
The design of equity trading markets in Europe

An economic analysis of
price formation and
market data services

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European Securities Exchanges

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Executive summary

Context

Equity markets are where investors meet to buy and sell shares in a company. These markets lie at the heart of modern economies. Strong equity markets can unlock investment and channel it to firms that need to expand and create jobs. They provide households with better options to meet their retirement goals, and they better connect financing to investment projects.

The past decade has witnessed a fundamental change in the market for equity trading in Europe due to technological development and entry by new players, supported by regulatory changes.

Historically, only one or possibly two exchanges offered trading in a given stock. In 2007, the introduction of the European Markets in Financial Instruments Directive (MiFID I) opened up competition for equity trading, delivering more choice and lower trading costs for European businesses.

In addition to the changes brought about by MiFID I, there have been other important changes in European equity trading. In particular, the ten years that followed were associated with significant growth in algorithmic and high-frequency trading (HFT) strategies, as well as a steep rise in dark trading, such as trading on dark venues and over the counter (OTC), without pre-trade transparency.

Since 2018, the implementation of successor legislation (MiFID II) has continued the trend of promoting competition for equity trading, with a focus on improving transparency and price formation in financial markets. New rules were put in place to limit the amount of dark trading, and to promote trading on the more transparent exchanges, which lie at the heart of the price formation process in equity markets.

There is an ongoing debate about the provision by stock exchanges¹ of market data services. This debate often overlooks the links between market data services, trading and price formation, and the design of the equity trading market more generally.

One year on from the implementation of MiFID II, the objective of this report is to inform the debate on the design of equity trading markets in Europe—in particular, market data services—by providing an economic analysis of:

- the role of the price formation process;
- the impact of regulatory change on the market design of equity trading and price formation;
- the value chain for market data services;
- the impact of different charging structures for market data.

¹ This report uses the terms 'stock exchange' and 'primary market' interchangeably to refer to a country's primary stock exchange, which is usually also a 'regulated market'. For a definition of regulated market, see section 3.2.1.

Key messages from the report

- Transparent trading on stock exchanges plays a central role in price formation, which contributes to fairer and more efficient markets and lower costs of capital for European businesses.
- The MiFID framework has facilitated the emergence of alternative transparent trading venues as well as increased dark trading. Both have used the quality of the price formation provided by transparent trading on stock exchanges.
- While MiFID I and II have delivered greater choice and lower trading fees, there is a risk that the growth in off-exchange trading threatens the quality of price formation going forward. Any further changes to the market design of equity trading would need to ensure that the price formation process is not negatively affected.
- Market data is the outcome of a dynamic price formation process, and is a joint product with trade execution—i.e. it is not possible to generate one without the other, and most activities undertaken by a stock exchange deliver both trading and price formation. The economics literature suggests that, in the case of joint products, it is efficient to generate revenues through fees from both products. Indeed, this is what exchanges do in practice: they recover their joint costs through a combination of market data fees and trade execution fees.
- MiFID II introduced rules on the provision and pricing of market data by trading venues. This is a small part of a longer value chain which includes data vendors and other distributors of data (analytics) services. If we consider the contribution of market data provided by European stock exchanges, we estimate that it represents around 15% of the total European spending on market data and analysis.
- In relation to the market data supplied by stock exchanges, our analysis finds the following:
 - the share of revenues coming from market data services ranges between approximately 20% and 50% of joint (trade execution and data) revenues across exchanges and has been relatively stable over time—on average 31% in 2018, unchanged from 2017, and compared to 32% in 2016 and 30% in 2015.
- Aggregate market data revenues (of stock exchanges that are members of FESE) amounted to approximately €245m in 2018 and increased in recent years by around only 1% per year in real terms.
- From a public policy perspective, the question is whether the current practice of recovering costs (i.e. partly through trade execution fees and partly through market data fees) has any negative implications for the functioning of equity markets and their end-users—i.e. investors and companies raising capital. The economic framework in this report shows that current charging structures for market data are unlikely to have detrimental effects on market outcomes for investors.

The design of the market for equity trading and the price formation process

Stock exchanges are the typical meeting place for investors in equity markets. They bring together buyers and sellers and establish prices to match demand with available supply. Typically defined in terms of their trading function (or liquidity provision) and listing services, another of their key economic functions, however, is price formation. This plays an important role for investors, by allowing them to (re)allocate their asset holdings and in turn to manage their financial risks according to their personal preferences.

The price formation function stems from the fact that the 'goods' being exchanged in equity markets are claims to uncertain future cash flows. Therefore, an important function of a stock exchange is an information-gathering and distribution process which ensures that market participants are sufficiently informed about the prices of the assets being traded in the market such that they can make informed commercial decisions.

The report describes in more detail the price formation process and how new information is incorporated into prices. The mechanisms and wider benefits of price formation are well covered in the established literature on market microstructure (albeit this literature is arguably complex and not always easily accessible), and are widely recognised by financial regulators such as the European Securities and Markets Authority (ESMA).

The literature on price formation highlights three important implications for the design of the market for equity trading.

1. The quality of price formation (and liquidity) is affected by the relative proportion of different types of trader on a particular trading venue—trading venues need traders motivated to profit from information (referred to in the literature as 'informed traders') and traders motivated to trade by a need to rebalance portfolios and smooth their consumption streams over time (referred to in the literature as 'uninformed traders').
2. The order flow to and from the order book on a stock exchange conveys information that makes a meaningful contribution to price formation.
3. By setting out the rules of the game and undertaking market surveillance, as well as coordinating and managing the flow of information, the activities of the stock exchanges facilitate the price formation process in equity markets.

In contributing to accurate prices, the activities of the stock exchanges thus lead to:

- more efficient markets—in a well-functioning market, the current price of an asset is the best estimate of the future price, expressed in today's terms at a risk-adjusted rate of return, conditional on the available information. Better price formation leads to reduced frequency of costly price shocks;
 - fairer markets—fairness in markets requires a reliable price formation process with effective detection of, and deterrence against, improper trading and thereby levels the playing field between sophisticated and less sophisticated participants, such as retail investors. Confidence in prices, through a reliable price formation process, leads to use of those prices;
 - lower costs of capital for businesses, allowing companies to raise additional funds to expand their activities, and thus create jobs and growth. If prices are efficient and information is incorporated quickly and effectively into asset
-

prices, this will also contribute to lower asset volatility and a lower cost of capital for European businesses;

- improved products and new business models—the price formation provided by exchanges has led to the development of new products and business models, resulting in more choice and competition for trading and new propositions for consumers;
- wider benefits—for example, the broader finance and valuation industry use the accurate prices formed on stock exchanges to determine the value of other assets.

The flow of information and the price formation process are both vital to the efficient functioning of equity markets. Indeed, it could be argued that the whole purpose of financial markets, more broadly, is to incorporate information. It is therefore no surprise that regulators and the academic community recognise the importance of price formation; nor is it surprising that market data, as the outcome of the price formation process, is of value to different types of market participant and trading venue, such as those that do not have their own price formation process.

Stock exchanges compete on the quality of this price formation via their activities—investing in hardware and software, setting trading rules, and monitoring compliance with these rules.

MiFID and the market design for equity trading

A primary objective of MiFID I was to increase competition in equity trading. Since implementation of the Directive, there has been a significant and persistent decline in the proportion of equity trading taking place on the traditional primary exchanges, with around 60% of trades currently taking place on primary stock exchanges.²

Given the importance of the price formation process to equity markets, the impact of liquidity ‘fragmentation’ across multiple trading venues on price formation has been a source of academic and policy debate.

There is some empirical evidence that suggests that new-entrant ‘lit’ venues contribute to price formation, despite lower levels of trading activity. However, there are limits to this. For example, significant falls in market-wide trading activity following trading halts on stock exchanges illustrate the value that traders place on the quality of price formation provided by primary stock exchanges.

Alongside the trend of falling market shares of the traditional primary exchanges, there has been a growth in dark trading—i.e. trades where orders are hidden prior to execution. Dark trading has generally occurred on dark trading venues or through OTC transactions, away from lit exchanges. When off-exchange trading is taken into account, the proportion of equity trading taking place on primary exchanges in each European market has been consistently less than 40% in recent years.³

² Oxera analysis of Cboe data. The proportion of equity trading taking place on primary exchanges in each European market is on average 60%, when trading on only RMs and MTFs is taken into account. See section 3 in this report.

³ Oxera analysis of Fidessa data. The proportion of equity trading taking place on primary exchanges in each European market is on average 40%, when RM, MTF, and all OTC trading, including systematic internalisers (SIs) and periodic auctions, is taken into account. See section 3 in this report.

Although improving transparency is a key goal of MiFID II, more trading occurring off-exchange has resulted in less transparency and a risk to the quality of price formation. While an intention of dark trading is to protect investors from market impact, this is mainly relevant to larger trades—it does not contribute to price formation and dark trading may also include smaller transactions, which do not necessarily require protection from market impact. Furthermore, the shift of trading from primary exchanges to other trading venues has led to more fragmentation.

The changes brought about by MiFID have been successful in creating wider choice in trade execution venues and lower trading fees. At the same time, regulators and policymakers must ensure that any further changes to the market design for equity trading do not impair the price formation process and transparency in European equity markets.

Market data services—value chain and economic characteristics

Market data provided by exchanges is the outcome of the price formation process. As an exchange improves its price formation process, its market data (both pre- and post-trade) becomes more valuable because the prices become more reliable to prospective users of the information.

MiFID II introduced some significant changes to the rules governing market data offered by trading venues. These include strengthened provisions underpinning the pre-existing requirement on trading venues to provide access to market data on a reasonable commercial basis, and new requirements on disaggregation of market data.

This data is a small element of a much longer value chain, in a broader market data industry that is large and growing. Stock exchange market data is often aggregated and complemented by other sources of data and value-added services, with stock exchange data revenues accounting for around 15% of the total value chain.⁴

Stock exchange market data is distributed directly and indirectly (through data vendors) to brokers, asset managers, and other market participants. There is significant variation in these different participants' use of market data. Despite the heterogeneity across users of market data, there has been a general upward trend in market data consumption. This has been driven by a rise in trading strategies that require more data, in particular from the significant growth in electronic trading, and an increase in data used to inform regulatory and commercial assessments.

Analysing market data fees and revenues, this report finds the following.

- For most exchanges, market data fee increases have been small (e.g. for Level 1 and Level 2 data, less than 1.5% per year in real terms).
- In 2018 market data revenues as a share of joint (trade execution and market data) revenues ranged from around 20% to 50% across exchanges (31% on average), and have remained fairly stable over the past five years.
- Unit costs (calculated as the joint revenue from trade execution and market data as a proportion of the value of trading in relevant securities) have declined in recent years for all participating exchanges except one.

⁴ See section 4.5.5 in this report.

Overall, there is no evidence to support the claims of broad increases in the total effective cost of trades levied by exchanges. The costs to end-investors are small—aggregate market data revenues were approximately €245m in 2018,⁵ which represents 0.003% of total assets under management.⁶

An economic framework for assessing the impact of different charging structures for market data

Regulators such as ESMA have widely recognised that trade execution and market data are joint products. Given the structure of electronic limit order books, it is not possible to generate one without the other. Most of a stock exchange's activities (investing in hardware and networks, setting trading rules, and monitoring and enforcing compliance with these rules) are undertaken to deliver both trading and price formation. Market data and trade execution are also interdependent (more trading makes market data more attractive, and vice versa) and are linked at the level of consumption (market data on a specific market is used by traders active in that market to take commercial decisions on trading).

The economic concept of joint products has important implications when considering how exchanges can recover their fixed costs. The total return that a stock exchange earns reflects the revenues it receives from the joint products and the total cost of the joint products. This means that the appropriate point of reference for recovering the costs in an economically efficient way is to look at the combined transaction and data revenues.

The economics literature suggests that, for joint products, it is efficient to generate revenues through fees from both products. Indeed, this is what stock exchanges do in practice: they recover their joint costs through market data fees and trade execution fees.

The core business model of trading venues is to maximise order flow, by attracting traders to submit bids. Investors are more likely to submit orders to venues providing access to reliable market data, low trade execution fees and deep liquidity, enhancing the likelihood of execution. Thus, there is competitive pressure on trading venues to ensure that the pricing of their services—for both market data and trade execution—incentivises market participants to trade on their venue.

Different charging structures may have distributional consequences, generating winners and losers. For example, shifting costs from trade execution services to market data services could worsen the competitive position of the brokerage firms with the highest data needs given their trading activity.

However, from a public policy perspective, the key question is whether the current practice of recovering costs through a combination of trade execution

⁵ Data covers the following exchanges: BME, Budapest SE, Deutsche Börse, Euronext, Nasdaq, Oslo Børs SIX Swiss Exchange and Wiener Börse. 2012 data for Nasdaq is estimated. 2018 revenue for Oslo Børs is indicative. 2018 revenues for other stock exchanges are provisional and unaudited. Market data revenues were provided directly by participating FESE member exchanges in local currencies (SIX Swiss Exchange and Oslo Børs revenues were converted to EUR). The revenues for BME, Nasdaq and Budapest SE are based on equity-only product revenue. Wiener Börse, Deutsche Börse and Euronext revenue covers cash market products only. The revenues for the remaining stock exchanges are calculated using total market data revenues. For all exchanges, market data revenues include revenue from non-equity market data. Luxembourg Stock Exchange is excluded from this analysis due to the very limited share of equity trading in its business model.

⁶ Market capitalisation as at December 2018. Data provided by FESE.

and market data fees has negative implications for the functioning of equity markets and their end-users.

These implications can be summarised as follows.

- **Market efficiency**—there is some recent academic literature on the impact of stock exchanges charging for market data on wider market efficiency. These are theoretical contributions and suggest that, under certain very specific conditions (e.g. no competition in equity trading), charging for market data could impair price formation. However, as competition for equity trading is present, the stock exchange has the incentive to maximise order flow. This in turn prevents it from setting market data fees at a level that would negatively affect the price formation process.
- **Competition**—the analysis indicates that there are no significant effects on competition. For example, the concern could be that market data fees may have a greater effect on smaller brokers and fund managers (who may make fewer trades per data user) than on larger players. However, in the unlikely event that this would encourage consolidation, this is unlikely to have a significant impact on competition due to the large number of fund managers and brokers in the market.

Ultimately, the economic analysis suggests that the current charging structures for market data are unlikely to have detrimental effects on market outcomes for investors.

Market design

This report provides an economic framework to assess the impact of stock exchanges charging for market data services on end-users and the functioning of equity markets.

A review of the extensive academic literature on market microstructure highlights the crucial role that stock exchanges play in the price formation process. By contributing to better price formation, stock exchanges contribute to fairer and more efficient markets and a lower cost of capital for businesses.

Regulatory and technological changes have had an impact on the market design of equity trading and price formation. Increased competition for equity trading in recent years has resulted in lit exchanges losing market share to trading venues that contribute less to price formation, but are using the price formation process of lit exchanges to conduct their business.

The key objectives of MiFID II for equity markets were to protect price formation and address some problems caused by dark trading and market fragmentation. One year on from the introduction of MiFID II, the European Commission and ESMA are closely reviewing the outcomes of this scale of regulatory intervention.

The analysis in this report suggests that although MiFID I and MiFID II have been successful in introducing competition and creating a market that delivers well in terms of choice and low trading fees, there is a risk that the growth in equity trading off-exchange will threaten the quality of price formation going forward. Any changes to the design of the market for equity trading would need to ensure that the price formation process is not further affected.

Glossary

BBO	best bid and offer
BCN	broker crossing networks
BME	Bolsas y Mercados Españoles
CAPM	capital asset pricing model
CDS	credit default swap
CLOB	central limit order book
DVCM	double volume cap mechanism
ESMA	European Securities and Markets Authority
ETF	exchange-traded fund
ELP	electronic liquidity provider
EU	European Union
FESE	Federation of European Securities Exchanges
HFT	high-frequency trading
IOSCO	International Organization of Securities Commissions
LOB	Limit order book
MAR	Market Abuse Regulation
MiFID I	Market in Financial Instruments Directive
MiFID II	the second Market in Financial Instruments Directive
MiFIR	Markets in Financial Instruments Regulation
MTF	multilateral trading facility
NYSE	New York Stock Exchange
OECD	Organisation for Economic Co-operation and Development
OTC	over the counter
OTF	organised trading facility
RM	regulated market
SE	stock exchange
SI	systematic internaliser
YTM	yield to maturity

Definitions of terms and concepts

Term/concept	Definition
Broker crossing networks (BCNs)	BCNs are not formally defined in legislation but are generally understood to be computerised trading systems operated by investment firms away from trading venues. Firms operating BCNs typically use them to match combinations of in-house principal liquidity flows, client orders and electronic liquidity provider (ELP) flows. BCNs are prohibited under MiFID II.
Dark pools	Venues where there is no pre-trade transparency i.e. orders are hidden prior to execution. Dark pools are not formally defined under MiFID but the term commonly refers to both dark MTFs (MTFs that utilise the MiFIR pre-trade transparency waiver system) and certain BCNs. Examples include SIGMA X, POSIT and Liquidnet.
Dark trading	A form of equity trading where orders (prices and volumes) are hidden prior to execution. This may include trading on dark pools and over the counter (OTC).
Lit trading	A form of equity trading where orders (prices and volumes) are visible prior to execution.
Multilateral trading facility (MTF)	One of the three categories of trading venue defined under MiFID II. According to Article 4(22), an MTF is a multilateral system, operated by an investment firm or a market operator, which brings together multiple third-party buying and selling interests in financial instruments, in the system and in accordance with non-discretionary rules, in a way that results in a contract.
Off-exchange trading	In this report, trading activity that does not occur on a primary stock exchange.
Organised trading facility (OTF)	One of the three categories of trading venue defined under MiFID II. According to Article 4(23), an OTF is a multilateral system that is not a regulated market or an MTF, and in which multiple third-party buying and selling interests in bonds, structured finance products, emission allowances or derivatives are able to interact in the system in a way that results in a contract.
Over the counter (OTC)	Trading that occurs between two parties away from a trading venue. OTC trading is an example of off-exchange trading.
Regulated market (RM)	One of the three categories of trading venue defined under MiFID II. According to Article 4(21), an RM is a multilateral system operated and/or managed by a market operator, which brings together or facilitates the bringing together of multiple third-party buying and selling interests in financial instruments, in the system and in accordance with the RM's non-discretionary rules, and in a way that results in a contract, in respect of the financial instruments admitted to trading under the RM's rules and/or systems. RMs are generally operated by traditional national stock exchanges (e.g. London Stock Exchange, Frankfurt Stock Exchange).
Stock exchange	The main trading venues that provide a market for the trading of equity instruments. Under the MiFID II framework, they are generally classified as RMs. This report refers interchangeably to 'stock exchanges', 'primary stock exchanges', and 'primary exchanges'.
Systematic internaliser (SI)	Defined under MiFID II as an investment firm that, on an organised, frequent systematic and substantial basis, deals on own account when executing client orders outside an RM, an MTF or an OTF without operating a multilateral system. The European Securities and Markets Authority (ESMA) is responsible for measuring the threshold for a 'frequent and systematic basis' to inform which investment firms qualify for the SI regime. SI activity must take place against the proprietary account of the operator (risk-facing) and generally does not include matching client orders against other client order or third-party liquidity.
Trading venue	Defined under MiFID II Article 4(26) as an RM, an MTF, or an OTF.

Source: Oxera

1 Introduction

The Federation of European Securities Exchanges (FESE) commissioned Oxera to undertake an independent economic analysis of the design of the market for equity trading in Europe, focusing on the role of price formation and market data services.

1.1 Context and objectives of this report

The past decade has witnessed a fundamental change in the market for equity trading in Europe due to technological development (e.g. electronification of trading systems, faster processing speeds, and wider use of algorithms) and entry by new players, supported by regulatory changes.

The introduction of the European Markets in Financial Instruments Directive (MiFID I) in 2007, followed in 2018 by revisions to the Directive with the implementation of a second Market in Financial Instruments Directive (MiFID II) and accompanying regulation (MiFIR), has opened up competition for equity trading and delivered more choice and lower trading costs for European businesses.

Stock exchanges continue to play an important role in the markets for equity listing and trading. These markets lie at the heart of modern economies. Strong equity markets can unlock investment and channel it to firms that need to expand and create jobs. They provide households with better options to meet their retirement goals, and they better connect financing to investment projects.⁷

At the most basic level, the core functions of a stock exchange are to facilitate the provision of i) trading; ii) price formation; and iii) listing of the shares of European business.

Most of the regulatory framework and a substantial part of the activities of the stock exchanges contribute to the delivery of a reliable price formation process, such that investors know that the prices they buy and sell at are fair and accurate. These functions deliver important benefits to financial markets and the economy.

Indeed, a key objective of MiFID II was to improve market transparency and price formation.⁸ As explained in a recent speech by the Chair of the European Securities and Markets Authority (ESMA), the aim was to move transactions to regulated platforms, close loopholes in the market structure, and respond to the increasingly complex market reality driven by technological innovation such as algorithmic trading.⁹ The new rules included a trading obligation¹⁰ for shares, a cap on certain types of dark trading on venues,¹¹ and requirements on trading venues to make market data available to the public free of charge 15 minutes after publication, with real-time data to be made available on a 'reasonable commercial basis'.

⁷ See also Oxera (2016).

⁸ See, for example, European Commission (2014a) and (2014b).

⁹ European Securities and Markets Authority (2018a).

¹⁰ MiFIR requires investment firms to ensure that the trades they undertake in shares admitted to trading on a regulated market (RM), or traded on a trading venue, take place on a RM, multilateral trading facility (MTF), systematic internaliser (SI), or an equivalent third-country trading venue.

¹¹ The MiFIR double volume cap mechanism (DVCM) (Article 5 of MiFIR) aims to limit the trading under the reference price waiver (Article 4(1)(a) of MiFIR) and the negotiated transaction waiver for liquid instruments (Article 4(1)(b)(i) of MiFIR) in an equity instrument. For further discussion, see section 3.

We are now one year on from the implementation of MiFID II. This report takes stock, looking at what MiFID I and II have delivered, the role of price formation, and the impact of trading venues charging for market data.

The report seeks to inform the debate on the design of the equity trading market in Europe. It provides new empirical analysis of market data services fees and revenues, and sets out an economic framework for assessing the impact on end-investors of charging for market data.

1.2 Scope of the report

Our analysis covers four broad areas.

1. **The price formation process**—we turn to the well-established economics literature on market microstructure to understand the price formation process and its benefits, both to financial markets and to the economy more generally.
2. **The impact of regulatory change on the market design of equity trading and price formation**—we review how recent developments in equity trading are affecting the market design of equity trading and the benefits of price formation.
3. **The value chain for market data services**—we review the broader value chain for market data services, and how trends in fees and revenues have evolved in recent years.
4. **An economic assessment of market data services fees**—we assess how end-investors, and the functioning of European equity markets more generally, are affected when stock exchanges recover some of their costs through market data services fees.

The report focuses on the market for equities in the EU. It is based on an economic evaluation of evidence and case studies, with sources cited throughout. The report updates and builds on Oxera's 2014 report on the pricing of market data services.¹²

Market data is also used in other trading markets such as fixed income and derivatives markets. Although the focus of this report is on equity trading, a short description of the role of market data in fixed income markets is provided (see Annex 1).

1.3 Information sources

We have gathered and analysed information from a range of sources, as follows.

- We conducted an extensive review of the theoretical and empirical academic literature on financial market microstructure. This was used as a foundation for our analysis of price formation and wider trends within European equity markets.
- Interviews were held with industry experts and leading academics in the fields of equity markets, asset pricing and market microstructure. These discussions were used to inform our understanding of the data needs and uses of different market participants, the interactions between different participants seeking to consume or distribute market data, developments in

¹² Oxera (2014).

the data vendor industry, and the role of stock exchanges in the price formation process.

- We analysed publicly available pricing schedules for trade execution and market data services provided by European trading venues.
- Confidential information on revenues from market data and trade execution services was provided by the FESE members.¹³ We analysed this further to assess the current pricing of market data services in Europe and to estimate the costs per user group. This was combined with publicly available information on the value and volume of trading at each stock exchange (and across other trading venues).

1.4 Structure of report—how to read the report?

This report provides an in-depth analysis and is aimed at informing the debate about the design of equity trading markets, rather than taking a particular position or proposing a particular change to the current regulatory regime. The report provides important insights, and these feed into the ongoing debate about the design of equity trading in general and about market data services in particular. The contribution of the report is therefore that it places the discussion about the pricing of market data services into the broader context of the functioning of equity trading markets, provides empirical analysis, and assesses market data services from a market design and end-investors' perspective.

It is best to read the report from beginning to end. If you do not have sufficient time, it is recommended that you read the executive summary and section 5.

Although each section builds on the analysis in the preceding sections, each section can also be read on its own.

Section 2 discusses the contribution of stock exchanges to price formation in equity markets, and their benefits to well-functioning markets. It draws heavily upon the well-established (but arguably complex and not always easily accessible) economics literature on market microstructure. If you are familiar with this literature and the role of stock exchanges in price formation, you can probably read about the functions of a stock exchange in section 2.2 and then skip to the benefits of price formation in section 2.5.

Section 3 considers the impact of MiFID I and II on the market design for equity trading and the consequences for price formation. It provides a useful summary of some of the main trends in equity trading (such as the emergence of new business models, and increased high-frequency trading), and their implications for the benefits of price formation covered in section 2. If you are in a hurry, you could skip section 3.4 on HFT.

Section 4 describes the value chain for market data services, and the prices and revenues over time from fees charged by stock exchanges. Readers familiar with the value chain and the broader market for data services may prefer to skip to the empirical analysis (sections 4.6–4.9).

¹³ The participating FESE members are Bolsas y Mercados Españoles (BME), Budapest SE, Deutsche Börse, Euronext, Luxembourg SE, Nasdaq, Oslo Børs, SIX Swiss Exchange and Wiener Börse.

Section 5 brings together the analysis in sections 2–4, and sets out an economic framework to assess the impact of the current level of market data fees on the functioning of equity markets.

We use some technical language (such as Level 2, best bid and offer) and some economic terms (such as joint products, network externalities). These are explained in the report itself.

For any questions about this report, please contact Oxera:
enquiries@oxera.com

2 The design of the market for equity trading and the price formation process

Key messages

- When defining stock exchanges, their role is typically captured in terms of their listing services and trading function (or liquidity provision). An important related function of stock exchanges is that of price formation. In this section, we turn to the well-established economics literature on market microstructure to understand the price formation process, and its benefits to both financial markets and the economy more generally.
- These functions play an important role for investors: they allow them to (re)allocate their asset holdings at low cost, enabling them to manage their financial risks according to their personal preferences.
- Price formation delivers other benefits to financial markets and the economy. By contributing to better price formation, stock exchanges contribute to fairer and more efficient markets and a lower cost of capital for businesses.
- Stock exchanges undertake various activities to deliver a reliable price formation process and trading services. These include creating and operating price-forming market models; setting trading rules and monitoring and enforcing compliance with these rules; investing in hardware and networks to provide for reliable markets even in times of market stress; measures to ensure the resilience of the trading systems to threats, such as cyber security; as well as offering testing, support and guidance to their members. Most of these activities are undertaken to deliver both trading and price formation, consistent with the notion that these are joint products.
- Stock exchanges compete on the quality and reliability of price formation in several ways, including through their listing and trading activities. An exchange will be successful in listing only if its price formation process is reliable and of high quality; the same applies to trading services. Investors will choose to trade on a venue only if they feel confident that the price is the result, direct or indirect, of a reliable price formation process.
- Regulatory changes have facilitated the entry of alternative trading venues (which benefit from the price formation process provided by stock exchanges), resulting in more choice and lower trading costs for traders and investors. This is explored in section 3.

2.1 Introduction

Stock exchanges have been around for many years. Their origins can be traced back to the trading of shares in the Netherlands in the early 17th century, and perhaps even further back to the trading of notes and bills in the medieval markets of Frankfurt in the 11th century.¹⁴ The first reported stock market involved trading shares in the Dutch East India Company on the Amsterdam securities market.

Stock exchanges undertake a range of activities and fulfil several functions. However, when defining stock exchanges, their role is typically captured in terms of their listing services and the trading function (or liquidity provision).

Another important function of a stock exchange is that of price formation. Interestingly, this function is often not mentioned explicitly—perhaps partly because it is a much less tangible function than trading and listing, and partly because it is simply assumed to be part of the trading function.

Indeed, trading and price formation are closely related functions. It is difficult to envisage how shares, which are claims to uncertain and imprecisely predictable future cash flows, can be bought and sold without there being some process by which information is incorporated and prices are determined. Similarly, it is difficult to see how prices could be ‘discovered’ without some trading taking place. Most of the regulatory framework and a substantial part of the activities of the stock exchanges are undertaken to contribute to the delivery of a reliable price formation process, so that investors know that the prices they buy and sell at are fair and accurate (i.e. they reflect the fundamental value of the asset).

