NORGES BANK
INVESTMENT MANAGEMENT

02 | 2020

THE ROLE OF CLOSING AUCTIONS IN WELL-FUNCTIONING MARKETS

ASSET MANAGER PERSPECTIVE

The growth in volume share at the close of the trading day has been well documented in the literature. Beyond their positive contribution to end-of-day price discovery, closing auctions have become significant liquidity events. We present several factors that have contributed to the volume growth, arguing that it is structural and not limited to the commonly cited growth in 'passive' investing. In our view, well-designed closing auctions attract natural liquidity and contribute to efficient price discovery.

In this note, we discuss some of the key themes around closing auctions in terms of their impact on both global asset managers and the well-functioning of financial markets. We show that, amongst the different market designs, auctions have become more attractive for equities as the mix of market participants has evolved. We then argue that well-functioning closing auctions have certain defining characteristics, enabling the benchmarking of exchanges' offerings globally. Lastly, we discuss the impact that the increase in closing auction volume has on broker product offerings. Our experience shows that the product offering is still evolving. We highlight some product aspects that would be beneficial to global asset managers.

Date 03/03/2020

The Asset Manager Perspective series articulates Norges Bank Investment Management's views and reflections on issues topical for the financial industry. They are not meant to be definitive; rather they are intended as timely contributions for the benefit of all market participants. The series is written by employees and is informed by our investment research and our experience as a large, long-term asset manager.

Contact information:
amp@nbim.no
www.nbim.no

ISSN2387-6255

Introduction

The structure of a market for financial assets is determined by several factors, including the historical precedent, technology, the set of market participants, as well as the regulatory framework. Changes in market structure are generally gradual, punctuated by rapid transformations. These transformations are often driven – at least with the benefit of hindsight – by specific technological or regulatory innovation. An example of technological innovation is the automation and 'electronification' of many asset markets, due both to changes in the technologically feasible set and to competitive cost pressures. The recent shift from dark pool trading to systematic internalisers in Europe is an example of regulatory driven innovation.

The appropriate measure for evaluating such transformations is whether they contribute to the well-functioning of markets. Every transformation affects the efficiency of financial markets – it has the potential to impact price discovery and liquidity, but it can also change the relative profitability of different types of market participants. Given the complexity of the market ecosystem, some transformation may also lead to unintended consequences.

We argue that equity markets are currently undergoing another rapid transformation, with trading volume shifting from the intraday, continuous session to auctions, particularly to the closing auction. There does not seem to be a clear technological or regulatory impetus to this transformation. Rather, it is the result of the interplay between a changing mix of market participants, efficiency of intraday price discovery leading to higher market impact costs for large trades, and greater competitive pressures on asset managers.

From a global asset manager perspective, the shift of trading volume towards the closing auction raises several questions. The first question is whether the shift is structural or a temporary result of relatively benign market conditions over the last few years, prior to the recent market turmoil. Second, if the shift is structural, what impact does it have on execution strategies for asset managers as well as for liquidity providers? Third, what is the most appropriate structure for a closing auction to facilitate efficient price and volume discovery? How can primary exchanges as closing auction operators, and brokers as our agents participating at the auction, structure their offerings to contribute to a fair and efficient price and volume discovery? Lastly, and on a more normative basis, is the shift towards closing auctions an overall positive for the well-functioning of markets?

In this note, we discuss some of the issues around closing auctions in terms of their impact both on global asset managers and on the well-functioning of markets. We show that, amongst the different market mechanisms available, auctions have arguably become more attractive for large-capitalisation equities as the mix of market participants has evolved. We then argue that well-functioning closing auctions have certain defining characteristics, enabling the benchmarking of exchanges' offerings globally. Lastly, we discuss the impact that the increase in closing auction volume has on broker

product offerings. We argue that the product offering is still evolving and highlight some aspects that would be beneficial to global asset managers.

Trading Mechanisms and Auctions

Financial markets use several mechanisms to match buyers and sellers. The main challenge is that natural buyers and sellers do not arrive in the marketplace at the same time. Hence, the level of natural market liquidity depends on the probability of a natural liquidity match happening within a suitable time frame. The availability of natural market liquidity influences which mechanism dominates for a given asset class.

