Industry Super Network

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By Email:
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The Treasury
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Re: Discussion Paper concerning ASIC Market Supervision Cost Recovery Arrangements

Dear Sir or Madam,

Industry Super Network (ISN) appreciates the opportunity to comment on the Discussion Paper concerning cost recovery by the Australian Securities and Investments Commission (ASIC).

ISN is an umbrella organisation for the industry super movement. ISN undertakes collective projects on behalf of a number of industry super funds with the objective of maximising the retirement savings and incomes of over five million members.

Industry super funds are stakeholders in Australia's financial markets, particularly as providers of patient capital to business entities and infrastructure projects. Industry super funds are long-term investors focussed on deploying capital that supports sustainable economic growth and generates superior returns for beneficiaries. Although industry super funds avoided the products and practices implicated in the global financial crisis, our funds and members, along with the broader public, were harmed. As a result, ISN has a keen interest in improving the operation of financial markets and institutions, including through regulatory improvement.

ISN welcomes the Discussion Paper. ISN strongly supports the regulatory mission of ASIC and believes robust cost recovery is an important part of ensuring ASIC has the resources it needs to maintain investor confidence and improve market quality.

ISN has comments for your consideration on four topics raised in the Discussion Paper.

In addition, ISN submits for your consideration a proposal for market structure reform in which trading would be conducted through a series of sealed bid call auctions held frequently throughout the day.

1. Increased use of message-based cost recovery

ISN appreciated the Treasury discussion of changes in the market environment – particularly a relative increase in the significance of message traffic to market surveillance and oversight, due in many ways to high frequency trading behaviour. In our view, these changes strongly support an increase in the use of message-based fees for operational cost recovery. We of course support the continued use of message-based fees for IT cost recovery.

The increased message traffic in today's equity markets creates externalities for all market participants and increased message-based cost recovery will result in some internalisation of these costs.

The Discussion Paper's review of this issue did include what appeared to be an arbitrary cap on message-based fees for operational cost recovery, which we think is inappropriate. Specifically, the Discussion Paper stated that: "The majority of ASIC's non-IT costs would continue to be allocated according to transactions." In our view, consistent with the overarching policy on regulatory cost recovery, whether ASIC's non-IT costs should be allocated based on trades or on messages should turn on the nature of non-IT oversight work in today's markets. Today, surveilling markets, monitoring for compliance, and understanding whether a violation of applicable law has occurred will often involve review and analysis of messages. With new and contemplated regulation of fast electronic trading on the rise, the burden will increasingly be a function of messages. For this reason, we would encourage policy makers to tailor cost recovery to the source of costs, rather than impose an arbitrary limit and require the majority of non-IT costs to always be on a transaction basis.

Real solutions

As ISN and a range of commenters have explained, there are serious concerns about market integrity, systemic risk, and market fairness arising from high frequency trading and the policy decisions that facilitate high frequency trading.

Increasing cost recovery on a per-message basis will likely provide some disincentive to high frequency traders. But it also is likely to leave in place the majority of high frequency trading activity and, perhaps more importantly, leave in place a market structure built upon an un-level playing field. By encouraging increasingly low-latency and high speed trading platforms, the share market will continue to evolve in ways that make it unwelcoming to investors who do not value speed, undermining the confidence of these investors.

We recommend market structure reform that implements sealed bid call auctions throughout the day. Our proposal is set out in greater detail in the attached research paper.

As the research paper makes clear, there is compelling empirical evidence and very strong finance theory demonstrating that our call auction proposal would:

- Reduce the prevalence and costs on investors of high frequency trading, and improve investor confidence, by removing the advantage of relative speed when trading in sub-second time frames.
- Provide numerous opportunities for price formation that better reflect all available information.
- Establish a stable market microstructure that is resilient against liquidity crashes and the risk of systemic failure.
- Establish a more straightforward market system that investors and policy makers can understand, increasing confidence.

We strongly encourage Treasury to carefully consider the broad public benefits of introducing call auctions for intra-day trading as outlined in the attached paper. Such a reform would enjoy the support of capital providers and investors, whose interests should drive public policy in financial market structure.

2. Providing discounts to market makers

ISN opposes the idea of providing a cost recovery discount to market makers on a number of grounds.

First, ISN does not think that there is the need for subsidising of market maker activities in the Australian equity market. The existing Australian market structure is a decentralised order-driven electronic market, and this has important implications for what benefits (and costs on other participants) market makers can be reasonably expected to generate.

- Theoretically, market makers are supposed to provide liquidity and immediacy in the market. In a decentralised continuous order-driven market, such as Australia's, this role is only necessary when there is an absence of potential natural investors/counterparties on either side of the book. Put another way, it is not necessarily an economic efficiency to insert a middle man between natural counterparties that are present and willing to transact. In a decentralized order-driven market, market makers necessarily compete with natural counterparties for order book placement. As a result, every market maker execution in a liquid instrument is necessarily an opportunity cost to capital providers who have placed passive orders. This has consequences, as we do not live in a stylised neo-classical world: a dedication of resources by investors to objectively small improvements in high speed low latency technology, and to digesting ever-growing market data, will change the capital stock of Australia, and result in underinvestment in other areas. This is especially true if market makers are subsidised through cost recovery exemptions (or in any other way), distorting the already undesirable tendency for purported market makers to compete with capital providers.
- While it is often asserted that market makers improve liquidity, this assertion is seldom sensitive to market structure. Empirically, analysis of market maker activity in decentralised order-driven markets has demonstrated that market makers provide useful liquidity only in the relatively illiquid stocks, not in the already liquid ones.[1] This is consistent with the notion that they compete with, rather than facilitate, interactions between natural counterparties in already liquid stocks.
- We note that Australian listed equity is a sizeable and growing market in which institutional and retail investors have been and will increasingly be transacting frequently, particularly in light of the increasing superannuation guarantee. There generally has been and will be adequate demand and supply between natural buyers and sellers in the market. For example, superannuation funds (self-managed or otherwise) will need to make purchases in the market to invest incoming contributions, as well as sell shares in the market to meet retirement cash flows, and honour portability requests (among other reasons for transacting). This counsels against a need to support market makers or other counterparties who do not have a natural buy/sell interest in the securities.

