, SEC Historical Society (2024) [[link](#)].

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## Information asymmetries

- AI.18. A pre-trade consolidated tape aims to reduce principal-agent problems associated with client-broker relationships. There is evidence that brokers do not fulfil best execution for their clients, particularly when they have conflicting interests, such as ownership of trading venues.<sup>42</sup> This is facilitated by information asymmetries between broker and trader, which can be mitigated through pre-trade transparency. When brokers route orders to ATSs that they own, this tends to harm execution quality. This finding is consistent with the hypothesis that that brokers may prioritise venues in which they have a financial interest, potentially compromising their obligation to secure the best execution for clients.
- AI.19. Similarly, research on exchanges shows a negative relationship between take fees (i.e. payment to the broker directing order flow to their exchange) and the quality of limit-order execution. Batallio, Corwin, and Jennings (2016) highlight that brokers who consistently route nonmarketable limit orders to venues offering the highest rebates may not be acting in their clients' best interests.<sup>43</sup> A consolidated tape, particularly one with pre-trade transparency, allows traders to assess order execution quality more effectively, potentially leading to better informed broker selection and increased pressure on brokers to fulfil their best execution obligations.

## Provision of market data

- AI.20. The consolidated tape may also act as a driver of price stability and efficient price discovery. The availability of across-system price and quote data prevents significant price discrepancies from developing across exchanges. Without the SIP, each exchange might reflect different prices for the same asset due to localised trading activities or delays in information dissemination. Tivnan et al. (2017) finds that the SIP helps efficient market functioning, particularly in minimising price divergence and preventing crossed books.<sup>44</sup>
- AI.21. The SIP is not the sole provider of market data, with many trading venues selling access to direct feeds, alongside third parties who sell consolidated feeds. These data products may offer greater depth (e.g. top five bids, odd lot trades, or even better latency) than the consolidated tape. Jones (2018) argues that the SIP plays an important role in this market, acting as a credible baseline option, particularly with the recent improvements in latency and falling prices.<sup>45</sup> Exchanges must price proprietary products carefully because overpriced data can drive market participants to other venues offering free or more affordable data. The plans to add more information to the SIP, outlined above, have been delayed by the exchanges challenging the legislation in court, consistent with the idea that they see the SIP as a competitive threat when it comes to data provision.
- AI.22. Yu (2022) finds evidence that consolidated feeds are directly relevant to trading activity, in that latency-insensitive professional users are increasingly using data from the tape to trade on directly, due to the latency improvements seen over the last decade. The author also finds that outages in the consolidated feed cause market liquidity to significantly worsen, adding to the evidence that the consolidated tape is used for trading.<sup>46</sup> In particular, market trading volume and order-book depth deteriorate, providing evidence that the feed is used for trading decisions rather than a legal

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<sup>42</sup> Anand et al. (2021) "Institutional Order Handling and Broker-Affiliated Trading Venues" *The Review of Financial Studies* [\[link\]](#).

<sup>43</sup> Batallio, Corwin, and Jennings (2016) "Can Brokers Have It All? On the Relation between Make-Take Fees and Limit Order Execution Quality", *The Journal of Finance* [\[link\]](#).

<sup>44</sup> Tivnan et al. (2017) "Towards a model of the US stock market: How important is the securities information processor?", *IEEE*, [\[link\]](#).

<sup>45</sup> Jones (2018) "Understanding the Market for US Equity Market Data", SEC [\[link\]](#).

<sup>46</sup> Yu (2022) "Does the Consolidated Feed Matter?", SSRN [\[link\]](#).



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requirement to comply with the order-protection rule. The literature cites anecdotal evidence that points to an increasing use of consolidated feeds for direct trading, particularly by algorithmic traders that are not latency sensitive, with even the SIP potentially becoming more relevant for trading decisions as its latency fell.<sup>47</sup>

## Liquidity

- AI.23. The sale of proprietary data and direct feeds can reduce market liquidity by creating information asymmetries between traders informed and uninformed on price. Traders with better access to this information, can exploit their advantage and price discovery becomes skewed towards these traders. This can prompt traders without access to such information to become less willing to trade, reducing liquidity. Enhancing pre-trade transparency can help mitigate these information asymmetries and improve market liquidity.<sup>48</sup>
- AI.24. A potential risk to market quality from increased transparency is the potential for phantom liquidity, particularly with the rise of HFTs. These traders often place buy orders across multiple exchanges but cancel most of them, executing trades on only one exchange. Within 100 milliseconds, transactions on the three most active trading venues are typically followed by the cancellation of limit orders on the same side of competing venues' order books, with cancellations amounting to 29 to 67 per cent of the transaction size. The direct, pre-trade, tape will consolidate these bid volumes, giving an impression of greater liquidity than is available to most investors. This would provide potential drawbacks for consolidated tapes with a greater degree of pre-trade depth. It can lead to false price signals, particularly in markets where HFTs are more concentrated.<sup>49</sup> The US has seen a growth in order-to-trade ratios (OTTRs), with 97 per cent of orders in US stock markets cancelled before they trade.<sup>50</sup> Kohmyn and Putninš (2021) attribute this to increased fragmentation in US markets and improving technologies to lower monitoring costs.

## Order Routing Decisions

- AI.25. For some market participants, the cost of a direct feed from all exchanges is prohibitively expensive. The evidence suggests that where there is the possibility to subscribe to a single feed from all the exchanges more cheaply, this may improve order routing decisions and encourage competition between exchanges on order quality and price. Battalio, Green, Hatch, Jennings (2002) found that there is a varying quality of order execution between exchanges, depending on size and type of order.<sup>51</sup> The lack of information about the entire market system may concentrate trading on venues even if there is potential for better execution elsewhere.
- AI.26. There is evidence that transparency about execution quality of exchanges impacted brokers' decisions around order routing in the longer term. In 2001, the SEC required market centres to publish monthly execution-quality reports to spur competition for order flow between markets. This was before the order-protection rules were introduced in the US markets. Boehmer, Jennings, Wei (2007) found that reporting better execution quality (lower costs and faster execution) tended to

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<sup>47</sup> Schmerken (2019) "Consolidated Market Data Feeds Gain Traction in Algo Trading and Fixed Income", FlexTrader [\[link\]](#).

<sup>48</sup> Easley, O'Hara, Yang (2016) "Differential Access to Price Information in Financial Markets" [\[link\]](#).

<sup>49</sup> Van Kervel (2015) "Competition for Order Flow with Fast and Slow Traders" [\[link\]](#).

<sup>50</sup> Kohmyn and Putninš (2021) "Algos gone wild: What drives the extreme order cancellation rates in modern markets?" [\[link\]](#).

<sup>51</sup> Battalio, Green, Hatch, Jennings (2002) "Toward a National Market System for US Exchange-listed Equity Options" [\[link\]](#).



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attract more order flow in the following month.<sup>52</sup> This provides evidence that transparency improves order routing by increasing information provision and may in turn encourage competition between exchanges. This competition for order flow increased fragmentation in the US equities market and led to improvements in market quality, with falling trading costs and improving execution quality.<sup>53</sup>

## Competition and fragmentation

- AI.27. The literature suggests that greater access to pre-trade data has increased fragmentation of trading across exchanges in the US.<sup>54</sup> Pre-trade data facilitates greater competition between exchanges to attract trades on their exchange, reducing crossed markets and trade-through rates, while narrowing spreads.<sup>55</sup> RegNMS and the order protection rules have superseded the role of competition in removing the possibility of crossed markets. The order protection rule alongside pre-trade data provision has also led to an increase in fragmentation of US equity markets since 2005, with fewer trades taking place on the NYSE and NASDAQ.<sup>56</sup> Fragmentation is not a necessary result of competition; a rule to increase competition between exchanges, prior to RegNMS, did not lead to a significant fall in market share for the NYSE, but instead led to a shift in strategy to maintain their dominance by lowering spreads.<sup>57</sup>
- AI.28. There are disagreements in the literature around the effects of this increased fragmentation on market quality. Pirrong (2014) argues that Reg NMS has led to the rise of multiple competing stock exchanges, significantly lowering trading costs and diminishing the economic advantages previously held by institutional traders linked to the once-dominant exchanges.<sup>58</sup> On the other hand, Chung and Chuwonganant (2012) found that the fragmentation resulting from RegNMS harmed market quality. This was evidenced through increased spreads, decreased depth and slower execution speeds.<sup>59</sup>
- AI.29. Haslag and Ringgenberg (2023) argue that increased market fragmentation has a heterogeneous impact on stocks of different sizes, benefiting large-cap stocks while disadvantaging small-cap stocks.<sup>60</sup> This uneven effect is partially attributed to a trade-off introduced by fragmentation. On the one hand, fragmentation increases competition across trading venues, potentially lowering trading costs. However, it also creates negative network externalities, where liquidity is dispersed across venues, especially impacting smaller stocks by reducing market efficiency.
- AI.30. The authors also introduce further impacts of increased fragmentation that have larger effects on smaller stocks which are more prevalent in the current environment, with the growing importance of the speed of information. Fragmentation introduces heightened risks of “pick-off” and “front-running.” Pick-off risk arises when prices are not perfectly synchronised across venues, which happens at with greater frequency in a more fragmented market. HFTs can exploit outdated quotes

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<sup>52</sup> Boehmer, Jennings, Wei (2007) “Public Disclosure and Private Decisions: Equity Market Execution Quality and Order Routing” [\[link\]](#).

<sup>53</sup> Zhao and Chung (2007) “Information Disclosure and Market Quality: The Effect of SEC Rule 11Acl-5 on Trading Costs” [\[link\]](#).

<sup>54</sup> Boehmer, Jennings, Wei (2007) “Public Disclosure and Private Decisions: Equity Market Execution Quality and Order Routing” [\[link\]](#).

<sup>55</sup> Battalio, Hatch, Jennings (2004) “Toward a National Market System for US Exchange-listed Equity Options” [\[link\]](#)

<sup>56</sup> Haslag and Ringgenberg (2023) “The Demise of the NYSE and Nasdaq: Market Quality in the Age of Market Fragmentation” [\[link\]](#).

<sup>57</sup> Kam, Panchapagesan and Weaver (2003) “Competition among markets: The repeal of Rule 390” [\[link\]](#).

<sup>58</sup> Pirrong (2014) “Pick Your Poison—Fragmentation or Market Power? An Analysis of RegNMS, High Frequency Trading, and Securities Market Structure” [\[link\]](#).

<sup>59</sup> Chung and Chuwonganant (2012) “Regulation NMS and Market Quality” [\[link\]](#).

<sup>60</sup> Haslag and Ringgenberg (2023) “The Demise of the NYSE and Nasdaq: Market Quality in the Age of Market Fragmentation” [\[link\]](#).

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by executing trades before exchanges can update prices. To account for this risk, liquidity providers widen bid-ask spreads, increasing trading costs. This issue is more pronounced for small stocks, which suffer from lower liquidity and more frequent price inefficiencies because there are fewer buyers and sellers.

- AI.31. Similarly, the risk of front-running is greater for small stocks. When a trader attempts to execute a large order for a small stock, it often needs to be split across several venues due to limited liquidity at each venue. This liquidity will be spread even more thinly across multiple venues as fragmentation increases. HFTs can exploit this by identifying part of the order on one venue and predicting that more trades will follow on other venues. They trade ahead of the remaining order, which worsens execution prices for the original trader. This will reduce liquidity as traders in these markets will be less likely to trade if they feel that they will lose out to this practice.
- AI.32. The literature does not provide a definitive conclusion on the effect of fragmentation on market quality. Fragmentation offers the benefit of competition between exchanges, while market consolidation provides a clearer view of supply and demand. The idea of a consolidated tape is to retain the competitive advantages of fragmentation, by offering data on the relative performance of each exchange, while eliminating the complexity that arises from a market spread across multiple venues by consolidating pre-trade data into one feed. The next section sets out how this is difficult to achieve for all market participants with the inherent gap in speed compared to other market data providers.