The need for more transparent financial markets has been a key element of the European regulatory framework since the global financial crisis in 2008. The markets that suffered most in this crisis were those characterised by limited transparency and unreliable price formation. The crisis highlighted the importance of promoting the fairness, efficiency and transparency of financial markets. The regulatory response has therefore aimed to promote transparency as a core principle in the design of financial markets, including in equity markets.

This report is about the design of equity markets, so it is important to provide an understanding of how these markets function and the roles of stock exchanges within them. In this section, we turn to the well-established economics literature on market microstructure to understand the price formation process and its benefits to both financial markets and the economy more generally.¹⁵

The design of equity trading markets has changed substantially over time, therefore we also discuss developments such as the rise of alternative trading venues, HFT and dark trading (see section 3).

This section is structured as follows:

- section 2.2 describes the central functions of a stock exchange;

¹⁴ See Petram (2011) and Deutsche Börse (2010).

¹⁵ ‘Market microstructure is the branch of financial economics that investigates trading and the organisation of markets’ (Harris, 2003).

- section 2.3 outlines how prices on a stock exchange are determined, with an illustrative example from a limit order book (LOB);
- section 2.4 explains the mechanisms underlying the price formation processes, including the sources of price formation and how new information is incorporated into prices;
- section 2.5 highlights the benefits of the price formation function;

Section 3 then discusses the impact on price formation from recent trends in the trading of European equity markets, including the rise of alternative trading venues, HFT and dark trading.

2.2 What is the function of a stock exchange?

The rationale for stock exchanges is well described in the economics literature on micro-market structure and in economic textbooks on stock exchanges. At the most general level, a stock exchange is described as a firm that creates a market in equity instruments. In addition to listing services, the stock exchange provides a mechanism for transferring the ownership of equities from one party to another, and fulfils two core, related, functions:¹⁶

1. **the provision of trading or liquidity**—the ability of traders to easily buy or sell assets;
2. **price formation**—the process of determining the price of an asset in the marketplace.

Straightforward as these market functions may seem, they play a crucial role for investors: they allow investors to (re)allocate their asset holdings at low cost, enabling them to manage their financial risks according to their personal preferences.

Traditionally, stock exchanges conduct a range of activities that support these core functions, including:

- liquidity services—operating physical (or, nowadays, electronic) and legal infrastructure that facilitates the meeting of demand and supply;
- trading rules—providing a set of rules under which orders are conveyed and matched, and trades executed. These rules define and protect the property rights of market participants, provide predictability, constrain fraud and market manipulation, foster liquidity and ensure that stock exchange members—through whom trades must be executed—are sufficiently creditworthy;

Some stock exchanges also provide other services, including post-trading services and data analytics.

Price formation is unique to financial markets. While the notion of matching buyers with sellers is also central to the stock exchange of many physical goods, equity markets differ from other non-financial markets, in that the ‘goods’ being exchanged are claims to uncertain and imprecisely predictable future cash flows.

This unique element gives rise to an important function of a stock exchange, which is an information-gathering process that ensures that market participants are sufficiently informed about the prices of the assets being traded in the

¹⁶ See, for example, Petram (2011) and O’Hara (2003).

market, such that they can make informed commercial decisions. This is a central ingredient to the well-functioning of financial markets.

Price formation can be seen as the process by which information gets incorporated into prices. In other words, a core product of a stock exchange can be summarised as:

accurate information, as reflected in the prices of the instruments traded on the exchange.¹⁷

It is important to think of price formation as a dynamic process. As a stock exchange improves its price formation, the information (both pre- and post-trade) provided by the stock exchange becomes more valuable to users because the information becomes more reliable, informative, and useful (this is discussed in more detail in section 2.4). If a stock exchange does not invest in its price formation, the value of the information on the stock exchange will be limited.

Focusing on price formation does not ignore the fact that stock exchanges accomplish many other functions, such as the standardisation of traded products. Many of these other functions are fulfilled to support the price formation process.

Stock exchanges compete on the quality of price formation via their activities (see Box 2.1). For example, stock exchanges compete on their mechanisms for determining prices in their listing activities, and on the quality of price formation in trading activities.

Box 2.1 Stock exchange activities facilitating price formation and trading

There are several activities undertaken by stock exchanges to facilitate a reliable and efficient price formation process. Some of these activities provide direct benefits; others are more indirectly beneficial, but still important. The range of activities can be divided into the following groups.

1. Meeting place

The first set of activities is around ensuring that market participants have a venue at which they can signal their intentions to trade, and at what price and volume.

Historically, this was provided through a physical premises (i.e. a building). Nowadays, the majority of European equity trading occurs at a virtual venue, with orders matched electronically via a 'matching engine.'

To ensure continuity and integrity of the price formation process, stock exchanges continually invest to maintain, monitor and improve their systems. Examples include their continual investment in:

- the capacity of matching engines to ensure they can process increasing volumes of message traffic. This includes investment in hardware and software designed to cope with significant over-capacity in order to ensure resilience of message traffic and a reliable price formation process in all market conditions;
- the latest technologies to protect their systems against threats stemming from cyber attacks, fraud or operational risks, such as monitoring and testing programs to minimise the risk of outages and interruptions.

These activities all aim to ensure the continuous provision of a reliable price formation process.

¹⁷ Mulherin et al. (1991).

2. Connectivity

A second set of stock exchange activities relates to the connectivity of traders. Alongside the infrastructure underpinning the processing of orders, participants need access to the trading venue.

In the case of a virtual venue, this means investment in networks—e.g. fibre optic lines, microwave towers—with participants valuing fast access and connectivity to the venue.

These costs can be borne by stock exchanges, third parties, or market participants directly.

3. Participants

A third set of stock exchange activities aims at ensuring that the trading venue is attracting a good mix of participants. These activities are designed to encourage liquidity providers to participate.

Stock exchanges seek to attract order flows on both sides of the order book from a diverse range of participants, including issuers, retail investors, institutional investors, quantitative prop-traders and passive market makers. For example, some stock exchanges provide liquidity programmes that are specific contractual arrangements with market makers to ensure regular liquidity provision at competitive prices and sizes, as well as during volatile market periods.

4. Rules setting

A fourth set of stock exchange activities surrounds setting the rules of the game, which facilitates predictability in the price formation process. The way a stock exchange organises the rules by which orders are prioritised and matched is crucial to the price formation process. For example, some stock exchanges provide opening and closing auctions as a way of concentrating traders at a particular point in time. These periods of high liquidity contribute significantly to the price formation process for large volume stocks.¹⁸

Trading rules also define and protect market participants' property rights, constrain fraudulent and manipulative activity, and aim to reduce the transaction costs associated with trading.

5. Monitoring and enforcement

A fifth group of stock exchange activities focuses on ensuring the monitoring and enforcement of the trading rules.¹⁹ To ensure that participants follow trading rules, stock exchanges monitor and enforce compliance. Traditionally, this was a self-regulated process, but now it is largely conducted in tandem with regulators.

For example, to prevent the risk of excessive volatility, outages and disruption to the price formation process, stock exchanges also impose limits on certain message traffic (e.g. to prevent excessive order modifications and cancellations). These activities help to ensure that the trading intentions being submitted to the order book are reliable and contribute to the price formation process, rather than undermining it.

Source: Oxera; and Armour et al. (2016).

Reliable price formation is affected by network effects and economies of scale.²⁰ This is because the more the trading undertaken on the exchange, the more valuable the information emanating from the exchange will be (see Figure 2.1 below).

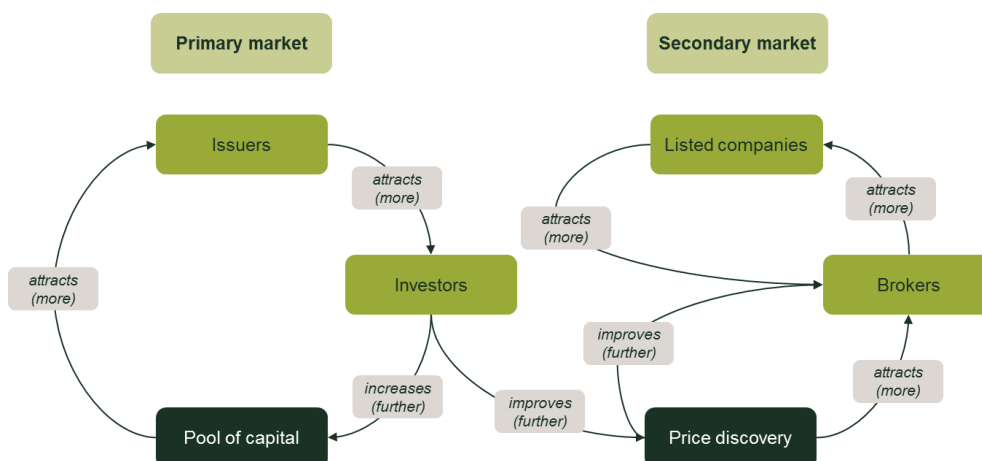
¹⁸ See, for example, Ibikunle (2015).

¹⁹ As well as monitoring compliance with trading rules, Article 51(3) of MiFID II requires stock exchanges to conduct surveillance and monitoring of listed companies to ensure they comply with disclosure requirements.

²⁰ From an economic perspective, network effects mean that an individual's demand depends not only on the individual's own preferences—as in normal markets—but also on the demand of other individuals.

A highly liquid exchange will benefit from reduced price impact from a trade of a given size compared with a venue with lower liquidity. In general, the more investors there are in the market wishing to buy or sell at or near the current price, the narrower the spread between the bid and offer and thus the cost of trading. In light of these network effects, stock exchanges invest in a broader ecosystem and offer both listing services and trading services to companies. Improved price formation attracts more brokers, and in turn more issues of securities, increasing the number of potential investors wishing to trade at or near the current price, and thus further enhancing the price formation process.

Figure 2.1 Network effects of price formation



Source: Oxera.

The rest of this section describes in further detail the central role of exchanges in this price formation process, which has been explored within an expansive body of academic literature on financial market microstructure.

2.3 How are prices determined on a stock exchange?

Traditionally, stock exchanges have facilitated the trading of securities through quote-driven or order-driven systems.

- **Quote-driven systems:** every transaction is facilitated by a dealer, a financial intermediary who is obliged to quote the prices at which they will buy and sell a particular stock. In these markets, anyone wishing to trade must negotiate with a dealer who will buy or sell from their own inventory but may subsequently trade with other dealers. Since dealers act as counterparties to all transactions, they are the liquidity suppliers in the market.
- **Order-driven systems:** participants can interact directly with each other. Trades are arranged according to specific trading rules regarding which buyers and sellers are matched and at which prices. This is nowadays the most common system for modern European stock exchanges. However, some predominantly order-driven exchanges are hybrid systems as they also appoint certain specialist dealers to provide quotes and execute particular orders.²¹

Both types of market structure have a mechanism for determining prices in a way that reflects the demand and supply for a given equity instrument.

²¹ For a comprehensive discussion of market structure terminology, see, for example, Harris (2003), Foucault, Pagano and Röell (2013) or Armour et al. (2016).

The most common format for share trading is through a central limit order book (CLOB) on an order-driven stock exchange. While trading systems have developed over the years to offer market participants alternative trading systems, such as periodic auctions,²² for simplicity the rest of this section focuses on the price formation process of a traditional CLOB on an order-driven stock exchange.²³

A CLOB is a platform that aggregates outstanding orders submitted to the exchange, organises the orders based on priority, and matches corresponding buy and sell orders according to trading rules. An important characteristic of the CLOB is the extent to which market participants can see the outstanding orders that have been submitted. This is known as the pre-trade transparency.

The most basic types of order that participants can submit to a CLOB are market orders and limit orders.²⁴

- **Market order:** these specify a volume to buy or sell immediately at the best available price. If the volume available for sale (purchase) is not large enough to fill the market order, the remaining volume is executed at the next lowest- (highest-) priced volume available.
- **Limit order:** they specify a volume and a maximum (minimum) price at which a participant is prepared to buy (sell) a security.

Market orders are seen as liquidity takers, while the limit orders supply liquidity.²⁵ This is because a market order is filled immediately by outstanding limit orders on the other side of the market. However, in the case of a limit order, there may not be a counterparty against which the order can be executed. In this case, the limit order is then added to the CLOB. Traders who submit limit orders offer liquidity to other traders and their limit orders give others the ability to trade when they want to trade.

Figure 2.2 below highlights the main features of trading on the CLOB.

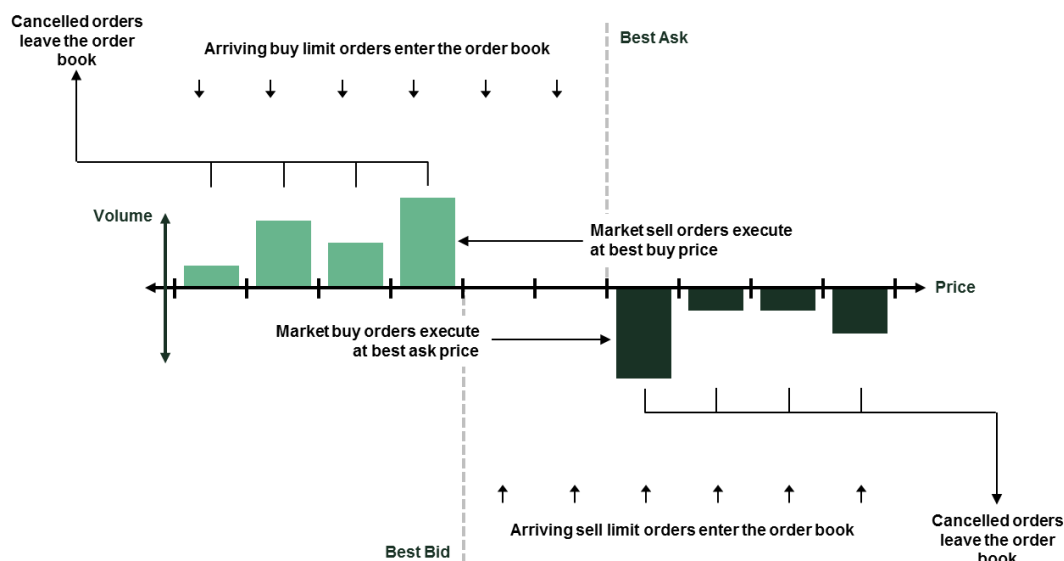
²² For more detail on the differences between LOBs and periodic auctions, see Financial Conduct Authority (2018).

²³ See Cardella et al. (2014).

²⁴ In reality, market participants can post a range of more complex order types depending on the specific market rules.

²⁵ A limit order with a price that can be immediately executed is also liquidity taking. This is known as a marketable limit order.

Figure 2.2 Illustration of a limit order book



Note: The horizontal axis represents the price of each order in the CLOB. At each price, the CLOB specifies a volume available to buy (dark green) or sell (light green). Prices on the CLOB are discrete, with the minimum interval known as the tick size. Market buy orders execute at the lowest ask price and market sell orders execute at the highest bid price. Traders posting limit orders can also cancel these orders, in which case they are removed from the CLOB.

Source: Oxera.

Participants making limit orders on both sides of the market are known as market makers. By posting both buy and sell limit orders, market makers seek to make a profit from posting a higher selling price than buying price (this is known as the bid–ask spread and is discussed in more detail below). This price differential is seen as compensation to market makers for the service of providing liquidity. In some markets, there are ‘designated market makers’ who are required to provide liquidity on a regular basis, including in times of market stress. There are also endogenous liquidity providers in stock markets, such as high-frequency traders, who are willing to take positions on the other side of the order book to match trades.

The CLOB details all the outstanding limit orders with volumes and prices. Market participants will be most interested in the highest price buy limit order and the lowest price sell limit order, which together are known as the best bid and offer (BBO). The difference between the lowest sell order and the highest buy order is known as the bid–ask spread. The mid-price is the midpoint between the best bid and offer.

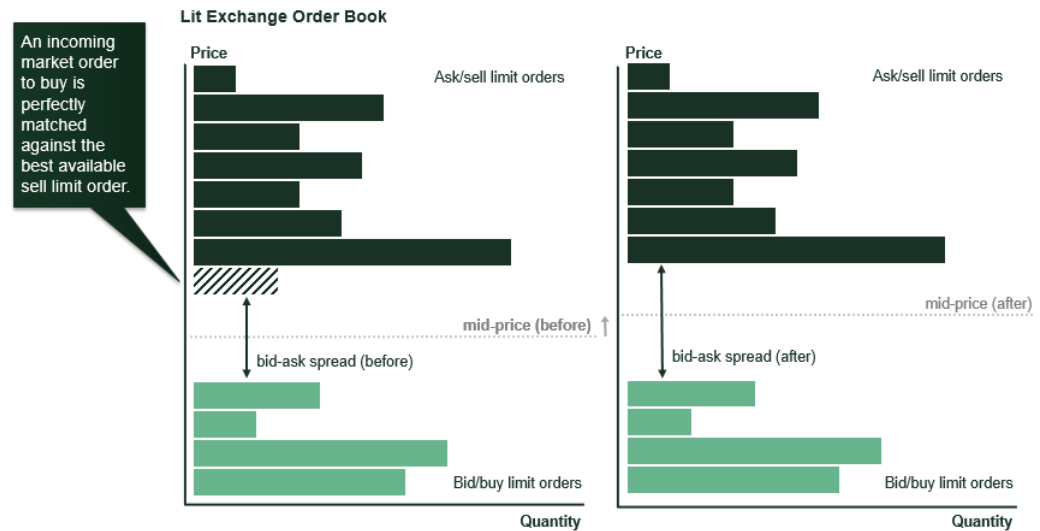
Figure 2.3 below gives an example of how prices are determined on a traditional CLOB.²⁶ In the example, a market order to buy a given volume of shares is submitted to the exchange. The order is executed by matching against the best available (lowest ask price) limit order on the other side of the order book. The trade is executed at the ask price and the limit order is removed from the order book.

As the order has been removed from the book, the new ask price is higher and the bid–ask spread widens, so the new mid-price is also higher.

²⁶ In Figure 2.3, price is represented on the vertical axis.

In a modern order-driven CLOB, this process happens in a near continuous way, driven by algorithmic trading strategies. The best bid, best ask and mid prices are continually updating as orders are matched on the order book.

Figure 2.3 Illustrative example of how prices are formed on a lit order book



Note: In this stylised example the incoming market buy order is the same size as the best available sell order. In reality, order sizes are generally not equal. If the incoming market buy order is large, the remaining volume must be executed at the next best price, until the desired volume has been matched. This is known as price impact.

Source: Oxera.

This simple example shows how the price formation process on a CLOB differs from the classic economic paradigm, in which buyers and sellers come together to trade at a common price, as announced by a Walrasian auctioneer.²⁷ On an exchange, reaching a price at which a trade takes place is a much more decentralised process.

2.4 How is information incorporated into prices?

As discussed in section 2, price formation is the process by which information gets incorporated into prices. When prices reflect all the information that is available, it is said that prices are 'efficient' or that we have an 'efficient price'. An efficient price can be seen as the expectation the market as a whole has about the true value (which is actually unobservable) of the asset given the available information (a consensus value).

When the price is efficient, we mean that nobody trading with information that is publicly known can make extraordinary profits (beyond a fair compensation for the risk undertaken). This is central to the 'efficient market hypothesis' introduced by economist Eugene Fama in 1970.²⁸

²⁷ A Walrasian auctioneer is the presumed auctioneer that perfectly matches supply and demand in a market of perfect competition, perfect information and no transaction costs. The auctioneer is assumed to simultaneously ask each participant to compute and then submit their demand for the good/service at every possible price. The auctioneer then calculates the price for the good so that demand across all the participants equals the total amount of the good, and the market clearing price gives rise to an equilibrium price where demand equals supply.

²⁸ Fama (1970).

According to classical economic theory and the strong form of the 'efficient market hypothesis', prices always reflect all available information and instantaneously update when new information appears. In practice, reality is more complex, and there are costs and frictions to acquiring and acting on information. As more recent academic literature has shown, there is a trade-off between the benefits of informational efficiency and the costs of having to compensate the participants that can help generate that efficiency.²⁹

Trading frictions include adverse selection costs, inventory holding costs, and order processing costs. These costs are borne by market makers and other liquidity providers, who demand compensation through their posted bid–ask spread and displayed depth. The higher the costs and risks they perceive, the wider the spread they post and the lower the depth they offer. It is this that makes the price formation process important.³⁰

Price formation can be seen as the process that takes us from one efficient price to the next, as new information gets processed by traders and incorporated into the consensus value.

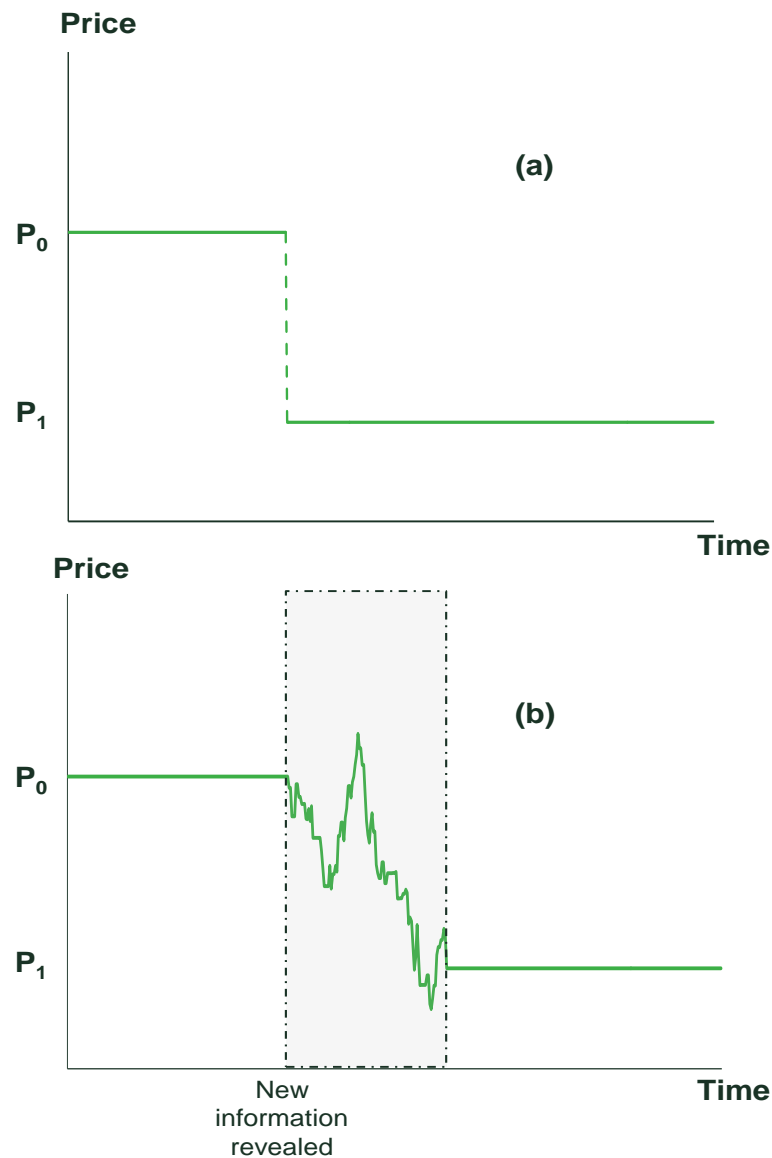
It is important to recognise that the price formation process is dynamic, with the market moving from one efficient price to another. As a result, the speed with which prices update to new values is a key component of measuring price formation. As price formation process of a stock exchange improves, the value of its information (both pre-trade and post-trade) will increase, as users become more confident in the quality of the information.

Figure 2.4 below provides an illustrative example, comparing how prices are assumed to evolve under the efficient market hypothesis, compared with reality.

²⁹ See, for example, Grossman and Stiglitz (1980).

³⁰ The literature about information asymmetries is quite extensive, but basic references include Bagehot (1971), Kyle (1985), Glosten and Milgrom (1985), Easley and O'Hara (1987), Admati and Pfleiderer (1988), Holden and Subrahmanyam (1992), Glosten (1994), and Easley et al. (1996). For quick literature reviews of these papers, see Madhavan (2000) or Biais, Foucault and Moinas (2005).

Figure 2.4 Price formation with new information



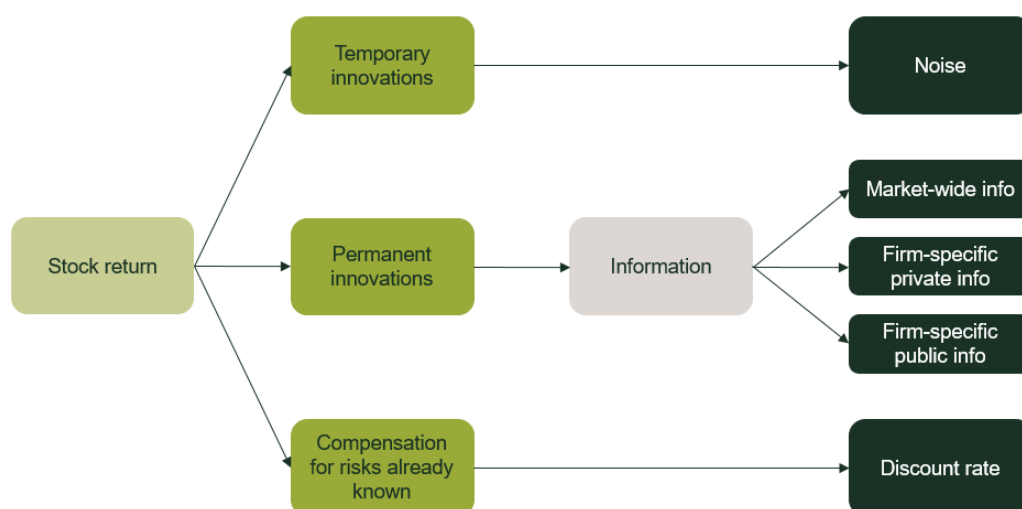
Note: Both panels depict the path of a share price over time. In both cases, the price of the share begins at the efficient price of P_0 , equal to its fundamental value and reflecting all available information at the time. New information is then revealed, which implies a new efficient price P_1 . The 'efficient market hypothesis' predicts that the stock price instantaneously adjusts to the new efficient price of P_1 , as shown in panel (a). However, in reality this price adjusts over a period of time through the orders of different market participants, as shown in panel (b). This involves a period of pricing error (the shaded box), where the actual price does not correspond to the efficient price. However, in modern electronic financial markets, algorithmic trading strategies often mean that this pricing error is short-lived. Reasons for pricing error are covered in section 2.4.1.

Source: Oxera.

2.4.1 Sources of price formation

In the asset pricing literature, the sources of stock returns can be decomposed into permanent innovations from new information, temporary innovations (e.g. noise), and factors that are already priced in based on existing information (e.g. compensation through the discount rate to the investor for risks already known). The permanent innovation, or the arrival of new information, could be in the form of new market-wide information (affecting all stocks), or it could be firm-specific.

Figure 2.5 Components of stock returns



Note: This diagram implicitly assumes that noise is uncorrelated with new information and innovations affect cash flows of the firm rather than the discount rate. There could also be innovations affecting the discount rate.

Source: Oxera, based on Brogaard et al. (2018).

Theoretically, and also empirically, the academic literature makes a distinction between firm-specific information that is revealed simultaneously to all traders through public announcements (such as the earnings announcement of firms, or macroeconomic or sentiment indicators) and information which is, by definition, accessible only to some traders ('informed traders') that try to exploit it through trading before it becomes publicly known. In the academic literature, the former is referred to as 'public information' and the latter 'private information'. Private information can simply be seen as advanced knowledge of public news (for example, private signals about firms' projects cash flows). So, although both types of information are revealed in different ways, both are relevant, and both contribute to price formation.

Within the academic literature, 'informed traders' are contrasted with 'uninformed traders', who are motivated to trade by a need to rebalance portfolios and smooth their consumption streams over time, rather than to profit from private information. There are also 'pseudo informed traders'—those that think they are well informed, but actually trade on information that has already been reflected in the price of the asset (referred to in the literature as 'stale information'). These are not the informed traders, but are actually 'noise traders'.

Informed traders will try to exploit the private information they hold by trading before the information reaches the wider market. See Table 2.1 below for some examples.

Table 2.1 Types of informed traders

Trader type	Most skilled at estimating...	Information speciality	Typical trading speed
Value traders	...total value	All available information	Slow
News traders	...changes in value	News	Fast on public information; slow on private information
Information-oriented technical traders	...systematic valuation mistakes	Statistical anomalies	Fast
Arbitrageurs	...relative values	Relative factor prices	Fast

Source: Harris (2003).