Auctions offered by exchanges are one of these mechanisms. Their distinguishing feature is that they allow for simultaneous, multilateral trading – they aggregate the trading demand at a discrete point in time, with any matched transactions taking place at the same price. This type of auction typically takes place a few times per day, for example at the open, midday, or close.

Auctions compete with other common market mechanisms, including continuous limit order books offered by exchanges as well as dealer liquidity provisioning. Market liquidity shapes the choice of market mechanism and is in turn shaped by the set of available mechanisms. Liquidity is a measure of the number of market participants, of their heterogeneity, and of the frequency with which they desire to implement changes in their asset holdings.

Liquid asset classes, such as large capitalisation equities, can support continuous limit order books as the market mechanism. There are many market participants, they are heterogenous, and their desire to trade is frequent enough to give a sufficiently high probability of a natural liquidity matching occurring. A transparent continuous limit order book can facilitate a rich set of signalling strategies, which lead to natural liquidity matching. Intermediation by market makers, when it exists, is relatively limited and focused on short-term liquidity provisioning.[1]

At the other end of the liquidity spectrum, for example corporate bonds and smaller capitalisation equities, the simultaneous occurrence of a natural match of similar trade size between a buyer and a seller is generally rare. This provides a market opportunity for dedicated intermediaries, such as market makers or dealers, to act as liquidity providers. If asset returns are driven by relatively few systematic factors, capital requirements for liquidity provisioning are relatively low. This leads to ample liquidity provisioning relative to the desired trade sizes. Historically, many fixed income asset classes have had these characteristics. Other asset classes' returns are driven by a higher number of systematic factors, requiring more capital for

1 On speed races in continuous vs. discrete market designs, see Budish E., Crampton P., and Shim J., "The high-frequency trading arms race: Frequent batch auctions as a market design response." The Quarterly Journal of Economics 130, no. 4 (2015). From a practitioner's perspective, see "High frequency trading: An asset manager's perspective", Norges Bank Investment Management, Discussion Note, no. 1 (2013).

liquidity provisioning strategies. Consequently, these asset classes see less intermediation, and hence less trading activity and liquidity.

Auctions can serve as the market model for assets that sit between these two extremes on the liquidity spectrum. Concentrating trading at focal points in time can serve to increase the probability of a natural liquidity match, even if the number of market participants is relatively low. Indeed, market structure theory suggests that under certain conditions auctions can offer an efficient aggregation of information leading to better price discovery.[2]

Closing Auctions Market Features

While global equity markets, in particular, have seen the introduction of several different auction elements and designs, auctions as the market closing mechanism have become near universal. Closing prices are of particular importance in equity markets. They often serve as reference prices for derivative contracts, for the calculation of fund net asset values, and for the computation of portfolio and benchmark returns. Establishing an efficient process for determining market-clearing closing prices is thus important for investors and for the well-functioning of markets.

The changing roles and responsibilities of market makers, as well as the move from a quote-driven dealer system to an order-driven, automated market system, have often led to the need for a distinct opening and closing auction event. The London Stock Exchange (LSE), for example, introduced a closing auction in 2000, in part as a result of moving to an automated order-driven trading system in 1997.[3]

In the absence of closing auctions, several alternative processes have been used in the past to determine a closing price. At the simplest, the last trade in continuous trading established the closing price. This was the case for the Paris Bourse until 1998, for example. Alternatively, a volume- or time-weighted average price over some time period has been used, such as at the Hong Kong Stock Exchange until 2016.[4] These processes have shown greater susceptibility to price manipulation. Almost all exchanges, particularly in developed markets, have gradually replaced these processes with an auction process for price discovery.[5]

The academic literature is generally supportive of the positive role of auctions at making the closing price discovery more efficient. Hillion and Suominen (2004) and Pagano and Schwartz (2003) demonstrate that the introduction of a closing auction in Paris Bourse improved price discovery

2 See discussion in Madhavan, A., "Trading mechanisms in securities markets." Journal of Finance 47, no. 2 (1992).

3 Ellul, A., Shin H.S., Tonks I., "Opening and closing the market: Evidence from the London Stock Exchange." Journal of Financial and Quantitative Analysis 40, no. 4 (2005).