Second, the Discussion Paper's apparent support for "algorithmic arbitrage traders" misunderstands their role and relies on perspectives on their liquidity supply that research, including some very recent results, rejects.

- ISN stresses that high frequency trading (HFT) activities should not be confused with real market making activities. HFT firms do not have any obligations or intention to provide liquidity to the

[1] See, e.g., Charitou, A., & Panayides, M. (2009), Market making in international capital markets: Challenges and benefits of its implementation in emerging markets. International Journal of Managerial Finance, 5(1), 50–80. doi:10.1108/17439130910932341 http://www.pitt.edu/~mariosp/MMindevelopingcountries.pdf

market; any effects in this area are accidental. They are in the market to exploit other investors for private gains. HFTs operate not by providing a counterparty where there would not otherwise be one, but by staying at the top of both sides of an already active order book – that is, an order book where there are natural buyers and sellers with views about the value of securities ready to transact. While the introduction of HFT into an active market can compress spreads in these securities (or narrow them more quickly by a fraction of second), it results in HFT capturing the spread, and this is a cost to lower frequency natural buyers and sellers who place passive orders in the order book.[2] Providing a cost recovery fee exemption for market makers would further encourage HFT activities, thereby hurting long-term investors such as superannuation funds.

- Results from research are far from conclusive regarding the liquidity effects of HFT/algorithmic arbitrage traders. A recent study by Kervel (2012) found that traditional measures of liquidity such as spreads or depth "strongly overstate" the actual amount of aggregate liquidity available across fragmented exchanges since they do not recognise "duplicate orders" HFTs post and cancel across markets. Studying the fragmented stock markets in London, Kervel (2012) found that:

> [A] specific type of high-frequency traders, those who operate like modern day market makers, might in fact cause a strong overestimation of liquidity aggregated across trading venues. The reason is that these market makers place duplicate limit orders on several venues, and after execution of one limit order they quickly cancel their outstanding limit orders on competing venues. As a result, a single trade on one venue is followed by reductions in liquidity on all other venues. The empirical analysis confirms that trades are followed by substantial cancellations on [other exchanges]. That is, within 100 milliseconds after trades on some venues 39-85% of the order size is cancelled on competitors. After one second this number increases to 98-125%, which shows that the impact of a trade on liquidity is in fact twice the trade size. Note that the reduction in liquidity is due to cancellations of limit orders, since the analysis controls for transactions on all individual trading venues.[3]

Third, ISN acknowledges that there might be benefits of having designated market makers for illiquid stocks as suggested in Venkatamaran and Waisburd (2007),[4] which the Discussion Paper references. It is worth noting that the paper studies Paris Bourse, where firms can choose to elect designated market makers for a flat fee.

The question is, however, who should bear the cost of real market making, recognising that market makers require compensation for their services and would reasonably be expected to incur losses insofar as they are transacting with informed investors. As the paper by Venkatamaran and Waisburd (2007) suggests, the private market can solve this issue in a way the produces superior incentives, transparency, and efficiency. For example, companies can pay for market maker services, or better, investors pay for it through transparent commercial arrangements.[5] Since the benefits of market making are private gains

[2] See, e.g., Baron et al (2012), which finds that HFTs earn supernormal profits as the expense of other investors in the market, including fundamental investors. http://www.bankofcanada.ca/wp-content/uploads/2012/11/Brogaard-Jonathan.pdf

[3] Kervel, V. Van. (2012). Liquidity : What you see is what you get ?, (April), 1–41. http://people.stern.nyu.edu/jhasbrou/SternMicroMtg2012/Accepted/WhatYouSee71.pdf

[4] Venkataraman, K., & Waisburd, A. C. (2007). The Value of the Designated Market Maker, Journal of Financial and Quantitative Analysis, 42(3), 735–758.

[5] Venkataraman, K., & Waisburd, A. C. (2007) also suggests that there is further private gain for those firms who provide market makers activities: "… more importantly, the market maker is often the executor of the listed firm's investment banking ventures, which indirectly subsidize the market making business. Thus, the high performance rating from the Paris Bourse provides the dealer with a powerful marketing tool for the investment banking business and is a major incentive to perform well as a liquidity provider".

for those parties involved, it is not in the public interest to subsidise such activities. It might be appropriate to encourage a market where users of market maker services more overtly and formally pay the service providers.

Fourth, we have little confidence that market marker standards and obligations would be sufficiently rigorous, even if the case could be made that they add value in a decentralised order-driven market. Policy makers seem enamoured by the idea of supporting market makers, with no strong justification for doing so (particularly in a way that reflects the Australian market structure), nor any discussion of more straightforward solutions, such as investor-pays or issuer-pays models.[6] The definition of market makers in the discussion paper is unclear. To the best of our knowledge, there are currently no designated market makers with contractual obligations to provide liquidity for the Australian cash equity market.[7] The Discussion Paper acknowledges that providing fee exemption or discounts for the market makers would require properly defining their roles and obligations. We would leave development of market making obligations to companies and investors through direct arrangements, and their judgment of whether market making services need to be supplemented.