## Implementation of the consolidated tape

### Latency

- AI.33. There has been significant focus in the literature on the speed of the consolidated tape and how it may limit the use cases for many professional traders. Advances in technology and the increased use of algorithms for executing trades have made small differences in information speed highly profitable.<sup>61</sup> The technology has now approached a point where transmission speeds are nearing theoretical limits, close to the speed of light. Over the past 15 years, there has been significant investment in the SIP, resulting in notable latency reductions.<sup>62</sup> However, the SIP still lags direct feeds, primarily due to the inherent latency involved in consolidating data from multiple geographic sources.
- AI.34. When high-frequency traders detect a trade through their faster data feeds, they can predict the resulting price change before others have received that information, potentially allowing them to immediately execute trades on exchanges where the price has not yet updated and profit, as mentioned in section 1.2.5.
- AI.35. Latency Arbitrage
- AI.36. HFTs can detect a trade on an exchange before the price updates and execute trades to “pick-off” quotes that are temporarily “stale.”<sup>63</sup> Other exchanges will receive this price information at a delay relative to these HFTs, so will update their prices after the HFT can trade on this data. By trading against these outdated prices, the HFT secures a profit once the price updates across all markets.

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<sup>61</sup> Lewis (2014) “Flash Boys: A Wall Street Revolt”.

<sup>62</sup> Holden, Pierson and Wu (2023) “In the Blink of an Eye: Exchange-to-SIP Latency and Trade Classification Accuracy” [\[link\]](#).

<sup>63</sup> Haslag and Ringgenberg (2023) “The Demise of the NYSE and Nasdaq: Market Quality in the Age of Market Fragmentation” [\[link\]](#).

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This practice capitalises on the time delay between the trade on one exchange and price adjustments elsewhere.

- AI.37. Brokers often slice large orders and execute them sequentially across multiple exchanges to limit the price impact of an individual trade. HFTs with faster data feeds can detect the execution of a part of this order on one exchange and front run the rest of the order. They then predict that similar orders will soon appear on other exchanges. Before those orders are executed, the HFTs buy up the available volume at the best price and then sell it back to the market at a slightly higher price, locking in a profit from the price movement they anticipate.

### Use of the Consolidated Tape

- AI.38. The use of a consolidated tape for trading will largely depend on the extent to which this practice harms the profits of traders. Latency arbitrage will still occur in an environment with direct feeds; the exchanges renting out space inside their datacentres at a premium to HFTs will give them a latency edge even to others with direct feeds. However, an even greater latency gap between HFTs and the consolidated tape offers more opportunity for profit. If latency is slow on the consolidated tape, the quotes and prices on this feed are stale, the potential losses from the risk of arbitrage could outweigh the cost savings from using a cheaper tape, making it less appealing for trading purposes. Latency arbitrage requires both a gap in the latency in information feeds and volatility in the stock price.
- AI.39. There is an ongoing debate about the degree to which slower investors would be affected by this dynamic. Wah (2016) estimated that the total potential profit from latency arbitrage opportunities involving S&P 500 stocks was approximately \$3 billion in 2014.<sup>64</sup> A more recent study found that there were limited profits to be made from this practice.<sup>65</sup> Focusing on a period of 11 months from 2015 to 2016 the authors found that the total potential profits from direct feed arbitrage are minimal, estimated at \$14.4 million over the study period, which is negligible compared to the overall trading volume of \$3.7 trillion. This finding is likely due to the improvements in latency of the SIP in this period. This would indicate that a consolidated tape may be useable for trading as price discovery. In 2015, the SIPs introduced microsecond timestamps, reflecting improvements in SIP processing speeds and the pace of trading. Bartlett and McCrary use the increased data granularity since 2015. It is possible that this more detailed data has led to the findings, suggesting that the issue of frontrunning in the past might not have been as pronounced, even with a slower tape.
- AI.40. In a comparison of the consolidated tape and direct exchange feeds, Hasbrouck (2018) found that at lower time resolutions (1 second), there is no significant difference in the information provided by both sources. However, at higher time resolutions, such as 10 microseconds or 100 microseconds, direct exchange feeds offer significantly more information to predict price movements than the consolidated tape. Even with the recent improvements in the speed of the tape, direct feeds will still be preferred among those who can profit from the faster access to data, such as HFTs and algorithmic traders.

### Solutions to frontrunning issues

- AI.41. One exchange, IEX, combats latency arbitrage with a 38-mile "speedbump" of coiled wire that delays orders by 350 microseconds. This speedbump is used alongside direct feeds from other exchanges, without the additional latency, so that the information coming into the exchange is slower than that received. They can then predict movements in the NBBO, while the orders are in transit. By adjusting prices before delayed orders arrive, IEX prevents HFTs from exploiting stale quotes. Hu (2018) found that after IEX became an exchange, overall market quality improved for securities with high IEX

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<sup>64</sup> Wah (2016) "How Prevalent and Profitable are Latency Arbitrage Opportunities on US Stock Exchanges?" [\[link\]](#).

<sup>65</sup> Bartlett and McCrary (2019) "How rigged are stock markets? Evidence from microsecond timestamps" [\[link\]](#).

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market share, suggesting the speedbump lowers adverse selection costs.<sup>66</sup> The author suggests that latency arbitrage opportunities could be reduced with symmetric speed bumps across exchanges.

## Accuracy

- AI.42. Beyond the potential for frontrunning, there are further concerns around the latency differences between the SIP and direct feeds. One concern is that latency issues may affect the accuracy of the information itself. This has implications for the classification of trades and the calculation of the NBBO: the true best quote at any given moment may not actually be the best quote. This directly impacts price signals, and the feasibility of the consolidated tape as a source of information for trading.<sup>67</sup>
- AI.43. Information arrives to the SIP from the exchanges with different latencies, largely due to the physical distance between the SIP's data centre and the other exchanges. Even though almost all exchanges are located within three cities in New Jersey, the SIP is in Mahwah, and exchanges based in the other two cities will take marginally longer to send their quote and trade data to the SIP. Even as the median latency has improved for the SIP, the latency with each exchange individually will differ. This information is processed and disseminated to the consolidated feed as it arrives to the data centre. This often gives an incorrect order classification, not reflecting the point at which the quote occurred, but when it arrived at the data centre. Tivnan et al. (2018) found 60 per cent or more of trades in high-volume stocks were reported out of sequence in the SIP in 2015.<sup>68</sup> This can affect calculations of liquidity, effective spreads and price impact.<sup>69</sup> Order classification inaccuracy is particularly harmful with the increased use of algorithmic trading, with the feed providing incorrect information about market signals.
- AI.44. Parties receiving direct feeds from multiple exchanges will still experience some order classification issues, but at a significantly lower rate. The latency of feeds from different exchanges will vary according to where the exchange is located, and which exchange has the faster feed. This can give rise to a misclassification as a quote or order carried out on the exchange with the faster feed will arrive ahead of an earlier transaction from the exchange with the slower feed. However, because these latencies are, in general, lower than for the SIP, the frequency of order classification errors will be reduced. This is because there is less time after an execution on a slower feed within which an execution on a faster feed would arrive to this exchange's data centre than for the SIP. There is a smaller gap in latency from the fastest exchange to the slowest. Improving latency performance of the consolidated tape is not only to protect against latency arbitrage but will improve its accuracy.
- AI.45. There is further concern about information inaccuracies, as exchanges generate their own Relative Best Bid or Offer (RBBO) using direct lines from the other exchanges. This can lead to time-based segmentation of the market, with different exchanges using different quotes for the same stock. Matching trades based on the SIP quote can be problematic because the exchange may have used a different, faster quote for its internal matching engine. Holden, Pierson and Wu (2023) find that 36.7 per cent of the executed market orders at NYSE and ARCA are routed from other exchanges. A consolidated tape may not accurately capture the best bid or offer that was available to all market

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<sup>66</sup> Hu (2018) "Intentional Access Delays, Market Quality, and Price Discovery: Evidence from IEX Becoming an Exchange" [\[link\]](#).

<sup>67</sup> Holden, Pierson and Wu (2023) "In the Blink of an Eye: Exchange-to-SIP Latency and Trade Classification Accuracy" [\[link\]](#).

<sup>68</sup> Tivnan et al. (2018) "Price discovery and the accuracy of consolidated data feeds in the US equity markets" [\[link\]](#).

<sup>69</sup> Holden, Pierson and Wu (2023) "In the Blink of an Eye: Exchange-to-SIP Latency and Trade Classification Accuracy" [\[link\]](#).

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participants. The authors discuss methodologies that could reduce the potential inaccuracies of a SIP by attempting to directly account for the latency by readjusting the time the quote arrives to the SIP.

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# Appendix 2: Trends in the use of Central Limit Order Books in UK (and EU)

## Objectives

A2.1. The twin objectives of the review of equity markets are to consider:

1. The recent trends in the use of the central limit order book (CLOB) and, by extension, alternative trading models in the UK (and the EU where helpful) and examine the possible drivers of these.
2. The impact of the current nature of the market for market data on the outcomes achieved by different types of investor.

## Methodology

A2.2. We have conducted a review of the recent literature relating to developments affecting lit CLOBs in the UK and, to provide additional context, in the EU (both before and after Brexit). In practice, many studies take the CLOB market structure as read and consequently we broadened the scope of our search to include equity markets more broadly and to terms relevant to potential trends, e.g. trends in alternative execution models.

### Box 0.1: Search terms for academic and pseudo-academic literature

Central “limit order book” or Order-driven combined with UK / EU, trends  
“Lit trading” “unlit trading” combined with “market quality”, UK  
“(equity) market data” combined with “market quality”, UK  
“equity market (fragmentation)” combined with “market quality”  
“High-frequency trading” combined with “equity market (quality)”  
“MiFID2” combined with “equity market (quality)”  
“Dark Pools” combined with “equity market (quality)”  
“(Closing call) Auctions” combined with “equity market (quality)”  
“Systematic internaliser” combined with “equity market (quality)”  
“Retail Service Provider” UK combined with “equity market”

A2.3. The last major regulatory restructuring of equity markets in Europe was the MiFID II initiative and we used this to set a somewhat loose cut-off point for the recency of the papers searched.

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## Trends in CLOBs and UK equity markets

A2.4. We have extracted trading data from LSEG Market Share Reporter (MSR).<sup>70</sup> Ultimately, they are drawn from reporting requirements codified in MiFID II. We have combined various bandings of trade into these categories:

- Fully lit CLOB trading.
- Auctions. These include call auctions conducted at set times through the venue’s electronic order book and periodic (or frequent batch) auctions (the latter being ad hoc and generally conducted alongside continuous trading). Both forms of auction can act as adjuncts to venues operating CLOBs. We discuss auctions later in this section.
- Systematic internalisation (SI). We discuss SI later in this section.
- Dark pools using a reference price. We discuss dark pools later in this section.
- Other trades executed subject to waivers. These include trades executed under the negotiated pre-trade transparency waiver (e.g. because a trade is executed away from the prevailing market price), trades qualifying for the Large-In-Scale (LIS) waiver, etc. A large part of the LIS waiver activity will be routed through dark pools.
- Trades reported to an exchange but executed off-book. This would include trades executed under a Negotiated Trade Waiver (NTW).
- Over-the-counter (OTC) trades executed bilaterally, e.g. with a market maker on a Request-for-Quote (RFQ) basis.