It is useful to draw a distinction between an informed trader and the more specific practice of insider trading, which is forbidden under the EU's Market Abuse Regulation (MAR).³¹

The fact that informed traders seek to benefit from their private signals through trading has an immediate and important implication: trades convey private information. It matters because other market participants learn from these trades. In this context, private information is distinct from insider information and market abuse. The reference here is to the ability of a particular investor type to act on information that is being revealed or can be inferred from the trading process. In other words, there may be information available to all investors but only some (the informed investors) have the ability to use that information to determine the fundamental value of the stock.

So price formation depends on both public information being revealed and private information being inferred from the trading process.

The line separating public from private information is extremely thin. As previously noted, private information is anticipated knowledge of public information. For example, a financial analyst may have prior information about the content of an earnings announcement by a given firm. Alternatively, private information may reflect a trader's ability to process and react faster to the noisy signals contained within public news than other market participants or an ability to extract signals from publicly available market data such as orders and trades.³²

The line between public and private information has become increasingly blurred with the increased prevalence of algorithmic and HFT (discussed in more detail in section 2.5).

The existence of 'information asymmetry' caused by some participants having private information has three important implications for price efficiency and the price formation process on a CLOB.

- If private information is costly for participants to acquire, they must be sufficiently compensated for the effort needed to acquire such information.

This highlights a contradiction within the efficient market hypothesis paradigm, as it cannot be possible for both i) prices to reflect all information,

³¹ For further information on the MAR definition of insider trading, see Regulation (EU) No. 596/2014, 16 April 2016, Articles 7 and 8. Technically speaking, insider trading would be a particular case of informed trading.

³² For an example of an informed trader's superior ability to react to this sort of information, see Kim and Verecchia (1994). For a discussion of the ability of high-frequency traders to anticipate order flow from public information, see Hirschey (2018) or van Kervel and Menkveld (2018).

and ii) it to be impossible to make superior returns based on information. This trade-off between markets being price-efficient and compensating participants for acquiring information has been recognised in the academic literature since it was first identified by Grossman and Stiglitz (1980).

- Liquidity providers have to set spreads that reflect their beliefs about the probability that privately informed traders can exploit their pricing errors. In economic terms, the liquidity providers face the risk of being adversely selected by informed traders. Exchange rules can make this less likely, enabling smaller spreads and more trading.
- The existence of private information implies that the order flow on a CLOB itself conveys information. This means that information is revealed to the market through the trading activities of informed traders.

In summary, informed traders drive the price formation process on a stock exchange. Price formation depends on both the revelation of public information and private information being inferred from the trading process itself, which is discussed next.

2.4.2 Price formation through the order flow

In the previous section, we discussed how price formation stems from the revelation of public and private information. Here, we set out how informed traders use the information in the order flow to influence price formation.

Orders are instructions to trade. They specify what traders want to trade, whether to buy or sell, how much, when and how to trade, and, most importantly, on what terms. Traders issue orders when they cannot personally negotiate terms.³³

Orders reflect trading strategies. For a trader to be effective, they must specify exactly what they want. Ensuring that the order is submitted in the right way, at the right time, can make the difference between a good trade, a costly trade, and no trade at all. The order submission strategy is the most important determinant of the success of a trader.

Stock prices fluctuate continuously, even over very short time spans, and in the absence of price-relevant news. These movements are responses by traders to incoming orders to buy or sell the stock. A buy market order exerts upward pressure on prices and similarly a sell market order exerts downward pressure on prices. As explained by market microstructure theory, a series of buy orders signals that informed traders may be buying due to the fact that the stock is undervalued. In contrast, a series of sell orders is a signal that the stock is overvalued. If price movements are seen as reflecting news about fundamentals in the valuation of the asset, the price movements tend to be long-lasting (as is the case in panel (b) of Figure 2.4); otherwise they tend to be reversed quickly.

Traders can infer private information from the flow of orders on the order book. Traders who arrange their own trades have an advantage over traders who use orders to express their intentions. The former can respond to market conditions as they change. The latter must anticipate such changes and write contingencies into their orders to deal with them.

Some (limit) orders will be written to represent the interest of the traders when market conditions change. When limit orders do not do this, traders must

³³ See Harris (2003), chapter 4.

cancel them and resubmit new instructions. If they do not do this quickly enough, their orders may execute during the time it takes to cancel and resubmit. Therefore, speed is important.

By submitting and cancelling limit orders, investors are providing signals to the market of their trading intentions. Informed traders can use the pattern of order flow to infer private information about the future direction of the stock price.³⁴

Liquidity providers can also assess the risk they run of trading with informed traders (adverse selection costs). The higher the risk they perceive, the less willing they will be to provide liquidity, or the higher the cost at which they would like to provide liquidity. Therefore, private information and liquidity are negatively correlated.

There is a broad academic literature analysing how private information is incorporated into prices by traders learning from the trading process.³⁵ One often-used framework is presented by Glosten and Milgrom (1985) (see Box 2.2), which shows how traders learn from the trading process. The intuition is that informed traders will generate imbalances between buys and sells. Liquidity providers (a dealer in the Glosten–Milgrom model) try to learn whether there is an imbalance between buys and sells in the market. A prevalence of buy orders indicates that informed traders know that the value of the stock is higher than the current price and vice versa. As the liquidity provider identifies an imbalance with more certainty, they continually adjust prices to reflect this and protect themselves by widening the bid–ask spread.

In the Glosten–Milgrom model, it is the process of uninformed liquidity providers trading with informed traders that causes the price to update to reflect private information.

Box 2.2 The Glosten–Milgrom model

The Glosten–Milgrom model is a microstructure model that is often used to analyse trading and price formation. The basic concepts of the model can be explained as follows.

- A market consists of one security with a value that randomly takes one of two values: low or high.
- Randomly selected traders arrive at the market one at a time, and interact with a liquidity provider.
- Arriving traders can be informed (they know the value of the stock) or uninformed (they do not know whether the stock is of low or high value).
- The liquidity provider posts bid and ask prices for the stock but does not know its true value and cannot tell whether an arriving trader is informed or uninformed.³⁶
- The liquidity provider is assumed to be ‘risk-neutral’ (they care only about their expected profit) and ‘competitive’ (they make zero expected profit).
- Once a trader arrives at the market, they can buy from the liquidity provider (at the ask price) or sell to the liquidity provider (at the bid price).

Within this model, price formation occurs as the liquidity provider interacts with traders.

³⁴ See, for example, Cartea et al. (2015).

³⁵ Seminal papers in this field include: Bagehot (1971), Kyle (1985) and Admati and Pfleiderer (1988). For surveys of the early theoretical work in this field, see, for example, O’Hara (1995) or Madhavan (2000).

³⁶ The original Glosten and Milgrom (1985) model assumes a quote-driven dealer market, although the insight remains relevant when discussing an LOB market.

- If the trader arriving at the market is informed, they will buy from the liquidity provider when the value is high and sell to the liquidity provider when the value is low, and the trader will profit at the expense of the liquidity provider. If the trader is uninformed, their order will be random.
- If the liquidity provider knew that the trader was informed, this order would instantly reveal the true value of the stock. However, the trader cannot distinguish between an informed trader and the random order of an uninformed trader.
- The liquidity provider gradually forms a more accurate belief about the value of the stock as they interact with more and more subsequent traders—an imbalance of the order flow towards buy orders implies that there are informed traders who know the stock is of high value and vice versa.
- The liquidity provider repeatedly updates the posted bid and ask prices to reflect their continually updating beliefs—as they become more certain of an imbalance in the order flow, they set prices closer to the true value.

Key insights of this model are that:

- the order flow conveys information—buy orders imply good news and sell orders imply bad news;
- the share of informed traders is important for the speed of price formation—a higher number of informed traders means information is incorporated into prices faster because the liquidity provider can be more confident that any given trader is informed;
- the model provides a justification for the bid–ask spread that centres on liquidity providers needing compensation for the risk of losses from encountering informed traders.³⁷

Source: Oxera, based on Glosten and Milgrom (1985).

In models such as this, private information is presumed to be transitory, so informed traders will want to maximise the value they extract from trading before the information becomes public. This means that informed traders will potentially try to trade using large orders and will prioritise immediacy and certainty of execution.³⁸ On a CLOB, this would be achieved by placing a market order. More recent theoretical developments suggest that informed traders also seek to use limit orders, meaning that the CLOB managed by an exchange itself also conveys information.³⁹

Ultimately, the market microstructure literature highlights three key points, with important implications for the design of the market for equity trading:

- the quality of price formation (and liquidity) is affected by the relative proportion of informed and uninformed traders on a particular trading venue;
- the order flow to and from a CLOB, including limit orders, conveys private information that meaningfully contributes to price formation;

³⁷ In the economics literature this is known as an adverse-selection cost.

³⁸ See Easley and O'Hara (1987).

³⁹ Kaniel and Liu (2006) extend the Glosten and Milgrom model to allow for the possibility that informed traders can submit either market orders or limit orders. They predict that informed traders will often prefer to submit limit orders, and this preference can be so strong that limit orders convey more information than market orders. These predictions are supported by a number of empirical studies. See, for example, Cao, Hansch and Wang (2009); Anand, Chakravarty, and Martell (2005); and Pascual and Veredas (2010). They are also supported by laboratory experiments. See Bloomfield, O'Hara, and Saar (2005). Other models allowing information-motivated limit orders include Harris (1998), Rindi (2008), Goettler, Parlour and Rajan (2009) and Rosu (2009).

- by setting out the rules of the game and coordinating and managing the flow of information, stock exchanges provide the price formation process in equity markets.

The coordinator role of the stock exchange is particularly important in equity markets due to the network effects of price formation (see Figure 2.1). Investors will choose to submit orders on a trading venue only if they feel confident that the price is the result of a reliable price formation process.

2.5 Benefits of price formation

Desirable properties of any price formation process are accuracy and speed. Prices must adjust quickly and accurately to news. When price formation processes satisfy those two properties, prices better reflect expectations about the true value of the asset.

The ultimate beneficiaries of an effective price formation process are the investors, fund managers, regulators, market authorities, etc., that take decisions based on those prices.

Accurate prices from stock exchanges lead to a number of benefits (see Figure 2.6 below).

- More efficient markets—in a well-functioning market, the current price of an asset is the best estimate of the future price, expressed in today's terms at a risk-adjusted rate of return, conditioned on all available information. Better price formation leads to reduced frequency of costly price shocks.
 - Fairer markets—fairness in markets requires a reliable price formation process with effective detection and deterrence against improper trading. Confidence in the prices leads to the use of prices.
 - Lower cost of capital for businesses—due to illiquidity cost and risk premia. If prices are efficient and information is incorporated quickly and effectively into asset pricing, this will also contribute to lower asset volatility and lower cost of capital.
 - Improved products and new business models—the price formation provided by exchanges has led to the development of new products and business models, resulting in more choice and competition for trading and new propositions for consumers.
 - Wider benefits—for example, the accurate prices formed on stock exchanges are used by the broader finance and valuation industry to determine the value of other assets.
-

Figure 2.6 Benefits of price formation



Source: Oxera.

Each point is discussed below in more detail. New business models are discussed in section 3.

2.5.1 Market efficiency

A market is efficient if the prices always fully reflect available information, and the current price of an asset should be the best estimate of the future price, expressed in today's terms at a risk-adjusted rate of return.⁴⁰

The fundamental value of a stock depends on the expected future dividends and rates of return of that asset. The expected dividends are discounted with the expected rates of returns, to arrive at the current price. If the market is efficient, the price of the asset should therefore always equal the fundamental value that is determined according to the information available.

A central idea in the theory of market microstructure is that asset prices do not need to equal full information expectations of value because of a variety of frictions. Given this, reliable price formation helps to improve market efficiency, as the fundamental value of the stock is discovered more quickly than would be the case if the price formation process was slow and unreliable.

Achieving a high-quality price formation process brings benefits for all participants: reducing transaction and search costs; building investor confidence; and underpinning deep and liquid markets to raise funds, invest or manage.

2.5.2 Market fairness

Investors clearly value fairness in trading. Confidence that their trades are executed at prices close to the fundamental prices, and that insiders and market professionals do not engage in insider trading, front running, or market manipulation, is crucial to a trader's decision about where to trade.

⁴⁰ See Fama (1970).

The set of rules and monitoring activities of the stock exchange facilitate the fair treatment of order flows and reliable price formation, supporting market fairness. Examples include the clearly defined rules around the priority of orders through which they are matched, and the rules and monitoring activities preventing front-running.

The importance of reliable price formation to market fairness is widely recognised by regulators. For example, according to the Objectives and Principles of Securities Regulation of the International Organization of Securities Commission:

Regulation should promote market practices that ensure fair treatment of orders and a price formation process that is reliable.⁴¹

For further discussion about the notion of fairness for financial markets, see Angel and McCabe (2013).

2.5.3 Cost of capital

Market microstructure theory has shown that the cost of providing liquidity and the risks associated with price formation (private information) are priced and affect the long-term value of assets. Differences between the price and underlying value of assets clearly affect financing and capital structure decisions.

There is growing support for the idea that expected returns must reflect a compensation for illiquidity. Stocks with more uncertain future illiquidity levels will also trade with a discount due to higher illiquidity risk.

Investing in illiquid assets implies higher transaction costs than investing in liquid assets. Illiquidity eats into the returns, and lowers the expected returns of any investment strategy. Illiquidity is like a tax on the capital gains of the investor. Therefore, investors will be willing to pay less for an illiquid asset than for an equivalent but liquid asset. The literature shows that asset returns contain an illiquidity risk premium in addition to the well-known market risk premium.

Box 2.3 below provides a summary of the literature.

Illiquidity is relevant to price formation because liquidity is known to encourage arbitrage activity and informationally motivated trading, and therefore price formation.⁴²

Researchers have shown that there is an illiquidity cost premium in stock returns. More illiquid stocks have a lower price in equilibrium because of the higher implicit cost of trading the security. This is known as the 'illiquidity cost premium'. By reducing transaction and search costs, more accurate prices provided by the price formation process reduce uncertainty and the illiquidity cost premium.

⁴¹ International Organization of Securities Commissions (2003).

⁴² See Chordia, Roll and Subrahmanyam (2008).

Box 2.3 Literature review: liquidity risk and the cost of capital

Liquidity refers to traders' ability to buy or sell an asset. A liquid stock can be quickly bought or sold in the market without significantly affecting the stock price; whereas an illiquid stock cannot be easily sold without a big loss in value. Illiquid assets may also be hard to sell quickly because of a lack of ready-and-willing investors to buy the asset.

Research on the links between liquidity and the cost of capital is well-developed. Acharya and Pederson (2005) highlight three empirical trends identified within the liquidity risk premium literature: the sensitivity of returns to market liquidity is priced in assets; average liquidity is also priced; and liquidity co-moves with returns and predicts future returns.

Key papers that identify and seek to explain these trends are:

- Amihud (2002), which examines the relationship between stock return and stock liquidity over time, showing that expected market illiquidity positively affects ex ante stock excess returns;
- Pastor and Stambaugh (2003), which finds that expected stock returns are related cross-sectionally to the sensitivities of returns to fluctuations in aggregate liquidity—i.e. return sensitivity to market liquidity is priced;
- Acharya and Pederson (2005), which presents a liquidity-adjusted capital asset pricing model (CAPM) to explain some of the empirical findings described above and test it against NYSE/AMEX stocks;
- Lee (2011), which tests the empirical predictions of the liquidity-adjusted CAPM on a global level. The paper presents evidence that a stock required rate of return depends on the covariance of its own liquidity with aggregate local market liquidity and with local and global market returns.

Key papers on the illiquidity cost premium include:

- Amihud and Mendelson (1986), which shows that expected returns are a decreasing function of liquidity because investors must be compensated for the higher transaction costs that they bear in less liquid markets. They find there is a significantly positive relation between returns and the bid–ask spread for NYSE/AMEX common stocks in the period 1961–80, which is consistent with the model;
- Amihud and Mendelson (1991), which finds similar results regarding the effect of liquidity on yield to maturity (YTM) for US Treasury securities. The authors compare YTM for Treasury notes and bills with matched maturities and find that it is higher on notes, which have lower liquidity. This paper adds to the authors' previous paper the fact that they are comparing matched pairs of equally risky assets. Therefore, their findings cannot be driven by difference in other risk factors.

A range of other empirical papers find similar results to Amihud and Mendelson (1986), and include Brennan and Subrahmanyam (1996), Muscarella and Piwowar (2001), and Amihud et al. (2015).

Source: Oxera.

The connection between higher expected returns and the illiquidity premia to firm cost of capital, and then firm value, is quite direct. More illiquidity leads to higher cost of capital (lower price or higher expected returns), which means fewer projects with positive net present value, which means lower expected cash flows for the firm's projects, which finally means lower firm value.⁴³ It also seems reasonable to assume that investors would require higher expected returns on assets whose returns have higher sensitivities to aggregate liquidity.⁴⁴ By reducing illiquidity premia, stock exchanges benefit the real economy.

There is also a link between price formation (in terms of speed and accuracy) and the cost of capital. In addition to the effect of greater transaction costs from poor price formation, research suggests that there are undiversifiable

⁴³ See, for example, Fang, Noe and Tice (2009).

⁴⁴ See, for example, Pastor and Stambaugh (2003).

information risks from poor price formation that directly affect expected stock returns.

In section 2.4 we discussed how the order flow, and market microstructure more broadly, matters because it influences the informational content of prices. We showed how having informed traders around is useful for reducing pricing error, and that uninformed traders do learn from prices and public information. Therefore, with this in mind, it is clear that improvements in the price formation process on a stock exchange may induce benefits due to both enhanced liquidity and greater informational efficiency in trading prices. Unless prices are revealing, or public information is perfect, non-diversifiable risk remains.⁴⁵ It follows that traders demand extra returns to induce them to hold assets in which information risk is greatest.

For further discussion on the links between price formation, liquidity risk and asset risk, see Amihud, Mendelson and Pedersen (2013); Foucault, Pagano, and Roell (2013); and O'Hara (2003).

2.5.4 Wider benefits

Price formation is important for a broader set of users than just those who participate on the stock exchange directly. A broader set of financial professionals use stock prices to make effective investment decisions, as well as to advise, monitor and validate transactions after they are executed. For example, the prices produced on stock exchanges are also used for the following applications:

- **marking to market**—for example, fund managers use the prices to value their portfolios;
- **derivative pricing**—many derivative and structured products (e.g. equity options, equity futures, equity exchange-traded funds (ETFs), equity swaps, warrants) are based on stock prices. Therefore, the pricing of the derivatives depends directly on the accuracy of underlying stock prices;
- **indices**—index providers use the prices to calculate and update indices;
- **valuation of mutual fund cash flows**;
- **valuation of private companies or estates**—one of the most commonly used approaches to valuing private or non-traded assets in corporate finance relies (directly, or indirectly) on the prices of comparable firms traded on stock exchanges;
- **corporate decision-making**—for example, managers use stock price reactions to inform on whether to proceed with proposed mergers or to inform on decisions about the optimal level of product differentiation.⁴⁶

The accuracy of the prices on stock exchanges therefore has important implications for these applications.

⁴⁵ This is discussed further in O'Hara (2003).

⁴⁶ For an example of stock market reactions affecting merger decisions, see Luo (2005). Foucault and Fresnard (2018) present a model in which optimal product differentiation is affected by an initial public offering.

3 MiFID and the market design for equity trading

Key messages

- A primary objective of MiFID was to increase competition in equity trading. The emergence of alternative trading venues has resulted in lower trading fees, and new service propositions to traders and investors.
- There has also been a growth in dark trading—where transactions are executed with no pre-trade transparency, as orders are hidden prior to execution. This growth has consisted of both dark trading on MiFID authorised venues (under the waiver system) as well as trades executed away from venues entirely, over the counter (OTC).
- New business models have resulted in greater choice for end-investors. Dark trading can offer investors protection from market impact and protection from potential front-running, particularly for larger orders. Other new trading platforms entered and met a growing demand from high-frequency traders seeking ever-faster execution speeds and lower transaction costs.
- The entry of many new trading venues has been supported by the price formation process provided by stock exchanges. These venues continue to use, to different extents, the price formation process of the primary stock exchanges. For example, MTFs using the MiFIR reference price waiver execute trades based on referenced prices (typically the midpoint) from primary exchanges.
- As a consequence of these competitive dynamics, there has been a shift of equity trading from primary exchanges to alternative trading venues. The share of order-book trading taking place on primary exchanges has fallen significantly, to around 60%⁴⁷ today, while dark trading has become more common. More recently, off-venue trading on systematic internalisers (SIs) has picked up considerably, supported by the introduction of the MiFID II cap on dark trading and the share trading obligation on 1 January 2018. Periodic auctions account for a small but rising share of European equity trading. When off-venue trading is taken into account, the proportion of equity trading taking place on primary exchanges in each European market has fallen to below 40%.⁴⁸
- With greater trading occurring off-exchange, there is a risk to price formation. While dark trading protects investors from market impact, this is mainly relevant to larger trades—it does not contribute to price formation and dark trading may also include smaller transactions, which do not necessarily require protection from market impact. Furthermore, the shift of trading from primary exchanges to other trading venues has led to more fragmentation.
- There is a question around how to preserve the quality of the price formation process. Any further changes to the market design for equity trading should ensure that the price formation process is not negatively affected.

⁴⁷ Oxera's analysis of Cboe data. See section 3.2 and Figure 3.2.

⁴⁸ Oxera's analysis of Fidessa data. See section 3.2 and Figure 3.3.

3.1 Introduction

The price formation provided by exchanges has supported the development of new business models.

With the help of regulatory change and the quality of price formation on primary exchanges, the last decade has seen sizeable growth in alternative trading venues, HFT, and dark trading.

This section looks at how price formation works in a market with different types of trading venue. It discusses the impact of EU regulation on the market design for equity trading and then looks at the consequences of this for price formation.

3.2 Impact of MiFID I and II on market design

Over the last two decades, equity trading in Europe has witnessed radical transformation. Regulatory reform and technological developments have reshaped the competitive dynamics and market design for equity trading.

3.2.1 MiFID I—the drive for competition in equity trading

Following the introduction of MiFID I in November 2007, Europe-wide trading in a particular product was no longer limited to the platform on which it was listed. This led to the rise of venues that competed for the order flow from the traditional primary exchanges.

The key objective of MiFID I was to encourage competition between European trading venues. It also aimed to ensure investor and consumer protection. These rules abolished the ‘concentration rule’ that required investment firms to route equity orders only to the stock exchange where the company was listed.

Prior to the implementation of MiFID I, trading in equities was concentrated on large national stock exchanges. MiFID I opened up equity trading via the following:

- regulated markets (RMs)—a venue that brings together third-party buyers and sellers (on a non-discriminatory basis) in financial instruments that have been admitted to trading under the rules of the trading venue. These trading venues are generally the traditional national stock exchanges;
- multilateral trading facilities (MTFs)—similar to RMs, except that these venues initially operated under a lighter set of rules and are not in general used for listing financial instruments (with the exception of ‘junior markets’);
- systematic internalisers (SIs)—investment firms that regularly deal on their own account by executing client orders outside an RM or MTF. They are generally large banks and brokers that trade on a bilateral basis by executing orders directly against their own books.⁴⁹

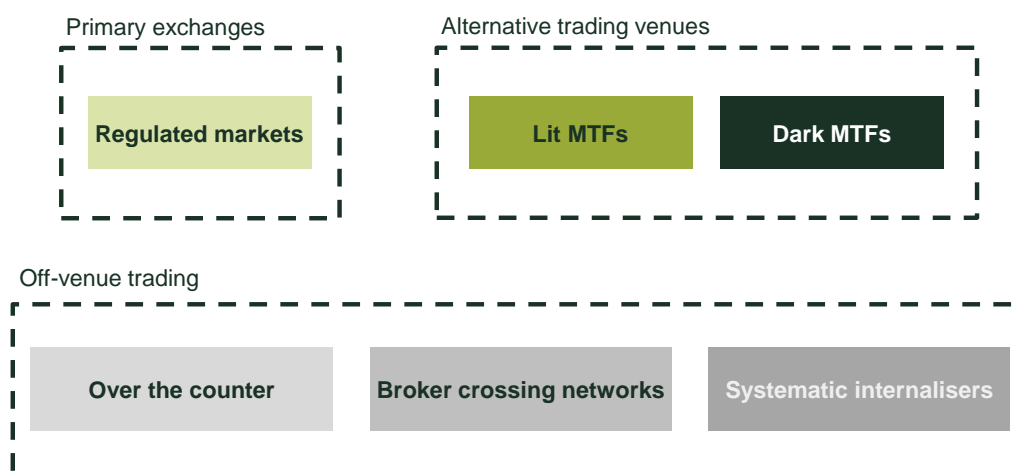
MiFID I allowed equity trading to be executed on a multilateral basis on MTFs, as well as on traditional stock exchanges. Alongside the framework’s provision of SIs for bilateral trading, orders were also matched internally by investment

⁴⁹ As an SI trades on its own account, trading occurs on a bilateral basis, with the SI acting as a counterparty to a client order. This contrasts with RMs and MTFs, which organise trading on a multilateral basis—i.e. bringing together different buyers and sellers. More specifically, an SI is ‘an investment firm which, on an organised, frequent systematic and substantial basis, deals on own account when executing client orders outside an RM, an MTF or an OTF without operating a multilateral system’ (Article 4(1)(20) of MiFID II). MiFID II prohibited the use of less strictly regulated BCNs.

firms.⁵⁰ Any transactions executed outside an RM or MTF, including those taking place through an SI, were considered to be OTC.

Figure 3.1 provides a summary of the types of trading available to market participants following MiFID I. As noted above, MiFID I allowed alternative trading venues (using the MTF designation) to compete for order flow. Although MiFID I introduced an SI framework for off-venue trading, this was not compulsory. Many banks and brokers chose not to register as an SI, but instead executed client orders off-venue through broker crossing networks (BCNs), which were not regulated as trading venues under MiFID I and did not provide for transparency and open price formation.

Figure 3.1 Types of trading



Source: Oxera.

Since the introduction of MiFID I, we can observe the following trends.

- There has been a shift in the market shares from the primary exchanges towards alternative trading venues. For example, the market share of CAC-listed shares trading on the primary stock exchange (Euronext) fell from 75% in 2009 to 62% in 2018,⁵¹ and Oslo Børs's market share of trading on OBX-listed shares dropped from 95% in 2009 to 62% in 2018.⁵²
- There has been a growth in dark trading—i.e. trades executed with no pre-trade transparency, where orders are hidden prior to execution. Following the introduction of MiFID I, dark trading occurred through two distinct mechanisms. First, MiFID I introduced a group of four pre-trade transparency waivers, which allowed RMs and MTFs, under certain conditions, to be exempt from the requirement to make an order visible on their CLOB. Dark MTFs that rely on executing trades using such waivers are commonly referred to as 'dark pools'.⁵³ Second, many large brokers and banks chose to set up systems to internally match client orders OTC, including via BCNs, away from lit exchanges, which avoided the need to publish any pre-trade information.⁵⁴

⁵⁰ Many larger brokers did not choose to internally match orders as an SI, but executed client orders OTC through BCNs, which were subject to less strict regulatory requirements.

⁵¹ The figure includes both 'lit' and 'dark' trading executed on Euronext platforms, based on data from Cboe.

⁵² The figure includes both 'lit' and 'dark' trading executed on Oslo Børs, based on data from Cboe.

⁵³ See, for example, Financial Conduct Authority (2016b).

⁵⁴ Some of these OTC arrangements are also referred to as dark pools.

3.2.2 Alternative trading venue competition facilitated by MiFID I

Lit venues

MiFID I saw the emergence of new-entrant MTFs including BATS (now part of Cboe), Chi-X (also part of Cboe), Turquoise (now part of the London Stock Exchange Group) and Burgundy (now part of Oslo Børs).

Figure 3.2 below shows how the distribution of equity trading has evolved across RMs and MTFs for shares listed on some major European indices. OTC trading is not included in these charts.⁵⁵

Overall there has been a significant and constant decline of the proportion of equity trading taking place on primary exchanges in each European market. Today, around 60%⁵⁶ of total trades in equities on RMs and MTFs are executed on RMs. As explained below, when OTC trading and trading executed through SIs is taken into account, the proportion of equity trading taking place on RMs in each European market has been constantly lower than 40%.⁵⁷

Over the last decade, Cboe and Turquoise have emerged as two strong players, capturing a significant share of the equity trading market. In 2018 about 20% of European shares, measured in terms of notional value, had been traded on a Cboe platform,⁵⁸ and 5% on Turquoise.⁵⁹ The amount of dark trading in Europe has also been growing significantly.