Fifth, and more importantly, even if appropriate requirements could be developed for market makers such that they could be "designated", designated market makers do not honour their obligations where it would be costly for them to do so, particularly in extreme situations when market making might be most useful. For example, in the 1987 market break (Black Monday), the Federal Reserve had to promise a liquidity backstop to market makers before they honoured their existing obligations. Severe market dislocations in recent times, such as the flash crash, also saw withdrawal by liquidity providers (to say nothing of the significant role that stub quotes from market makers played in the crash). As a result, a special purpose utility organised by market participants collectively as a mutual, rather than a number of for-profit private enterprises, might be a better approach and more resilient.

Lastly, insofar as an exemption from cost recovery for qualifying market makers might indirectly be paid for out of ASIC's (and thus the Commonwealth's) budget, we can think of countless more economically and socially useful applications of the money.

3. Mandating pass through of cost recovery fees

ISN does not believe it is appropriate for market participants to be required to pass on cost recovery fees. We agree with the difficulties set out in the Discussion Paper (namely, that (i) passing along regulatory costs is usually considered a commercial decision for firms, and (ii) passing along fees based on trades and messages from particular clients might involve costly new compliance systems and tracking systems for brokers without a clear and compelling need). We also question whether mandatory pass through would actually result in better signalling to end-users. Money is fungible and, in theory, market participants subject to cost recovery have already set their prices in ways that maximise their net profit. As a result, firms that seek to keep their prices at a level where net profit is maximised will send the same price signal to their customers, even if the purported composition of that price will change to expressly include a cost recovery component.

[6] While investors technically pay for the service offered by market makers (immediacy/the transfer of market risk for some small period of time) in the form of the spread, they do not do so under transparent conditions (e.g., they cannot identify counterparties and choose to trade or not trade with market makers) or through a direct contract negotiated with the market making service provider.

[7] By contrast, there are contractual arrangements in place for market makers in the exchange traded derivative markets. http://www.asxgroup.com.au/media/PDFs/asx_section_23.pdf

We also note that, if market participants are able to fully pass on regulatory costs to customers without a change in demand or a reduction in other components of the price, then there will be no incentive for market participants to improve the efficiency of their activities from a regulatory perspective.

4. Application of penalties to cost recovery

ISN does not support application of penalties to support cost recovery. Using penalties in this way would be likely to, directly or indirectly, result in money obtained through sanctions to benefit the firm that engaged in wrongdoing, which undermines the deterrence objective of penalties and clashes with equitable principles (cf., the unclean hands doctrine). In addition, by reducing the cost recovery burden in general, the use of penalties could distort business conduct (i.e., the application of penalties to subsidise regulatory costs could encourage activity that otherwise would be unprofitable). Application of penalties to cost recovery also could create perverse incentives for members of the Markets Disciplinary Panel (whose institutions might face lower cost recovery fees if they apply penalties).

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If ISN may answer any questions about this submission or otherwise be of any assistance, please do not hesitate to contact me at zmay@industrysuper.com or on (03) 9657 4369.

Kind regards,

Zak May
Director of Regulatory Policy, ISN

Attachment

Toward a fairer and more efficient share market: Frequent sealed bid call auctions at random intervals

ISN RESEARCH REPORT

TOWARD A FAIRER AND MORE EFFICIENT SHARE MARKET

FREQUENT SEALED BID CALL AUCTIONS AT RANDOM INTERVALS

February 2013

Industry SuperFunds

Industry Super Network

Contents

About Industry Super Network

Industry Super Network (ISN) is an umbrella organisation for the industry super movement. ISN manages collective projects on behalf of a number of industry super funds with the objective of maximising the retirement savings of five million industry super members. Please direct questions and comments to:

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1. Executive Summary

Industry Super Network (ISN) undertakes collective projects on behalf of a number of industry super funds with the objective of maximising the retirement savings and incomes of over five million members. Industry super funds are stakeholders in Australia's financial markets, including as providers of patient capital to listed companies. ISN has a keen interest in improving the operation of financial markets and institutions to better serve the needs of long-term investors and to promote capital formation and sustainable growth.

Market structure plays an important role in determining market quality and market fairness. There is considerable scope for improvement in Australia's market structure:

- The current market structure facilitates high frequency trading, and is resulting in wealth being redistributed from investors like superannuation funds to certain classes of traders.
- In addition to significant private costs, the current market structure is costly in broader economic terms, encompassing ever-growing operating costs, interactivity costs, and regulatory and surveillance costs.
- The current market structure is fragile and requires effective implementation of kill switches and other endogenous features to seek to reduce systemic risk.

ISN proposes a straightforward market microstructure reform: implement electronic call auctions frequently throughout the day for the exchange of equity shares.

This proposal would:

- Reduce the prevalence and costs on investors of high frequency trading, and improve investor confidence, by removing the advantage of relative speed when trading in sub-second time frames.
- Provide numerous opportunities for price formation that better reflect all available information.
- Establish a stable market microstructure that is resilient against liquidity crashes and the risk of systemic failure.
- Establish a more straightforward market system that investors and policy makers can understand, increasing confidence.

Call auctions are used in a number of major exchanges around the world, including at the open and close of trading on the Australian Securities Exchange (ASX). The key feature of call auctions is that they "concentrate liquidity," by aggregating orders over a period of time and executing them together at 'the call'. The auction transacts between multiple parties (is multi-lateral) and clears at a single price and volume. The auction clearing price is the one at which the maximum number of shares are exchanged.