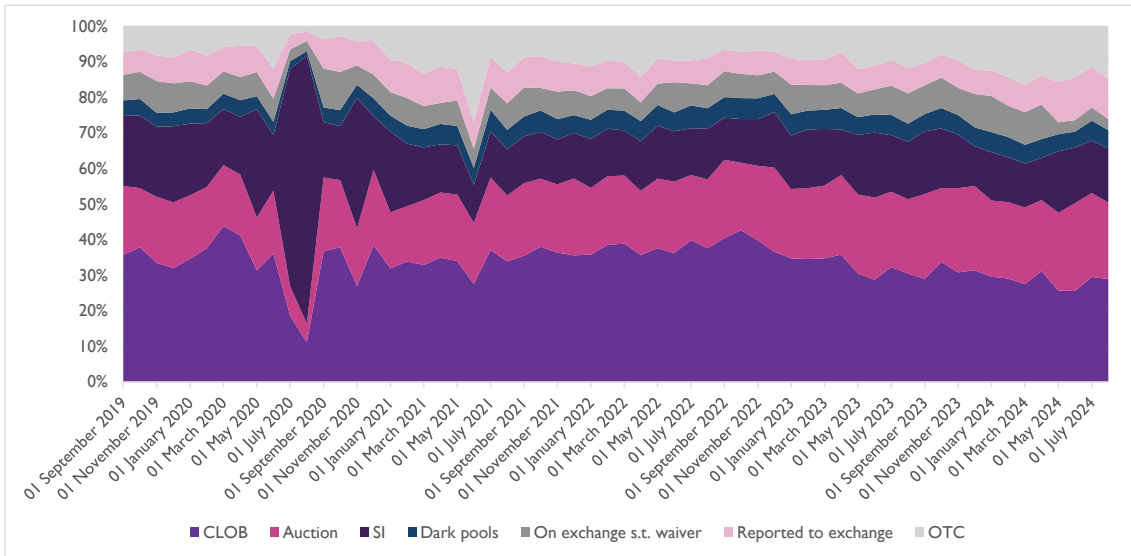
A2.5. The development of these different trading models in 2019–2024 is shown below. The overall share and value of continuous, fully lit trading on CLOBs has decreased. Indeed, since the overall value of equity trading has marginally declined relative to the highly volatile around COVID, the CLOB’s decline comes into stark relief. There has been growth in trading under various pre-trade transparency waivers and in the scale of on-venue auctions, both call and periodic auctions. (The MSR data include various trades that are tagged as non-price forming or not contributing towards price discovery. These are particularly prominent in OTC trading, although not limited to that segment. The charts below exclude such “technical” trades.)

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<sup>70</sup> We have considered equity trading in UK instruments wherever that trading takes place. We considered this more complete than focusing solely on UK-based venues. Indeed, the MSR data available to us effectively treated some dark pools as non-UK venues. In any event, execution on or reported to non-UK trading venues is relatively trivial, typically 4-5 per cent of total equity trading, with Euronext Amsterdam being the most significant player.

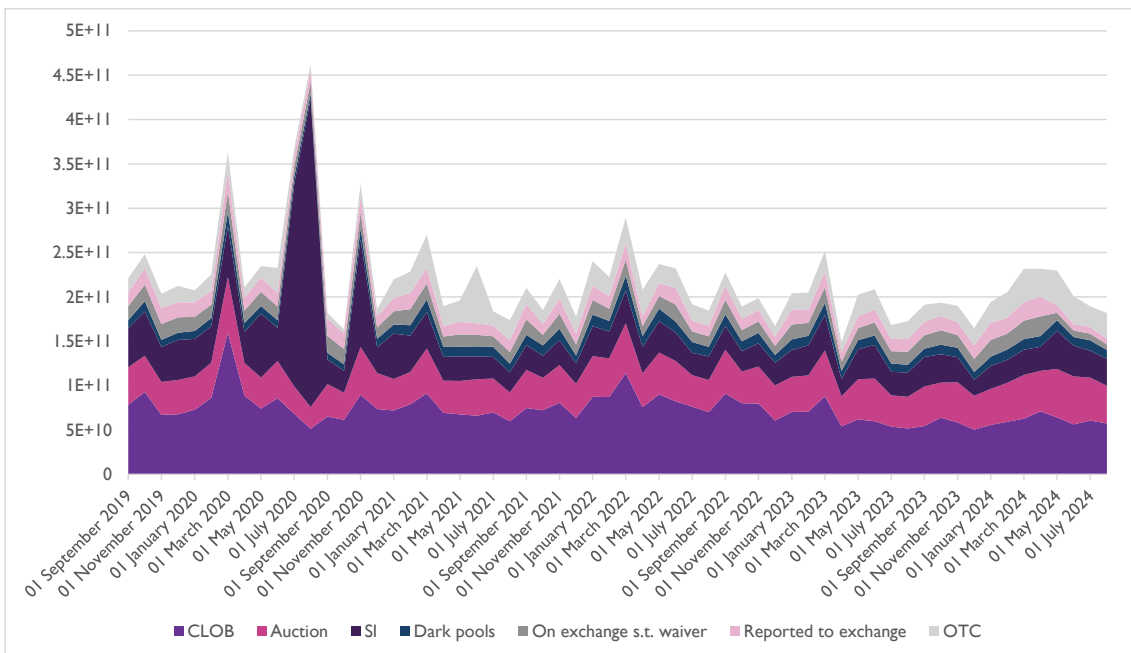


**Figure A0.1: Market shares of different trading models in UK equity markets**



Source: LESG MSR, Europe Economics analysis.

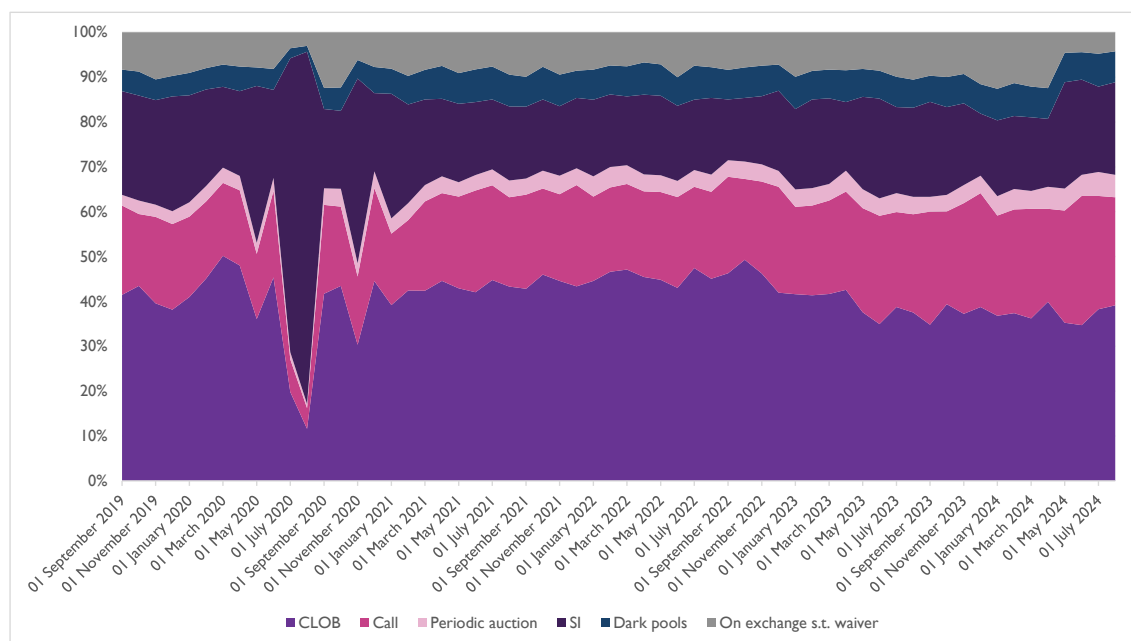
**Figure A0.2: Value of activity on different trading models in UK equity markets**



Source: LSEG MSR, Europe Economics analysis.

A2.6. Whilst the persistence (even growth) in bilateral trading models (OTC, NTW, etc.) is interesting it can disguise shifts in the rest of the trading landscape. The groupings below represent the spectrum of pre-trade transparency in (more or less) multilateral trading models (i.e. excluding OTC, NTW) from the CLOB through to dark pools. These show a relatively stable picture (the onset of the COVID-19 lockdown aside), albeit with the CLOB declining in share (and value of trading) and with both forms of auction and dark pools gaining some traction.

**Figure A0.3: Market shares of multilateral trading models in UK equity markets**



Source: LSEG MSR.

A2.7. The CLOB is a trading method where there is matching and execution of buy and sell orders with embedded price limits (i.e. limit orders). The central conceit is that it is a continuously updated representation of liquidity in a particular financial instrument, displaying a matrix of order volumes at various price points. The order book is transparent (i.e. lit) and is provided to market participants as a direct real-time data feed or via intermediaries to enable trading activity and related ancillary tasks. A CLOB market is working well when price discovery is efficient and the liquidity available is deep, immediate and resilient.

A2.8. The CLOB offers a trade-off between certainty and cost of execution. However, alternative models exist (auctions, SI, dark pools, etc.) and these naturally have different trade-offs with appeal to various market participants such that the overall market has become (superficially) fragmented. As we describe in the following pages, the evolution of CLOBs and these alternative equity trading models is driven by the complex interplay of:

- Regulation.
- Technology and product innovation.
- Developing market microstructure.

A2.9. Given that CLOBs are one part of a fragmented UK equity trading scene we cannot consider the trends in the use of transparent CLOBs without also considering the trends, and the drivers of those trends, in UK equity trading more generally. This review is organised as follows: we discuss various factors impacting equity markets, and their drivers, that are directly or indirectly impacting upon trading on CLOBs. We divide these between contextual factors (such as the growth in ETFs and HFT) and micro-structural ones (such as increased trading at the close — whether on auctions or elsewhere and the growth of alternative trading structures). We then bring these together to discuss where this leaves CLOBs in the UK.

A2.10. Whilst our focus is the UK, we have also considered literature relating to the EU as the market infrastructure, regulatory framework and the players are broadly the same there.

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## Choice and fragmentation

- A2.11. The fragmentation of equity markets, meaning that trading occurs across multiple platforms, has been a major development in financial markets in the UK and Europe. This phenomenon has been driven by technological advances (high-frequency trading, algorithms for smart order routing (routing orders to the venue with the best price), cheaper data bandwidth, etc.) and enabled by regulatory reforms (such as MiFID and MiFID II).
- A2.12. Liberalisation away from monopolistic, traditional stock exchanges should be expected according to theory to enhance market quality by fostering competition, leading to narrower bid-ask spreads and deeper overall liquidity pools. Indeed, the proliferation of trading venues experienced in the UK, EU and elsewhere reduced the rents available to established primary market operators by reducing the direct costs of trading as new entrants sought to attract liquidity by lowering direct trading costs. Whilst the latter have reduced, revenues from selling (pre-trade data) have become more consequential to those same trading venues. However, fragmenting liquidity may lead to increased implicit trading costs and increased difficulty in assessing actionable liquidity that in turn can have a chilling effect on lit trading.<sup>71</sup>
- A2.13. The literature has found both positive and negative associations of fragmentation with liquidity. For example, Boneva et al. found that whilst the LSE experienced a loss in lit trading to new entrants, overall trading volume was driven up by trading on dark pools (implying a latent pre-existing demand for such a trading model) — but with dark trading also complicating any interpretation of the impact on market quality.<sup>72</sup> Gresse (2014) found that for FTSE 100 stocks (at least those in her sample, i.e. non-financials) price efficiency was increasing with fragmentation, with depth also improved, at least for those traders connected to multiple platforms.<sup>73</sup> She did however identify potential harm for mid-cap stocks (based on the performance of non-financial constituents of Euronext's SBF 80 index) where spreads increased with fragmentation and depth reduced. This could plausibly relate to relatively reduced coverage of these stocks by larger trading firms, although Gresse does not suggest a cause for this divergence in the article.
- A2.14. Overall, then, the trade-off between these forces is context-dependent – and this context is continually changing with market entry and innovation. For example, some data vendors provide feeds that combine pre-trade data from multiple venues, with venue choice customisable by the client. The more sophisticated investment firms undertake internal consolidation of direct feed data in support of their trading needs. We now turn to those contextual factors.

## Growth of passive funds and exchange-traded funds

- A2.15. Passive (e.g. index-tracking) funds are an increasingly important investment model. These often take the form of exchange-traded funds (ETFs). An ETF is a basket of assets (e.g. of equity shares) that trades, as a basket, on some exchange (e.g. a stock market) in much the same way that an individual share does. Because they trade continuously, ETF prices also vary continuously. (This is by contrast with, for example, a mutual fund where prices may be updated only infrequently – e.g. once per day.) ETFs provide investors with a low cost, high liquidity instrument to facilitate greater diversification. They are actively used by both retail and institutional investors through exposure to a basket of assets. An actively traded ETF may even be more liquid than the underlying assets or basket.

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<sup>71</sup> Baldauf, M and Mollner, J (2021) “Trading in Fragmented Markets.”

<sup>72</sup> Boneva, L, Linton, O and Vogt, M (2016) “The effect of fragmentation in trading on market quality in the UK equity market”.

<sup>73</sup> Gresse, C (2014) “Market Fragmentation and Market Quality: The European Experience”.