4 The HKEX had introduced a closing auction mechanism in 2008; however this was suspended in March 2009, and replaced with a time-weighted average price mechanism. The re-introduction of a closing auction session in 2016 incorporated a price limit based on reference prices.

5 Cordi, N., Félez-Viñas, E., Foley, S., Putniņš, T., "Closing time: The effects of closing mechanism and design on market quality." Working Paper (2018).

and reduced price manipulation at the end of the continuous trading phase.[6] Pagano, Peng, and Schwartz (2013) show that NASDAQ's opening and closing auctions reduce spreads and price volatility at the open and close.[7] Similarly, Ellul, Shin and Tonks (2005) analyse changes in the market structure of the London Stock Exchange (LSE) and show that opening and closing auctions have better price discovery properties.[8]

While all auctions are designed with the goal of liquidity aggregation at particular points in time, their implementation details can differ substantially. Implementation details will be a function of historical precedent but will also depend on the trading objectives and constraints of auction participants. Differences in implementation have the potential to impact price efficiency and integrity. Cordi et al (2015) identify several design elements that provide significant improvements for the price efficiency and integrity of closing auctions.[9]

From a global asset manager's perspective, the most significant differentiator for closing auction design across asset markets is whether they are implemented as an on-close facility (such as in US equity markets) or as a single-price call auction (such as in European equity markets). The time frame for order submission to on-close facilities overlaps with that for continuous trading, while that for a single-price call auction will occur only after continuous trading has finished. The choice between these two approaches has significant implications for the quality of the closing price and for the optimal auction participation strategy.

On-close facilities allow a tighter relationship between continuous trading and the closing auction volume, since auction participants can combine their closing auction order submission strategy with trading in continuous markets. In addition, closing imbalances and indicative clearing prices are available and can be used for some liquidity arbitrage. In such an environment, opportunistic liquidity seekers are likely to delay their order submissions until just before the closing cross.

In a call auction, in contrast, imbalances and indicative clearing prices are available only after continuous trading has concluded. This has the potential to lead to greater price dislocations and manipulation for less liquid stocks[10], since the contemporaneous arbitrage possibilities with the continuous market are absent. On the other hand, liquidity discovery is likely to be more efficient in call auctions, since the incentive to delay order submission is much reduced. The risk of information leakage is also likely to be more

6 Hillion, P., and Suominen, M., "The manipulation of closing prices." Journal of Financial Markets 7, no. 4 (2004); Pagano, M. S., and Schwartz, R. A., "A closing call's impact on market quality at Euronext Paris." Journal of Financial Economics 68, no. 3 (2003).

7 Pagano, M., Peng L., Schwartz R.A., "A call auction's impact on price formation and order routing: Evidence from the NASDAQ stock market." Journal of Financial Markets 16, no. 2 (2013).

8 Ellul, A., Shin H.S., Tonks I., "Opening and closing the market: Evidence from the London Stock Exchange." Journal of Financial and Quantitative Analysis 40, no. 4 (2005).

9 Cordi, N., Félez-Viñas, E., Foley, S., Putniņš, T., "Closing time: the effects of closing mechanism and design on market quality." Working Paper (2018).

10 Camilleri, S., and Green, C., "The impact of the suspension of opening and closing call auctions: Evidence from the National Stock Exchange of India", International Journal of Banking, Accounting and Finance 1, no. 3 (2009).

limited in a call auction setting as there are less opportunities for exploitation in the absence of parallel continuous trading.

Another element of closing auction design is the level of transparency provided about the state of auction order book. Transparency of the indicative volumes, imbalances and closing prices may influence price efficiency by discouraging participants who do not want to expose their intentions to trade (see Biais, Hillion, and Spatt (1999), as well as Comerton-Forde and Rydge (2006)).[11] Transparency, however, has the advantage in deterring potential harm from price manipulation and preserving market integrity. Market design of auctions needs to maintain a delicate balance between a limited level of pre-trade transparency offsetting the potential for temporary market impact, on the one hand, and sufficient transparency to all market participants ensuring a level playing field, on the other.