Regulators and researchers generally accept that these features lead to better market quality in comparison to continuous trading. As a result, there is growing appreciation of the benefit of modern call auctions to address many issues in contemporary markets.

The key elements of the ISN proposal are:

- Equity trading would be conducted throughout the day in a series of sealed bid double call auctions. These call auctions would replace the continuous double auction executed through a limit order book, which is the current order matching microstructure of Australian cash equities markets.

- Individual orders into the auction would remain sealed or undisclosed before the auction to constrain predatory behaviour by certain market participants, such as high frequency traders.
- The duration of the call auctions would be short (as short as, for example, one second) and randomised so that the exact time when an auction closes cannot be known in advance, and thus is less vulnerable to gamesmanship by certain market participants.
- A clearing price is calculated for the auction such that the volume of instruments bought and sold is maximised.

As discussed in detail below, the features of the proposed call auction structure used throughout the day would result in market wide improvements, including a significant improvement in market fairness (and thus a reduction in high-frequency trading that exploits latency advantages). Market technology has today reached a point where frequent electronic call auctions are feasible.

Shifting to a call auction market likely would involve government intervention. However, Australia's current equity market structure is heavily dependent upon government intervention and regulation, including obligations on holders of market licenses and obligations on participants falling under the rubric of "best execution". Shifting to a call auction market structure would require similar levels of intervention, at least initially. Government intervention in market structure is well-supported, and rests on well-recognised coordination problems in trading, notwithstanding that coordination would be welfare enhancing. As a result, by encouraging or enforcing the batching of orders through a call auction, intervention would correct a market failure and assist traders in committing to single trades.

2. Introduction: Exchange Microstructures

Exchanges can be classified as either order-driven or quote-driven. In order-driven markets, participants send orders at specified prices to an exchange, whereas in quote-driven markets, designated market makers provide bid and ask quotes for stocks on the exchange. Order-driven markets can be further classified as continuous auction or periodic auction. Periodic auction markets are most commonly referred to as call auction markets.

In a continuous order-driven market, both market and limit orders are matched immediately with other orders in the limit order book and executed. Unmatched limit orders usually remain in the book (although some orders types specify other behaviours). (Throughout this briefing note, we refer to "continuous auctions" as "continuous trading" to avoid confusing this structure with "call auctions.")

By contrast, in a call auction order-driven market, orders are entered into the limit order book, but are not executed immediately. The execution occurs at a specific time (i.e., the call), at which all orders received are aggregated and the auction is cleared according to rules which determine a single clearing price and volume together. For example, an exchange might open the auction book at 11:55am, and continue to receive orders for 5 minutes until the auction is called at midday. In almost all cases, the price is determined as that which maximises volume exchanged. The number of auctions, their duration and their frequency during a trading day can vary.[1]

Since the 1980s, exchanges have gradually replaced call auctions with continuous markets as exchanges became increasingly electronic and have sought to encourage trading activity that is profitable to themselves and participants. In many cases, the change was from a single call auction per day to continuous trading during business hours. During the late 1990s and early 2000s, however, a number of exchanges have reintroduced call auctions in electronic form to deal with stressed market conditions such as openings and closings, as well as market shocks.

The re-introductions of call markets is consistent with the insight of Madhavan (1992) that the "periodic auction aggregates information efficiently and is more robust to problems of information asymmetry in that it can operate where continuous markets fail."[2] In this context, market failure concerned the difficulty in establishing prices in periods with high levels of information compared to trade volume, such as openings or for stocks with low trading volume.

With the increasing prevalence of call auctions (at least during openings and closings) a number of empirical studies have compared continuous trading and call auctions in contemporary financial markets. These studies have documented many benefits of call auctions including improved market quality, improved price discovery, successfully addressing market manipulation, and being beneficial to initial public offerings.[3]

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[1] For two comprehensive surveys on microstructure see; Madhavan, Ananth. "Market Microstructure : A Survey." *Journal of Finance* 3 (2000): 205–258; and Biais, Bruno, Larry Glosten, and Chester Spatt. "Market Microstructure : A Survey of Microfoundations, Empirical Results, and Policy Implications." *Journal of Financial Markets* 8.2 (2005): 217–264.

[2] Madhavan, Ananth. "Trading Mechanisms in Securities Markets." *Journal of Finance* 47.2 (1992), p 609.

[3] The following papers complement this briefing note in providing a literature review regarding call auctions; Economides, Nicholas, and Robert A. Schwartz. "Electronic Call Market Trading." *The Journal of Portfolio Management* Spring (1995) and Thomas, Susan. "Call Auctions : A Solution to Some Difficulties in

It is important to recognise that changes over time in market microstructure always occur in context, typically in response to the then-existing market structure and the concerns of market participants and policy makers of the time. The transition to electronic trading coincided with implementation of continuous trading in many markets because serial call auctions may have strained the technology available at the time. Today, the technology to implement contemporary call auctions is well-established, and call auctions can be designed to maximise public policy objectives in a given context and fulfil a number of different functions.[4]

Theory and empirical evidence each weigh heavily in favour of the benefits of modern call auction markets. Accordingly, adopting this structure would be in the public interest -- it would better enable equity markets to facilitate economic growth, and support the three policy objectives in market oversight:

- Fairness (by reducing the significance of sub-second differences in receipt of market data and latency, levelling the playing field for low frequency traders while still leaving untouched appropriate profit opportunities for well-designed algorithms).
- Orderliness (by introducing a less volatile mechanism that naturally pools liquidity and functionally reduces the risk of anomalous trades).
- Transparency (in terms of pricing, by producing a single clearing price reflecting an amalgam of market interest; and in terms of market operations by replacing a market structure that is unintelligible to the public and even many public officials with one that is easier to comprehend).