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- A2.16. Whilst actively managed ETFs exist, the classic form of ETF passively tracks an index. The index in question could be a pre-existing index (e.g. FTSE 250) or it could be specifically created for the purposes of the fund. A synthetic strategy uses a bundle of derivatives based on factors such as correlation, exposure and risk to execute the index-matching strategy, whereas physical replication would mean holding each of the securities within the index in question. Synthetic ETFs have sometimes been characterised as providing superior tracking performance compared to physical ones,<sup>74</sup> but market practitioners see preferences for one strategy over the other as context-dependent not time-invariant. All ETFs (whether physical or synthetic) are well-suited to algorithmic trading.
- A2.17. An ETF can be subject to “tracking errors” whereby the value of the ETF does not precisely match the net asset value of the index it is notionally tracking, which will require remedial action.

### ETFs and their impact on CLOBs

- A2.18. Most of the literature identifies high ETF ownership with a deterioration in price formation in the underlying equities on CLOBs. Höfler, Schlag, and Schmelting (2023) highlighted that increased passive ETF ownership might reduce the firm-specific information embedded in prices, by crowding out active traders who usually act based on firm fundamentals.<sup>75</sup> Similarly, Chandler (2023) found that passive ETF ownership increased non-fundamental return noise and reduced the contribution of firm-specific information and reduced efficiency in asset prices and market-making capacity.<sup>76</sup> Ben-David et al. (2015) showed that equity ETFs are more liquid than a basket of the ETFs’ constituent equities.<sup>59</sup>
- A2.19. However, this liquidity also attracts noise traders to ETFs such that this noise can then be propagated to the underlying equities through arbitrage. This can mean those equities with higher ETF ownership display higher volatility.<sup>77</sup> Fiedor and Katsoulis (2020) found that the linkages between ETFs and the underlying varied by asset class, with these links strongest in equities (which are, generally, highly liquid).<sup>78</sup> Again, higher ETF ownership was associated with higher volatility in the underlying equities on CLOBs. By contrast, Calamia and Meloso (2024) found high ETF ownership to increase the price informativeness of the underlying assets.<sup>79</sup>
- A2.20. Liebi (2020) notes that during stable market periods, ETFs generally enhance market liquidity and reduce transaction costs. However, during times of financial distress, ETFs experienced significant illiquidity, arbitrage activity declined, and the underlying securities became less liquid, leading to potential additional market destabilisation. Similarly, Saġam et al. (2020) and Calamia and Meloso (2024) also identify high ETF ownership as leading to impaired liquidity during market stress events. During market stress, ETF liquidation might lead to high liquidation costs for stocks, impairing the underlying market's liquidity.
- A2.21. Sushko and Turner (2018) noted that the additional volatility associated with ETFs potentially posed greater risks to investors during periods of market stress, particularly retail investors who may be less equipped to manage such volatility.<sup>80</sup>

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<sup>74</sup> Grill, M, Lambert, C, Marquardt, P, Watfe, G and Weistroffer, C (2018) “Counterparty and liquidity risks in exchange-traded funds” European Central Bank’s Financial Stability Review November 2018.

<sup>75</sup> Höfler, P, Schlag, C and Schmelting, M (2023) “Passive Investing and Market Quality”.

<sup>76</sup> Chandler (2023) “How do passive ETFs affect stockmarket quality?”

<sup>77</sup> Grill, M, Lambert, C, Marquardt, P, Watfe, G and Weistroffer, C (2018) “Counterparty and liquidity risks in exchange-traded funds” European Central Bank’s Financial Stability Review November 2018.

<sup>78</sup> Fiedor, P and Katsoulis, P (2020) “Information and liquidity linkages in ETFs and underlying markets” Central Bank of Ireland, Vol.2020/8.

<sup>79</sup> Calamia, Anna and Meloso, Debrah C (2024) “ETF Characteristics and Underlying Asset Price Informativeness”.

<sup>80</sup> Sushko, Vladyslav and Turner, Grant (2018) “The Implications of Passive Investing for Securities Markets”.

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## The dominance of algorithmic trading and HFT on CLOBs

A2.22. HFT and algorithmic trading have a very significant role in equity trading. The Market Share Reporter does not delineate HFT/algo trading from screen-based trading but algorithmic trading/HFT combined represented about 80 per cent of equity on-venue trading in the EU in 2018–19,<sup>81</sup> with HFT increasingly the dominant model of algorithmic trading. ESMA (2021) reports that HFT alone accounts for about 60 per cent of trading volumes in highly liquid markets in the EU, further solidifying its role as a core component of modern trading systems. Indeed, some interviewees in this study suggested that 90+ per cent of UK trading was algorithmic.

A2.23. The role of algorithmic trading and HFT can be divided in two main categories:

- Market-making: liquidity is provided by submitting orders, which are continuously updated to reflect changing market conditions, e.g. through rapid response to emergence of new public information. This role of liquidity provision by HFT and algorithmic traders is increasingly important, spreading beyond the CLOB to other trading models including adoption of the systematic internalisation role.
- Arbitrage: this exploits pricing disparities between different markets or, indeed, between low and high latency traders in the same market. A further form of arbitrage is directional trading which involves taking a short-term position in anticipation of a price move that is already implicit in other market data.

A2.24. There is little literature focused on non-high frequency algorithmic trading per se. Indeed, to the extent that any trading algorithm will incorporate pricing data it will be latency-sensitive even if speed is not the core factor in successful execution of the algorithm.

A2.25. To date there is no dominant theoretical model to analyse the role of HFT in a market.<sup>82</sup> However, there is empirical research available on HFT, and how it affects markets. To analyse HFT such studies are often forced to attempt to identify who is HFT and who is not: there is not a definitive way of doing this (MiFID II transaction reporting does not distinguish between algorithmic and HFT). With this in mind, we expanded the geographic spread to include global markets to better capture HFT's impact. Equally, study results may be time, market or event specific. With those caveats in mind, we summarise some of the key results below.

A2.26. HFT can provide liquidity, improve market quality (through reduced total transaction costs and increased arbitrage) and dampen volatility, at least in normal market conditions.<sup>83</sup> There remain residual concerns that HFT “might move ... market prices away from fundamental values in the short term and impair the price discovery process that takes place on public and transparent markets”.<sup>84</sup> Indeed, Fische and Smith (2018) tentatively suggested that HFTs could exacerbate volatility in a stressed commodity market by withdrawing liquidity.<sup>85</sup> However, when markets experienced high volatility and abnormal trading conditions at the onset of the COVID19 crisis, there were no major issues caused by algorithmic trading firms.<sup>86</sup> Boehmer, Li, and Saar (2017) also found that competition among HFT firms enhances price discovery and reduces volatility in normal market conditions (in Canada).<sup>87</sup>

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<sup>81</sup> ESMA (2021) “MiFID 2/MiFIR Report on Algorithmic Trading”. ESMA drew on data from 52 Regulated Markets and MTFs from 24 EU Member States.

<sup>82</sup> Linton, O and Mahmoodzadeh, S (2018) “Implications of high-frequency trading for security markets”.

<sup>83</sup> Linton, O and Mahmoodzadeh, S (2018) “Implications of high-frequency trading for security markets”.

<sup>84</sup> IOSCO (2021) “Principles for the Regulation and Supervision of Commodity Derivatives Markets: Consultation Report.”

<sup>85</sup> Fische, RPH and A, Smith (2018) “High-frequency trading of commodities”.

<sup>86</sup> ESMA (2021) “MiFID2/MiFIR Review Report on Algorithmic Trading”.

<sup>87</sup> E. Boehmer et al. (2017) “The Competitive Landscape of High-Frequency Trading Firms”.

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- A2.27. Brogaard (2010) found that HFT contributed substantially to the price discovery process.<sup>88</sup> Indeed, Hendershott and Riordan (2013) found that algorithmic trades played a more significant role in discovering the efficient price than human trades<sup>89</sup> with Brogaard et al. (2014) identifying HFT's benefit to the price discovery process as trading in the direction of permanent price changes and so reducing temporary pricing errors, i.e. noise.<sup>90</sup> Brogaard et al. (2012) found that HFT had no impact on institutional trading costs at that time.<sup>91</sup>
- A2.28. Liquidity is fundamental to market function. HFT's contribution to liquidity can be distinguished between normal and stressed market conditions. Hendershott et al. (2011) found that HFT can contribute to liquidity.<sup>92</sup> Similarly, Brogaard and Garriott (2017) found that the arrival of HFT enhanced various measures of liquidity.<sup>93</sup>
- A2.29. HFT is not widely seen as increasing volatility in normal market conditions. Linton and Wu (2016) show that for large stocks the ratio of overnight to intraday volatility has increased over the period 2001-2016 (when HFT increased most significantly in prominence) which is hard to reconcile with HFT having increased volatility.<sup>94</sup> Boehmer et al. (2017) further showed that HFT can reduce short-term volatility through its market-making activities, especially in highly liquid instruments.
- A2.30. In times of market stress, the views on HFT's impact are much more mixed: whilst Hasbrouck and Saar (2013) found HFT to be beneficial in reducing volatility for small stocks during market stress, Zhang (2010) found that HFT increased market volatility during market stress.<sup>95,96</sup> Aquilina et al. (2021) report that latency arbitrage profits spike during periods of high volatility, worsening market stability.
- A2.31. In addition, during a crisis the liquidity HFT normally provides can evaporate as the algorithms shut down. Kirilenko et al. (2017) found that whilst HFTs did not trigger 2010's Flash Crash their response to the consequent unusually large selling pressure exacerbated market volatility.<sup>97</sup> However, when markets experienced high volatility and abnormal trading conditions at the onset of the COVID19 crisis, there were no major issues caused by algorithmic trading firms.<sup>98</sup>
- A2.32. The CLOB's price-time priority makes it subject to exploitation by HFTs. HFT has been found to create negative externalities on other traders (e.g. through excessive cancelled messaging). Practices such as front-running orders and "quote sniping" (or "latency arbitrage") exploit execution speed to profit from new public information. In the latter case, HFTs profit by matching stale quotes that do not yet reflect the new information. Aquilina et al. (2021) estimated this to impose a 0.5 basis point tax on trading, costing the UK market around £60 million annually and approximately \$5 billion

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92 Hendershott, T, Jones, C and Menkveld, A (2011) "Does algorithmic trading improve liquidity" *Journal of Finance*, 66(1).

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96 Zhang, F (2010) "High-frequency trading, stock volatility, and price discovery".

97 Kirilenko, A, Kyle AS, Samadi, M and Tuzun, T (2017) "The Flash Crash: High-Frequency Trading in an Electronic Market".

98 ESMA (2021) "MiFID2/MiFIR Review Report on Algorithmic Trading".



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globally.<sup>99</sup> HFTs can also engage in dubious practices such as creating orders with very low execution likelihood (spoofing)<sup>100</sup> and wash trading<sup>101</sup> that trading venues, regulators and supervisors have sought to deal with. The FCA (2023) raised concerns that the rising costs of trade data related to algorithmic trading could incentivise manipulative practices to offset costs, such as over-execution and rapid order cancellation.

A2.33. Budish et al. (2015) argue that the HFT “arms' race” results from continuous trading, characterising continuous CLOB as a flawed market design – that arbitrage opportunities exist and are exploited by HFT – and claiming that this harms liquidity provision. (As noted above, the connection between HFT and liquidity is less clear.) The preferred solution to the arms race put forward by Budish et al. is a switch to a market based upon discontinuous batch auctions.<sup>102</sup>

### Increased importance of Auctions to operators of CLOBs

A2.34. The Market Share Reporter distinguishes between (a) auctions operated through an electronic open limit order book, e.g. a call auction is used to set the opening pricing level for a subsequent period of continuous trading, and (b) periodic (or frequent batch) auctions where trading occurs in discrete timed segments (normally, less than one second).

A2.35. Call auctions are a complement to CLOB trading, typically run at the opening, at a set time in the trading day and at the close. Trading at the close has grown in importance and the closing call auction remains the most important mechanism to achieve this (we discuss this further below). In a call auction operated through the order book, level five pre-trade transparency is required. A periodic auction might follow a volatility-induced halt to trading (e.g. such that a circuit breaker has been triggered). During a periodic auction the trading venue must publish the price “that would best satisfy its ... algorithm” and the volume potentially executable at that price.<sup>103</sup> However, the full level of buying and selling interest at different price levels is not disclosed. In addition, some of our interviewees made the point that what pre-trade data are available is neither public nor actionable for more than “a few milliseconds” at a time. The literature is somewhat divided in its treatment of periodic auctions as being closer to dark or fully lit forms — indeed, many market participants consider it “grey” liquidity. Operators of CLOBs, such as CBOE, are thus offering a hybrid set of trading mechanisms.