A third element is the matching algorithm design. In general, traders can submit market and limit orders into the auction. Whereas market orders take priority, limit orders determine the market clearing or equilibrium price through the demand and supply schedules ordered by the buy and sell limit prices. Beyond this foundation, other design features have been introduced. These include randomised closing times and price stabilisation features. The intention of a random end of the call phase is to limit price manipulation.[12] Flexibility to modify or cancel orders during the batching period can also vary across markets. In the case of call auctions, mechanisms for price stabilisation have been introduced in the form of volatility extensions and price collars. In some markets, designated market makers have additional responsibilities to stabilise prices at the close.

Exchanges' design decisions for their closing auction mechanisms should take these elements into consideration. In many cases, optimal mechanisms may evolve over time, as auction volume share and the needs of auction participants change. As an example, market participants with relatively price-insensitive liquidity demand at the close (such as index fund rebalances, or European ETF creations/redemptions) are likely to prefer an on-close auction facility that enables efficient hedging in continuous markets before the close. On the other hand, the more price sensitive market participants there are in the closing auction, the more appropriate a call auction process becomes for efficient price discovery.

We have observed considerable innovation by exchanges in design of the closing auction over time. In general, we believe that the innovations have contributed to improved well-functioning of markets. However, the magnitude of the current market structure transformation may justify a more holistic review of closing auction mechanisms. We also advocate more academic research in this area covering both the theoretical merits of specific auction features across global markets, and empirical evidence using event studies comparing market quality measures as these features have evolved over time.

11 Biais, B, Hillion, P., Spatt C., "Price discovery and learning during the pre-opening period in the Paris Bourse." Journal of Political Economy 107 (1999). Comerton-Forde, C., Rydge, J., "The influence of call auction algorithm rules on market efficiency", Journal of Financial Markets 9 (2006).

12 See for example Medrano, L.A., Vives, X., "Strategic behaviour and price discovery." RAND Journal of Economics 32 (2001).

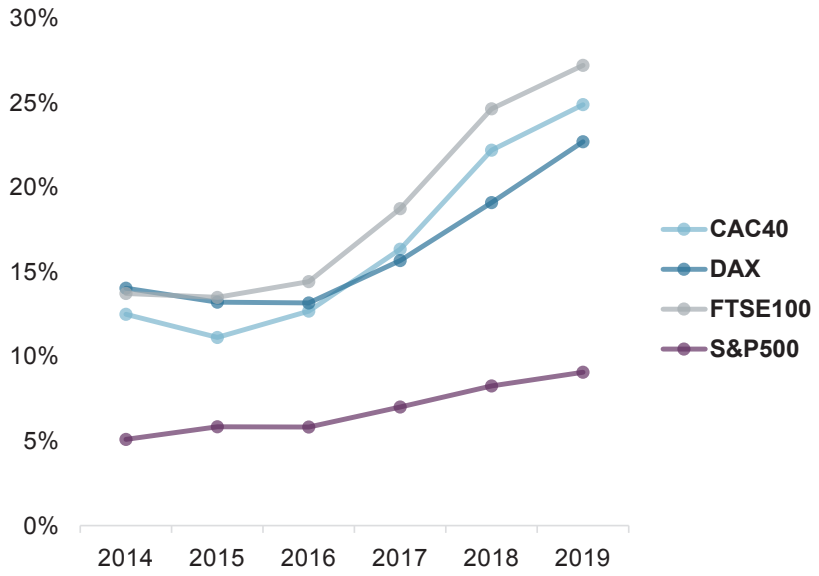
Closing Auctions Market Share

Closing auctions were initially introduced to provide an efficient price discovery process for end-of-day prices, and to avoid some of the potential for price manipulation inherent in other methods of determining end-of-day prices. Since then, they have become increasingly popular as a liquidity event, with volume shares of closing auctions increasing across both Europe and North America.