3. Modern Call Auction Markets, Their Benefits and Limitations

This section outlines some of the benefits and limitations of call auctions arising from their structural features. In many cases these benefits and limitations are discussed in relation to continuous trading.

The key features of a call auction are:

- *Temporal aggregation*: the orders are aggregated in the order book over a period of time before they are executed at the call.
- *Multi-lateral execution*: the auction clearing executes multiple orders from multiple parties at one time.
- *Harmonised single price*: the auction clears at a single price determined by maximising the number of trades that can be cleared/shares that would be exchanged.

Indian Finance." (2010) Working paper, WP-2010-006, Reserve Bank of India, Indira Gandhi Institute of Development Research, Mumbai.

[4] Schwartz, Robert A. "The Call Auction Alternative." *Call Auction Trading: New Answers to Old Questions*. Ed. Robert A Schwartz, John Aidan Byrne, & Antoinette Colaninno. Boston: Kluwer Academic Publishers, 2002. 1–14.

> "Recent advances in computer technology have considerably expanded the call auction's range of functions. I suggest that the problems we are facing in the markets with liquidity, volatility and price discovery are largely endemic to the continuous market. I contend that call auction trading can counteract these destructive forces in the markets. In fact, the introduction of fully electronic call auction trading in the U.S. would be the most important innovation in market structure." (p 1)

As a result of these features, the call auction amalgamates the information embedded in each order in that auction into a single price signal. As discussed below, this structurally reduces volatility, increases the informativeness of market signals, and results in superior liquidity.

1. Price Discovery

Call auctions accumulate orders as they enter the order book and execute at a single price at the call. Consolidating the order flow in this way can lead to deeper supply and demand and, by reflecting the information embedded in the aggregate of orders, increases the informational efficiency of the market.

The overall result is an improvement in price discovery of the stock under a call auction.[5]

> "The 'temporal aggregation' of orders in the call auction, gives a relatively deep supply and demand curve. This fosters better price discovery, in comparison with the relatively small number of orders from moment to moment determining prices in the continuous market."[6]

It is for this reason that call auctions are commonly used for market openings (during which a potentially large amount of information from overnight must be incorporated quickly into an opening price) and closings (in which there is often a rush to finalise deals and sometimes attempts to manipulate the closing price), and in other periods of stressed market conditions.[7] There is a significant volume of evidence finding that call auctions do perform better than continuous trading systems in respect of price discovery and informational efficiency. This includes evidence from the Singapore Exchange[8], the Hong Kong Exchange[9],

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[5] Schwartz, Robert A, and Paul L Davis. "Call Auction Markets." *Encyclopaedia of Quantitative Finance*. 1998.

> "Because they consolidate orders and amass liquidity, call auctions have been used to sharpen price discovery." (p 1)

[6] Thomas, Susan. "Call Auctions : A Solution to Some Difficulties in Indian Finance." 2010, p 8.

[7] Madrid has successfully used call auction for other periods of market stress in place of trading halts. Reboredo, Juan C. "The Switch from Continuous to Call Auction Trading in Response to a Large Intraday Price Movement." *Applied Economics* 44.8 (2012): 945–967. 30

> "Taking intraday data for the Madrid order driven continuous market, I find post switch improvements in the information content of prices and reductions in volatility, especially for thinly traded stocks. Trading volume and intensity peaked around auctions, but soon returned to pre-event levels." (p 945)

[8] Rhee, S., Stone, G., Tang, N., 2004. The Impact of Trading Method on Volatility and Market Manipulation: New Evidence from the Singapore Exchange. University of Hawaii Working Paper.

> "After the introduction of the Call Market Method (CMM), the Singapore Exchange experienced an unambiguous improvement in its price discovery process and a decline in market manipulation at the close."

[9] Aitken, Michael J, Andrew Lepone, and Ka Nok Chan. "The Impact of Closing Call Auction on Liquidity and Price Discovery Process: An Analysis on the Stock Exchange of Hong Kong." *SSRN Electronic Journal* March (2009).

> "Our empirical analysis finds that the introduction of the closing calls leads to an increases [sic] in transaction costs. The percentage of daily volume traded in the closing call auction is high, and the

OMX Futures[10], the Paris Bourse[11] and the Milan Stock Exchange[12], among others. A comparison of the New York Stock Exchange (NYSE) and NASDAQ found more efficient pricing in the NYSE utilising a call auction, however the presence of specialists in the NYSE auctions decreases the ability to precisely determine the degree to which the call auction mechanism resulted in this outcome.[13]

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price discovery process is improved. Overall, the suspension of the closing call auction leads to a decrease in market quality." (p 1)

In relation to the increase in transaction costs, this is experienced because of a shift in volume from the continuous trading session to the call auction period:

"The most liquid stocks, associated with the highest average dollar traded volume, have traded most actively in the auction-period than the less liquid stocks. From the quantity perspective, we find that the order depth in the continuous trading session decreases significantly which leads to an increase in transaction costs." (p 17)

[10] Hagstromer, Bjorn, and Lars Norden. "Closing Call Auctions at the Index Futures Market." *SSRN Electronic Journal* (2011) 1–45.