A2.36. There has been a degree of apparent substitution between trading on a fully lit CLOB (i.e. excluding trades subject to pre-trade transparency waivers) and trading through auctions. The growing importance of the closing call auction was noted by various interviewed stakeholders in the context of increased trading at the close more broadly (including, for example, through internalisation).

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<sup>99</sup> Aquilina, M, Budish, E and O'Neill, P (2021) “Quantifying the High-Frequency Trading Arms Race” Bank of International Settlement Working Paper 955.

<sup>100</sup> Spoofing is a manipulative practice by High Frequency or Algorithmic Traders whereby buy (sell) orders are created to suggest a false sense of overall demand (supply) but which are cancelled prior to execution. The spoofer can profit by trading around the consequent price volatility.

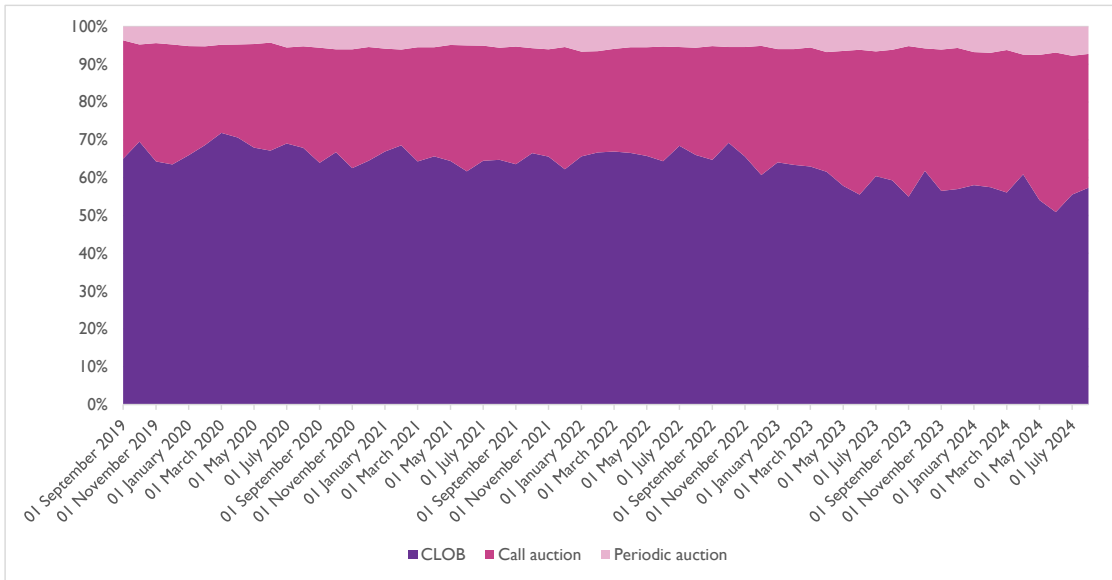
<sup>101</sup> Wash trading is where there is no change in ownership or market exposure but is intended to give a misleading impression of a security's price or demand/supply to other market participants.

<sup>102</sup> Budish et al. (2015) “The High-Frequency Trading Arms Race: Frequent Batch Auctions as a Market Design Response” Quarterly Journal of Economics” Volume 130/4.

<sup>103</sup> FCA Handbook, Annex 1: Information to be made public. See: [link](#). This is the UK version of EU Delegated Regulation 2017/587.



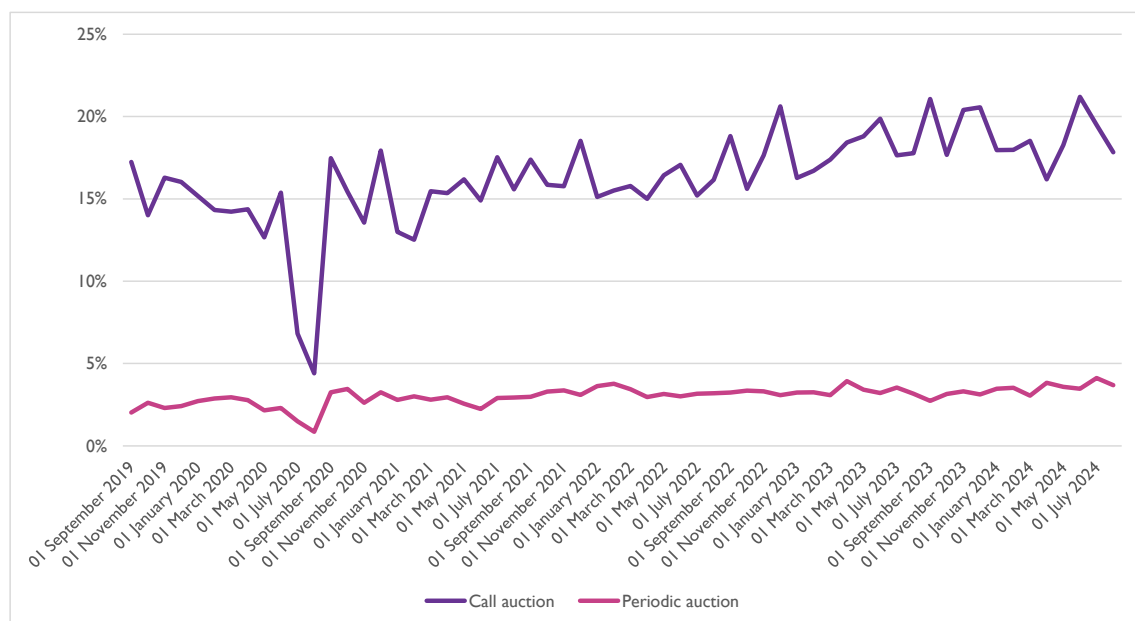
**Figure A0.4: Comparison of auction activity and fully lit CLOB UK equity trading**



Source: LSEG MSR.

A2.37. Auction activity in the context of total reported UK equity trading has been relatively stable until 2024 itself – and the permanence of this recent uptick in scale is naturally unclear. We note that some of the stakeholders interviewed as part of this study to date considered that trading at the close at the auction was unattractive compared to internalising those trades at an SI – but also that the exchanges are currently actively seeking to win some of that volume back to the closing call auction through rebates and other mechanisms.

**Figure A0.5: Share of auctions in overall UK equity trading**



Source: LSEG MSR.

- A2.38. The importance of both closing call and periodic auctions has increased. The growth in the closing call auction should be seen as part of growing market participant demand for end-of-day trading mechanisms, with the closing call auction still the most important.<sup>104</sup>
- A2.39. The closing auction is used to determine the closing price of a security at the end of the trading day and this price is also used for index calculation, derivatives settlement and portfolio performance evaluation.<sup>105</sup> This broad use case contributes to its increased appeal as a trading opportunity, e.g. for managers of passive index-tracking exchange-traded funds aiming to minimize tracking errors.<sup>106</sup> Indeed, the trend away from active funds towards passives and ETFs has tracked closely with the growth in trading at the close, including call auctions, relative to trading on the CLOB.<sup>107</sup>
- A2.40. Zhang and Ibikunle (2023) additionally characterise increased volumes in periodic or frequent batch auctions as a response to MiFID II’s restrictions on trading on dark pools, with the auctions acting as a “safe haven” for slower traders concerned about adverse selection due to latency arbitrage. (Anagnostidis et al. (2020) note that HFT are also notably less present, but not necessarily absent, in call auctions.<sup>108</sup>) The other side of this coin is that the CLOB (e.g. on other trading venues) experiences a loss in liquidity (relative spread increases) and (marginally) a reduction in pricing efficiency.
- A2.41. Brogaard et al. (2021), reviewing NASDAQ Nordic, found that a short (five minute) noon call auction acted as a coordination device to resolve mid-day illiquidity for those buyers and sellers that value depth above immediacy. This auction attracted end investors more than intermediaries, with

<sup>104</sup> Aramian, F. & Comerton-Forde, C. (2023) “Closing Mechanisms in European Equities” The University of Melbourne. Aramian and Comerton-Forde estimate the call auction share at 82 per cent in the UK, against 12 per cent with SIs guaranteeing trades at the closing price with the balance mostly with Aquis’s market-at-close mechanism.

<sup>105</sup> Ibid. The market share across all closing mechanisms is much higher on re-balancing days and at month-ends, which speaks to the importance of indexing and benchmarking.

<sup>106</sup> Féliz-Viñas, E and Hagströmer, B (2021) “Do volatility extensions improve the quality of closing call auctions?” *Journal of Finance*, Volume 56, 3. This looked at the CCA on NASDAQ Nordic.

<sup>107</sup> This is also the experience in the USA, see for example, Bogouslavsky, V and Nuravyev, D (2021) “Who Trades at the Close? Implications for Price Discovery and Liquidity” *Journal of Financial Markets*.

<sup>108</sup> Anagnostidis, P et al. (2020) “Price informativeness and high frequency trading in electronic call auction markets”.

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increased end investor flow linked to reduced price impact. It is argued that such call auctions improve overall market performance.<sup>109</sup> This is partly reinforced in Sarkar (2016, i.e. pre-implementation of MiFID II) where the LSE's intraday auction was more successful as a coordination device for midcaps than for more liquid (FTSE 100) stocks but did make the LSE the locus for that liquidity available whilst the auction was live.

- A2.42. Perspectives on opening and closing call auctions are mixed. Ibikunle (2014) identifies the opening call auction as promoting price discovery for high liquidity stocks with low liquidity stocks seeing little benefit – with the opening auctions even sometimes failing for such stocks. On the other hand, he identifies the closing call auction with informationally efficient price discovery on the LSE.<sup>110</sup> Comerton-Forde and Rindi (2022) found no evidence of the closing call auction disrupting market quality on the CLOB in the UK and found that the closing call auctions contributed towards price discovery (especially for the most liquid stocks).<sup>111</sup>
- A2.43. Chelley-Steeley (2009) also notes how closing call auctions, by reducing market failures caused by information asymmetry, enhanced market quality on the London Stock Exchange with “low-liquidity securities experienc[ing] greater improvements to market quality than securities with high pre-call liquidity”.<sup>112</sup> However, her work found opening auctions contributed to price discovery more than closing call auctions. More recent work by Anagnostidis et al. (2020) considers the role of HFT in the opening auction on Euronext Paris, with HFT ultimately driving efficient price discovery as the opening of continuous order-book trading approaches, although earlier in the preopening prices are often noisy.<sup>113</sup>
- A2.44. Félez-Viñas and Hagströmer (2021) additionally found that closing call auction extensions triggered by volatility resulted in enhanced market integrity in the mid- and small-cap stocks found on NASDAQ Nordic.<sup>114</sup> Furthermore, the existence of such extensions encouraged the migration of activity from continuous trading to the closing call auction. Such extensions are supply-side innovation (in some cases triggered by regulatory change) to increase trust in the auction mechanism from the venue is married to additional demand from market participants.

## Growth in alternative trading structures

- A2.45. A substantial part of equity trading is regularly diverted to venues (SIs, dark pools, etc.) away from CLOBs. Dark pools are unlit trading venues that offer low-cost trading, anonymity (meaning reduced information leakage and less market impact) and better order management. The latter, especially, makes them attractive to the buy-side institutions. This is illustrated by the FCA (2021) where a higher proportion of dark execution in an order was associated with a lower implementation shortfall.<sup>115</sup> Buy-side institutions have made the point that the CLOB lacks the liquidity to satisfy institutional-scale trades, but the nature of the liquidity provision on a CLOB, i.e. HFT-driven, also makes efficiently executing such orders fully on a CLOB difficult for the buy-side.

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<sup>109</sup> Brogaard, J, Hagströmer, B and Xu, C (2021) “Mid-Day Call Auctions”.

<sup>110</sup> Ibikunle, G (2014) “Opening and Closing Price Efficiency in Hybrid Markets: Does the London Stock Exchange need the Call Auction?” 2014 FEBS Conference.