Figure 1 shows the proportion of volume traded at the closing auctions of S&P 500, CAC 40, DAX, and FTSE 100 stocks. It is evident that there has been a significant increase in closing auctions' market share over the last 5 years, particularly in European equity markets. For example, the portion of the daily volume executed in closing auctions almost doubled in the case of FTSE 100 constituents nearing 30% of trading volume.[13] We observe a similar pattern for CAC 40 and DAX stocks. While closing auction volume share for S&P 500 stocks started from a lower base in 2014, it saw a comparable near doubling since then, with about 9% volume share in 2019.

Several hypotheses have been offered for this increased focus on closing auctions. Some are based on the constraints or design choices of some market participants. As an example, mutual fund flows in the US and ETF creations in Europe are struck against closing prices. Similarly, portfolio trades associated with episodic index rebalances and with hedging for derivative contracts are calculated with closing prices as the reference. In many markets, participants with these constraints and design choices now represent a greater share of assets under management.[14]

Figure 1 Volume share of closing auctions – Local market indices



Source: CBOE Global Markets, Bloomberg, and NBIM calculations

13 Estimates provided by industry practitioners may differ based on methodological assumptions – for example, treatment of dark and off-exchange volumes in the denominator.

14 As an example, ICI estimates that index equity mutual funds were 29% of total US equity mutual fund assets in 2018, compared to 14% in 2009. See Chapter 3 of the ICI Factbook at http://www.icifactbook.org.

Common to these examples is that the originating traders (for example, an index fund manager) privately know their liquidity needs ahead of time, often as a function of the closing prices. The traders can negotiate with liquidity providers before the close to ensure their liquidity needs are met at the close. Liquidity providers often compete for this flow, and may, in turn, choose to hedge their positions before the close to be able to deliver the liquidity negotiated. Other market participants anticipate the liquidity demand of these hedging trades and build positions, particularly for major index rebalances. As a result, the price informativeness at the closing auction of this portion of closing volume is likely to be limited since it has already been anticipated.

In addition to these mechanical reasons for increasing volume traded in the closing auction or at the closing price, we believe that there is also a deliberate shift towards trading at the closing auction by other market participants. The reason for this shift lies in the changing composition of market participants. We observe an ongoing concentration of assets under management across fewer management companies. This is true both for index managed portfolios as well as active mandates, since it reflects increasing margin pressures for asset managers.[15] This increased concentration, coupled with a move towards lower-turnover strategies leads to a reduction in natural liquidity.[16] The number of individual decisions to trade has decreased, both because of the greater concentration of asset managers, and because of the lower-turnover strategies employed by the managers. This decreases the probability of finding a natural liquidity match in the market.

Focal points for liquidity, such as auctions, become relatively more attractive in such an environment. While the decision to wait for a focal auction has the potential of increased opportunity costs, it may also lead to lower market impact costs if the probability of finding natural offsetting liquidity at the close is sufficiently high. The reduction in natural liquidity means that liquidity providers take on greater liquidity risk. At the same time, the greater concentration in assets under management tends to lead to greater, if less frequent, trades for which liquidity is demanded. This also increases the risk for liquidity providers for a given amount of working capital. The net result of these effects on liquidity providers is that the liquidity premium in the form of market impact has increased, everything else being the same.

One portion of market impact cost is the fair compensation to liquidity providers for the risk that they take on. Another portion is due to information leakage where trade intentions become known to the market. Decreasing heterogeneity in trading, driven both by greater concentration and by decreasing turnover, makes it more difficult to 'hide in the flow'. With decreasing natural liquidity, it is easy to become the dominant liquidity

15 ICI estimates that the largest 5 mutual fund complexes in the US had 51% of total mutual fund AUM in 2018, versus 36% in 2005. The 25 largest complexes accounted for 79% of total mutual fund AUM. See chapter 2 of the ICI Factbook at http://www.icifactbook.org.

16 See Chapter 3 of the ICI Factbook at http://www.icifactbook.org. The asset-weighted turnover rate of US mutual funds has declined from around 60% in 2009 to 32% in 2018, continuing a multi-decade downward trend.

demand in the market, which might lead to excessive market impact beyond the fair compensation to liquidity providers.