"Our empirical results show that the closing call auction indeed leads to increased trader patience and successfully improves the futures closing price accuracy."

[11] Pagano, Michael S., and Robert a. Schwartz. "A Closing Call's Impact on Market Quality at Euronext Paris." *Journal of Financial Economics* 68.3 (2003): 439–484.

"First, improved price discovery at the close is believed to have increased the efficiency of the derivatives markets by making the marking-to-market of French stock options more orderly and by making it easier for options traders to unwind their positions at appropriate prices. Second, improved price discovery at the close and a likely reduction in the overhang of unfilled orders after the close have further sharpened price discovery at market openings, albeit to a lesser extent. Third, if closing prices and opening prices are both established with greater precision, one would expect the synchronicity of close-to-open returns to be improved, and our empirical results suggest that this has been the case." (p 477)

[12] Amihud, Y., Mendelson, H., Murgia, M., 1990. Stock market microstructure and return volatility, evidence from Italy. *Journal of Banking and Finance* 14, 423–440.

"However, our evidence suggests that the call transaction provides a more effective value discovery mechanism at the opening of the trading day." (p 438)

[13] Madhavan, A., Panchapagesan, V., 2000. Price discovery in auction markets: a look inside the black box. *The Review of Financial Studies* 13, 627–658.

"Third, there is strong evidence that the NYSE's designated dealer (specialist) sets a more efficient price than the price that would prevail in a pure call market using only public orders. It is important to recognize that this result is obtained in the context of existing protocols and does not imply that an opening with a designated dealer is preferred to a fully transparent call market where all investors observe the limit order book in the preopening period." (p 656)

2. Volatility

Price volatility and price discovery are two sides of the same coin. The more efficient a market is at incorporating information, the more efficient and stable the price discovery process and the less volatile the price of traded instruments (given the same input of information). Both call auctions and continuous trading are sensitive to extreme orders (in both price and size). However, in call auctions, extreme orders cannot be executed on their own terms and result in extreme trades and market signals. The clearing price and volume in a call auction is influenced by all trades, including extreme trades and moderate trades, in which the consolidation of orders and aggregate supply and demand reduces the impact of any one particular order.[14]

A series of studies on Taiwanese exchanges provides valuable insight into call auctions, trade frequency and volatility. During 1993, the Taiwan Stock Exchange (TWSE) increased the frequency of its call auctions from once every two minutes to once every ninety seconds to twice every ninety seconds. Two studies have found that as frequency increased, volatility increased[15] with little impact on market quality.[16]

> "Madhavan and Panchapagesan (2000) analyze empirically the limit orders in the book at the opening and the specialist's opening trade. They find that this trade tends to bring the opening price closer to the fundamental value of the asset. While they interpret this result as suggesting that the specialist enhances price discovery at the opening, we offer the alternative interpretation that the specialist buys (sells) when the price reflecting the orders in the book is undervalued (overvalued). In that interpretation, the intervention of the specialist creates an adverse selection problem." (p 32)
>
> Biais, Bruno, Larry Glosten, and Chester Spatt. "Market Microstructure : A Survey of Microfoundations, Empirical Results , and Policy Implications The Microstructure of Stock Markets." *Journal of Financial Markets* 8.2 (2005): 217–264.

> "This result indicates that it is the consolidation of orders, rather than the physical proximity of the traders or the intervention of the specialist, that is important for price efficiency in a typical market opening." (p 118) Barclay, Michael J., Terrence Hendershott, and Charles M. Jones. "Order Consolidation, Price Efficiency, and Extreme Liquidity Shocks." *Journal of Financial and Quantitative Analysis* 43.01 (2009).

[14] Thomas, Susan. "Call Auctions : A Solution to Some Difficulties in Indian Finance." 2010.

> "A new order will influence the market clearing price in both call and continuous markets. However, the "traded price" in call auction would be less sensitive to outliers compared to the continuous market price. A consequence of this is that intra-day volatility of traded prices from a continuous market would be higher than prices in a call auction." (p 10)

[15] Chang, R., Hsu, S., Huang, N., Rhee, S., 1999. The effects of trading methods on volatility and liquidity: evidence from the Taiwan Stock Exchange. *Journal of Business Finance and Accounting* 26, 137–168.

> "A number of important results emerge from our analysis. First, significant differences in volatility exist between the two trading methods. Price volatility under the call market method for the whole sample is, on average, one-half of that under the continuous auction method. Second, the call market method is more effective in reducing volatility in the early and later part of the trading session…

Moreover, the call auction mechanism had half the level of volatility in comparison to a simulated continuous trading using the same trade data.

The Taiwan Future Exchange (TAIFX) also increased the frequency of its call auctions in steps from once every 30 seconds, to once every 20 seconds, to once every 10 seconds and then to continuous. A recent study of this process suggests that volatility increased when the interval was reduced from 30 seconds to 20 seconds, but remained unchanged after the later changes.[17]

3. Liquidity

Broadly defined, liquidity refers to the 'ease of trade'. It is an umbrella concept incorporating the immediacy of trade, price impact of trading, the ability of the market to incorporate information, order book depth, execution cost and search costs relating to shopping an order.

The more efficient management of supply and demand in a call auction appears to result in decreased overall depth, reflecting a decrease in opportunistic orders trying to pick off larger impatient orders.[18]

> Third, the call market method works more effectively in reducing price volatility of high-volume stocks than low- volume stocks. This contradicts conventional wisdom which suggests that the call market is better for thinly traded stocks, while the continuous auction market is preferred for heavily traded stocks. Fourth, the call market method is able to reduce volatility without sacrificing liquidity. No difference in the price impact of large order imbalances is found between the two trading methods. " (p 162)

[16] Lang, L., Lee, Y., 1999. Performance of various transaction frequencies under call markets: the case of Taiwan. *Pacific-Basin Finance Journal* 7, 23–39.