The success of the MTFs has been as a direct consequence of the following:

- the competitiveness of the propositions—MTFs entered the equity trading markets with a lower cost base, maker-taker fee structures (with rebates for liquidity suppliers), anonymity, and modern technological solutions. These business models have significantly increased competitive forces in equity trading;
- the rise in HFT—the rise in MTFs has come alongside the growth of HFT (discussed further below). New market players have thrived by providing competitive price quotes that well-connected high-frequency traders (HFTs) can deliver and then offload (any non-zero position) in any market they are connected to.⁶⁰

Another important consequence of the increased choice and competition of equity trading has been a general reduction in trade execution fees.⁶¹

⁵⁵ The Cboe data does not include OTC trading data on off-exchange venues other than MTFs, such as through OTFs and SIs, and off-order book trading on exchanges.

⁵⁶ The figure includes both 'lit' and 'dark' trading executed on RMs and MTFs, based on data from Cboe.

⁵⁷ The figure includes both 'lit' and 'dark' trading executed on RMs, MTFs, OTC (including SIs), based on data from Fidessa.

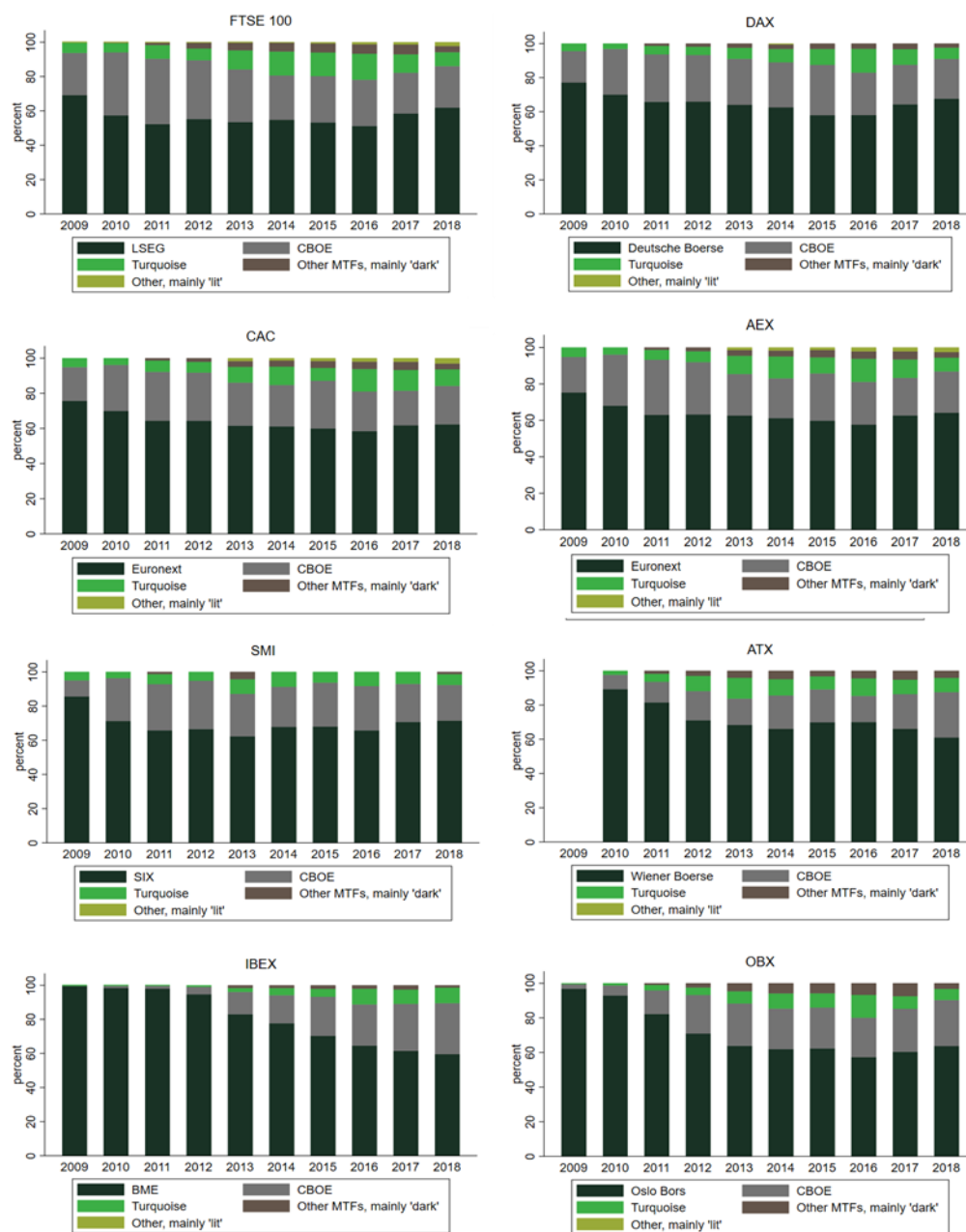
⁵⁸ The figure includes both 'lit' and 'dark' trading executed on Cboe platforms, based on data from Cboe.

⁵⁹ The figure includes both 'lit' and 'dark' trading executed on Turquoise platforms, based on data from Cboe.

⁶⁰ For an example of how a single high-frequency trader facilitated the success of Chi-X in the German market, see Menkveld (2013).

⁶¹ See, for example, European Commission (2012), p. 22. For a discussion of the fall in trading and post-trading costs post MiFID, see Oxera (2011).

Figure 3.2 Distribution of trading in shares listed on major European indexes, 2009–18



Note: Figures for primary exchanges, Cboe and Turquoise include both 'lit' and 'dark' trading.

Source: Cboe.

On-venue dark MTF trading

The introduction of the MiFID I waiver system led to the entry of several MTFs, which were designed to exploit exemption from pre-trade transparency requirements. Commonly referred to as dark pools, early examples of these venues include ITG Posit, Liquidnet and Turquoise. Set up by existing stock exchanges, groups of brokers and investment banks, these venues were primarily used by institutions to trade large blocks of shares. They provided participants with the following benefits:

- protection from market impact—as price and volumes are not published until the trade has taken place, an investor buying or selling a large block of shares avoids the risk of the price moving unfavourably against them;
- protection from front-running—a large block order would often need to be routed to several different lit venues. This can be exploited by HFTs, who can identify a large trade on one venue and beat the block trader to the next venue;
- potential price improvement—dark pools can sometimes offer a better price than that available on a lit venue. This is because dark pools often execute trades at the mid-price—halfway between the best bid and ask price (see Figure 3.8). For a trader submitting a market order, this mid-price will be lower than the best price available on a lit exchange. In other words, a sell market order will receive a price that is at least half a spread worse than the mid-price. Similarly, a buy market order will pay a price that is at least half a spread more expensive than the mid-price.

OTC dark trading—broker crossing networks

The rules in MiFID I (which did not contain a share trading mandate) did not prevent banks from matching volumes in their own internal dark pools, known as BCNs—i.e. on an OTC basis outside of exchanges, MTFs or SIs.

BCNs were hybrids between multilateral and bilateral trading venues. They enabled the matching of client orders against: (i) each other (client versus client); (ii) the house account of the bank (client versus bank); and, crucially, (iii) third-party liquidity providers (client versus liquidity provider). Orders were matched at the broker's discretion, as typically happens in any bilateral OTC transaction.⁶² Two characteristics made BCNs particularly attractive to market participants: they enabled clients to avoid paying exchange and clearing fees, as they bypassed RMs and MTFs; and they could provide price improvements as they did not have to comply with the standard tick sizes adopted by RMs and MTFs. BCNs were also able to attract additional liquidity from third-party proprietary trading firms that traded against client flow.

With these advantages, BCNs were usually the first port of call when banks executed client orders under MiFID I.

3.2.3 MiFID II—reforms to improve transparency

As a result of some shortcomings identified in the global financial crisis, the European legislators updated the rule book on equity trading, with the introduction of MiFID II, and the associated regulation (MiFIR). This updated and replaced MiFID I.

The updated rules affecting equity trading aim to strengthen investor protection and to address the development of the new trading platforms and activities, and included the following.

- **A mandatory requirement for equity to be traded on RMs, MTFs or SIs.** While this effectively prohibited trading via BCNs on an OTC basis, investment firms have looked to SIs to accommodate such trading activity.

⁶² RMs and MTFs are governed by rules that leave the operator of the trading venue with no discretion as to how participants may interact.

- **A cap of equity trading in dark pools—the double volume cap mechanism (DVCM).** The DVCM was designed to limit trading in equity instruments on dark pools by restricting trades executed via the MiFIR waiver system.⁶³ The double volume cap limits the volume of certain transactions that can be executed on dark pools to 4% at the trading venue level and 8% for all EU trading venues. The DVCM applies to transactions that are:
 - executed in systems where the price is determined by reference to a price generated by another system—referred to as the reference price waiver;⁶⁴
 - bilaterally negotiated and formalised on a trading venue—referred to as the negotiated transaction waiver.⁶⁵

However, the DVCM does not apply to the other two waivers defined under MiFIR. These are the large in scale waiver and order management facility waiver, which are subject to minimum size restrictions.⁶⁶

- **Increased pre- and post-trade transparency.** The transparency regime was extended to cover non-equity instruments. Market operators and investment firms operating a trading venue must make public the range of bid and offer prices and the depth of trading interest at those prices. SIs and investment firms trading outside a trading venue are also subject to a pre-trade transparency regime; however, the thresholds are significantly lower than on trading venues. Such firms are required to provide quotes as a response to a client request for quotes, with the obligation to publish and share that quote with other investors, provided that it is below a certain volume threshold and the instrument is sufficiently liquid.

The post-trade disclosure obligations for all market players, including investment firms and SIs, were also extended to the fuller list of financial instruments and derivatives that are clearing-eligible or reported to trade repositories under the European Market Infrastructure Regulation. Trading venues would have to offer pre- and post-trade transparency data separately and publish it to the public free of charge within 15 minutes of publication of a transaction, while investment firms must make public information about volume, price and time of execution through an Approved Publication Arrangement. MiFID II also introduced legislation governing market data, requiring trading venues to disaggregate their pre- and post-trade data and make the data available on a 'reasonable commercial basis'. This is discussed in more detail in section 4.

- **A tick size regime.** MiFID II requires all trading venues to price stocks in the same increments. This is intended to create a level playing field between the different trading venues. SIs were not included in the original drafting of this rule, which has allowed them to provide price improvements with the aim of diverting client orders towards SIs rather than on-exchange venues. Due to concerns about price formation, ESMA has recently proposed an amendment to the European Commission for the MiFID II tick

⁶³ See Article 5 of MiFIR.

⁶⁴ See Article 4(1)(a) of MiFIR.

⁶⁵ See Article 4(1)(b)(i) of MiFIR.

⁶⁶ The large in scale waiver allows trades above a certain size at any price to forgo the pre-trade transparency requirement. These are usually large block trades. The order management facility waiver allows venues to hold an order in a separate system before sending it to the order book. This is used for certain more complex trade types.

size regime to partially cover SIs as well. A legislative amendment to MIFIR to extend the tick size regime to SIs in a more comprehensive fashion is currently before the co-legislators as part of the Investment Firm Review proposals.

- **A new category of trading venue, called an organised trading facility (OTF), for non-equity instruments.** The OTF category was created for bonds, derivatives, structured products and emission allowances, with the aim of moving more OTC trading to trading venues. The SI regime was also expanded to cover non-equity instruments.

MiFID II introduced some important provisions also with respect to market data (which are discussed further in section 4). These provisions apply to stock exchanges and other trading venues, but not other parties in the market data value chain, such as data vendors, which are outside the scope of MiFID II.

- **Reasonable commercial basis.** Data on transactions executed on a trading venue (both RMs and MTFs) or OTC must be made public as close to real time as is technically possible. Market operators and investment firms operating a trading venue must provide access to the published market data on reasonable commercial basis and on a non-discriminatory basis.
- **Free delayed data.** Access to delayed data—i.e. access to data 15 minutes after trade execution—must be made available to the public free of charge.
- **Disaggregation.** Data needs to be easily and readily available to users in a format as disaggregated as possible in order to allow investors, and data service providers serving the investors' needs, to customise data solutions as much as possible. Pre- and post-trade transparency data should be made available to the public in a disaggregated way so as to reduce costs for market participants.

These changes were aimed at further enhancing investor protection and transparency in securities markets, as well as tackling some of the unintended consequences of MiFID I, such as the growth of dark trading. Between 2017 and 2018, the European regulators granted authorisation to 42 RMs, 130 MTFs, 77 OTFs and 173 SIs.

3.2.4 MiFID framework—impact on market design

Figure 3.3 illustrates equity trading fragmentation in relation to shares listed on some major European indices. They include auction markets,⁶⁷ trading on trading venues (both RMs and alternative trading venues) and off-exchange trading.

When off-venue trading is taken into account, the proportion of equity trading (in terms of notional value) taking place on primary exchanges has been constantly less than 40%,⁶⁸ dropping to 15–20% for the trading of FTSE 100,

⁶⁷ 'Equity auction markets' refers to those trades executed on dedicated auction platforms. This emerging trading format is provided by both traditional stock exchanges (e.g. London Stock Exchange Group, Deutsche Börse, Euronext, SIX Swiss Exchange, BME, NASDAQ, Oslo Børs, Wiener Börse) and MTFs (e.g. Sigma-X, Turquoise, Posit, Aquis, Equiduct). This does not refer to the opening auction and the closing auction that are often part of a typical trading day on many regulated exchanges, nor to the auction phase that often follows periods of high market volatility on RMs.

⁶⁸ The figure includes both 'lit' and 'dark' trading executed on primary exchanges, based on data from Fidessa.

DAX and IBEX shares.⁶⁹ In 2018, 'lit' trading accounted for less than 50% of total equity trading across all European markets.⁷⁰ The other 50%, comprising off-order book and non-displayed trading on MTFs or via SIs, can be classified as 'dark' volume.⁷¹ Data on OTC trading should be interpreted with care. Due to the lack of a standardised reporting format and a centralised collecting entity, the data on OTC trades may not be fully accurate.

The charts in Figure 3.3 below also highlight a progressive move towards periodic auction⁷² trading systems, which are becoming more popular, and a sudden increase in trades executed by SIs in 2018, which have been on average 25% of total equity trading.⁷³ These trends are likely to be a consequence of the limits to dark trading in equity and equity-like instruments introduced by MiFID II, with the intent of promoting price-forming trading on RMs.

However, since the entry into force of MiFID II in January 2018, while equity trading on an OTC basis, including via BCNs, has fallen significantly, the share of trading on lit exchanges barely rose in the first months of 2018. In fact, a large proportion of this trading moved on to SIs, off-order book trading and, to a lesser extent, specialist periodic auction services.

⁶⁹ The figures include both 'lit' and 'dark' trading executed on London Stock Exchange Group platforms, based on data from Fidessa.

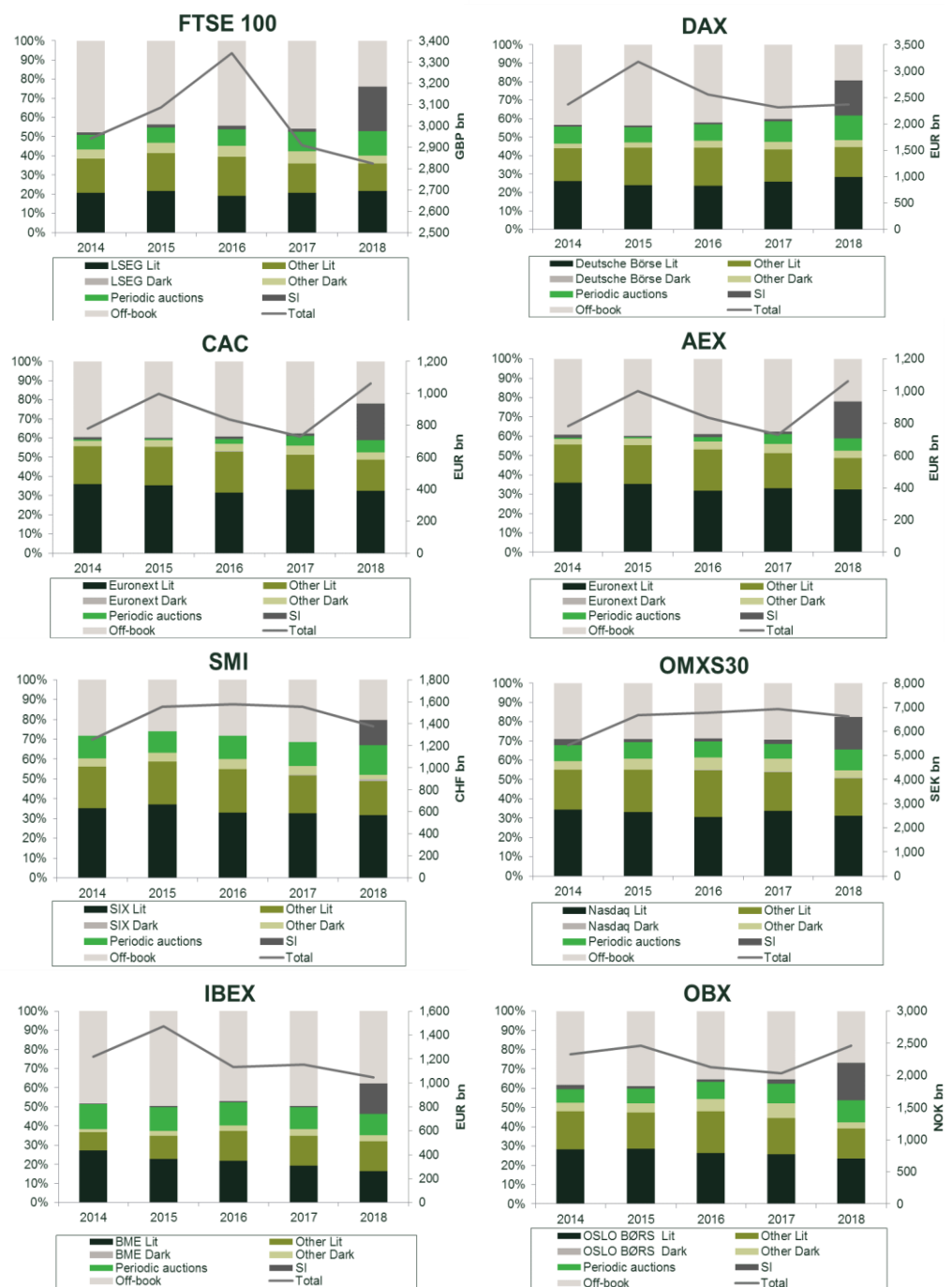
⁷⁰ Oxera's elaboration of Fidessa data.

⁷¹ Oxera's elaboration of Fidessa data.

⁷² 'Periodic auctions' refers to all type of periodic auctions, including 'frequent batch auctions'.

⁷³ Oxera's elaboration of Fidessa data.

Figure 3.3 Distribution of trading in shares listed on major European indexes, 2014–18



Source: Fidessa.

Figure 3.4 below shows the trend in equity trading through SIs and periodic auction services in the six months before and after the application of the new MiFID II regime. Periodic auction platforms increased their share of equity trading by about 30% in June 2018 compared with July 2017, while the amount of SI equity trading in June 2018 was more than 10 times higher than in July 2017.⁷⁴

⁷⁴ Oxera analysis of Fidessa data.

Figure 3.4 Value of trading through SIs and periodic auctions before and after the introduction of MiFID II



Note: Data on off-venue trading should be interpreted with care. Due to the lack of a standardised reporting format and a centralised collecting entity, the data on off-venue trades may not be fully accurate, for example.

Source: Fidessa.

3.3 Alternative lit trading models and price formation

One consequence of the growth in alternative trading venues has been fragmentation in liquidity.

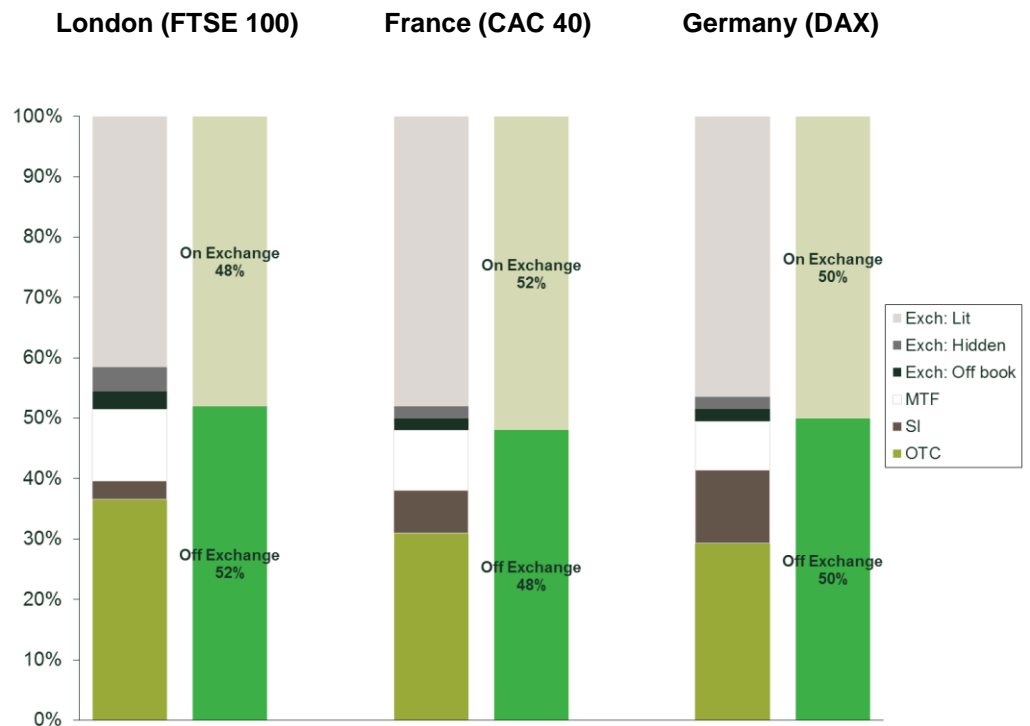
As explained in section 3.2, since the implementation of MiFID and the entry of alternative trading platforms, and then MiFID II, which accelerated this entry, more and more trading has been occurring away from lit markets. Figure 3.5 and Figure 3.6 below highlight the significant volume of trading that occurs off-exchange. There has also been a shift of stock trading from the RMs to alternative lit trading venues.

By attracting order flow away from the exchanges on which securities are listed, these trends are fragmenting market liquidity. Trades not subject to pre-trade transparency rules also fragment trading information. Such fragmentation could impede price formation as fewer market participants come together at any one lit trading venue.

At the same time, there is recognition in the literature that entry by new trading venues and the resulting increase in competition has benefited overall liquidity. This is often through competitive pressure on venues to provide lower transaction costs and faster execution.⁷⁵

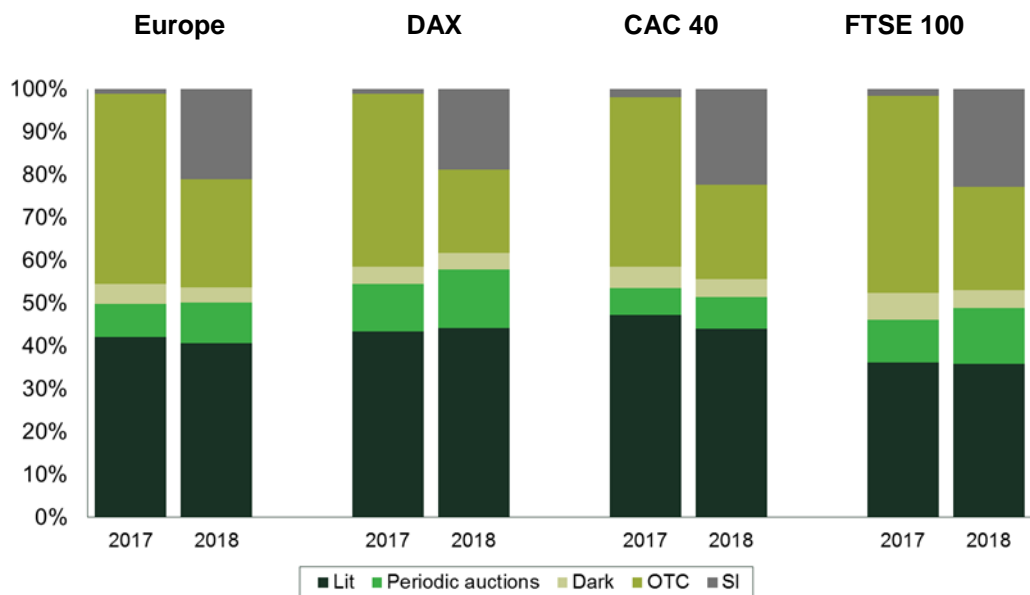
⁷⁵ See, for example, O'Hara and Ye (2011) and Degryse, De Jong and van Kervel (2015).

Figure 3.5 Distribution of trading among European venues, December 2015–March 2016



Source: OECD (2016), 'OECD Business and Finance Outlook 2016: Changing business models of stock exchanges and stock market fragmentation', p.129.

Figure 3.6 European equity trading value, 2017 and 2018



Notes: 'Lit' indicates trades executed on-book. 'Dark' indicates trades executed on a dark pool where the orders are not visible pre-trade. 'SI' indicates trades executed by an SI. OTC includes over-the-counter trades reported to one of the reporting venues.

Source: Fidessa Fragmentation Index.

The relative contribution that different venues provide to the price formation process is open to debate.

Primary exchanges have large pools of liquidity and so contribute to effective price formation through the large volumes of trading activity that they administer. However, empirical evidence suggests that new-entrant lit trading venues can contribute to price formation, even with lower levels of activity, by providing services that are particularly attractive to informed traders.⁷⁶

There is also a live debate about the benefits of new trading systems, such as periodic auctions, which have grown in popularity since the introduction of MiFID II. ESMA recently published a call for evidence on the impact of periodic auctions for equity trading, noting that some of these new trading systems contribute little if anything to price determination.⁷⁷ Some of these systems lock in the auction price at the start of the auction period without providing a mechanism to break the lock, and therefore do not contribute to price formation. While this type of periodic auction set-up provides certainty on execution price, there is limited (if any) transparency about trade intentions, and modifications to the order book during the call period do not affect the auction price, and thereby do not contribute to price formation.

Some commentators have suggested that the superior price formation of primary exchanges is demonstrated by the significant drop in trading that has occurred following outages on those primary exchanges. Despite the ability to trade on alternative venues, the low confidence of traders in the price formation on alternative venues may have deterred them from trading on those markets during the outage period.⁷⁸

Evidence from some recent outages on primary exchanges appears to support this hypothesis. For example, Figure 3.7 below shows the trading volumes of French stocks on 29 October 2018. On the morning of this trading day, there was an unintentional halt to trading on the primary exchange, Euronext. Following this there was almost no trading in CAC 40 stocks across most alternative European trading venues.⁷⁹ Once trading on Euronext resumed, the trading on alternative trading venues also returned to normal levels.

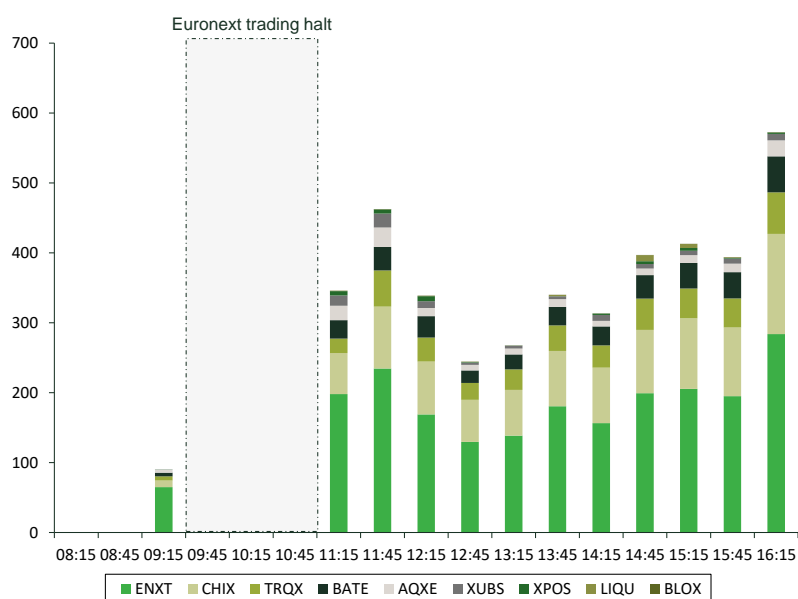
⁷⁶ For example, this may involve providing low-latency connections, allowing certain traders to extract information from the order flow on the primary exchange and quickly submit informative quotes on the new-entrant venue. See Ibikunle (2018).

⁷⁷ European Securities and Markets Authority (2018b).

⁷⁸ For example, for commentary on a recent outage for the London Stock Exchange, see *Financial Times* (2018c).

⁷⁹ For further information on the Euronext outage, see *Financial Times* (2018e).