<sup>111</sup> Comerton-Forde, C and Rindi, B (2022) “Trading @ the close” Working paper, University of Melbourne and Bocconi University.

<sup>112</sup> Chelley-Steeley, P (2009) “Price synchronicity: The closing call auction and the London stock market” *Journal of International Financial Markets, Institutions and Money*, Volume 19:5.

<sup>113</sup> Anagnostidis, P et al. (2020) “Price informativeness and high frequency trading in electronic call auction markets”

<sup>114</sup> Félez-Viñas, E and Hagströmer, B (2021) “Do Volatility Extensions Improve the Quality of Closing Call Auctions?” *Financial Review*.

<sup>115</sup> Financial Conduct Authority (2021) “Banning Dark Pools: Venue Selection and Investor Trading Costs” *Occasional Paper 60*.

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- A2.46. Venues with reduced pre-trade transparency, not least dark pools, exhibit lower execution costs.<sup>116</sup> Whilst dark pools have also been characterised as a potential ‘safe haven’ from HFT, much like periodic auctions, the operator of a dark pool may have incentives to relax impediments to HFT to increase liquidity and improve order execution. Indeed, the ECB (2017) notes that only dark pools specialising in block trades are unsuited to HFT.<sup>117</sup>
- A2.47. European-level regulation facilitated innovation (by allowing for MTFs and liberalising equity trading by removing the concentration rule) and provided motivation for the emergence of dark pools (by harmonising pre-trade transparency rules and, necessarily, setting waivers to those rules, e.g. for large-in-scale trades).
- A2.48. In a dark pool, the absence of pre-trade transparency means that the information contained within a trade is only available to the whole market post-trade. This could result in reduced contribution towards real-time price discovery.
- A2.49. The empirical evidence presented by the literature on this point is mixed. Degryse et al. (2014) found dark trading to be detrimental to lit market quality (based on the experience in the Netherlands).<sup>118</sup> Comerton-Forde and Putniņš (2015) find that trades executed on dark venues are less informed than those made on lit exchanges and in consequence, increasing adverse selection risk on the lit venue by increasing its concentration of informed traders. The result is that low levels of non-block dark trading are benign (or even beneficial) for price discovery, but high levels could become harmful. Comerton-Forde and Putniņš concluded that block trades on dark venues do not adversely affect lit market price discovery.<sup>119</sup>
- A2.50. Aquilina et al. (2017) had a more positive take on dark pools, speculating that the shift of trade towards a dark venue could also reduce pricing noise on CLOBs. Indeed, Aquilina et al. found that the existence of dark trading in UK equity markets has a positive effect on overall market quality — improving liquidity and price discovery, and reducing adverse selection risk — until it exceeds a threshold of approximately 15 per cent of total trading volume, above which the effects start to reverse.<sup>120</sup> The concept of a turning point in the effects of dark pools as their trading share increases is common ground with Comerton-Forde and Putniņš.
- A2.51. Overall trading on reference price-based dark pools has not exceeded five per cent of total trading volume over the past five years. Of course, this fraction may be exceeded at times in particular stocks (in the 2017 study, the 15 per cent threshold was exceeded in 1.7 per cent of the days on which in-sample stocks were traded).
- A2.52. Johan et al. (2019) show that MiFID II’s double volume cap restriction on trading in dark pools shifted trade in a cross-section of European stocks towards auctions, systematic internalisation, and OTC trading models with only limited return of liquidity to continuous lit CLOB-based trading (being about one quarter of the switched trade volume).<sup>121</sup> This implies that there is a demand for routing trade through less than fully lit venues, with periodic auctions often identified as the closest analogue in the absence of dark pools. Guagliano et al. (2020) also saw significant substitution into periodic or

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<sup>116</sup> Financial Conduct Authority (2021) “Banning Dark Pools: Venue Selection and Investor Trading Costs” Occasional Paper 60.

<sup>117</sup> European Central Bank (2017) “Dark pools in European equity markets - Emergence, competition and implications” Occasional Paper 193.

<sup>118</sup> Degryse et al. (2014) “The Impact of Dark Trading and Visible Fragmentation on Market Quality”>

<sup>119</sup> Comerton-Forde, C and Putniņš, T J (2015) “Dark trading and price discovery” *Journal of Financial Economics*, 118(1), 70-92.

<sup>120</sup> Aquilina, M et al. (2017) “Aggregate Market Quality Implications of Dark Trading” FCA Occasional Paper 27.

<sup>121</sup> Johann, T et al. (2019) “Quasi-dark trading: The effects of banning dark pools in a world of many alternatives”, SAFE Working Paper 253.

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frequent batch auctions (with this partly reversing post-ban) and increased liquidity on CLOBs during the dark pool ban.<sup>122</sup> On the other hand, Ibikunle et al. (2021), looking only at the market's response to MiFID II's restrictions on trading on dark pools in the UK (FTSE 100 and 250 stocks), found that a suspension from trading a given stock on dark pools led to reduced liquidity (uninformed traders can find dark pools attractive to reduce adverse selection risk and are unwilling to return fully to CLOBs given partially dark alternatives), less market resilience and worse informational efficiency (informed traders need uninformed order flow for execution).<sup>123</sup> The DVC has since been disapplied in the UK.

- A2.53. Systematic internalisation describes closed systems for matching and executing client orders, which are operated by investment firms such as broker-dealers and major investment banks, and latterly HFTs. The investment firm provides quotes on a continuous basis and matches client orders against its own inventory. The degree of transparency in systematic internalisation can be seen to sit between fully lit trading on a CLOB and trading on a dark pool. SIs also provide an alternative to exchange-run call auctions for those seeking to trade at the close by offering guaranteed trade at the closing price.
- A2.54. Internalisation has been found to negatively affect market quality by widening bid-ask spreads and reducing liquidity in lit markets.<sup>124</sup> However, it can still be attractive to individual market participants in that it avoids exchange fees, with some stakeholders wishing to trade at the close preferring to channel orders through SIs rather than closing call auctions. The information obtained through SI can give the broker a competitive edge: if substantive flow is internalised, then the investment firm can potentially obtain a private informational advantage, e.g. in setting out its market making quotes and “cream-skim” attractive trading opportunities (Aramian and Nordén, 2021).<sup>125</sup> The result is that less information is being revealed in lit markets, impacting price discovery and the identification of true extent of liquidity. Aramian and Nordén (2020), studying Nordic markets, find activity by HFT-run SIs to be detrimental to lit market liquidity, as liquidity provided to lit markets is constrained as part of inventory-management by SIs.<sup>126</sup>

### Where do these trends leave CLOBs?

- A2.55. The literature mainly shows technology (especially HFT and algorithmic trading) and product innovation (passive investing, particularly through ETFs) to be positive for liquidity on CLOBs, at least in normal market conditions. In terms of price formation, HFT is broadly seen as contributing to more efficient price discovery whereas ETFs are viewed as introducing additional noise.
- A2.56. These trends have contributed to driving evolution in market microstructure and trading behaviour in an increasingly diverse market ecosystem. In particular, traders seeking a safe haven from HFT and the growing scale of ETFs have pushed liquidity towards closing at the close (whether through closing call auctions or through systematic internalisation or other alternative closing trading mechanisms) and darker platforms (dark pools and also periodic auctions). Another way of viewing this is the agency market participants show in establishing a pecking order in venue selection to execute institutional-scale orders, with dark pools up first due to anonymity and low cost and then switching to lit markets only when the need for immediacy outweighs the additional costs of CLOB trading.

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<sup>122</sup> Guagliano, C et al. (2018) “DVC mechanism: The impact on EU equity markets” ESMA Working Paper 3.

<sup>123</sup> Ibikunle, G et al. (2021) “Dark matters: The effects of dark trading restrictions on liquidity and informational efficiency”.

<sup>124</sup> HMG Foresight (2012) “The impact of internalisation on the quality of displayed liquidity”.

<sup>125</sup> Aramian, F and Nordén, L (2021) “Costs and Benefits of Trading with Stock Dealers: The Case of Systematic Internalizers”.

<sup>126</sup> Aramian, F and Nordén, L (2020) “High-Frequency Traders and Single-Dealer Platforms.”

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A2.57. These factors represent significant countervailing headwinds for CLOB liquidity against the positive effects arising from ETFs (at least for equities, generally larger cap, covered by passive indexes) and HFT.

## The current market for market data in the UK and investor outcomes

A2.58. Trading is motivated by perceived informational advantage and as the UK equity market has shifted from a centralised to more distributed model, it has introduced the potential for more information asymmetries to exist amongst participants. The literature does not generally speak directly to how the current market for market data impacts upon the outcomes experienced by different forms of investor.

A2.59. The FCA's wholesale markets review identified considerable market concentration with discriminatory pricing (e.g. low latency non-display data users being charged more and facing rising costs) and licensing complexity.<sup>127</sup> This can be contrasted with the US situation described by Jones (2018) in the USA where there is robust competition on latency and depth of data, with low barriers to entry, and with the affordability of the SIP exerting a degree of market discipline.<sup>128</sup>

A2.60. The growth in importance of algorithmic trading (including HFT) and adoption of smart order routing technologies means that sell-side firms will struggle to compete for mainstream institutional business without consuming all the low-latency, non-display data necessary to make such technology meaningful. Successful sell-side firms obtain competitive advantage not from the quantum of data acquired but from how it is internally manipulated and parsed, and the speed with which trading decisions are executed.

A2.61. The FCA (2023) raised concerns that the growth in algorithmic trading had led some venues to introduce new charges and the consequent rising costs of trade data had raised the cost of doing business in the UK's wholesale capital markets. The FCA (2023) also found instances of rising data costs resulting in firms not purchasing that data such that this "could ultimately lead to poorer outcomes for retail investors and savers whose investments and savings depend on the efficient and effective use of wholesale data".<sup>129</sup> On the other hand, we note that Oxera (in a 2019 study undertaken for FESE, which represents the trading venues) makes the claim that market participants' data costs are typically low in proportion to other costs.<sup>130</sup>

A2.62. The FCA (2023) also raised concerns that these increasing costs could incentivise manipulative practices by HFTs to offset such costs, e.g. over-execution and rapid order cancellation.<sup>131</sup> This would potentially reduce market quality and worsen outcomes for all end investors, although it has not been raised a particular concern by the stakeholders that we have interviewed.

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<sup>127</sup> FCA (2023) "Wholesale trade data review — findings report".

<sup>128</sup> Jones, C (2018) "Understanding the Market for US Equity Market Data".

<sup>129</sup> FCA (2023) "Wholesale trade data review — findings report".

<sup>130</sup> Oxera (2019) "The design of equity trading markets in Europe".

<sup>131</sup> FCA (2023) "Wholesale trade data review — findings report".



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# Appendix 3: Metrics for Assessing Market Quality

- A3.1. In this appendix we describe and evaluate the most commonly used metrics assessing market quality. Whilst all metrics are well-suited as documented through existing literature, some will be more suited to assessing the quality in the context of moving from fully lit to dark trading venues. It will also strongly depend on how much trade takes place on the lit venues relative to the dark ones: if a given metric addresses only the trade on the lit venues, but most venues in a market are dark, movement of the metric will hold little information on the actual quality of the market in question. Hence, the evaluation below also focuses on the utility of each metric in this context.
- A3.2. Overall, no metric is ideally suited to evaluating market quality in this context on its own, and many authors suggest combining multiple measurements to obtain a full view of overall quality. It is also worth noting that some effects on market quality might not be instantaneous but could appear in the long- or medium-run. Additionally, in the case of a modest impact on activity before and after the consolidated tape, the quality metrics will not change much.

## Bid-ask spreads

- A3.3. This market metric captures the transaction costs aspect of market quality, which assesses the market liquidity.<sup>132</sup> Markets characterised by lower transaction costs are considered to be of higher quality.<sup>133</sup>
- A3.4. The quoted bid-ask spread is the difference between the bid and ask prices.<sup>134</sup> It represents the immediate costs of liquidity consumption at the best prices, expressing the transaction cost of marginal trade in the market.<sup>135</sup> The existing literature examines a number of modifications to this metric. The most popular types include:
- Effective spread, which examines the difference between the trade price and the midpoint of the consolidated best bid or offer at the time of order receipt.<sup>136</sup> This metric is usually computed for each time the trade occurs throughout the day.<sup>137</sup> This is a useful measure of market quality as it captures the overall costs of trade from the point of view of the trader.<sup>138</sup>
  - Realised spread, which examines the difference between the execution price and the midpoint of the consolidated quote five minutes after the trade. This metrics captures the market quality well, as it approximates the profits available to market makers during the trade process.<sup>139</sup>

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<sup>132</sup> Degryse et al. (2014) “The Impact of Dark Trading and Visible Fragmentation on Market Quality”.