As a result, market participants have tended to reduce their maximum participation rates in the continuous trading session. The overall size of their liquidity demand has meant that they either have to spread their trades across a longer time period, or to make greater use of focal points for liquidity such as the closing auction as well as alternative block discovery services. We thus believe that another component of the observed increase in closing auction volume share is the shift in the optimal trading decision by institutional asset managers. This is a deeper, structural shift reflecting the macro-characteristics of the financial industry.

Attributing the growth in closing auction volume to the two distinct drivers of investor constraints on the one hand and decreasing natural liquidity due to AUM concentration on the other hand, also enables us to consider how closing auction volume share may evolve in the future. Furthermore, the attribution allows us to consider the impact of further growth in closing auction volume on the efficiency of the price discovery process.[17]

Broker Algorithms for Trading the Close

Investors and asset managers commonly engage brokers as agents to execute orders for them in the market, including at the closing auction. Brokers may offer different execution strategies – including block transactions, internal matching, capital provisioning and algorithmic execution strategies. The details of the strategies need to be tailored to the stage of the trading day – continuous markets will need different approaches than a closing auction strategy. Brokers have spent considerable effort in developing these execution strategies, and to respond both to changing market environments and client expectations.

There are three elements to the design of closing auction execution strategies. First, it might be optimal to trade out part of an order in continuous trading – execution strategies need an approach to decide this. A second element is a market-on-close component for price-insensitive liquidity demand at the close. Third, brokers have started to offer an opportunistic trading strategy for price-sensitive market participants, which can evaluate the evolution of available liquidity at the close.

A key challenge in designing a successful strategy is the appropriate choice of trade-off between attracting liquidity by releasing information on the one hand and limiting adverse selection by delaying the release of information on the other hand. During continuous trading, execution strategies combine a sequential signalling strategy – e.g. through limit order placement, immediate-or-cancel pings, indications of interest – with typically sequential execution events filling the parent order. These sequential fills provide an

17 In a recent study, the Autorité des Marchés Financiers (AMF) suggests a feedback loop from the design of execution algorithms can contribute to the growth in closing auction volume. See Raillon, F. "Growing importance of the closing auction in share trading volume", AMF Risk and Trend Mapping, 2019.

important feedback loop to the execution strategy and can enable timely calibration of current market state and liquidity.

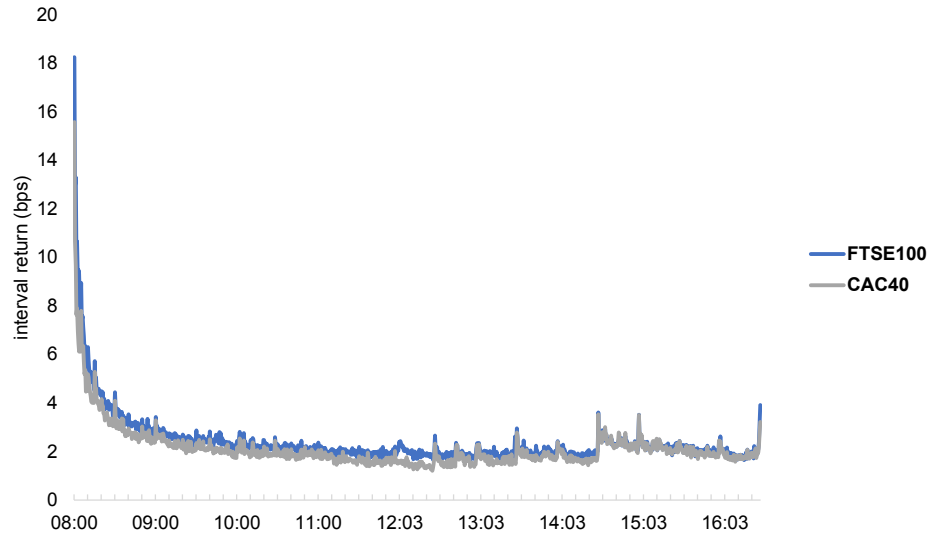
Closing auctions, on the other hand, offer only an imperfect feedback loop through indicative price and volume as well as imbalances. This more limited information makes an assessment of available liquidity more challenging. Depending on the dissemination mechanism for the information, as well as the availability or absence of contemporaneous hedging opportunities, it might also lead to a need for potentially very rich signalling strategies. These strategies need to consider the urgency of liquidity needs as well as the price sensitivity of client orders.