> "Our evidence uncovers the relative performance of three different transaction frequencies. We conclude that a frequent transaction frequencies may result in a more volatile and a more liquid market, but the market efficiency does not improve significantly." (p 37)

[17] Webb, Robert, Jayaram Muthuswamy, and Reuben Segara. "Market Microstructure Effects on Volatility at the TAIFEX." *Journal of Futures Markets* 27.12 (2007): 1219–1243.

> "The evidence suggests that futures price volatility increased as the frequency of market clearing increased from 30 to 20 seconds. However, there is no appreciable evidence that volatility increased following the other two increases in call market frequency [from 20 to 10 seconds on December 6, 1999 and from 10 seconds to continuous trading on July 29, 2002]. However, on the examination of a relative volatility metric, the evidence found suggests that the volatility on two competing futures exchanges will be alike if trading frequency of those contracts converge, other things being equal." (p 1240-1)

[18] Hagstromer, Bjorn, and Lars Norden. "Closing Call Auctions at the Index Futures Market." *SSRN Electronic Journal* (2011) 1–45.

> "However, tightness and resiliency are unaffected by the regulatory change [the introduction of a closing call auction in the OMXS 30 index futures market], and depth is decreasing. We hypothesize that the depth effect is due to an "order fishing" phenomenon, which is not considered in current theoretical models. When the potential of large market orders is high, opportunistic patient traders post limit orders in the depth of the order book to profit from impatient traders."

Call auctions have the capacity to accommodate large orders, but the transaction costs may be relatively higher.[19] These findings are consistent with call auctions being more efficient at price discovery (i.e. more efficient management of supply and demand means that robust prices are generated from fewer orders).

We note that studies finding a relationship between an increase in volume and continuous trading are the result of confounding effects (in Paris, for example, the determination of whether a stock trades continuously or in a call auction is based on the trading volume in the stock).[20] Where call auctions are followed by continuous trading, there is also evidence that the improvement in price discovery in the call auction creates spill over affects in increasing volume in post-call continuous trading.[21] This is why many markets open with a call auction.

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[19] Kehr, Carl-Heinrich, Jan P. Krahnen, and Erik Theissen. "The Anatomy of a Call Market." *Journal of Financial Intermediation* 10.3-4 (2001): 249–270.

> "Our empirical results document that the transaction costs for small transactions in the call market are lower than the quoted spread in the order book of the continuous market, whereas transaction costs for large transactions in the call market are higher than the spread in the continuous market. Although the latter finding is evidence of insufficient market depth, it does not necessarily imply that the depth in call markets is generally insufficient to accommodate large orders." (p 251)

[20] The Tel Aviv stock exchange switched from one call auction a day to continuous trading [with an opening call auction], and the Paris Bourse studies suffers from adverse selection as more liquid stock were selected for continuous trading. Amihud, Y., Mendelson, H., Lauterbach, B., 1997. Market microstructure and securities values: evidence from the Tel Aviv Stock Exchange. *Journal of Financial Economics* 45, 365–390.

> "Stock liquidity improved following the transfer to the new trading method: there was a large and significant increase in both the market-adjusted trading volume and in the liquidity ratio. Across stocks transferred to the new method, the value gains were positively associated with the increase in liquidity. The new method also led to improved efficiency of the value-discovery process. Stock prices adjusted faster to market information, and the noise in stock prices declined." (p 387)

Pagano, Michael S., and Robert A. Schwartz. "A Closing Call's Impact on Market Quality at Euronext Paris." Journal of Financial Economics 68.3 (2003): 439–484.

> "Muscarella and Piwowar (2001) found that market quality deteriorates at the Paris Bourse for stocks that are moved from their continuous market to call market only trading (or vice versa) during 1995–99 and that market quality increases for stocks that are moved from their call market to their continuous market trading. The authors attribute these findings to the superiority of the continuous market. However, call market only trading is used in Paris for the less liquid, less frequently traded stocks, and moving to the call market is equivalent to being delisted from the continuous market. For this reason, the finding could be interpreted as reflecting the impact of delisting and listing, rather than market structure, per se." (p 439)

[21] See Pagano, Michael S., and Robert a. Schwartz. "A Closing Call's Impact on Market Quality at Euronext Paris." *Journal of Financial Economics* 68.3 (2003): 439–484 and Amihud, Yakov, Haim Mendelson, and Beni Lauterbach. "Market Microstructure and Securities Values: Evidence from the Tel Aviv Stock Exchange." *Journal of Financial Economics* 45 (1997): 365–390.

4. Market Manipulation and Agency Risk

Call auctions have been successfully implemented to address the manipulation of closing prices.[22] The design of call auctions has also been argued to inhibit agency risk and front-running. The consolidation of orders and single execution price removes the possible benefit of relative time advantage in a multi-price continuous trading system.[23]

However, call auctions themselves are not entirely immune from being gamed. In 2000, the Tel Aviv stock exchange modified their opening auction to have a randomised closing time (until then it had closed at 9:45am each day) due to concern regarding efforts to engage in manipulative behaviour in the auction. This modification has been successful in addressing this concern and has resulted in improved price discovery in the opening auction.[24]

5. Transaction Costs

Transaction costs include both explicit costs such as fees and quoted spreads and implicit costs such as price impact and latency costs. Due to the complexity of trading costs, it is difficult both conceptually and empirically to establish relationships between trading mechanism and trading costs. Some empirical evidence does exist which suggests no obvious relationship.[25] [26] [27]

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[22] See note 9 and 29.