<sup>133</sup> O’Hara and Ye (2009) “Is Market Fragmentation Harming Market Quality?”.

<sup>134</sup> OXERA (2024) “The functioning of equity markets in the UK: Implications for an equity Consolidated Tape” on behalf of the London Stock Exchange Group.

<sup>135</sup> OXERA (2024) “The functioning of equity markets in the UK: Implications for an equity Consolidated Tape” on behalf of the London Stock Exchange Group.

<sup>136</sup> O’Hara and Ye (2009) “Is Market Fragmentation Harming Market Quality?”.

<sup>137</sup> Aquilina et al. (2017) “Aggregate Market Quality Implications of Dark Trading” FCA Occasional Paper 27.

<sup>138</sup> O’Hara and Ye (2009) “Is Market Fragmentation Harming Market Quality?”.

<sup>139</sup> O’Hara and Ye (2009) “Is Market Fragmentation Harming Market Quality?”.



- Proportional bid-ask spread, which is calculated throughout the day by subtracting the bid price from the ask price, and dividing by the midpoint price.<sup>140</sup> To obtain a more realistic representation of the transaction costs that an investor is likely to incur during a given trading day (instead of relying on historical estimations only) limit order book can be taken over a pre-specified time interval while averaging over the time these spreads have lasted. This will give a time-weighted percentage bid-ask spread estimation.<sup>141</sup>
- A3.5. All of the bid-ask spread metrics, regardless of their calculation method, will be lower when the market quality increases,<sup>142</sup> as narrower spreads imply greater liquidity in the market.<sup>143</sup>
- A3.6. Given the fact that bid-ask spreads (especially effective and realised spreads) can measure the transaction costs in both fragmented and consolidated markets, these metrics could be applied to assessing market quality in the move from lit to dark venues. In dark pools, with no pre-trade transparency, this metric might not reflect the same market pressure as in lit venues, but the possibility to obtain this metric for both types of venues and compare the results can provide an insight into market liquidity.<sup>144</sup> However, this measure has its limitations, as it cannot capture all dimensions of market quality, such as price discovery. Hence, even with narrower spreads on the dark venues might indicate better quality, they might not fully take into consideration the trade-offs in price discovery and transparency that occur in dark trading.<sup>145</sup> Along a similar line of argument, Degryse et al. (2014) state that bid-ask spreads might not reflect the true liquidity conditions when the dark trading is significant in the market, since dark trades are not publicly quoted and their spread data are only available after the trades have been executed. Aquilina et al. (2017) express a similar view that bid-ask spreads, especially effective spread, is a good metric for market quality as long as dark trading is at moderate levels in the market; in dark-dominated markets bid-ask spread should be complemented with additional metrics that would fully reflect market quality.

## Volatility

- A3.7. Volatility is an important measure of trading frictions, with greater volatility indicating more trading frictions.<sup>146</sup> Hence, markets with lower volatility would be of higher quality.<sup>147</sup>
- A3.8. There are various permutations of this metric, such as: short-term price volatility, total (ex-post) volatility, temporary and permanent volatility.<sup>148</sup> The split between temporary and permanent volatility is a decomposition of total volatility; the latter relates to the underlying uncertainty about the future payoff stream for the asset while the former describes the volatility that is unrelated to fundamental information but instead is caused by the traders over- and under-reacting to perceived events.<sup>149</sup> Other types of volatility look into overnight and intraday volatility, where the overnight

<sup>140</sup> He, Jarnecic and Liu (2015) “The determinants of alternative trading venue market share: Global evidence from the introduction of Chi-X”.

<sup>141</sup> He, Jarnecic and Liu (2015) “The determinants of alternative trading venue market share: Global evidence from the introduction of Chi-X”.

<sup>142</sup> O’Hara and Ye (2009) “Is Market Fragmentation Harming Market Quality?”.

<sup>143</sup> Aquilina et al. (2017) “Aggregate Market Quality Implications of Dark Trading” FCA Occasional Paper 27.

<sup>144</sup> O’Hara and Ye (2009) “Is Market Fragmentation Harming Market Quality?”.

<sup>145</sup> O’Hara and Ye (2009) “Is Market Fragmentation Harming Market Quality?”.

<sup>146</sup> O’Hara and Ye (2009) “Is Market Fragmentation Harming Market Quality?”.

<sup>147</sup> Boneva, Linton and Vogt (2016). “The effect of fragmentation in trading on market quality in the UK equity market”.

<sup>148</sup> Boneva, Linton and Vogt (2016); Benos and Sagade (2012) “The Effect of Fragmentation in Trading on Market Quality in the UK Equity Market”; “High-frequency trading behaviour and its impact on market quality: evidence from the UK equity market”.

<sup>149</sup> Boneva, Linton and Vogt (2016). “The effect of fragmentation in trading on market quality in the UK equity market”.

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volatility refer to the changes in prices that occur between the closing auction and the opening auction and are not subject to the continuous trading process.<sup>150</sup>

- A3.9. In general, volatility is measured as the sum of the quote-to-quote squared returns of the quote midpoint.<sup>151</sup> Alternatively, the short-term volatility is alternatively defined as a standard deviation of the returns over the three-month period, where the returns over a given interval are calculated based on the spread midpoint at the beginning and ending of that interval.<sup>152</sup> In another paper, volatility is measured by the squared returns of the ten most recent trades.<sup>153</sup> All of these permutations of volatility capture its role in measuring market quality, and which to use will depend on data availability.
- A3.10. In the context of shifting from fully lit to dark venues volatility can be a useful metric in assessing market quality, however its effectiveness will decrease with more dark trading occurring in the market.<sup>154</sup> Boneva, Linton & Vogt (2016) also point out that the type of volatility matters depending on the type of the trading in the market, hence distinguishing between temporary and permanent volatility can be of greater importance in the context of shifting from lit to dark venues. Benos & Sagade (2012) consider volatility as an important metric approximating market quality, but its interpretation is less straightforward in the context of dark trading venues. The authors decompose volatility into two components, “good” (price discovery) and “excessive” (noise) volatility. The latter one would usually tend to increase in dark trading, which might not present a fully accurate representation of market quality. Instead, they suggest a combination of volatility and some other metrics (e.g., bid-ask spreads) to obtain a full view of market quality in the presence of dark trading. A similar view is held by O’Hara & Ye (2009), who suggest pairing volatility metrics with an additional measurement (preferably effective spread or return autocorrelation) in non-transparent trading environments where volatility can reflect better the trading noise rather than price discovery. Degryse et al. (2014) further investigate volatility as a signal of underlying market risks not only market quality, since more volatility in the dark trading context suggests more adverse selection on lit markets. Still, these authors also suggest pairing volatility with additional metrics, potentially spreads or depth, that could provide a complete picture of market quality and, particularly in the context of dark trading, market risks.

## Probability of informed trading

- A3.11. This metric investigates both market quality and market risk, as reflected through adverse selection risk.<sup>155</sup> Probability of informed trading (PIN) is an inverse proxy for market quality,<sup>156</sup> which means that the lower its value the greater the quality of the market in question. This measurement requires more sophisticated probability estimations before the final ratio can be estimated, but this metric is particularly suited for assessing the market quality in moving from fully lit to dark trading venues. The model assigns a probability that informed traders would receive a signal about the value of the stock and separate probabilities of good and bad news based on that signal. Additionally, market makers generate their bid and ask prices when orders arrive from the liquidity traders at a given rate; with

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<sup>150</sup> Boneva, Linton and Vogt (2016). “The effect of fragmentation in trading on market quality in the UK equity market”.

<sup>151</sup> Benos and Sagade (2012) “High-frequency trading behaviour and its impact on market quality: evidence from the UK equity market”.

<sup>152</sup> O’Hara and Ye (2009) “Is Market Fragmentation Harming Market Quality?”.

<sup>153</sup> Degryse et al. (2014) “The Impact of Dark Trading and Visible Fragmentation on Market Quality”.

<sup>154</sup> Boneva, Linton and Vogt (2016). “The effect of fragmentation in trading on market quality in the UK equity market”.

<sup>155</sup> Aquilina et al. (2017) “Aggregate Market Quality Implications of Dark Trading” FCA Occasional Paper 27.

<sup>156</sup> Aquilina et al. (2017) “Aggregate Market Quality Implications of Dark Trading” FCA Occasional Paper 27.

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more information available more informed traders would join the market at a given arrival rate of their orders.

- A3.12. Under these assumptions it is possible to estimate the distribution of trades between the informed and uninformed traders through observable buy and sell orders using the existing data on sales and purchases. This in turn can be used to estimate the assumed probabilities and finally the likelihood function. The probability of informed trading would then be the ratio of the product of probability of the signal and the probability of new informed traders' arrival over the sum of this product and the probability of arrival of all traders.
- A3.13. Aquilina et al. (2017) assess PIN as a good metric with a dual role of assessing market quality and market risk. It captures well the increased adverse selection and the potential non-linear impact of dark trading on quality and risk. However, like other metrics, PIN also requires supplementary metrics (spread measures) to fully reflect market quality in the context of dark trading, since the lack of visible information on trading can amplify information asymmetry, distorting the quality and risk impacts reflected through this metric.

## Efficiency

- A3.14. This metric moves away from more typical approach to market quality via transaction costs framework. A lower market efficiency would indicate poor market quality.<sup>157</sup> Since efficiency measures how accurately prices reflect available information,<sup>158</sup> it can be particularly interesting in the context of moving from lit to dark trading. Efficiency can be a good indication whether or not lit venues reflect well the available market information, revealing how dark trading (and how much of it) may be fragmenting price signals across venues, which will consequently inform about market quality via the price discovery channel.<sup>159</sup> As such, this metric captures both market quality and market risk.
- A3.15. One way to measure efficiency can be based on the daily closing prices, and estimated as the degree of autocorrelation in the stock return series (return autocorrelation).<sup>160</sup> Alternatively, it is also possible to compute the level of noise in each trading venue relative to the rest of the market and aggregate the estimates for each venue across the market (labelled as Relative Avoidance of Noise / RNA metric) – this will measure the efficiency of the price discovery process across different venues (measuring efficiency via the price discovery channel).<sup>161</sup>
- A3.16. Boneva, Linton & Vogt (2016) consider efficiency a good market quality metric in the context of shifting from lit to dark venues, as it highlights changes in transparency and information incorporation, two factors readily observable in the change toward dark trading. A similar view is shared by Aquilina et al. (2017), however, they argue that with a substantial presence of dark trading venues quality might not be fully reflected via this metric alone, since overall transparency, and hence price efficiency, would be reduced in the market. The authors suggest combining this metric with others capturing liquidity and adverse selection elements of market quality to obtain a more informative result. Efficiency alone, reflected via lower noise in prices, remains a valuable approximation of market quality when dark trading is not dominating the market.<sup>162</sup>

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<sup>157</sup> Boneva, Linton and Vogt (2016). "The effect of fragmentation in trading on market quality in the UK equity market".

<sup>158</sup> Boneva, Linton and Vogt (2016). "The effect of fragmentation in trading on market quality in the UK equity market".

<sup>159</sup> Boneva, Linton and Vogt (2016). "The effect of fragmentation in trading on market quality in the UK equity market".

<sup>160</sup> Boneva, Linton and Vogt (2016). "The effect of fragmentation in trading on market quality in the UK equity market".

<sup>161</sup> Aquilina et al. (2017) "Aggregate Market Quality Implications of Dark Trading" FCA Occasional Paper 27.

<sup>162</sup> Aquilina et al. (2017) "Aggregate Market Quality Implications of Dark Trading" FCA Occasional Paper 27.