Figure 3.7 CAC 40 value (€m) traded on 29 October 2018



Note: The horizontal axis represents discrete time periods on 29 October 2018. The shaded region represents the period when trading was halted on Euronext.

Source: Liquidmetrix.

Box 3.1 Literature on the impact of alternative trading models on price formation

There is extensive literature on the impact of market fragmentation on liquidity and price formation. Several empirical papers have found that fragmentation in European equity markets has been beneficial for liquidity; however, these findings are contingent on the type of fragmentation occurring. For example:

- Foucault and Menkveld (2008) found that competition between the London Stock Exchange and Euronext exchanges in the Dutch stock market increased overall liquidity;
- Degryse, De Jong and Van Kervel (2015) found that visible fragmentation improves aggregate liquidity but noted that movement of trading to dark venues harms overall liquidity;
- Aitken, Chen and Foley (2017) found that fragmentation between exchanges and MTFs significantly reduces spreads and depth for different stocks, which they attributed to entrant markets providing an opportunity to 'queue jump' the primary venue.

In a US context, O'Hara and Ye (2011) found that similar fragmentation is associated with improved price efficiency, in that prices are closer to a random walk. However, Gentile and Fioravanti (2012) applied a similar methodology to data on Stoxx Europe 50 share trading between 2008 and 2011, and found that fragmentation reduced the information efficiency of prices.

The link between certain MTFs and HFT is well documented in the literature. In particular, the success of Chi-X has been attributed to its low latency (He, Jarnecic and Liu, 2015) and even the activity of a single HFT firm (Menkveld, 2013).

Source: Oxera.

3.4 The impact of high-frequency trading

One of the main trends in financial markets has been the proliferation of algorithmic and HFT strategies. HFT strategies rely on computer algorithms to route, monitor, execute and cancel thousands of orders at incredibly high speed.⁸⁰

These traders are usually deciding, on the basis of detailed analysis of past market behaviour, precisely when to trade, using detailed monitoring of current market conditions to create very short-term (within seconds or minutes) predictions of whether they can execute the full sequence of trades that returns them to a neutral position within that timeframe. Some empirical analysis of trading data suggests that HFT response times are in the order of microseconds.⁸¹

The reaction to changing market conditions leads to traders sending very high levels of orders to trading venues, and then cancelling a fairly high proportion of these orders before they actually execute. In many cases, such trading strategies account for the majority of message traffic on trading venues.⁸²

HFT strategies may be trying to identify how prices will change or find fleeting anomalies in the price of the same securities trading in different locations, or anomalies in the price of different securities that are linked in some way.

To deliver successful implementation of HFT strategies, price changes must be predictable—at least on a probabilistic basis.⁸³ Improvements in the price formation process provided by stock exchanges have provided this stability, and enabled a range of HFT strategies to emerge.

There is a broader debate about the benefits of HFT for financial stability and market efficiency. The empirical evidence on the contribution of HFT to price formation is also mixed (see Box 3.2 below). Some recent academic work seems to suggest that HFT trading strategies are making a positive and substantial contribution to making prices more efficient. For example:

- Brogaard, Hendershott and Riordan (2014) analyse a sample of US stocks and find that HFT strategies make a substantial contribution to efficient prices;
- Benos and Sagade (2016) study the UK equity market and find that HFTs contribute 14% of all trade-induced information;
- Riordan and Storckenmaier (2012) analyse the impact of a speed upgrade to Deutsche Börse's Xetra system and find that the contribution of quotes to price formation doubles to 90% after the upgrade.

However, there is also some consensus that HFTs are not informed in the traditional sense. They do not tend to invest resources to find new information about the fundamentals of the firms. Rather, they tend to free-ride on information acquisition by other traders. As a consequence, more intense HFT can lead to a deterioration of the price formation process, as fundamental traders can stop investing in acquiring new information (i.e. information production falls).⁸⁴ For example, if a trader has information that a stock is

⁸⁰ For further information, see Oxera (2012).

⁸¹ One microsecond is 0.000001 seconds. For further information, see Menkveld (2016).

⁸² Brogaard, Hendershott and Riordan (2014).

⁸³ For more detail on the drivers of HFT trading strategies, see Government Office for Science (2012), section 2.2.1.

⁸⁴ References on this include Baldauf and Mollner (2018); van Kervel and Menkveld (2018); Weller (2017).

undervalued and wishes to buy, HFTs may be able to infer this information from order flow and quickly place buy orders. This will move the price upwards, which is unhelpful for the original informed trader, whose reward for acquiring information is the difference between the stock price and true value. The concern is that, by eroding the informed trader's reward, HFT may reduce the incentive to acquire information.

Box 3.2 Literature on the impact of HFT on price formation

The literature on HFT is very broad. For useful literature surveys of key theoretical and empirical contributions, see, for example: Goldstein, Kumar and Graves (2014), O'Hara (2015), or Menkveld (2016).

In the context of price formation, a number of papers support the idea that HFT improves price formation by allowing information to be incorporated into prices faster. These include:

- Hendershott, Jones and Menkveld (2011);
- Riordan and Storkenmaier (2012);
- Brogaard, Hendershott and Riordan (2014);
- Chakrabarty, Moulton and Wang (2018).

However, other papers suggest that HFTs free-ride on information acquisition by other traders, which harms price formation. Examples include:

- Baldauf and Mollner (2018), which presents a theoretical model in which an increase in trading speed crowds out information acquisition by reducing the gain from trading on such information. This causes price efficiency to deteriorate;
- Both Weller (2017) and van Kervel and Menkveld (2018) provide empirical support for this prediction.

Papers that are critical of HFT often predict a socially wasteful 'arms race', as HFTs do not consider the costs they impose on other market participants. Examples of such theoretical papers include:

- Budish, Crampton and Shim (2015), which presents a theoretical model in which HFTs extract rents from the imperfectly continuous nature of trading in CLOBs, which the authors argue leads to a socially wasteful arms race for speed;
- Bias, Foucault and Moinas (2015) present a model in which there is over-investment in speed in equilibrium. Consequently, welfare could be improved by taxing investment in fast trading technology;
- Cartea and Penalva (2012) present a model in which HFTs extract rent by acting as intermediaries between non-HFT participants, which leads to increased noise around the fundamental value of the asset and higher execution costs.

3.5 The impact of dark trading

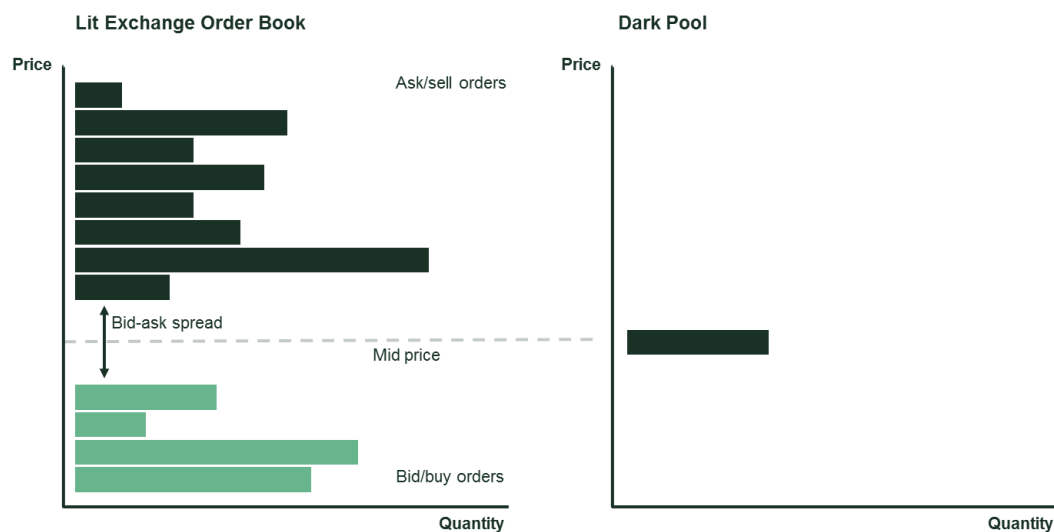
As noted earlier, another significant trend in European equity markets over the last decade has been the emergence of dark trading driven by the introduction of pre-trade transparency waivers in MiFID I and the growth of OTC trading. As discussed in section 3.2, dark trading is where transactions are executed with no pre-trade transparency, as orders are hidden prior to execution.

3.5.1 On-venue dark trading

As described in section 3.2, MiFID I introduced a waiver system facilitating the emergence of dark-venue MTFs providing trading exempt from pre-trade transparency requirements.

The lack of transparency regarding order flow on dark pools means that they cannot determine prices in the same way as a lit venue. Instead, they must refer to the price provided by lit venues, often using the mid-price (i.e. the midpoint of the BBO, see section 2.3). Traders will submit orders to a dark pool and if there is a sufficient volume of orders available, these trades will often be matched at the mid-price (a process known as ‘uncrossing’). In such venues, price formation cannot occur internally and the dark pool must use the exchange to provide an accurate price. For example, most UK-based dark pools use the London Stock Exchange as a reference price for stocks listed on that exchange.⁸⁵

Figure 3.8 Price setting in a dark pool

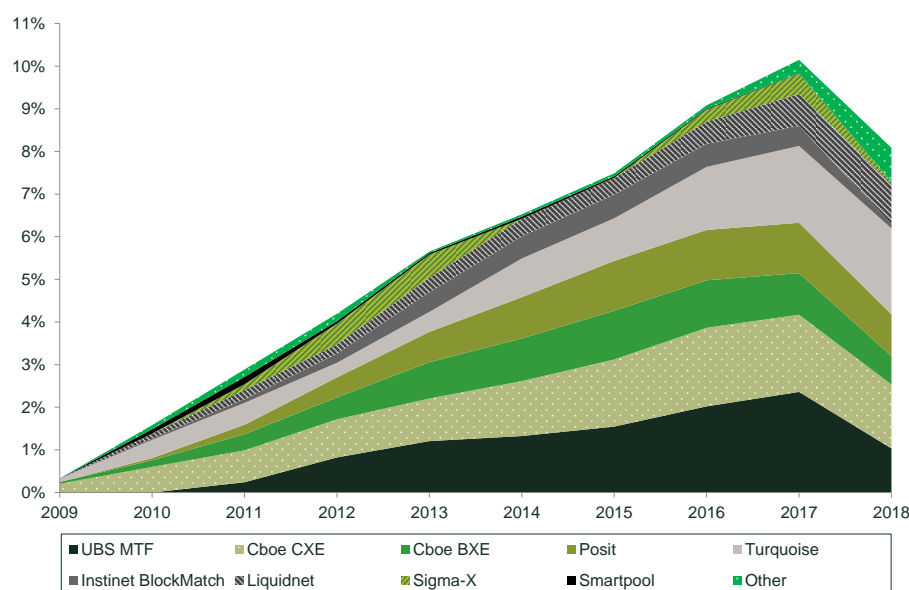


Source: Oxera.

Dark pools have emerged as a significant contributor to European equity trading volume in the last ten years, partly as a result of the price formation process provided by exchanges, as they often use the mid-price from the primary exchange to determine the price. Figure 3.9 below highlights how the volume of dark trading in Europe has grown steadily since 2009.

⁸⁵ Financial Conduct Authority (2016b).

Figure 3.9 Growth in dark pool market share for European equities trading, 2009–18



Note: The y-axis shows dark trading percentage of total volume traded on RMs and MTFs, by value. The period analysed goes from 1 January 2009 to 31 December 2018. The drop in dark pool volumes observed from in 2018 can be explained by the volume caps introduced by MiFID II.

Source: Oxera's analysis of data from Petrescu and Wedow (2017), Cboe and Fidessa.

3.5.2 Growth of systematic internalisers

Since the implementation of MiFID II, and the prohibition on BCNs arising from the share trading obligations, SIs have captured around 20% of market share in pan-European equities trading.

In the policy debate, it is important to understand that, today, the SI category contains two distinct types of platform, operated by two different types of operator.

- The first category of SI is composed of new independent liquidity centres operated by proprietary trading firms. These are sometimes referred to as electronic liquidity providers (or 'ELPs'). Examples include SIs operated by Hudson River Trading, Citadel Securities, Jane Street and Tower Research. According to the latest available data (published for Q2 2018 on individual SI websites), 'ELP' SIs executed €860m average daily volume in June 2018. This represented 2% of overall SI reported activity.
- The second category concerns a use of the SI regime that was not anticipated by policymakers. Specifically, the vast majority of SI reported volumes are a reclassification of business previously done within banks' own internal pools of liquidity. They have reorganised trading previously reported as OTC (including BCNs) around SIs.

As noted above, the growth in SI trading has been driven partly by the MiFID II requirement that equity trading take place on either RMs, MTFs or SIs. While the SI regime was established by MiFID I, many brokers and banks opted instead to trade with clients on an OTC basis through BCNs, which were not regulated as trading venues under MiFID I. Although these structures are now prohibited, some commentators have expressed concerns that firms are establishing networks of interconnected SIs, which could facilitate OTC trading

in a fashion similar to BCNs.⁸⁶ This would pose potential risks to price formation, as SI networks would be able to replicate de facto the multilateral trading nature of RMs and MTFs without providing the same transparency. This has led to concerns that, as with BCNs prior to MiFID II, the ability to trade without transparency on a multilateral basis away from regulated venues would attract a significant volume of order flow away from 'lit' markets.

3.5.3 Policy concerns

Both academics and regulators have voiced concerns about the impact of dark trading on the price formation process, which has ultimately resulted in MiFID II imposing a volume cap on the amount of dark trading permitted via the waiver system and introduction of the share trading obligation.

These concerns stem from the fact that trades conducted in dark pools are often executed at the mid-price of a lit venue and therefore do not represent the latent demand and supply of traders on the dark pool. If such trades were to occur on a lit venue, they would be likely to contribute to the price formation processes outlined in section 2.4.

While dark trading protects investors from market impact, this is mainly relevant to larger trades—it does not contribute to price formation and dark trading may also include smaller transactions, which do not necessarily require protection from market impact.⁸⁷

The academic literature also recognises the effect that dark pools can have on price formation in segmenting informed traders (those seeking to profit by trading off private information) and uninformed traders (those motivated to trade by a need to rebalance portfolios and smooth their consumption streams over time).

Lit venues are particularly appealing to informed traders, who value immediacy and certainty of execution in order to maximise the gains from their private information.⁸⁸ Conversely, dark pools appeal to uninformed traders, for example by offering price improvement. A concentration of informed traders on lit venues can have positive consequences for price formation but this can come at the expense of lower liquidity (see section 2.3).

Some empirical studies on the impacts of dark trading appear to confirm the prediction regarding segmentation of traders.⁸⁹ However, other studies find evidence of a significant informed trader presence on dark pools.⁹⁰

3.6 Implications for the design of equity trading markets

The key objective of MiFID I to introduce competition in equity trading appears to have been successful in terms of wider choice in trade execution venues and methods and lower trading fees.

The flipside of greater choice and competition is fragmentation of liquidity and more trading occurring away from the primary exchanges.

⁸⁶ See Rosov. (2018).

⁸⁷ See, for example, Petrescu and Wedow (2017), Tables B1 and B2; and Sun, Ibikunle and Mare (2017).

⁸⁸ See, for example, Hendershott and Mendelson (2000) and Zhu (2014).

⁸⁹ For example, Comerton-Forde and Putniņš (2015) find that dark trades tend to be less informed than trades on the lit market, with low levels of dark trading potentially beneficial for price formation. This segmentation is also noted in a European context by Brugler (2015) and Degryse et al. (2015).

⁹⁰ Nimalendran and Ray (2014).

Although this trend in itself is not an issue, it would be of concern for policymakers if this is coming at the cost of price formation or as a result of regulatory arbitrage.

Let us take the price formation point first. Despite the emergence of the new trading venues, the primary exchanges are still driving the majority of the price formation. Indeed, as we have seen, many of the new business models explicitly refer to the pricing on the primary exchanges when matching trades.

Given the importance of price formation for these new business models, and the financial markets more broadly, it is important that the market design for equity trading does not impair the price formation process. With a greater share of equity trading off-exchange, there is a risk of price formation becoming diluted.

Second, there is an open question about the level playing field across trading venues. There are some suggestions that many SIs business models may be driving a competitive advantage from the different regulatory rules only, such as on tick sizes and transparency.⁹¹ This matters less if the new trading models are serving different types of need. However, while this is partly the case (e.g. dark trading arguably helps reduce the price impact of trades for large institutional investors, and some users may benefit from a low latency solution from an MTF), off-exchange trading is also increasingly taking market share away from the types of trade that would have traditionally occurred on the primary exchanges.

⁹¹ As discussed in section 3.2, the tick size issue has been reflected in ESMA's recent recommendation to the European Commission for the MiFID II tick size regime to cover SIs as well. The Commission and the co-legislators need to endorse this proposal before the change will come into effect. See European Securities and Markets Authority (2018c).

4 Market data services—value chain and economic characteristics

Key messages

- Market data is the outcome of a dynamic price formation process. As an exchange improves this process, its market data (pre- and post-trade) becomes more valuable, as the prices become more reliable for prospective users of the information. This section analyses the market data value chain, its users, and fee and revenue levels.
- The market data offered by stock exchanges is a small element in a much longer value chain, in a broader market data industry that is large and growing. Stock exchange market data is distributed directly or indirectly, via data vendors, to brokers, asset managers, and other market participants. Data vendors are not covered by MiFID II market data obligations, which are focused on data providers such as stock exchanges.
- Market data provided by stock exchanges is often complemented by other sources of information and data to which market participants may have different levels of access, and which they may interpret in different ways. There is an industry of data vendors who distribute the market data and offer value-added services. Stock exchange market data revenues account for around 15% of this longer value chain.
- Demand for market data provided by stock exchanges has grown in recent years, supported by increasing trading volumes and trading strategies that require more data, and an increase in data used to inform assessments and decisions from both commercial and regulatory perspectives. Other trends include more widespread use of non-display data and netting arrangements (to reduce end-user costs). Data packages are also now offered on a disaggregated (unbundled) basis, alongside aggregated data packages.
- The analysis shows that, for most exchanges, increases in the fees for market data have been small (e.g. for Level 1 and Level 2 data, less than around 1.5% and 1% per year in real terms, respectively). There have been some more significant price changes for two exchanges—these fees are generally still within the broader range of fees observed.
- The contribution of market data revenues as a share of total combined (trade execution and market data) revenues has also remained fairly stable over the past few years—ranging around 20–50% across exchanges in 2018 (31% on average, unchanged from 2017 and compared to 32% in 2016 and 30% in 2015). Since 2012, the unit costs (calculated as the total joint revenue from trade execution and market data as a proportion of value of trading in relevant securities) have declined for all participating exchanges except one. Overall, there is no evidence to support the claims of broad increases in the total effective cost of trades levied by exchanges.

4.1 Introduction

As recognised by ESMA and other regulators, trade execution and market data are joint products. It is not possible to generate one without the other.

There is also a close link between price formation and market data. As discussed in section 2, price formation is the process through which information is incorporated into prices. It is the process through which information is revealed to the market through the trading activities of informed traders.

In section 2 we discussed how quotes are the building blocks behind trading strategies in most European equity markets, and that the submission of quotes and orders to the order book can reveal information to market participants about the future direction of the stock price. This generates demand for the information on (pre- and post-trade) prices and quotes on the stock exchanges (the 'market data').

As the activities of the stock exchange improve the price formation, this also increases the willingness to pay for its market data. Brokers and other parties use market data as an input into their commercial trading decisions.

There are a number of dimensions to market data, and a long and complex value chain.

This section is structured as follows:

- section 4.2 clarifies the focus and our definition of 'market data' in this report;
- section 4.3 describes the dimensions to market data provided by stock exchanges;
- section 4.4 outlines the value chain for market data provided by stock exchanges, explores the role of data vendors and the demand for market data across user groups;
- section 4.5 describes some emerging themes in the market data industry;
- section 4.6 gives an overview of the pricing structures for market data services in Europe;
- section 4.7 shows the trends in market data revenues of major European stock exchanges for the period 2012–17;
- section 4.8 shows the trends in market data fees over time;
- section 4.9 analyses market data costs per user type, from an end-user perspective.

4.2 What is market data?

For the purpose of this report, 'market data' refers to the information produced as a result of the price formation process and the trading of equity on a stock exchange.

As explained in section 2, information is generated during the submission of orders and the execution of trades on a trading venue. It is generated as a joint

product with trade execution. The market data generated by stock exchanges⁹² can be grouped into three main categories:

- pre-trade information—includes quotes and orders and respective volumes;
- post-trade information—includes execution prices and volumes;
- surveillance data for identifying participants and analysing behaviour for regulatory and legal reasons⁹³.

This report focuses on the pre- and post-trade information related to cash equity markets. Many stock exchanges also undertake activities relating to the production of market data for other asset classes (e.g. derivatives, bonds). In addition, some exchanges provide value-added services, such as data analytics, reference data, indices, and stochastic data. These are not the focus of this report.

Different levels of details are provided for each group of market data. This reflects the different purpose of the data. The market surveillance and market supervision data typically includes sensitive confidential information, such as trader identification, that would not be appropriate for distribution. By contrast, pre- and post-trade data can be anonymised and distributed to other market participants. Market data can take various forms and be licensed in packages with multiple data products.

4.3 Dimensions to market data

An end-user can choose from several types of data products. These products can vary in the following dimensions:

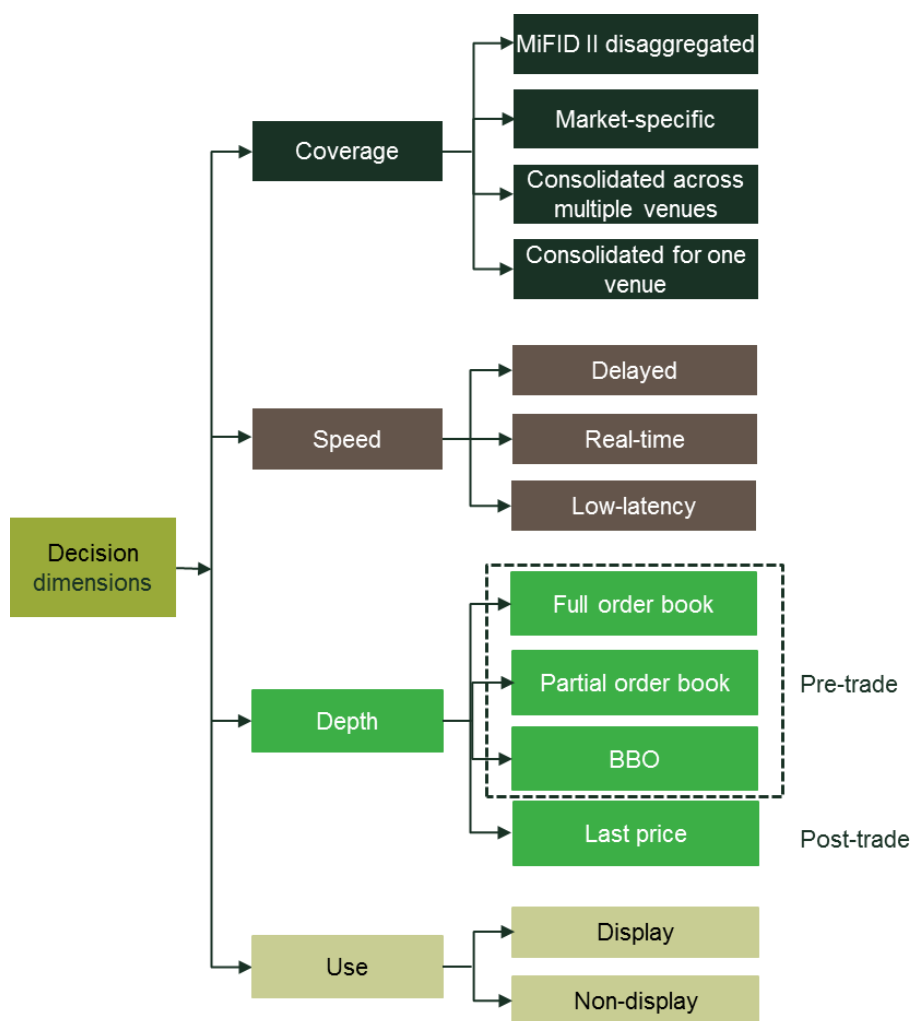
- **coverage**—at the asset class level, across geographies and trading venues;
- **use**—by the intended use of the data;
- **depth**—by the number of data fields provided in the package;
- **speed**—with varying degrees of latency.

Figure 4.1 illustrates these variations, and each dimension is discussed in more detail below.

⁹² Some other trading venues, such as MTFs, also offer and charge for market data.

⁹³ This data is not made publicly available.

Figure 4.1 Data dimensions



Note: Data dimensions can also vary between the type of user (i.e. professional or non-professional); however, this is not a decision dimension for data, as users fall into one of these categories in accordance with the data agreements of exchanges. Under MiFID II, exchanges must offer pre- and post-trade data separately (disaggregated).

Source: Oxera.

4.3.1 Coverage

Some data packages can cover different venues and asset classes, while others provide data separately by asset, venue or other splits.

One of the main sources of variation after the introduction of MiFID II is the assets that are covered in a given data product. For instance, the requirement for trading venues to disaggregate previously consolidated products by offering on request data products that conform to pre-set categories has introduced an additional source of product variability for market participants when deciding on data requirements.

However, data vendors/redistributors are not obliged to follow the exchange's (dis)aggregating choices, and will make commercial (dis)aggregating choices based on the commercial viability of offering the product. It is not uncommon for vendors to offer a consolidated bundle of the products offered by the data provider and not the full list of disaggregated products that an exchange must provide under MiFID II rules.

4.3.2 Type of use

Stock exchanges also vary their product offering based on the intended use of the data.

At a high level, the majority of stock exchanges in Europe offer separate data agreements for:⁹⁴

- **display data**—provided for the purpose of visual consumption and analysis on a screen by market participants. The format of the data received tends to be raw financial data for screens/terminals;
- **non-display data**—this refers to data that is generally licensed for the purpose of pre-specified use, such as for automated trading and market analysis and the creation of secondary analysis.⁹⁵ Exchanges require end-users to declare such usage subject to a non-display usage policy. An automated trading platform is an example of a party that would be likely to seek this type of direct data product.

The use of the data will depend on the needs of the users. Table 4.1 below shows some typical uses for data consumers. This information is based on updated interviews that we have conducted with market participants, including exchanges and data vendors.

User requirements will vary—for example, academic researchers or analysts involved in technical analysis may require delayed data with high depth from a vendor; whereas arbitrageur activity and high frequency and algorithmic trading would be likely to prioritise a non-display, direct link to the exchange that provides detailed data with the lowest latency. In addition to the non-display data product, exchanges typically offer co-location capabilities that place the servers of the traders next to the exchange hubs, reducing latency from milliseconds to microseconds.⁹⁶ For instance, SIX Swiss Exchange offers a co-location latency of 14 microseconds.⁹⁷

⁹⁴ This categorisation is not always used—some stock exchanges provide more detailed categorisation.

⁹⁵ The classifications of standard types of non-display data use and special cases varies by stock exchange.

⁹⁶ As reported in *Financial Times* (2018a).

⁹⁷ See SIX Swiss Exchange, '[Co-location: the fastest connection to our exchange](#)'.

Table 4.1 Typical data requirements for data consumers

User	Purpose (use) of data	Type of data required	
Trader: broker, prop trader, HFT, etc.	Front office	To execute trades	Real-time (often low-latency) Level 2
	Middle office	Risk, credit and strategy management, including forecasts and some modelling	Generally delayed or real-time Level 1, but some activities (e.g. testing strategies) can require Level 2
	Back office	To monitor and administer settlement and clearing obligations, regulatory compliance (including evaluation of best execution), and reconciliation of trades	Delayed and/or end-of-day
Market maker	Observing the liquidity and depth in the market to fulfil quoting obligations, generate prices and calculate risk	Real-time (often low-latency) Level 2 ¹	
Indexing (e.g. credit default swap (CDS), benchmarks)	To analyse and group companies' risk profiles to form CDS indexes or to form and manage an index	Real-time Level 1 or Level 2	
Fund manager	Research and strategy, including forecasts and modelling, assessment of brokers and other service providers	Dependent on individual manager. Often, delayed data is sufficient. Some managers may choose to receive real-time data at Level 1 or 2 according to their strategy. End-of-day data used to calculate and report portfolio values	
Competitor trading venue (e.g. MTF, organised trading facility, dark pool, SI)	To inform traders/market makers of pricing on other venues To provide a reference price when the venue does not have its own price formation mechanism To provide order pegging services—i.e. where a trader enters an order that does not contain a price, but the instruction to execute only at a price better than available on other venues	Real-time Level 1	
Market surveillance, regulators and governments	Identify illegal behaviour by participants	Private information on trading participants, Level 2 (real-time and delayed)	
Retail investor	To assess investment prospects and strategy	Delayed data; occasionally Level 1 real-time data	
Media	To broadcast financial market information over television channels and on websites	Post-trade, Level 1 real-time and delayed data	
Issuer	To form a correct pricing and demand estimation at issuance; to assess listing venues	Delayed post-trade	
Other research/academic	To model markets and market mechanisms, investigate specific relationships between economic variables	Historical data	

Note: At several European stock exchanges, registered members of the exchange are entitled to free data for trading on the exchange. ¹ Level 1 and Level 2 are explained in more detail below.