Broker algorithms for trading the closing auction have to be tailored to these distinct challenges. As a client, we are focusing on several potential differentiators in broker offerings. First, because of the imperfect feedback loop around orders submitted for closing auctions, the signalling strategy in a closing auction algorithm is likely to be more complex than that in continuous trading. In particular, it has to be calibrated to specific microstructure elements of each closing auction implementation across markets – examples include exchange imbalance dissemination schedules, as well as matching algorithms and market participant mix. As a result, we observe very different order submission strategies in North America than in Europe, for example.

Second, there is greater variability in closing auction volume and volatility characteristics, both cross-sectionally and over time, than in the continuous trading session. This is illustrated in Figures 2 and 3, where we report the average intraday volatility for FTSE 100 and CAC 40 stocks over the six-month period between May and October 2019 for continuous trading and the closing auction, respectively.[18] Figure 2 illustrates volatility's L-shaped pattern, generally peaking around the start of the trading session with a spike at the end of the continuous trading session. To illustrate the variability of indicative prices during the closing auction, Figure 3 zooms in on price dynamics during the closing auction. The data suggests high indicative price dispersion in the first 4 minutes of the auction, and a decrease towards the end of the auction, when the market-clearing equilibrium price and quantity is established.

18 To represent the microstructure evolution of intraday volatility over short time intervals, we calculate the absolute log-return for each stock over a sliding 30-second interval over a trading day and average across the constituents for each index between May and Oct 2019, as illustrated in Figure 2. In Figure 3, we calculate volatility in the same fashion over the closing auction phase using indicative prices.

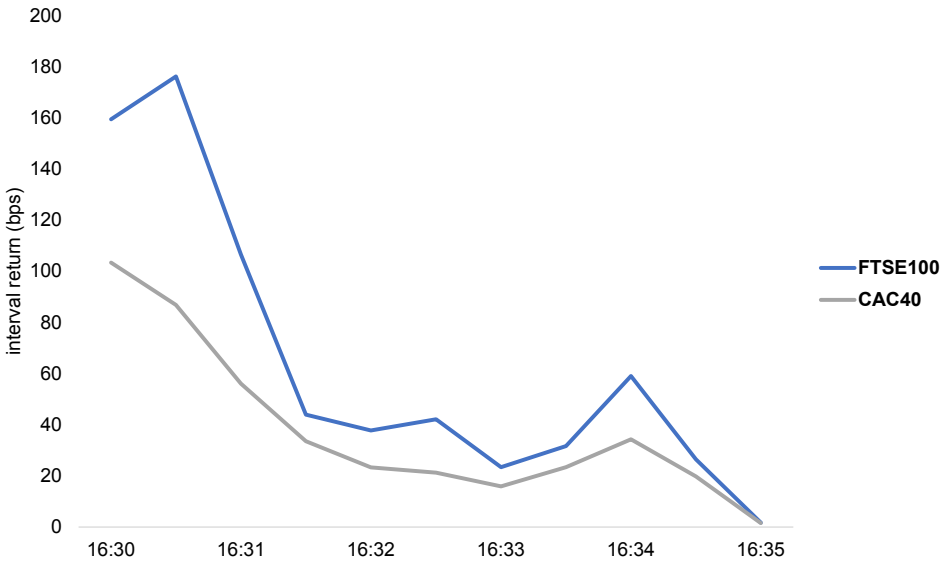
Figure 2 Average volatility during continuous time trading – FTSE 100 and CAC 40 (May – Oct 2019)



Source: Bloomberg and NBIM calculations

These price and volume dynamics throughout the trading day and during the call auction period, makes forecasting closing volume and price, particularly on a single-stock basis, challenging. A successful forecasting model is likely to involve considerable microstructure inputs and a dynamic feedback function based on continuous trading volume as well as on auction price, quantity and imbalance indications observed. These forecasts are critical for all three elements of a broker's closing auction offering – determining how to split an order between continuous trading and the closing auction, filling a market-on-close order at a reasonable price, and identifying liquidity opportunities around the close.