## Quoted depth

- A3.17. This is another metric used to measure liquidity on the market, which in turn indicates market quality. This metric is proportional to market quality, meaning the higher the depth the greater quality of the market.<sup>163</sup>
- A3.18. The most traditional way to capture quoted depth is the number of orders / shares available at the best prices across all trading venues.<sup>164</sup> Alternative ways to capture quoted depth exist. One such measurement incorporates not only the quantities available at the best quotes but also those available at further limit prices.<sup>165</sup> This measurement aggregates the monetary value of the shares offered within a fixed interval around the midpoint (the average of the best bid and ask price of the global order book).<sup>166</sup> This alternative way to capture depth is insensitive to the size of the orders and reflects the quantity immediately available for trading, which is sometimes cited as its advantage over the more traditional approach.<sup>167</sup>
- A3.19. Whilst quoted depth is a valuable metric to assess market quality via the liquidity channel in fully lit markets, with a shift towards dark trading this metric becomes less informative on its own, as it excludes hidden orders.<sup>168</sup> Hence, Boneva, Linton & Vogt (2016) suggest always using this metric in combination with others, such as bid-ask spreads and volatility, to account for the existence of hidden volumes in dark trading venues. A similar point is iterated by Degryse et al. (2014) that quoted depth will not capture what is happening at dark venues, so this element of trade will not directly contribute to the quoted depth, which means that with increased prevalence of dark venues on the market, the quoted depth of lit venues becomes less representative of the overall market quality. Consequently, the authors suggest combining this metric with an additional measure of market quality that would incorporate dark liquidity as well to give a better overview of quality of the whole market.

**Table A3.1: Quality metrics and their suitability in the context of lit-dark trading shift**

	Bid-ask spread	Volatility	PIN	Efficiency	Quoted depth
O'Hara & Ye (2009)	Suitable for lit vs dark trading context.	Suitable, but should be paired with effective spread or return autocorrelation (preferably).	N/A	N/A	N/A
Degryse et al. (2014)	Suitable, but with a substantial amount of dark trading, might not reflect the true overall market quality.	Suitable as a market quality measure and market risk measure, but in fragmented dark context should be paired with other metrics.	N/A	N/A	It will not capture activity on the dark venues; always has to be paired with other metrics to obtain the overall quality of the whole market.

<sup>163</sup> Hagstromer (2022) "Market Fragmentation in Europe".

<sup>164</sup> Boneva, Linton and Vogt (2016). "The effect of fragmentation in trading on market quality in the UK equity market".

<sup>165</sup> Gresse (2014) "Market Fragmentation and Market Quality: The European Experience".

<sup>166</sup> Degryse et al. (2014) "The Impact of Dark Trading and Visible Fragmentation on Market Quality".

<sup>167</sup> Degryse et al. (2014) "The Impact of Dark Trading and Visible Fragmentation on Market Quality".

<sup>168</sup> Boneva, Linton and Vogt (2016). "The effect of fragmentation in trading on market quality in the UK equity market".

Aquilina et al. (2017)	Suitable, but only if the amount of dark trading in the market is not too great.	N/A	Suitable, but should be paired with other metrics (especially spread measures).	Suitable, but for better quality of the metric paired with other measurements for liquidity and adverse selection.	N/A
Boneva, Linton & Vogt (2016)	N/A	Suitable, but would be the most informative with not too much dark trading.	N/A	Suitable; will provide good insight into price transparency and information incorporation.	Not very suitable for dark environments; always has to be complemented by other metrics.
Benos & Sagade (2012)	N/A	Suitable, but only when paired with other metrics (preferably bid-ask spreads).	N/A	N/A	N/A

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# Appendix 4: Stakeholder Interview Questions

1. We set out below the questions that we covered in our stakeholder engagement. Slight differences existed between interview with the sell-side, the buy-side, data vendors and venues.

## Introduction

2. Europe Economics has been commissioned by the FCA to analyse the impact of including pre-trade data in an equities consolidated tape on the quality of the UK's market for equities trading. Our work includes engagement with a wide range of market participants to ensure that our findings are based on robust evidence.

### **Objective of this interview**

3. In this interview we are seeking to gather information on:

4. The current market for different forms of equity market data and how these data are used.

5. The importance of latency and how tolerance for higher latency (i.e. moving away from real time) may vary with the cost and volume of data available in a CT.

6. Use-cases for a pre-trade consolidated tape across different market participants, and the specifications necessary for different use cases (latency, data depth, venue attribution, operational features etc).

7. Possible impacts of a consolidated tape on individual market participants and the equities market more widely.

8. Potential equity market developments (e.g. trends in trading away from CLOBs) and how these might influence the impacts of a pre-trade CT.

9. The questions below will serve as a guide to the interview. We understand if you are not able to answer all of them / have other relevant points to discuss.

### **Confidentiality**

10. In order to facilitate candid discussions and enable us to gather sufficient information to inform our analysis, the interviews will remain confidential between Europe Economics and the parties participating. The FCA will know which organisations we have spoken to, but we will not share detailed information e.g. in the form of notes or recordings beyond that.

11. Any participants who specifically wish for their views and/or materials to be shared with the FCA should make this clear to us.

12. The information gathered from the interviews will be aggregated and used to inform our analysis on an anonymous basis.

13. If you have any questions regarding the interview please contact the manager of this study, Deborah Drury: [Deborah.drury@europe-economics.com](mailto:Deborah.drury@europe-economics.com)

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## Current use of equity market data

14. What pre-trade data feeds to you currently buy (direct or from market data vendors)? If multiple direct feeds, how are these consolidated in-house?
15. What do you use the (direct / consolidated / vendor) data for?
16. How important is latency of data for you, and how does this differ across different uses?
17. Would higher latency (moving away from real time) be tolerable for greater volume/depth, or lower cost? If yes, what degree of latency would be acceptable?
18. Would adding EU-type pre-trade data (top-of-book with no venue attribution) add any value here?

## Use-cases for a pre-trade equities consolidated tape

19. In what ways would you use an equities CT with pre-trade transparency? E.g.
  - a. For screen trading
  - b. To steer venue preference / liquidity assessment
  - c. TCA, risk management and surveillance, research and analysis
  - d. Optimize execution strategies
  - e. To help demonstrate best execution
20. For each use-case, please specify the necessary CT specifications e.g.
  - 20.1. Degree of latency e.g. “Scenario 1” – Lowest practicable latency, i.e. measurable in milliseconds; “Scenario 2” – Not real time, i.e. latency measurable in seconds to minutes
  - 20.2. Minimum number of layers of bid/offer orders (e.g. top-of-book; 5 layers; full market)
  - 20.3. Venue attribution
  - 20.4. Inter-operability with other systems (API, standardized format)
21. If a pre-trade equities CT were available,
22. How would your data purchasing behaviour adjust?
23. How would your trading approach change?
24. Any impacts on business other than trading?
25. If cost were a factor in CT uptake, what would be a tipping point?
26. Would a post-trade only CT be worthwhile / economically viable?

## Other possible consequences of a tape

27. How would you expect the equity market to react to a CT? e.g. across Scenario 1 (real time) and Scenario 2 (not close to real time)?
  - 27.1. Any differences between large and small stocks (e.g. FTSE 100 versus AIM)?
  - 27.2. How would a CT affect retail investors’ participation in the market?
  - 27.3. Would you expect any effect on margins for HFTs and if so in which direction?
  - 27.4. Would you expect any effect on volumes for HFTs?



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28. How might a CT affect price formation/efficiency and volatility?
  29. How might a CT affect liquidity? Would this vary across different types of stocks / instruments?
  30. How and why would a CT affect the balance of lit / unlit trading?
  31. Are there likely to be any impacts on the wider market, such as issuance or the balance of trade across instruments?
  32. How, if at all, would you expect the pricing of direct feeds from the trading venues to change?
  33. What do you think the impact of a pre-trade equities CT would be on competition between different venues' CLOBS?
  34. If used for best execution, would you expect additional price improvement relative to now?
  35. Are any additional regulatory changes required to make an equities pre-trade CT a positive addition to UK markets / market quality? (e.g. order protection rules, speed bumps, etc.)

### Wider equity market developments and possible implications for a CT

36. What are the most important current trends to / away from CLOB absent a CT, and what's driving these?
37. Does this differ across different venues / for different types of securities?
38. Are there any other market trends which could impact the benefits or disadvantages of a pre-trade equities CT?
39. What is the impact of these developments on market quality? (Individually and in aggregate.)
40. What are the key features of the UK market compared to US which may affect read-across of the impacts of a CT?

## Appendix 5: Modelling costs

Scaling factor	Value
Single country out of 30 EEA institutions	0.03
UK share of EU equities trading volume (2019) <sup>169</sup>	0.5
EUR to GBP exchange rate <sup>170</sup>	0.83

### UK Consolidated Tape Cost Estimates Based on Oliver Wyman Costings

#### Set-up costs

**Table: Set-up costs calculation for a UK consolidated tape using Oliver Wyman data**

	Cost (€ million)*	Scaling factor	Scaled cost
Leadership & project mgmt.	1	1	1
Proposition design	0.6	1	0.6
Bus. dev. & go-to-market	6	0.03	0.2
Technology implementation	25	1	25
Connectivity*	4.3	1	4.3
<b>Total (€ million)</b>			<b>31.1</b>
<b>Total (£ million)</b>			<b>25.8</b>

Source: Oliver Wyman

Assuming 43 venues (all the UK RMs and MTFs), since the cost per venue is €100k. In the case of just connecting five lit venues, the connectivity costs would be €0.5m. All other elements would be unchanged, so the total costs would be €27.3m or £22.7m.

#### Ongoing costs

**Table: Ongoing costs calculation for a UK consolidated tape using Oliver Wyman data**

	Cost (€ million)*	Scaling factor	Scaled cost
Technology	12	1	12
Tech operations	3	0.5	1.5
Venue managers	3	0.03	0.1
User managers	15	0.5	7.5

<sup>169</sup> ESMA (2022) “Evolution of EEA share market structure since MiFID II” [\[link\]](#)

<sup>170</sup> Google Finance (11<sup>th</sup> November 2024), EUR/GBP Exchange rate [\[link\]](#)

<b>Corporate functions</b>	3	1	3
<b>Real estate and other</b>	3	0.5	1.5
<b>Total (€ million)</b>			25.6
<b>Total (£ million)</b>			21.2

Source: Oliver Wyman.

## UK Consolidated Tapes Cost Estimates Based on MSP Costings

### Set-up costs

41. For set-up costs, we assume 27 per cent of the costs will be unaffected by how many venues are connected or transactions conducted. This is informed by the share of costs that we assumed were fixed when looking at the set-up costs using Oliver Wyman data, for which there is more granularity about the cost items.

**Table: Share of scalable costs estimation**

	<b>Value (€m)*</b>	<b>Share of costs (%)</b>
<b>FIXED COSTS</b>	26.6	27
<b>Leadership &amp; project mgmt.</b>	1	
<b>Proposition design</b>	0.6	
<b>Technology implementation</b>	25	
<b>SCALABLE COSTS</b>	71	73
<b>Business Developer</b>	6	
<b>Connectivity</b>	65	
<b>TOTAL</b>	97.7	100

Source: Oliver Wyman

**Table: Set-up costs calculation for a UK consolidated tape using MSP data**

	<b>Cost (€m)</b>	<b>Scaling factor</b>	<b>Scaled cost</b>
<b>Fixed Costs</b>	.27 * 11 = 3	1	3
<b>Scalable costs</b>	.73 * 11 = 8	0.5	4.0
<b>Total (€ million)</b>	11		7.0
<b>Total (£ million)</b>			5.8

Source: MSP

### Ongoing costs

42. For on-going costs, we assume staff costs are fixed (consistent with the way that MSP built up their labour costs). For non-staff costs, we assume 80 per cent of non-staff costs are scalable, which accords with the split

we assumed when estimating the costs of a UK consolidated tape when using Oliver Wyman data (€12m technology which was deemed fixed and €3m relating to real estate and other which we treated as scalable).

**Table: Ongoing costs calculation for a UK consolidated tape using MSP data**

	<b>Cost (€ million)</b>	<b>Scaling factor</b>	<b>Scaled cost</b>
<b>Staff costs</b>	2	1	2
<b>Fixed non-staff costs</b>	$0.8*5 = 4$	1	4
<b>Variable non-staff costs</b>	$0.2*5 = 1$	0.5	0.5
<b>Total (€ million)</b>	7		6.5
<b>Total (£ million)</b>			5.4

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