Source: Oxera analysis, based on views expressed by market participants, data vendors and data providers.

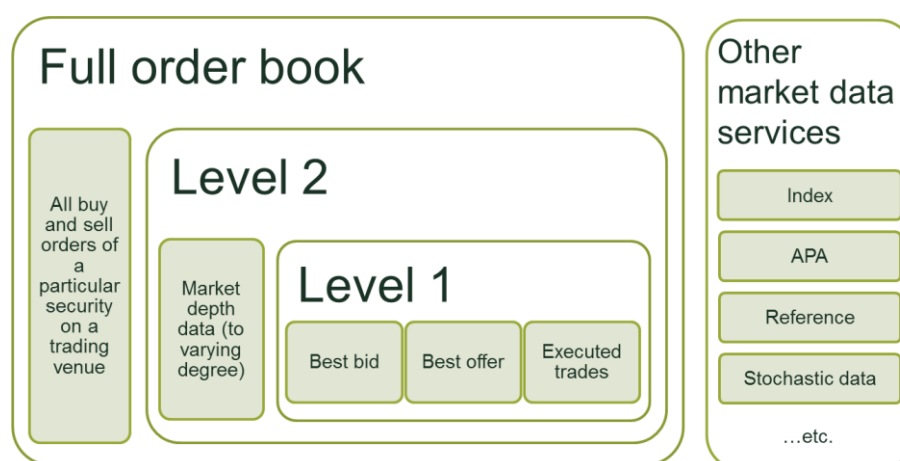
4.3.3 Depth

Data packages also vary by the depth of the financial information included, and can be grouped into the following categories:⁹⁸

- **post-trade**—this package may include information on executed trades only;
- **Level 1**—typically includes the BBO, in addition to the information on executed trades;
- **Level 2**—typically provides users with pre-trade information on the 5–10 BBOs from the order book respectively;
- **full order book**—offers the greatest level of transparency of all individual orders on the order book. Examples of this product include Deutsche Börse’s Xetra Order by Order and Euronext’s Cash Level 2.

Figure 4.2 indicates the depth of pre-trade market data typically available. The categories are additive and a product of a certain depth will include data from packages of lower depth for the same coverage.

Figure 4.2 Types of market data packages



Note: The definition of Level 2 may vary across stock exchanges; for instance, Euronext’s cash market Level 2 product provides visibility of the full order book. Not all exchanges provide all three categories of data package, and availability of Level 1 can depend on whether the end-user is on a professional or non-professional pricing tariff. For example, Oslo Børs does not currently offer a professional Level 1 product. APA stands for ‘approved publication arrangement’.


Source: Oxera.

In general, the more detail that is included in the data package, the more valuable it will be to a user. It therefore not surprising that the fees of market data typically increase with depth and speed (Figure 4.3 below).

⁹⁸ These categories are not completely standardised and the exact details can vary by stock exchange.

Figure 4.3 Depth and speed of data

Speed/depth	Post-trade	Pre-trade Best bid-offer (Level 1)	Pre-trade Top of order book (Level 2)	Pre-trade Full order book
Real-time— low latency				
Real-time				
Delayed	Normally free of charge to the public*/low-cost			



Note: * Under Article 13(1) of MiFIR, pre-and post-trade data should be made available free of charge to the public 15 minutes after publication.

Source: Oxera.

4.3.4 Speed

Market data products may vary by speed. Normally delayed data refers to data that is published 15 minutes or more after the initial publication of the transaction.

Under MiFID II, this data should be made available free of charge to the public. Guidance by the ESMA clarifies where charges apply to delayed data:

Trading venues, APAs and CTPs may not impose redistribution fees or other similar restrictions on redistributors/third parties making available data free of charge 15 minutes after the initial publication. Where a redistributor/third party charges fees for the distribution of data – including a general fee for accessing its services – trading venues, APAs and CTPs may impose redistribution fees or other similar restrictions on this redistributor/third party.⁹⁹

Real-time data is charged for and can be subdivided into the ‘standard’ real-time product (which is fast enough for a human user to experience it as real time) and ultra-low latency connections. The latter are more bespoke and can involve more technical optimisation of the connection, such as on-site computer location (collocation). These are mainly of interest to high-frequency traders, who require connections with latency in the low milliseconds or even micro-seconds.

Speed is particularly important for users who are employing fast trading strategies. As explained in section 2, timing is critical to some strategies. At the other end of the spectrum there may be users who are content to use delayed data, for example some professional investors, fund managers, analytics firms creating secondary data, retail investors, academics, and media outlets.

The requirement for exchanges to publish market data free of charge 15 minutes after publication has opened up access to the public to a valuable resource, without the need to pay for it. This benefits all users, but particularly those user groups who do not need real-time access, such as some researchers. Delayed data is also valuable for trading, particularly for securities that trade infrequently (e.g. stocks on smaller companies or fixed income products). In this case, whether the information on prices and orders is

⁹⁹ MiFIR Article 13(1).

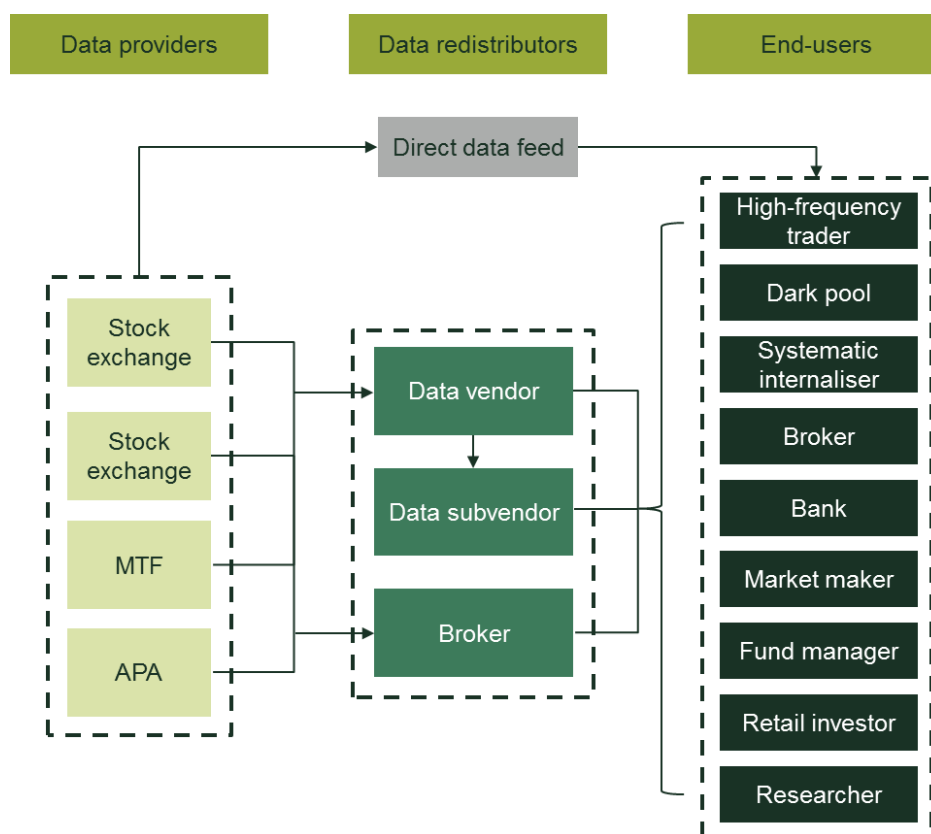
disseminated after 15 minutes or earlier does not make much difference, as the order book is unlikely to change significantly over the 15-minute period. For fixed income securities, the most recent price for a highly liquid security like an AAA corporate bond could be several hours or, in some cases, several days old.

4.4 Value chain

Trading venues, such as exchanges and MTFs, provide pre- and post-trade data to a variety of users. Although the MiFID II market data requirements apply to stock exchanges, exchanges are part of a large value chain for market data, including data vendors, software providers, IT and connectivity infrastructure, and end-users.

This section describes the main players in this value chain, the channels through which the data reaches end-users, and the value-added of each player in the chain.

Figure 4.4 Value chain for market data



Note: This is a simplified representation of the value chain. Certain end-users, such as academic researchers and retail investors, are unlikely to source a direct feed from a trading venue and tend to use delayed data. Brokers may also redistribute market data to their clients. Data vendors may also redistribute to other data vendors (subvendors).

Source: Oxera.

4.4.1 Stock exchanges as data providers

As explained above, market data is generated during the submission of bids and offers and the execution of trades on a trading venue.

Stock exchanges are able to sell pre- and post-trade information across various asset classes. However, they are not able to sell all data: sometimes

for regulatory reasons (e.g. delayed data that, under MiFID II, must be provided free of charge to the public) or confidentiality reasons (e.g. market surveillance data that contains sensitive personal information on trader identification).

Market data can be sold directly or indirectly to the end-user, with varying coverage, detail, latency and form:

- **direct distribution**—a stock exchange engages directly with an end-user, such as a large stock broker or fund manager;
- **indirect distribution**—access to the market data is provided indirectly through a data vendor, who often aggregates the information as part of a broader data package, which may include additional data analytics services. If data is distributed through a data vendor, the users may still have a direct contract with the relevant stock exchanges for the data products they receive.

The market data from exchanges is made available on a fair and non-discriminatory basis (see section 4.6).

It is the choice of the end-user how they obtain the market data. Typically the large users (e.g. a larger stock broker, or a large fund manager) have direct contracts in place. There are administrative costs from having to engage in separate contracts with every stock exchange for those markets in which you choose to be active or watching. Moreover, sourcing market data directly from stock exchanges requires more technical infrastructure. As such, for smaller market players, it may be more economical to obtain the data from a data vendor than directly from exchanges.

The primary stock exchanges have traditionally acted as the main provider of stock market data. This has been due to the higher proportion of stock trading on their platforms, compared to alternative trading venues (although, as discussed in section 3, their market share has been decreasing in recent years). As a result, the market data licensed by the primary stock exchanges is also often used as reference data by other exchanges.

MTF operators Cboe European Equities and Aquis Exchange now charge for market data from their alternative trading venues, increasing competition for market data. With increasing pressure on the prices that stock exchanges can charge for trade execution and market data services, some exchanges have started to branch out into the new and growing market for alternative data.

4.4.2 Data redistributors/data vendors

Historically the most common route by which market data provided by stock exchanges reaches the end-users is through intermediaries acting as data redistributors or data aggregators. These are data vendors who typically aggregate data from multiple sources and distribute them to subscribers. Data can also be redistributed by other financial institutions—for example, large retail brokers distributing market data to retail customers via their own platforms.

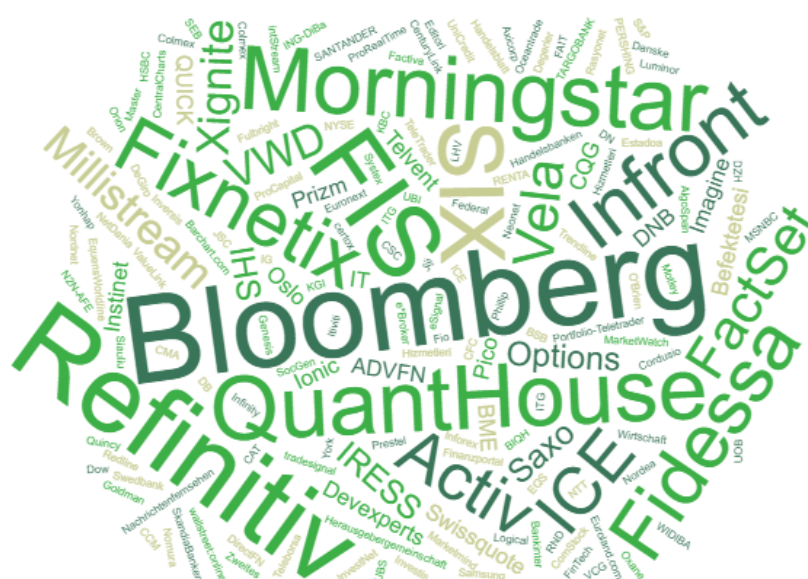
In the case of data vendors, the market data is normally provided to end-users via a single, unified platform through which they can access market data from a variety of exchanges. In addition to offering the aggregation service, data vendors tend to provide value-added services, such as pre-trade analysis and data cleaning.

It is common practice for exchanges to make their market data available for licensing to data vendors on a wholesale basis. Data vendors may then pass on this data to their clients after signing up to a redistribution licence agreement with the stock exchanges. This also applies to other parties seeking to purchase the market data for onward distribution.

Market structure of data vendor industry

In terms of the market structure of the data vendor and data analytics sector, there are a number of active players. Figure 4.5 shows a range of companies that have re-distribution licences for market data services with European stock exchanges.

Figure 4.5 Data re-distributors in Europe



Note: Compiled from the data vendor lists of the following stock exchanges: Budapest; Cboe European Equities; Deutsche Börse; Euronext; Nasdaq; Oslo Børs; SIX Swiss Exchange.

Source: Oxera.

The two largest players are Bloomberg and Thomson Reuters, with global market shares in 2017 of 33.2% and 23% respectively.¹⁰⁰ There are also a number of independent data providers who specialise in particular areas. Furthermore there is a group of companies offering additional data, such as indices and ratings.

Business model of data vendors

The traditional business model of a data vendor has been to aggregate and normalise the data and then distribute it. In addition, we have observed a trend of data vendors increasingly seeking to offer other value-added or specialised services, such as market surveillance, compliance tools, or alternative data. There remain a number of end-users for whom the cost of aggregating still means that it is more economical to use a data vendor.

In the case of indirect contracting, data vendors typically pay a redistribution fee to the exchange for the licensing of the data. They typically charge a mark-up on the data fees set by the stock exchange to end users. The proportion of

¹⁰⁰ Burton-Taylor International Consulting (2017); *Financial Times* (2018b).

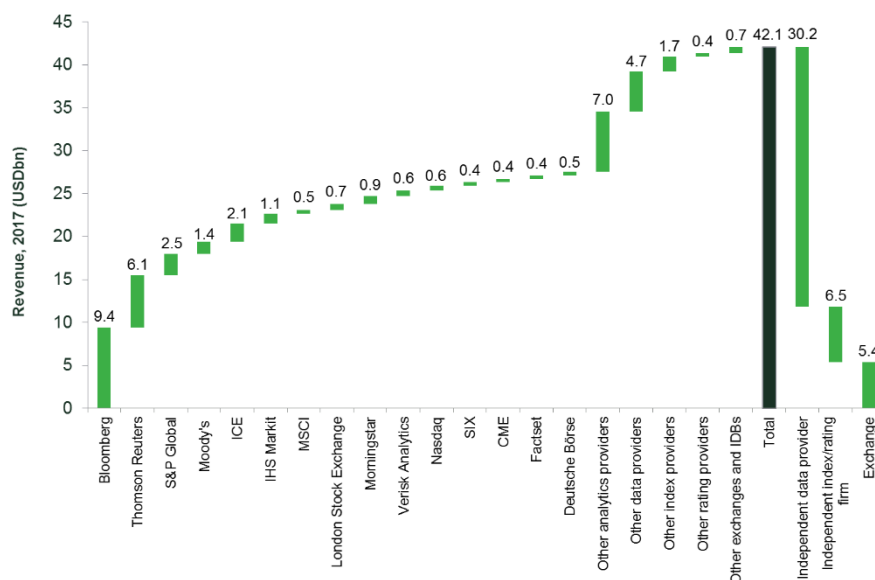
revenues collected directly or indirectly varies in accordance with the demand for direct access to exchanges.

Data vendors typically employ a subscription pricing model where access to the vast depth of aggregated data is available for an annual fee. Although Bloomberg does not publish its fee schedule, for two or more terminals the indicative annual cost is up to USD 20,000, excluding Bloomberg real-time data add-ons such as display fees from exchanges.¹⁰¹ Another major data vendor is Refinitiv's Eikon, until 2018 solely operated by Thomson Reuters, when Blackstone led a consortium that took a majority stake in Thomson Reuters' Financial & Risk Business.¹⁰²

To obtain real-time data from stock exchanges through data vendors, subscribers apply for and license additional products. In the indirect model of distribution, the data vendor will contract with a particular exchange on behalf of an end-user. The exchange will then provide a subscription for the data (and will usually charge the vendor a redistribution fee). The data vendor will then charge the end-user a fee, which often includes a mark-up component. Our analysis suggests a mark-up on average of 5–10%, which varies by data vendor and user.

In terms of revenues, the market data provided by stock exchanges represents only a small share of total revenues generated in the data vendor industry. Figure 4.6 shows an estimated breakdown of the global revenues of the data vendor industry by market player in 2017. We estimate that the cost of the market data provided by the European stock exchanges is likely to represent between 6% and 25% of the total revenues of data vendors in Europe.

Figure 4.6 Data vendor revenues (USD): global breakdown, 2017



Note: This chart estimates the share of total global revenues for vendors offering data redistribution and data analytics services based on 2017 data in USD. This analysis includes data on all financial instruments—i.e. not just equity market data.

Source: Oxera analysis of annual reports of providers. The estimate for Bloomberg is sourced from Burton-Taylor International Consulting.

¹⁰¹ See indications in WallStreetPrep 'Bloomberg vs. Capital IQ vs. FactSet vs. Thomson Reuters Eikon'.

¹⁰² As reported in *Financial Times* (2018d).

4.4.3 End-users

The final part of the value chain is the end-user. As discussed in section 4.3.2, a wide range of users use the market data provided by stock exchanges for a variety of applications.

The profile of the end-user can vary extensively. In addition to traditional consumers such as brokers, market makers and fund managers, there are researchers, media outlets and other analysts. As explained in section 3, the data provided by stock exchanges is also important for dark pools and SIs for the purposes of acquiring a reference price for a security.

Market data helps inform traders for their trading intentions, as discussed in section 2. The data also inputs into models for valuation, compliance, and risk monitoring, among many other applications. For example, funds use market data to set the net asset value of their funds; dark pools use the data to provide traders with a reference price; and media outlets distribute the data over channels, such as the Financial Times, Yahoo Finance and Reuters.

With the requirement under MiFID II for trading venues to provide delayed data free of charge, many end-users have benefited from this; although data vendors may continue to charge for it.

As noted in section 4.3, market data has a multitude of dimensions, which an end-user reconciles with specific requirements. Dependent on the application of the data and potentially, the corporate policy of the end-user, actual data requirements and the market data package subscribed to may not necessarily be identical. For instance, non-professional users of Euronext incur a token monthly fee of €1.50 for a consolidated subscription of real-time data comprising all indices, cash market Level 2, currency and equity derivatives data.¹⁰³

4.5 Trends in the market data industry

Based on analysis and interviews with industry participants, we have observed a number of trends, including: a general increase in the consumption of data and data analysis, partly driven by regulatory requirements and trading strategies that require data; a shift in demand from terminal-based data consumption to more use of non-display data products, due to broader structural changes in equity markets.

4.5.1 Shift in data consumption towards non-display data products

Another trend has been the shift in data consumption away from terminals towards non-display data feeds.

A non-display product is a licence to use market data for purposes in addition to visual consumption (e.g. on a terminal). For example, trading-based activities are normally covered under a non-display licence. In the case of a non-display data product, raw data is transmitted directly into computing platforms that analyse, monitor or create secondary data in line with the non-display policy of an exchange.

Alongside the growth of high-frequency and algorithmic trading, there has been shift of market data consumption away from terminals and towards direct and low-latency data products for automated applications.

¹⁰³ This figure is based on the Euronext fee schedule for January 2018.

This trend has had an impact on the revenue mix for data vendors and exchanges. Bloomberg's share of revenue from sales of its terminal fell from 85.22% in 2010 to 74.10% in 2017.¹⁰⁴ Similarly for Thomson Reuters, its revenue share from sales of its desktop terminal decreased from 46% in 2012 to 39% in 2017.¹⁰⁵

4.5.2 Growth in the demand for (non-equity) market data and related services

Another trend has been the growing demand for value-added data analytics services.

At the global level we have observed an increase in the spending on financial market data and data analytics, far beyond just the market data provided by stock exchanges for equity trading. Market commentators have estimated that, in 2017, total spending on all financial market data, analysis and news was USD 28.5bn.¹⁰⁶ While McKinsey & Company estimated the total value of the market for financial information to be USD 50bn in 2017.¹⁰⁷

This rising demand for data and data analytics extends far beyond the traditional categories of pre- and post-trade data that is licensed by trading venues. If we consider only the contribution of equity market data provided by the European stock exchanges, we estimate that it represents approximately 15% of the total European spending on market data and analysis.¹⁰⁸

Data vendors and exchanges have responded to changing consumer demands and preference through new product offerings. Examples include new tools for market data analysis, as well as supplying 'alternative data' such as social media sentiment analysis or satellite data.¹⁰⁹ Many of the exchanges have followed suit, entering into partnerships or acquisitions to incorporate these new technologies and expertise into their core operations. For example, in December 2018 Nasdaq announced the acquisition of Quandl, a provider of alternative data to users. Multiple exchange groups have recognised the applicability of artificial intelligence for operations and a potential first-mover advantage of adopting this technology. In this area we have observed similar partnerships by Nasdaq, London Stock Exchange, CME Group and Euronext.

The greater demand for data analytic capabilities beyond equity market data has been driven by three factors:

- great advances in information technology and the data processing capacity of end-users and the useful applications of big data analytics in financial markets;
- greater need for data to meet regulatory and compliance requirements; and
- the drive of trading participants to achieve a competitive advantage based on data capabilities.

¹⁰⁴ Burton-Taylor International Consulting; courtesy of *Financial Times* (2018b).

¹⁰⁵ Thomson Reuters Annual Report 2017.

¹⁰⁶ Burton-Taylor International Consulting; courtesy of *Financial Times* (2018b).

¹⁰⁷ McKinsey & Company (2018).

¹⁰⁸ This estimate is obtained by dividing total market data revenue of participating stock exchanges by an estimate of the total European spending on market data and analysis. Exchanges included: BME, Budapest SE, Deutsche Börse, Euronext, Nasdaq, Oslo Børs and SIX Swiss Exchange. The estimate was based on Burton-Taylor International Consulting (2017), excluding commodities & energy, fixed income sales & trading and FX/Treasury sales & trading segments.

¹⁰⁹ As reported *Financial Times* (2018a).

The impact of changing European and global financial regulation following the global financial crisis has motivated some vendors to focus on regulatory solutions. Establishing processes to ensure regulatory compliance can be carried out internally by financial institutions but can be outsourced to third parties. Vendors are increasingly seeking to provide value to clients through best-execution solutions, as this is more competitive for some end-users to outsource to a data vendor than process in-house.¹¹⁰ Similarly, the Fundamental Review of the Trading Book has imposed more stringent requirements on banks to understand and report the risks associated with their portfolios, requiring access to more and higher-quality market data.

4.6 Pricing structures of market data

The structure of market data pricing across stock exchanges varies along the following dimensions:

- type of user—e.g. professional, private;
- application of data—e.g. display/non-display, trading, index creation;
- level of volume—e.g. per message/quote/ticker;
- number of users by data product—e.g. volume discounts are often available for some non-display applications;
- number of users by physical id—e.g. fees charged per user, rather than per device or data product;
- product detail—e.g. Level 1, Level 2, full order book;
- product speed—real-time, delayed, end of day;
- level of disaggregation—e.g. consolidated or disaggregated. A consolidated data package is a data bundle granting access to multiple asset classes and/or trading venues. A disaggregated data package typically contains one isolated data product for a given security or trading venue.

We observed the following in the pricing structures across exchanges in Europe over the last decade.

- **Non-discriminatory access**—while fees do vary by intended use, the pricing schedules do not discriminate based on company name.
- **Netting policies**—exchanges now offer the option for fees to be paid per user, rather than per device or per data product, reducing the cost for end-users. Through the concept of 'netting' arrangements, or per physical user tariffs, users are therefore able to optimise their data costs and avoid unnecessary multiple billing. This could have occurred if an organisation had sourced market data through multiple data products or subscriptions.¹¹¹
- **Non-display fees** (see section 4.5.1)—since our last report, we have seen an increased use in non-display data fees across exchanges. Non-display pricing policies vary across exchanges. For example, Oslo Børs specifies a non-display licence fee based on the intended use of the data (e.g. trading),

¹¹⁰ Risk and compliance users were identified as the fastest-growing consumer market for 2017 in the data vendor sphere according to Burton-Taylor International. As reported in *Financial Times* (2018b).

¹¹¹ In 2018 Euronext established the similar concept of a 'natural user', where display data fees are billed based on the number of physical persons accessing disseminated data. Deutsche Börse similarly accounts for this with a 'per Physical User ID' tariff, priced approximately 10% higher than the 'per access ID' tariff, but with the possibility to net uses.

but does not distinguish between data products or asset classes. External distribution of this data would incur a separate distribution fee. Many exchanges charge non-display fees on a company-wide level, rather than per-device.

- **Direct access** (see section 4.4.1)—it appears to have become more common for latency-sensitive users to contract directly with the exchange than via a data vendor. This is typically subject to a periodic ‘direct access fee’ (also known as a ‘technical connection fee’), which is payable to the exchange, and can be either charged per legal entity or per data connection. In the case of the latter, there is scope for some discounting on the cost of additional connections at some exchanges (e.g. BME). Euronext allows for the netting of the distribution and direct access fee; trading members and redistributors are not subject to the latter. On the other hand, SIX Swiss Exchange charges data vendors both a distribution and a technical connection fee on a yearly basis.
- **Distribution licence fees**—parties that redistribute market data to market participants in a data vendor capacity are subject to a redistribution licence fee and, dependent on exchange, additionally the aforementioned direct access fee. Redistribution licences can vary from a complete entitlement to distribute across all asset classes, to restrictions by specific asset classes at a set depth and speed.
- **Disaggregation of data packages, offered alongside bundled packages**—MiFID II requires all trading venues to sell data products that are more granular. This involves providing pre- and post-trade data in a disaggregated fashion, i.e. available to be purchased separately. Trading venues are also required, upon request by customers, to provide data broken down by asset class, country of issue, currency and trading mode. This has significantly increased the choice of data packages available, but inevitably incurs technical and administrative costs.¹¹²

Outside the pricing structures of the primary exchanges, another development was that MTFs started charging for their market data. After the 2011 merger of BATS and Chi-X, the combined entity, BATS Chi-X Europe, began charging for market data in 2012, having offered market data free of charge following their entry as European MTFs.¹¹³ Similarly, Aquis, a London-based MTF, which had provided market data free of charge from its launch in 2013, introduced market data fees in 2018.¹¹⁴ For some of the uses identified in Table 4.1—including for example back and middle office, indexing, and retail investors—primary exchanges face direct competition from these alternative trading venues, whose data (at least at lower levels of latency) can be expected to closely reflect the market data available from the primary exchanges.

4.7 Market data revenues over time

It is useful to consider how the total market data revenues of different stock exchanges in Europe have evolved from 2012 to 2018.

¹¹² Alongside disaggregation and unbundling, MiFID II imposes some technical requirements on trading venues. These include a requirement that trading venues synchronise the business clocks they use to record the date and time of any reportable event to Coordinated Universal Time, with microsecond timestamp granularity. Similarly, ESMA requires that all trades conducted on venues are reported in a standardised way, using a range of four character flags to identify trades.

¹¹³ As reported *Financial Times* (2012).

¹¹⁴ Aquis Exchange (2018), p. 2.

Aggregate market data revenues have gradually increased over time, from approximately €230m in 2012 to approximately €245m in 2018.¹¹⁵ This is equivalent to an annual real growth rate of approximately 1%. Total market data revenue in 2018 represents approximately 0.003% of total market capitalisation for the same stock exchanges.¹¹⁶

Underlying this trend are several differences across stock exchanges:

- market data revenues for Wiener Börse, Deutsche Börse and Budapest SE fell over the period;
- for all other exchanges except SIX Swiss Exchange, revenues grew by less than 2% per year in real terms over the period;
- SIX Swiss Exchange market data revenues grew by 6% per year in real terms over the period. As explained above, SIX Swiss Exchange increased fees in 2016 and 2017. Despite this increase, SIX Swiss Exchange market data fees remained broadly in line with the average across stock exchanges. As noted below, the contribution of SIX Swiss Exchange market data revenue to its combined revenues from market data and trading services remained within the range of other stock exchanges.

The Oxera 2014 report on market data services analysed market data revenue as a proportion of combined revenues from market data and trading services (including membership and access fees). Figure 4.7 below shows how this proportion changed between 2012 and 2018.