Figure 3 Average volatility during the closing auction – FTSE 100 and CAC 40 (May – Oct 2019)



Source: Bloomberg and NBIM calculations

A third challenge and differentiator will likely be the technology infrastructure used to manage order placement for closing auctions. Over the last few years, brokers have invested in optimising their technology infrastructure, reflecting the increasing automation and latency-sensitivity of equity trading. The objective has generally been to optimise continuous trading by, for example, locating a smart order router at the market share-weighted minimum distance from the set of trading venues. Closing auctions, on the other hand, occur at the primary exchange. Indicative quantities and prices are disseminated from these primary exchanges. The location strategy, therefore, needs to be optimised in a different manner for closing auction order management than in continuous trading.

We see the broker offerings for closing auction order management as very much an emergent field, and welcome innovation and development in this area in the coming years, particularly where they provide increased efficiencies and contribute to the well-functioning of markets. From the perspective of the buy-side, evaluating broker's offerings around closing auctions will still be based on transaction cost analysis. However, closing auctions pose several unique challenges to this evaluation, particularly for more opportunistic trading strategies. We are looking forward to observing developments in this field.

Conclusion

The volume share of closing auctions has seen tremendous growth over the last few years. There are several potential reasons for this growth, most of which appear to be structural. These include the rise of investment strategies that are benchmarked to the closing price, the changing mix and concentration of market participants, and the resultant increasing cost of liquidity.

Well-designed closing auctions can attract natural liquidity interest contributing to efficient price and liquidity discovery. The design and implementation of closing auction mechanisms should be evaluated to ensure that they contribute to well-functioning markets, and especially to efficient price discovery.

Continuous markets have historically been the main venue for price discovery. They have several desirable characteristics. They enable a continuous price discovery process, allowing investors to update their information by observing previously executed transactions. They provide an efficient trading mechanism for market participants with very different risk profiles and return horizons to interact. In addition, they allow for slack in the market by providing 'second chances' through repeated trading.

These benefits of continuous markets are at least to some extent not available in a discrete matching market such as closing auctions. On the other hand, closing auctions offer benefits such as providing a focal point for liquidity, which may be more appropriate for the current market and investor environment.

Exchanges thus need to balance the attractiveness of continuous trading with that of closing auctions. In the presence of the structural factors favouring closing auctions, exchanges have responded by making continuous trading more attractive. The main avenue has been cost – access fees for continuous trading are typically considerably lower than those for closing auction trading, though there are variations across exchanges. Despite these efforts, closing auction volume share has continued to increase.

We believe that exchanges should continue their efforts to ensure that market mechanisms reflect the needs of the changing sets of market participants. In the context of closing auctions, we recommend a more thorough review of the mechanisms used. As an example, the increasing use of closing auctions for price discovery may mean that the North American approach of on-close facilities should be reviewed. In addition, closing auction liquidity needs to remain accessible to all market participants with the appropriate level of transparency. Innovations linked to closing auctions, offered outside of the primary exchange, should be assessed for potential unintended consequences. For example, market-on-close facilities, which generally offer lower transaction costs than the primary exchanges, have the potential to increase market fragmentation further. This could be mitigated by considering improved transparency on crossed volumes ahead of the primary auction, in addition to reporting after the close.

If it is the case that structural factors will continue to make closing auctions more dominant relative to continuous trading, market participants will have to adjust their trading behaviour. Price discovery during the closing auction will concentrate more of the daily volatility at the close, compared to the volatility realization during continuous markets. As a result, order submission strategies for closing auctions will become more complex and require signal processing and feedback loops that have generally not been necessary in continuous trading.

We are observing a rapid evolution of exchange and broker offerings in this space, which we welcome. We believe that further development work by brokers is required, both in the forecasting of auction volume and in the order submission and signalling strategies. We are open to working with the community on these new offerings, articulating our expectations and use cases.