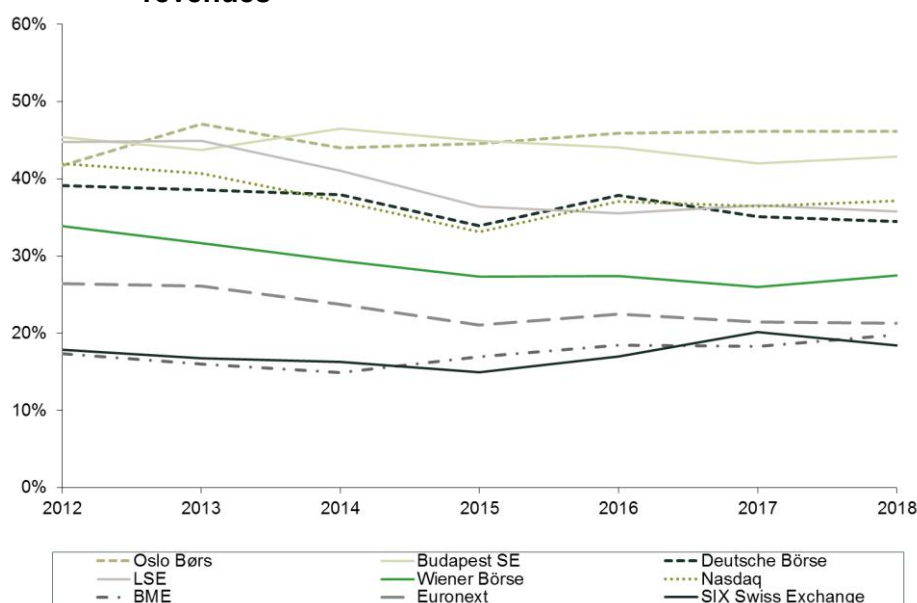
During the period 2012–18, market data constituted between 15% and 50% of combined trading and market data revenues for FESE members.

The changes in the ratios over time have been small and there was no clear pattern across stock exchanges, with the ratio slightly increasing for some stock exchanges and slightly falling for others. The average ratio across stock exchanges has remained steady in recent years, moving from 30% in 2015 to 31% in 2018.

¹¹⁵ Data covers the following exchanges: BME, SIX Swiss Exchange, Nasdaq, Wiener Börse, Oslo Børs, Budapest SE, Euronext and Deutsche Börse. 2018 revenue for Oslo Børs is indicative. 2018 revenues for other stock exchanges are provisional and unaudited. Market data revenues were provided directly by participating FESE member exchanges in local currencies (SIX Swiss Exchange and Oslo Børs revenues were converted to EUR). The revenue for BME, Nasdaq and Budapest SE are based on equity-only product revenue. Wiener Börse, Deutsche Börse and Euronext revenue covers cash market products only. Remaining stock exchanges are calculated using total market data revenues. Luxembourg Stock Exchange is excluded from this analysis due to the very limited share of equity trading in its business model.

¹¹⁶ Market capitalisation as of December 2018. Data provided by FESE.

Figure 4.7 Proportion of total joint revenues attributed to market data revenues



Note: All stock exchanges provided direct data except for London Stock Exchange, whose revenues have been sourced from annual reports (2018 based on preliminary results). The ratios for BME, Nasdaq and Budapest SE are based on equity-only figures. Wiener Börse, Deutsche Börse and Euronext ratios are cash markets only. Remaining stock exchanges are calculated using total revenues. Ratios are all calculated using revenue attributable to matching products. Luxembourg Stock Exchange is excluded from this analysis due to the very limited share of equity trading in its business model. 2018 data is provisional and unaudited.

Source: Oxera analysis of data provided directly by participating stock exchanges, and annual report data.

Overall, although the analysis shows some small changes in the ratios since 2012, there have been no substantial changes to the contribution of market data revenue to combined market data and trade execution revenue. The majority of revenues come from trade execution.

4.8 Market data fees over time

Figure 4.8 to Figure 4.11 below summarise how market data fees for different types of market data package have evolved since 2012. The Oxera 2014 report on market data services analysed how fees for different types of market data products had changed over 2005–12. It concluded that fees had not, in general, increased significantly (especially after taking inflation into account).¹¹⁷

An analysis of fees is subject to limitations. First, the purpose of the figures below is to measure changes in fees over time rather than comparing fees across exchanges, which would be challenging due to differences in the product coverage and fluctuations in the exchange rate. Second, the fees paid and data products purchased may depend to some extent on the type and profile of the user. A number of stock exchanges revised their fee schedule in 2018, which has resulted in certain types of user paying more and others paying less. In other words, there are distributional effects and the impact of such fee changes is difficult to assess by looking at individual fees. It is therefore relevant to look at revenues over time. As explained above, from 2012 to 2018, aggregate market data revenues increased year on year in real terms by approximately 1%. Furthermore, as explained in section 4.9 below, the unit costs (calculated as the total joint revenue from trade execution and

¹¹⁷ See Oxera (2014).

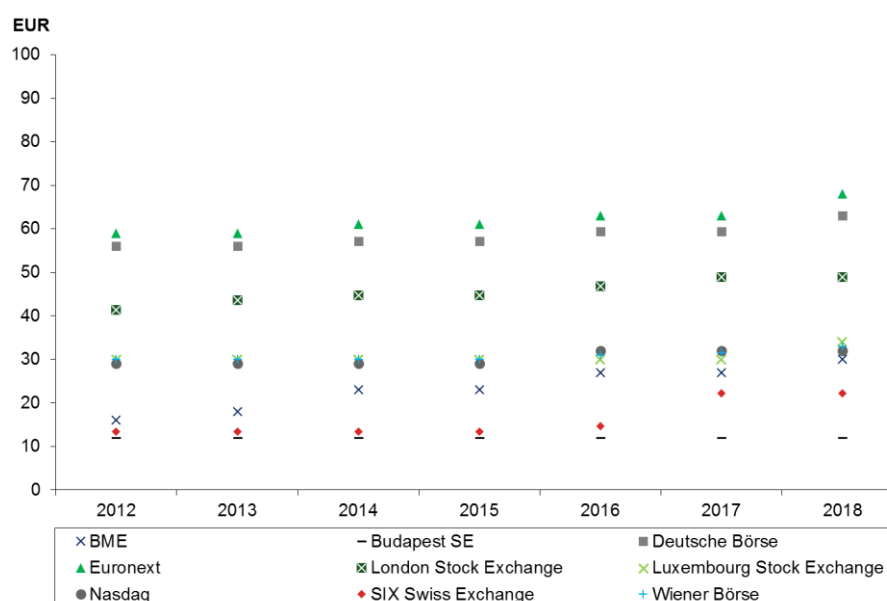
market data as a proportion of total value of trading in relevant securities) have declined for all stock exchanges considered, except one.

Figure 4.8 presents the changes in Level 1 market data fees from 2012 to 2018.¹¹⁸ As explained in section 4.3, a Level 1 data package typically includes the last price and the BBO available.

Oxera's analysis notes the following observations over the period:

- for all exchanges (except BME and SIX Swiss Exchange) fees increased by less than around 1.5% per year in real terms;
- BME revised its fee schedule resulting in a fee increase of 88% between 2012 and 2018. This percentage increase was applied to a relatively low base fee in 2012 and the level of the 2018 fee is below the average Level 1 fee observed across exchanges in 2018;
- SIX Swiss Exchange did not change fees between 2010 and 2015. The Level 1 fee was increased by 10% in 2016, by 52% in 2017 and held constant in 2018, all year-on-year. The 2018 fee is below the average Level 1 fee observed across exchanges in 2018;
- Budapest kept its Level 1 fee constant across the entire period.

Figure 4.8 Fee trends for a Level 1 data product (€)



Note: This figure illustrates fees over time rather than across stock exchanges. It would be challenging to compare fees across exchanges due to differences in the product coverage and fluctuations in exchange rates. The fees (€) are per access id/device in nominal terms. Fees for SIX Swiss Exchange and London Stock Exchange have been converted to € at the 2018 year-end European Central Bank published exchange rate. Deutsche Börse's fee is based on the product Spot Market Germany until 2017 and Xetra Core for 2018. Euronext's fee is based on the Euronext Cash Level 1 product, including data from its pan-European markets covering equities, ETFs, funds, warrants, certificates and fixed income markets.

Source: Data provided by the participating stock exchanges.

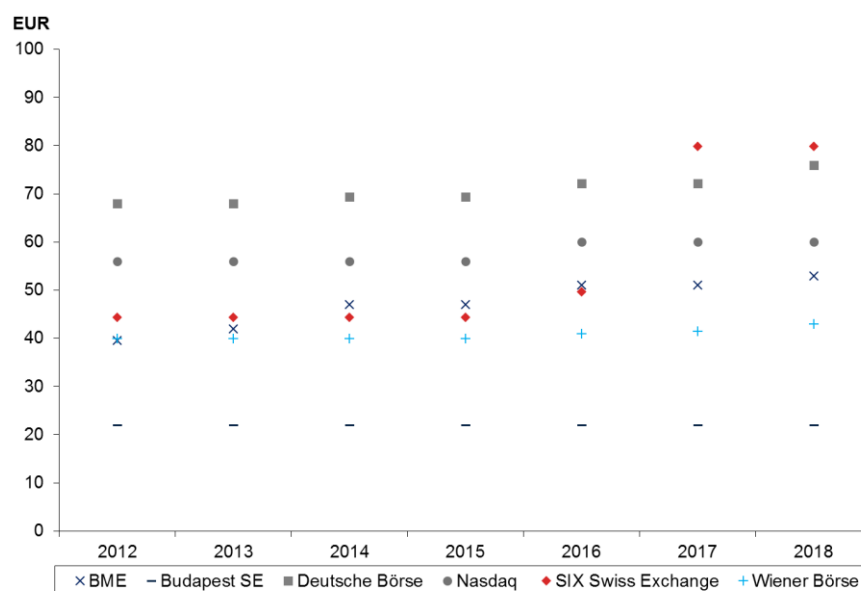
¹¹⁸ Oxera-defined Level 1 product offered by: BME, Budapest, Deutsche Börse, Euronext, London Stock Exchange, Luxembourg Stock Exchange, Nasdaq, SIX Swiss Exchange and Wiener Börse. Euronext's fee is based on the Euronext Cash Level 1 product, including data from its pan-European markets covering equities, ETFs, funds, warrants, certificates and fixed income markets.

Figure 4.9 below presents the changes in Level 2 market data fees from 2012 to 2018.¹¹⁹ As explained in section 4.3, a Level 2 data package typically includes the last price and the best five or ten bid and offers.

Oxera's analysis observes the following over the period.

- For all stock exchanges (except BME and SIX Swiss Exchange) fees increased by less than around 1% per year in real terms;
- BME revised its fee schedule resulting in a fee increase of 35% between 2012 and 2018. This percentage increase was applied to a relatively low base fee in 2012 and the level of the 2018 fee is below the average Level 2 fee observed across stock exchanges in 2018;
- SIX Swiss Exchange kept its Level 2 fees constant between 2010 and 2015. Its Level 2 fee increased by around 10% in 2016 and 60% in 2017 versus the previous year, respectively. There were no fee increases in 2018;
- Budapest kept its Level 2 fee constant across the entire period.

Figure 4.9 Fee trends for a Level 2 data product (€)



Note: This figure illustrates fees over time rather than across stock exchanges. It would be challenging to compare fees across exchanges due to differences in the product coverage and fluctuations in exchange rates. The fees (€) are per access id/device in nominal terms. Fees for SIX Swiss Exchange have been converted to € at the 2018 year-end European Central Bank published exchange rate. Deutsche Börse's fee is based on the product Spot Market Germany until 2017 and Xetra Core for 2018. London Stock Exchange Group, Euronext, Oslo Børs and Luxembourg SE's 'Level 2' data products have been excluded from this chart, since these 'Level 2' products provide full depth visibility of the order book. This corresponds to what most stock exchanges call 'Full order book', therefore we include these products in Figure 4.9 on 'Full order book' data products. All stock exchanges are based on at least a best five BBO product or at the next available depth.

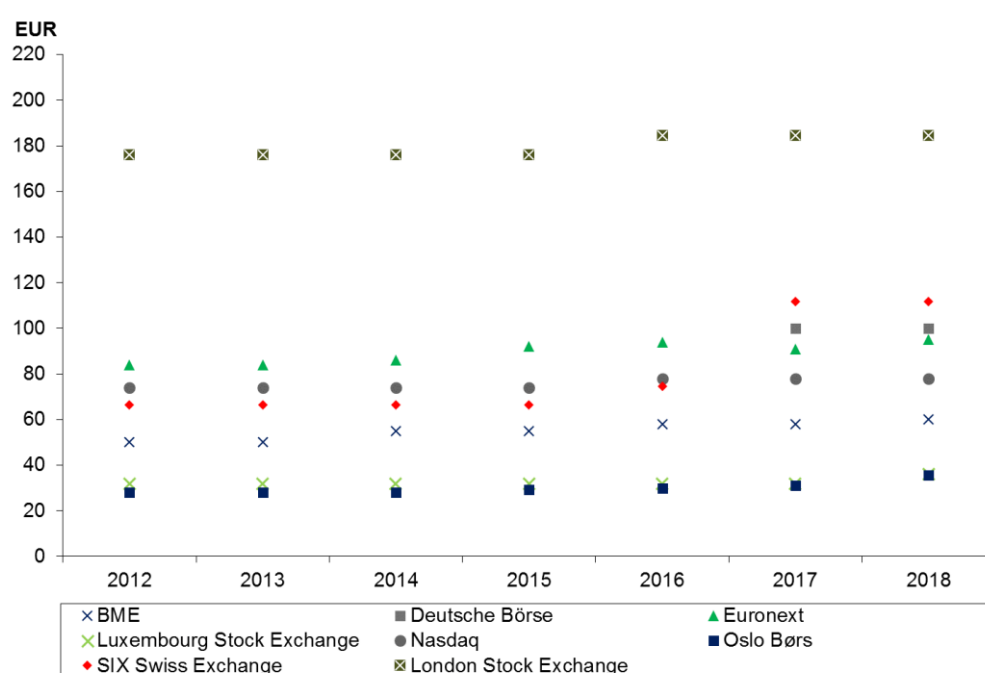
Source: Data provided by the participating stock exchanges.

¹¹⁹ Oxera-defined Level 2 product offered by: BME, Budapest, Deutsche Börse, Nasdaq, SIX Swiss Exchange and Wiener Börse. As Euronext, London Stock Exchange, Luxembourg Stock Exchange and Oslo Børs Level 2 products offer visibility over the entire order book, these are considered in the full order book analysis.

Figure 4.10 presents the fees for full order book data products from 2012 to 2018.¹²⁰ Oxera's analysis observes the following over the period.

- For all stock exchanges (except BME and SIX Swiss Exchange) fees increased by less than around 1.5% per year in real terms;
- BME revised its fee schedule resulting in a fee increase of 20% between 2012 and 2018. This percentage increase is high since it was applied to a relatively low base fee in 2012 and the level of the 2018 fee is below the average full order book fee observed across stock exchanges in 2018;
- SIX Swiss Exchange did not change full order book fees between 2010 and 2015. However, the fee was increased by 12% in 2016 and by 50% in 2017, and held constant in 2018 versus the previous year, respectively.

Figure 4.10 Fee trends for a full order book product (€)



Note: This figure illustrates fees over time rather than across stock exchanges. It would be challenging to compare fees across exchanges due to differences in the product coverage and fluctuations in exchange rates. The fees (€) are per access id/device in nominal terms. Fees for London Stock Exchange, Oslo Børs and SIX Swiss Exchange have been converted to € at the 2018 year-end European Central Bank published exchange rate. Deutsche Börse started offering one single full order book product (Xetra Order by Order) from 2017. Euronext's fee is based on the Euronext Cash Level 2 product, including data from its pan-European markets covering equities, ETFs, funds, warrants, certificates and fixed income markets. London Stock Exchange Group, Euronext, Oslo Børs and Luxembourg SE's 'Level 2' data products have been included in this chart, since they provide full depth of the book, which corresponds to what most stock exchanges call 'Full order book'.

Source: Data provided by the participating stock exchanges.

¹²⁰ Full order book products provide full visibility to the order book of the trading venue. Analysis of this fee was subject to stock exchanges offering this product. Considered stock exchanges include BME, Euronext, London Stock Exchange, Luxembourg Stock Exchange, Nasdaq, Oslo Børs and SIX Swiss Exchange. Budapest SE and Wiener Börse do not offer this product. Deutsche Börse started offering this product in 2017. Euronext's full order book analysis is based on the Euronext Cash Level 2 product, including data from its pan-European markets covering equities, ETFs, funds, warrants, certificates and fixed income markets.

Figure 4.11 below presents the fees for non-display data from 2012 to 2018. Based on a user profile at firm level for the use of at least the five best BBO,¹²¹ Oxera's analysis observes the following.

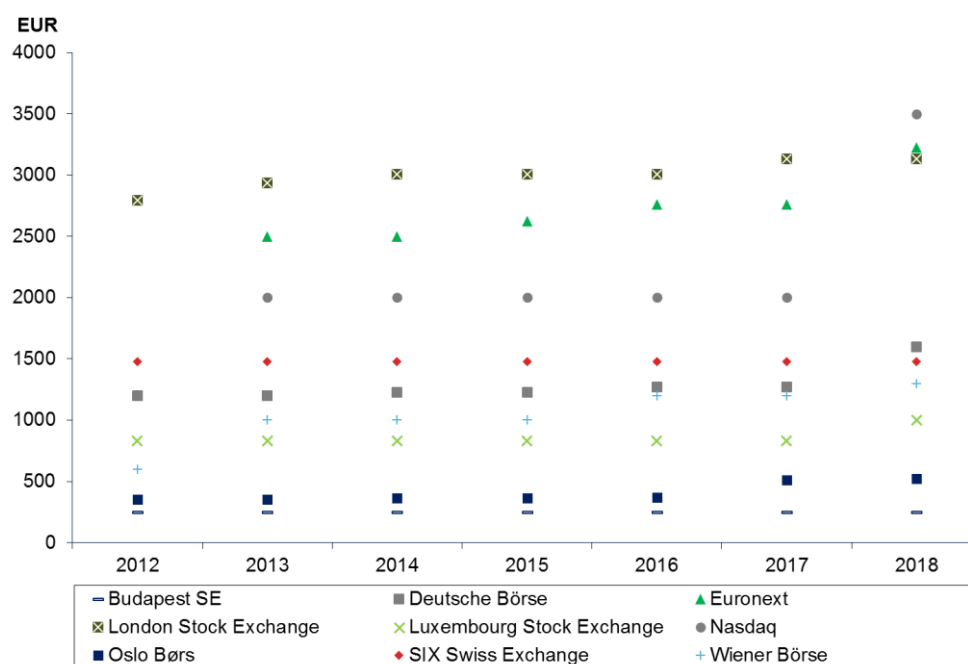
- For all stock exchanges (except Nasdaq and Wiener Börse), fees for non-display increased by less than 4.5% per year in real terms.¹²²
- Budapest and SIX Swiss Exchange retained a constant non-display fee across the entire period.
- Between 2012 and 2017, Deutsche Börse's fees increased by 6%. In 2018 its fee schedule was revised, resulting in some fee increases and some fee decreases for non-display data, depending on the data usage and user profile. The fee for the selected products in Figure 4.11 increased by around 25% on the 2017 level.¹²³ As explained above, the market data revenues remained fairly stable for Deutsche Börse over the period 2012–18.
- The structure of Nasdaq's fee schedule was revised in 2018, resulting in some increases and some decreases in the non-display fees, depending on the data usage and user profile. Nasdaq maintained a constant non-display fee between 2013 and 2017. In 2018, a user would have incurred a fee increase of 75% on the 2013–17 level. Oxera has observed that the equity market data revenue of Nasdaq remained fairly stable over the period 2012–18.
- Wiener Börse increased non-display fees between 2012 and 2018 by around 115%. This percentage increase is high since it was applied to a relatively low base fee in 2012 and the 2018 fee is below the average non-display fee observed across stock exchanges in 2018.

¹²¹ The structure of non-display fees varies across stock exchanges. The analysis presented in this section is based on a user profile at a firm level (or per legal entity) that seeks market data for exchange-specific trading use of at least the five best BBO.

¹²² Euronext and Nasdaq introduced a non-display fee from 2013 onwards, and any consideration of this fee for these exchanges encompasses the 2013–18 period only. Euronext's fee is based on the enterprise non-display use licence for the Euronext Cash Level 2 product, including data from its pan-European markets covering equities, ETFs, funds, warrants, certificates and fixed income markets. Nasdaq's fee is based on an equity depth data fee.

¹²³ Prior to 2018, Deutsche Börse levied fees for both internal and external use of data; for dual use, both fees were applicable. For Oxera's analysis prior to 2018, the non-display licence (internal use) for the Spot Market Germany product has been selected; for 2018, the product used for the analysis is Xetra Core for tier 3 users.

Figure 4.11 Fee trends for non-display usage



Note: This figure illustrates fees over time rather than across stock exchanges. It would be challenging to compare fees across exchanges due to differences in the product coverage and fluctuations in exchange rates. The fees (€) are per firm (or legal entity) in nominal terms and allow for exchange-specified trading use of at least the best 5 BBO. As a result, data coverage and depth can vary and some exchanges' fees are reflective of a more detailed product offering. For instance, Euronext and Nasdaq fees explicitly offer non-display access to the entire order book; the selected products are marketed as Level 2 and depth data respectively. The fees for Luxembourg Stock Exchange, Oslo Børs, SIX Swiss Exchange and Wiener Börse cover all data products. Deutsche Börse's fee is based on the Spot Market Germany product, internal use until 2017, and on Xetra Core for tier 3 users for 2018. SIX Swiss Exchange has a set fee for unlimited non-display internal use for trading purposes, covering varying data depth and products. SIX Swiss Exchange charges per application, with a capped fee for a company running more than five applications (using fewer applications incurs a fee per application). Oxera has plotted the fee for two applications, as this represents the average number of applications per client noted by SIX Swiss Exchange.

Euronext and Nasdaq introduced a non-display policy in 2013. In 2018, Euronext raised its firm-level fee, while introducing a (restricted) non-display use licence fee that is lower than the firm-level fee for smaller market participants. Oxera has selected the enterprise non-display use licence for the Euronext Cash Level 2 product, including data from its pan-European markets covering equities, ETFs, funds, warrants, certificates and fixed income markets. In 2018, Deutsche Börse expanded the classification of non-display user types, and Nasdaq implemented changes to its non-display fee schedule.

Fees do not consider discounts (such as the Oslo Børs member discount of 65%, or the London Stock Exchange member pricing). Fees for London Stock Exchange, Oslo Børs and SIX Swiss Exchange have been converted to euros at the 2018 year-end European Central Bank-published exchange rate. The 2018 Euronext fee marker is slightly hidden by that of London Stock Exchange.

Source: Data provided by the participating stock exchanges.

In addition to market data fees for display and non-display fees, Oxera has noted an average change in real-time distribution licence fees from 2012 to 2018 of approximately 1.5% per year in real terms.¹²⁴

¹²⁴ Per enterprise fees of real-time distribution licences for cash market data for Oxera-defined Level 2 depth. Average of the compound annual growth rate of the deflated series taken across the following stock exchanges: BME, Budapest, Deutsche Börse, Euronext, London Stock Exchange, Oslo Børs, Nasdaq Nordic, SIX Swiss Exchange and Wiener Börse.

In summary, the trend for price changes on market data fees has been reasonably stable in real terms. Oxera has observed some price increases for certain data packages, to reflect some structural changes to how some of the stock exchanges implement their pricing strategies, and in response to external forces (e.g. additional regulatory requirements from MiFID II). The structural changes in fee schedules have resulted in some users paying more and others paying less, while overall market data revenues increased only by approximately 1% on an annual basis (in real terms), as explained in section 4.7.

4.9 The end-investors' perspective

The main policy debate in Europe around market data has focused on the costs of market data services to brokers and fund managers. Brokers and fund managers are intermediaries and pass on the market data costs they incur to end-investors. To understand comprehensively the impact of the price of the market data provided by stock exchanges on the functioning of the market for equity trading, it is important to look at how these costs affect end-investors.

The focus on this report is on the equities market and the market data provided by stock exchanges. As explained above, equity market data provided by stock exchanges is typically only a small part of broader data costs incurred by these users. Therefore, for the purpose of this analysis, we ignore other data costs.

There are two ways to estimate the relative importance of market data fees compared to other costs incurred by end-investors.

- A 'top-down' approach compares market data revenues of a stock exchange (as a proxy for the market data fees incurred indirectly and directly by end-investors) against the domestic market capitalisation of stocks traded on the stock exchange (as a proxy for the value of investments held by the end-investors in the local market).
- A 'bottom up' approach considers all services provided to an end-investor, estimates the expenditure by each intermediary on market data, and compares this to the total costs of these services charged to the end-investor.

The top-down approach compares the total revenues earned by a stock exchange from equity market data services to the total market capitalisation of stock traded on such a stock exchange. The basis for this approach is that the main end-consumers of a particular stock exchange's market data are likely to be those investors holding the market capitalisation of stocks traded on the stock exchange.¹²⁵

Table 4.2 shows the contribution of market data revenues as a proportion of market capitalisation. It shows that the costs of market data represent less than 0.01% of the value of an investor's assets under management (AUM).

¹²⁵ This can be considered to be an upper bound, because some of the data purchased from an exchange will have been used to inform the decision not to purchase the listed equities, and thus will be borne by investors whose assets are not included within this particular stock exchange's market capitalisation.

Table 4.2 Market data revenues as a proportion of market capitalisation

Trading venue	Market data revenue as a % of market capitalisation of stocks traded on exchange, 2018
Wiener Börse	0.009
Budapest Stock Exchange	0.008
Oslo Børs	0.005
BME	0.004
Deutsche Börse	0.004
Nasdaq	0.004
London Stock Exchange Group	0.003
SIX Swiss Exchange	0.002
Euronext	0.002

Note: London Stock Exchange Group data is taken from the preliminary results for 2018, released on 1 March 2019; other stock exchanges directly reported data for 2018. Market capitalisation data represents the value on December 2018.

Source: World Federation of Exchanges and FESE; market data revenues provided directly by Budapest Stock Exchange, Wiener Börse, BME, Oslo Børs, Nasdaq Nordic, SIX Swiss Exchange and Euronext, or retrieved from London Stock Exchange Group 2018 annual report.

The bottom-up approach to estimating the significance of market data costs to end-investors is to consider the amount spent on the market data by each of the financial intermediaries using that market data. To fully understand the impact of the price of market data on these users, and on the functioning of the market for equity trading more broadly, we can compare the market data costs incurred by the intermediaries with the pass-on of the costs (i.e. the fees) that they typically charge to end-investors.

There are two types of intermediary providing services to end-investors that are likely to incur relatively material market data costs: fund managers, and brokers.

Table 4.3 provides estimates of the cost of market data services to the main user groups of this market data as a proportion of the fees they typically charge to end-investors.

Table 4.3 Market data costs as a proportion of other costs incurred by end investors

Service provider	Activity provided	Typical fees ultimately charged to end-investors	% of fee attributed to market data
Fund manager	Management of fund	0.3–1.5% of AUM	0.001–0.005
Large ¹ broker	Execution of trades	2bp of value of trading	1.2
Clearing member and custodian	Clearing and settlement of trades, and management of assets	3bp of AUM	0
CCP	Clearing of trades	0.12bp of value of trading	0
CSD	Settlement and custody of assets	0.17bp of AUM	0

Note: The analysis in this table is based on 2017 data. Fund manager and large broker analysis conducted on data sourced from stock exchanges. ¹ Transacting more than €50bn per year, as defined by one participating exchange.

Source: Oxera analysis.

Table 4.3 shows that the costs of market data services to investors are quite small. For large brokers the costs are less than 1.2% of the total annual costs of the trading in, and holding of, securities. For fund managers, the costs are less than 0.005% of the total annual costs of managing funds.

Market data costs are also a small proportion of total costs incurred to employ brokers. Based on the data reported by stock exchanges, we have estimated that per-user (device) licence fees for Level 2 data from the five biggest European stock exchanges amount to €502¹²⁶ per month. This is equal to around €6,100 per annum. Considering that typical salaries for traders with three to five years' experience are around €70,000–€105,000 per annum, with the potential for bonuses of 20–50%,¹²⁷ we can assess that market data costs account for approximately 4–7% of the typical broker salary.

These are important findings. Market data fees are only one component of trading costs. If market data costs are small relative to the other costs of trading and holding securities, changes in the fees for market data services would appear unlikely, in general, to have a significant effect on the overall level of activity of trading.

Likewise if the costs are small relative to other costs of managing funds, it would seem unlikely that changes in fees for market data services (from stock exchanges) would significantly affect the overall level of investment in funds.

Data provided by FESE member stock exchanges shows a general trend of increasing trading volume, alongside a fairly stable share of market data revenues as a share of the total combined revenues across the stock exchanges. It is also useful to look at the total unit cost—i.e. the total cost (of the joint product) per euro of stock traded. This is the metric that matters above all for the end-investor. The question is how much does it cost them to trade and how has this evolved over time.

Since 2012 the unit costs (calculated as the total joint revenue from trade execution and market data as a proportion of total value of trading in relevant securities) have declined for all stock exchanges considered, except one.¹²⁸ The exception to this was BME, whose total unit cost over the same period increased.

Overall, there is no evidence to support the claims of broad increases in the total effective cost of trades levied by stock exchanges.

¹²⁶ Deutsche Börse EUR 82, Euronext EUR 95, London Stock Exchange Group EUR 185, SIX Swiss Exchange EUR 80, Nasdaq EUR 60.

¹²⁷ See Page Executive (2018).

¹²⁸ Unit costs have been calculated as the total joint revenue from trade execution and market data for each exchange as a proportion of the total value of trading on the exchange. As some exchanges do not offer an equity-only market data product, the calculated unit cost must cover a broader range of asset classes. BME and Nasdaq unit costs cover equity only. Unit costs for Deutsche Börse, Euronext, and SIX Swiss Exchange also include fixed income, ETFs, funds and warrants. Unit costs for Budapest SE, London Stock Exchange, Oslo Børs, and Wiener Börse, include all assets—i.e. covering fixed income and derivatives as well. Revenues directly reported apart from Budapest SE and London Stock Exchange (annual report data); value of trading data from FESE (except London Stock Exchange, for which World Federation of Exchanges data was used).

5 Economic framework for assessing the impact of different charging structures for market data

Key messages

- For stock exchanges, trade execution and market data are joint products with joint costs—it is not possible to generate one without the other. Both services deliver value which means that stock exchanges can recover the joint costs through a combination of market data fees and trade execution fees.
- The core business model is to maximise order flow, by attracting traders to provide liquidity. Prospective investors seek venues that provide both access to reliable market data and low trade execution fees. Thus, there is competitive pressure on stock exchanges to ensure that the pricing of their services—for both market data and trade execution—should incentivise market participants to trade on their exchange.
- The economics literature suggests that in the case of joint products it is efficient to generate revenues through fees from both products. Indeed, this is what stock exchanges do in practice: they recover their joint costs through market data fees and trade execution fees. As explained in section 4, the share of revenues coming from market data services varies across stock exchanges and has been relatively stable over time.
- Different charging structures will result in winners and losers—i.e. there will be a distributional impact. For example, increasing the proportion of cost recovery through trading fees is likely to harm those who buy both trading and market data services. This is because anyone who buys trading services is also likely to buy market data services. Participants who consume market data only would then be contributing less to cost recovery, and the burden would fall more on a subset of market data users that are also trading participants. At the same time, increasing the share of cost recovery through market data fees is likely to harm those who consume market data but do not frequently trade, and benefit those who frequently trade and provide liquidity to the market.
- However, from a public policy perspective, the key question is whether the current practice of recovering costs (i.e. partly through trade execution fees and partly through market data fees) has any negative implications for the functioning of equity markets and their end-users—i.e. investors and companies raising capital. The economic framework in this section focuses on that question.
- Volume of trading—the direction of the effect is not clear-cut. With more cost recovery from market data services there may be increasing trading volumes from lower trading fees, but the higher market data fees may result in less data consumption by fund managers. This, in turn, could reduce the demand for trading services (if decisions are made not to trade when, with access to data, the decision would be to trade). Nevertheless, given that market data is likely to account for a small proportion of fund managers' overall costs, any potential impact on volume of trading is unlikely to be significant.

- Market efficiency—although there is some theoretical literature on this, there is not sufficient evidence from these models to draw a conclusion about the relationship between the efficiency of markets and the pricing of market data. In theory, charging for market data services could reduce the demand for data, and therefore potentially have a negative effect on the price formation process. However, if there are multiple trading platforms, individual platforms have incentives to ensure that they are attractive in terms of both fees (for trade execution and market data services) and non-fee elements (such as price formation and liquidity).
- Competition—the analysis indicates that there are no significant effects on competition. For example, the concern could be that market data fees may have a greater effect on smaller brokers and fund managers (who may make fewer trades per data user) than on larger players. However, in the unlikely event that this would encourage consolidation, this is unlikely to have a significant impact on competition due to the large number of fund managers and brokers in the market.
- In conclusion, the economic analysis suggests that current charging structures for market data are unlikely to have detrimental effects on market outcomes for investors.

5.1 Introduction

Section 2 described how a stock exchanges has two core functions: the provision of trading and price formation; and stock exchanges undertake a range of activities to facilitate these functions, which require investment and maintenance.

To deliver these functions, the stock exchanges generate revenues to cover their costs and to earn a return on their investment. Trading venues are characterised by high fixed costs, low marginal costs, and significant economies of scale. Most equity trading venues around the world generate revenues by charging both trading fees and market data fees, and, if relevant, fees for listing and post-trade services.

From a public policy perspective, the key question is whether the current practice of recovering costs (i.e. partly through trade execution fees and partly through market data fees) has any negative implications for the functioning of equity markets and their end users—i.e. investors and companies raising capital.

As explained in section 4, to understand the impact of the different charging structures on the functioning of equity markets, it is important to understand how the costs, passed on by financial intermediaries (brokers, fund managers etc.), affect end-investors.

This section sets out the economic framework for addressing this question and draws upon the analysis presented above in sections 2–4 and the relevant academic literature.

5.2 Economic framework

For the purpose of this discussion, trade execution and market data exhibit three main economic features that are important for discussing the economic framework for cost recovery in equity trading. In particular, trade execution and market data services are:

- joint products—it is not possible to generate one without the other (see Box 5.1);
- interdependent—the more trades you have, the more attractive the market data is, and vice versa;
- linked not only at the product level but also when it comes to consumption—market data is required for traders to take commercial decisions on trading.

First, as also explained by ESMA, trade execution and market data are joint products and have joint costs.¹²⁹ Given the general structure of electronic order books and electronic order matching, it is not possible to provide transaction services without generating market data, and it is not possible to generate pre-, or post-, trade data without also supplying a trade execution service (see section 2).

The joint product nature of market data and trade execution services, and the presence of 'joint costs', has also been acknowledged within the Commission Delegated Regulation:

The costs of producing and disseminating market data may include an appropriate share of joint costs for other services provided.¹³⁰

The total return that a stock exchange earns reflects the revenues it receives from the joint products and the total cost of the joint products. This means that the appropriate point of reference for recovering the costs in an economically efficient way is to look at the combined transaction and data revenues.

Box 5.1 Joint products

Joint products is an economic concept designed to explain a situation in which the production of one product simultaneously involves the production of one or more other products. This means that (at least part of) the production costs cannot be separated—they are joint costs. A textbook example is cattle livestock, which results in the production of beef and leather.

In other words, joint costs of production are incurred when production facilitates simultaneously two or more products in fixed proportions, such that an increase in the output of one product will necessarily mean a corresponding increase in the output of the other product.

A stock exchange or trading platform produces two products at the same time using the same inputs—'trade execution' and 'market data services'—as each transaction is necessarily linked to the production of data.

The joint production costs in this case are common costs that include the costs of designing, maintaining and operating the exchange's platform, as discussed in section 2.

Source: Based on Oxera (2014).

Second, market data and trading services are interdependent. This allows for the possibility that a higher volume of trading on a stock exchange makes its market data more attractive to buyers, for example. This is because more

¹²⁹ See European Securities and Markets Authority (2014), p. 221, para. 20.

¹³⁰ See Commission Delegated Regulation (EU) 2017/565, 25 April 2016, Article 85.

traders on a given venue contribute to a more reliable price formation process on that venue (see section 2).

Third, market data and trade execution are linked not only at the level of production but also at the level of consumption, due to the fact that market data is required in order for traders to take commercial decisions on trading. Thus, most market participants that pay for trade execution services will also purchase market data (see section 4).

The economic characteristics of the combined trade execution and market data services are relevant for the assessment of the cost recovery mechanism through analysis of different pricing structures for market data and trading.

5.3 Implications for pricing of market data and trading

Given the economic characteristics discussed in section 5.2, the next question is how stock exchanges generate revenues and set their prices.

Both services, trade execution and market data, deliver value to its users. For example, market data can generate value by informing trading strategies and can be used by trading venues that do not have a price formation process. This means that in practice stock exchanges are able to recover the joint costs (of trade execution and price formation) through a combination of fees for trade execution and market data services, and the exchange needs to find a balance between a number of competing constraints.

Trading venues are characterised by high fixed costs and low marginal costs, and significant economies of scale. In industries with these characteristics, the pure competitive outcome—whereby prices for all outputs are set at forward-looking marginal costs—may not be economically efficient. In particular, marginal cost pricing would not be sufficient to recover the total cost of production, and therefore trading venues would exit the market. (An outcome that would not be in the interests of the users of these services.)

Different market participants have very different valuations of what is essentially the same information. This suggests that charging a single price for all users may not be efficient. This is indeed what we observe in practice—the fees for market data depend to some extent on the type of usage of the data.

Since the costs are jointly incurred and cannot be separated, the costs of production cannot be allocated according to the input drivers, and are often allocated based on demand factors, such as price, revenue, or consumers' willingness to pay.¹³¹ One variant is to allocate costs using the Ramsey pricing principle.¹³² This states that it is economically efficient to recover a relatively large part of the costs from those customers whose demand is less sensitive to price than the demand of other customers. The efficiency of Ramsey pricing lies in the fact that it generally leads to higher total output, and hence higher surpluses for consumers.

It can be shown in economic theory that in order to maximise social welfare under these circumstances, the stock exchanges should be charging a price for each service that is inversely related to the elasticity of demand for that particular service. The intuition here is that if the customers are relatively insensitive to changes in the price for one of the goods, they will still be willing to buy that good at a relatively high price, and the producer of that good will be

¹³¹ As recognised in Marshall (1920).

¹³² See Ramsey (1927).

able to charge a relatively low price for the other good, for which the consumers are relatively sensitive to changes in the price.

Another characteristic of stock exchanges that is beneficial from a policy perspective is that, in this business model, shareholders are incentivised to maximise order flow. Thus there is competitive pressure on exchanges to ensure that the pricing of their services—for both market data and trade execution—should incentivise market participants to trade on their exchange.

Participants of a trading venue will not normally want to send their order to an exchange without some prior knowledge of the quotes and the prices on that exchange. The accuracy of the price formation (as discussed in section 2) is also of vital importance. At the same time, the more information on prices and orders that the stock exchange makes available to other participants, the easier it will be for trading to take place off-exchange. This is not merely a conceptual point, but has been happening in practice, with the emergence of alternative trading venues and greater trading on SIs and MTFs, as discussed in section 3.

Competitive pressure in equity trading, as discussed in section 3, incentivises stock exchanges to find the right balance of market data disclosure.

In practice, exchanges recover costs through both trade execution fees and market data services fees.

5.4 The impact of different charging structures

It has been established that the stock exchange needs to recover its costs for providing trading and price formation services, by charging trade execution fees and market data fees. But what is the impact of different charging structures?

A stock exchange will evaluate the profits it receives from both market data and trading services, and seek to set prices that maximise its overall profits. This will need to take into account the dependencies and demand elasticities between trade execution and market data, as briefly noted in section 5.3.

Different trading platforms may choose from a range of possible pricing strategies to recover costs. For example, some may choose to pay rebates to attract orders, charge relatively low prices for market data products (or provide market data for free), and charge relatively high prices for investors seeking to access already posted orders. Others could choose to pay lower rebates (or no rebates) to attract orders, set relatively high prices for market data products, and relatively low prices to access posted liquidity. For example, Cboe previously did not charge for market data in order to attract order flow, and used rebates from resulting additional executions to maintain low trade execution charges for its users.

Important network effects are at work here, which make this case unusual from an economic perspective. A trader will be attracted to a trading venue that has reliable prices (high quality price formation), high liquidity, and low trading execution fees. At the same time, lower market data fees make off-exchange trading more attractive,¹³³ which can reduce liquidity and price formation on the

¹³³ Lower market data fees will make off-exchange trading more attractive through two channels: i) due to the fact that market data is often used as an input into the business model of this type of trading (see section 3.3 for details); and ii) due to the joint cost nature of market data and trade execution, which means that lower market data fees would result in higher trading fees on the primary exchanges, making them less competitive than trading fees off-exchange.

exchange. This would suggest that the more that costs are recovered through market data fees and the less through trading fees (i.e. lower trading fees), the greater the liquidity and the better the price formation on the trading venue.

There is, however, a limit to this feedback loop. Traders would normally trade on a venue only if they have access to good information about prices and quotes to inform the trading decision. This means that the trader will also be attracted by lower market data fees. If the cost recovery through market data fees becomes too high, potential new traders may not post new orders, and price formation and liquidity would diminish.

5.4.1 Distributional effects and impact on volume of trading

The choice of whether to recover costs through market data or trade execution will result in distributional effects. Changing the balance of cost recovery may create winners and losers among market participants.

The number of customers purchasing data services will tend to be higher than the number of buyers of trade execution services. Those who buy trade execution services are also likely to buy market data services to inform their trading strategies. However, other customer groups (e.g. fund managers and dark pools and other trading venues) will also value market data services as a key input into their business models, without requiring the trading services.¹³⁴ These customers are generally buying the market data thanks to the value generated by the price formation process provided by the stock exchange. As a result of there being a higher number of customers purchasing market data services than trading services, reducing market data fees and increasing trade execution fees will tend to leave those purchasing both services (e.g. primarily brokers) paying, in aggregate, more to trading venues, while those who use only market data services will pay less. This is because a larger proportion of costs are now being recovered through trading fees, for which there is a smaller consumer base.

The change in the structure of trading venue prices is also likely to have a differential relative effect within different customer groups. Assuming that the only relevant costs are a fixed data fee and a per-unit trading fee, the balance of data and execution fees results in different unit costs for users with different volumes of activity and different marginal costs for each trade. Shifting costs from market data services to trading services, for example, would improve the competitive position of brokerage firms with the highest data needs, given their trading activity.

These distributional effects of changes in charging structures can be explored by considering two highly stylised and hypothetical examples. In the first, the hypothetical monopolistic exchange recovers all costs through market data fees, and in the second, it recovers costs purely through trading execution fees.

If the stock exchange were to recover all costs through market data fees, and trade execution fees were set at zero, this would lead to:

- an incentive for market participants to maximise their volume of transactions per data user (to spread the fixed cost of market data across more trades);

¹³⁴ Although most fund managers do not purchase trade execution services directly themselves, they are users of market data and pay for it indirectly. However, the cost recovery mechanism is different. For trade execution, the costs are deducted from the value of the fund. However, for market data the fund manager pays directly themselves and the cost is deducted from its annual management charge.

- consolidation among brokerage firms, as niche brokers with fewer and smaller trades per trader are disadvantaged, but there are still sufficient brokers for competition to be effective;
- lower marginal transaction costs (from lower trading fees) and potentially narrower spreads, although the reduction in spreads would be offset by the need to compensate market makers for higher data fees;
- more trading from brokers, which contributes to improved liquidity;
- fund managers paying more for their data services, which could lead to a reduction in the consumption of market data, and in turn to a reduction in the demand for trading services.

This implies that there are two potentially opposing effects as the marginal cost of trading falls, but fund managers experience rising costs of developing trading strategies. However, as shown in section 4, the current cost of market data to fund managers accounts for approximately 15% of the market data value chain. Therefore, any potential negative impact on trading is likely to be small, and, overall, high data fees and low trade fees can be expected to result in fewer traders and brokerage firms, and more marginal transactions. (For further details on market data costs as a proportion of other costs incurred by end investors, see Table 4.3.)

If the stock exchange were instead to recover all costs through trade execution fees, and market data fees were set at zero, this would lead to:

- a lower fixed cost, but higher variable costs, associated with providing brokerage services;
- traders with lower volumes per data user gaining an advantage, and participants with high trading volumes per data user losing out;
- rising overall costs recovered from trading participants, as those consuming market data but not directly involved in trade execution (e.g. fund managers and dark pools) are no longer contributing to cost recovery for the trading venue.

Overall, low data fees combined with high trade fees can therefore be expected to result in more traders and/or brokerage firms, and fewer marginal transactions. The general pattern is that anyone buying both trade execution services and market data services will be worse off, while those buying market data only will be better off.

In this simplified example, the main drivers of transaction volumes are subject to conflicting pressures. The balance of the outcome will depend on how strong each dynamic is.

5.4.2 Impact on market efficiency

Another consideration is how different charging structures might affect broader market efficiency. One factor here is the potential effects of cheaper or more expensive dissemination of market data, and how this might affect price formation and the cost of capital, and lead to wider effects on the financial markets as a whole.

The literature on the impact of exchange charging for market data on wider market efficiency is limited and still developing. Two theoretical papers have

sought to model this effect directly, albeit with critical assumptions that drive the results.

The first is Easley, O'Hara and Yang (2016), who present a theoretical model of differential access to price information, with two critical assumptions.

- The paper considers a single monopolistic exchange—in other words, the model assumes that the quality of the price formation process is something generated by the participants' actions, without allowing participants to choose between venues of different quality. Allowing such a choice results in an important insight: because participants will prefer the market with the best price formation, if data fees harm or reduce this price formation, a venue charging high fees will become less attractive and therefore less competitive:

[t]o the extent that traders perceive greater ambiguity attaching to markets that selectively sell data, they can opt to trade elsewhere or not at all. Such an outcome will surely restrict an exchange's data sales even without regulatory involvement.¹³⁵

- The paper also assumes that the exchange derives revenues from the sale of price information only, and ignores trade execution revenues. This also means that when, in the authors' theoretical model, the exchange introduces market data fees, there is no impact on trade execution revenues. The paper explains that '[f]ully incorporating this linkage would significantly complicate the analysis.'¹³⁶ In other words, the paper does not incorporate the joint product nature of market data services.

The authors predict that charging for market data fees will increase the cost of capital and asset volatility and reduce their chosen metrics for price formation and liquidity. One would expect such a prediction if the model ignores competition between stock exchanges and the joint product nature of market data and trade execution. The authors do explicitly recognise that 'in reality exchanges also derive revenues from a variety of sources, including trading fees'¹³⁷ and that there is competition between trading platforms, and that these facts were ignored in order to simplify the model.¹³⁸ Indeed, the authors specify that "in the presence of multiple exchanges, the competition among them tends to improve market quality and benefit liquidity traders".¹³⁹

Cespa and Foucault (2014) present another model that seeks to take into account the joint product nature of trading and market data. In this case the exchange can now derive revenue from both trade execution and market data.

However, as with the Easley et al. paper, the limitation of the Cespa and Foucault paper is that it still does not model for the competitive dynamics between trading venues. Instead, the model considers a monopolistic exchange. As the theoretical monopoly exchange does not face competition, it is optimal for it to restrict access to its market data, which would limit price formation and harm liquidity. Importantly, the paper does include some sensitivity analysis with an element of competition for order flow, and then concludes that the effects on price formation and liquidity are 'less clear cut'.

¹³⁵ Easley, O'Hara and Yang (2016), p. 1101.

¹³⁶ Easley, O'Hara and Yang (2016), p. 1082.

¹³⁷ Easley, O'Hara and Yang (2016), p. 1082.

¹³⁸ Other limitations to this paper include the way in which the contribution of high-frequency traders is modelled; however, as these are less relevant to this section, we do not elaborate on them here.

¹³⁹ Easley, O'Hara and Yang (2016), p. 1099.

The authors also model the welfare effects of different charging structures, and do not find any conclusive results.

In summary, some recent theoretical contributions suggest that, under certain specific conditions (e.g. no competition in equity trading), charging for market data could impair price formation. However, as also discussed in section 5.3, when competition for equity trading is present, the incentives of the stock exchange are to maximise trading flow, which prevents it from setting market data fees at a level that would negatively affect the price formation process.

5.4.3 Impact on competition

From a competition policy perspective, a question would be to what extent market data fees could affect the viability of new trading platforms that use market data. The evidence discussed in section 3, points to significant acquisition of market share by new-entrant MTFs and other alternative trading venues. The amount of dark trading in Europe has also been growing significantly.

As previously discussed, trading on dark pools is not price-forming, as trades are executed at reference prices based on lit venues. As a result, these venues are particularly building their business models using market data provided by stock exchanges. Therefore, a monopolistic exchange could in theory use market data pricing as a strategy to deter entry by such trading venues. However, the significant growth in dark trading of European equities and the resulting MiFIR DCVM on trades using the waiver system suggest that, if anything, regulators view the level of market share acquired by dark pools as too high.

Overall, there is no evidence to suggest that market data fees charged by stock exchanges have adversely affected the level of entry and competition among trading venues.

As noted in section 5.4.1, the distributional consequences of different charging structures for market data could potentially have impacts on consolidation of brokers and fund managers, as different patterns of cost recovery benefit different brokers. However, the impact of such changes is likely to be small given the large number of fund managers and brokers currently in the market. As such, market data is unlikely to have significant effects on competition in the market for brokers and fund managers.

5.5 Conclusions

This report provides an economic framework to assess the impact of stock exchanges charging for market data services on end-users and the functioning of equity markets.

Section 2 explained the key contribution of stock exchanges to European equity markets. As well as matching buyers and sellers, stock exchanges have a widely recognised role in price formation. Market data can be seen as an output of the activities that a stock exchange undertakes to support these functions.

It was shown how price formation brings many benefits. Stock exchanges, by contributing to better price formation, contribute to fairer and more efficient markets and a lower cost of capital for businesses. Reliable price formation is (partly) what makes market data valuable. Indeed, the rise of new trading venues in European equity markets has been made possible due to non-

discriminatory access to equity market data and the price formation process provided by stock exchanges.

Section 3 assessed the impact of regulatory change on the market design of equity trading and price formation. Increased competition for equity trading in recent years has resulted in lit exchanges losing market share to trading venues that contribute little, if anything, to price formation. This has been recognised by regulators. Given the regulatory objectives to support price formation and promote more trading on lit markets, policymakers should be cautious when assessing the impact of MiFID II in order to avoid the risk of further undermining price formation.

Section 4 described the value chain for market data services and reported the trends in fees, revenues and cost per user for market data. Data provided by stock exchanges is part of a much larger data value chain that includes data vendors, software providers, IT and connectivity infrastructure, and end-users. The empirical analysis in section 4 suggests that there is no evidence to support the view that there are widespread increases in stock exchanges' revenues for market data services.

Contrary to concerns raised by market participants, the empirical analysis in this report has found that, for most stock exchanges, market data fees have been relatively stable, and that for all of them the proportion of revenues coming from market data services has also been fairly stable. Furthermore, the total cost for end-users per euro of stock traded appears to have generally fallen across exchanges.

Finally, section 5 has provided an economic framework to bring together the analysis in the earlier sections and assess the impact on end-users of charging for market data, which is ultimately what matters for the functioning of equity markets. The first important point to note is that stock exchanges have an incentive to find a balance in setting their fees. Given the economic characteristics of trading and the incentives of stock exchanges to maximise orders, it is to be expected that stock exchanges should recover some of their costs through market data services fees and some through trade execution fees.

Although charging for market data services will result in winners and losers (i.e. some market participants end up paying more in total while others end up paying less), the key question is whether the current practice of recovering costs (i.e. partly through trade execution fees and partly through market data fees) has any negative implications for the functioning of equity markets and their end-users—i.e. investors and companies that are raising capital.

Shifting costs from market data services to trading services, for example, would improve the competitive position of those brokerage firms with the highest data needs given their trading activity.

However, the number of customers purchasing data services tends to be higher than the number purchasing transaction services. This is because anyone who purchases trading services is also likely to purchase market data services, while some customer groups (such as fund managers, media outlets, dark pools) will purchase market data services but not directly purchase trading services or other related services for which a stock exchange charges a fee.

The general pattern is therefore likely to be that those who purchase both transaction services and market data services will be worse off, while those who purchase only market data will be better off. For some brokers, market

data is free of charge, and these brokers will therefore not benefit from lower data fees, and will experience only the higher trading fees.

From an end-investor perspective, this may not matter much. If trading fees were increased and market data fees reduced, the fund management fee would decrease, but commissions paid to brokers (often directly by the funds) would increase.

Although there is some assessment in the economics literature of the impact on market efficiency of charging or not charging for market data services, there is not sufficient evidence from these models to draw a conclusion on the relationship between the efficiency of markets and the pricing of market data. In theory, charging for market data services could reduce the demand for data and therefore potentially have a negative effect on the price formation process. However, if there are multiple trading platforms, individual platforms have incentives to ensure that they are attractive in terms of both fees (for trade execution and market data services) and non-fee elements (such as price formation and liquidity).

In conclusion, the economic analysis suggests that the current charging structure for market data is unlikely to lead to detrimental effects in terms of market outcomes for investors.

At the same time, the analysis suggests that although MiFID I and II have been successful in introducing competition and creating a market that delivers well in terms of choice and low trading fees, there is a risk that the growth in equity trading off-exchange will threaten the quality of price formation going forward. Any further changes to the design of the market for equity trading would need to ensure that the price formation process is not negatively affected.

A1 Price formation in fixed income markets

In any financial market, prices are formed from the interaction between 'informed' and 'uninformed' investors, who incorporate information into prices. This was described in section 2.

In practice, there are differences between the price formation processes in equity, the focus of this report, and fixed income markets, partly as a result of differences in the microstructure of these markets. In this appendix, we set out the main characteristics of fixed income securities and describe the role of different market participants, including stock exchanges, in the price formation process.

A1.1 Key features and regulatory framework

While a large proportion of equities are traded on trading venues, fixed income securities are exchanged mostly OTC. OTC markets are dealer-intermediated and quote-driven, with no pre-trade information being disclosed. Furthermore, fixed income securities are typically characterised by relatively low levels of trading activity.¹⁴⁰ Large institutional investors, such as pension funds and insurance companies, which are among the main investors in bonds, tend to adopt a buy-and-hold strategy. Typically, they buy large volumes of bonds and hold them for long periods of time.

The lack of transparency in OTC fixed income markets has drawn regulatory attention and prompted intervention, with MiFID II being a recent example. The Directive introduced some important pre- and post-trade transparency obligations in relation to fixed income securities, in order to:

- create a price formation mechanism for fixed income securities;
- shift trading away from OTC markets to organised trading venues, such as RMs, OTFs and MTFs (see section 3.2 for further details on MiFID II);
- increase the amount of available reference price data.

The pre-transparency requirements set by the MiFID II can be waived under certain conditions—for instance, if the transaction involves orders larger in scale than for normal market practices.¹⁴¹ As a result, not all outstanding fixed income securities are currently subject to MiFID II transparency obligations.

A1.2 Price formation and market data

Three main information sources inform the price formation process.

- Data on actual trades—trade data is published by trading venues or through approved publication arrangements for securities traded OTC. For fixed income securities, the most recent price for a 'highly liquid' security, such as a high credit quality (e.g. AAA) corporate bond, could be several hours or even several days old.
- Quotes from dealers—fixed income markets are largely quote-driven, in which trades are executed through dealers. The dealers, working with

¹⁴⁰ Association for Financial Markets in Europe (2012).

¹⁴¹ It is possible to defer transparency obligations if the instrument does not have a liquid market, or if the transaction size is above large-in-scale thresholds, or above a size specific to the instrument. ESMA publishes quarterly liquidity assessments for bonds, providing indications on the extent to which each instrument is to be considered liquid.

investment banks, commercial banks, and broker-dealers, provide to potential buyers or sellers quotes for different instruments.

- Estimation of the fair value of the securities—clearing houses, asset managers, brokers and custodians are continuously valuing securities for collateral purposes. Their estimations incorporate traded price information and current dealer quotes, together with other publicly available information and analysis of issuer creditworthiness.

Owing to the low volumes of trading, stock exchanges not only rely on their own trade execution data, but also gather data and analytics from other sources, including other trading venues, APAs, dealers, issuers, analysts and other market participants involved in the valuation of fixed income securities. This allows them to provide both indicative and valuation prices in relation to each fixed income security.

For 'highly liquid' securities, indicative prices are calculated by consolidating pricing data from different trading venues. In doing this, trading venues ensure that the prices published and accepted for trading on their platforms are within an acceptable range.

Valuation prices are an attempt to calculate the fair valuation of a security based on analysis of fundamentals. Stock exchanges often validate and publish valuation analyses provided by issuers, contributing to the dissemination of information that would otherwise be more difficult to obtain.

The market data on fixed income securities that is produced by stock exchanges is used by market participants such as broker-dealers and asset managers, investors, issuers, and clearing houses.

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