[23] Thomas, Susan. "Call Auctions : A Solution to Some Difficulties in Indian Finance." 2010, Reserve Bank of India, Indira Gandhi Institute of Development Research.

> "In the continuous market, when a customer places a large order with a broker, there is the danger of front-running. Since execution in the call auction is done at a single price, both the broker and the customer gets the execution at the single price announced after the call auction, the same as everyone else." (p 9).

[24] Hauser, Shmuel, Avraham Kamara, and Itzik Shurki. "The Effects of Randomizing the Opening Time on the Performance of a Stock Market Under Stress." *Journal of Financial Markets* 15.4 (2012): 392–415.

> "Randomization has improved price discovery and reduced excess volatility and price distortion, especially on expiration dates." (p 1)

[25] Kehr, Carl-Heinrich, Jan P. Krahnen, and Erik Theissen. "The Anatomy of a Call Market." *Journal of Financial Intermediation* 10.3-4 (2001): 249–270.

> "Our empirical results document that the transaction costs for small transactions in the call market are lower than the quoted spread in the order book of the continuous market, whereas transaction costs for large transactions in the call market are higher than the spread in the continuous market. Although the latter finding is evidence of insufficient market depth, it does not necessarily imply that the depth in call markets is generally insufficient to accommodate large orders." (p 251)

[26] Pagano, M., Schwartz, R., 2003. A closing call's impact on market quality at Euronext Paris. *Journal of Financial* Economics 68, 439–484.

> "Our empirical analysis of price behavior for two samples of firms (50 B stocks and 50 A stocks) for two different calendar dates (1996 and 1998) indicates that introduction of the closing calls has

However, finance theory supports the notion that the implicit search costs due to increasingly fragmented markets, the use of order splitting, and dark pools, may be reduced by the introduction of a call auction.[28] In addition, the increase in market quality, and hence confidence, and the better accommodation of large orders achieved by call auctions could result in a reduction in these costs.

6. Capital Raising

The improved information efficiency of call auctions would suggest they are suitable for IPOs.[29] An investigation of call auctions in Singapore, in part implemented to address IPO manipulation, found that the call auction mechanism for IPOs reduced the spread, increased volume and had no impact on volatility.[30] A comparison of the impact of secondary market mechanisms between the NYSE (order driven

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lowered execution costs for individual participants and sharpened price discovery for the broad market." (p 439)

[27] Liu, Y., 1994. A simulation model of the Taiwan security market. *Journal of Asian Economics* 5, 413–423.

"The simulation analyses lead to the following conclusions:

1. Execution costs are higher in continuous markets than in three call markets.

2. Liquidity time is lower and price discovery is better in continuous markets than in the call markets.

3. Call markets with lower transaction frequency demonstrate lower price volatility and lower execution costs. However, these markets are relative illiquid and are slow in the price discovery process.

4. Compared with the active markets, inactive markets are less liquid and slower in the price discovery process." (p 422)

[28] Biais, Bruno, Larry Glosten, and Chester Spatt. "Market Microstructure : A Survey of Microfoundations , Empirical Results , and Policy Implications The Microstructure of Stock Markets." *Journal of Financial Markets* 8.2 (2005): 217–264.

"The theoretical analysis of Vayanos (1999) … offers another reason why mandating agents to concentrate their trades, as in a call market, can be welfare improving. [S]trategic agents split their trades. Since this reduces their ability to trade out of their endowment shocks, it reduces the gains from trade achieved in the marketplace. Gains from trade could be improved if the trader could credibly commit to engage in a single trade."

[29] Economides, Nicholas, and Robert A. Schwartz. "Electronic Call Market Trading." *The Journal of Portfolio Management* Spring (1995).

"Because liquidity and price stability are, ceteris paribus, associated with higher share prices, more liquid and stable secondary markets should facili- tate the capital-raising ability and result in lower costs of capital for the listed companies." (p 15)

[30] Comerton-Forde, Carole, Sie Ting Lau, and Thomas McInish. "Opening and Closing Behavior Following the Introduction of Call Auctions in Singapore." *Pacific-Basin Finance Journal* 15.1 (2007): 18–35.

"We find a significant increase in market model adjusted R-squares, which is an indication of an enhancement in market quality. We also examine whether the introduction of the opening and

market with an opening call) and NASDAQ (quote driven market opening with dealer quotes) has found that the informational efficiency of opening call auctions reduces the uncertainty of the price and associated volatility in initial trading.[31] The analysis found more extreme under-pricing of IPOs on the NASDAQ, indicating that the absence of the call auction resulted in NASDAQ's being a less effective mechanism for capital raising. The recent controversy over the NASDAQ's Facebook IPO highlights the difficulties in determining opening prices when facing with continuous and high speed cancellation activities of high frequency trading (HFT).[32]

We also note that, by reducing the intensity of HFT, it is possible that a call auction could improve the confidence of operating companies in issuing and leaving outstanding equity capital. A recent study suggests that increased intensity in algorithmic trading (using measurements that would reflect high frequency trading) is associated with a decline in new issuances of equity, as well as an increase in repurchase activity by operating companies.[33]

7. Execution Risk and Immediacy

"Immediacy" in the context of trading is the execution of an order as soon as it is received by the exchange. In a call auction, execution only occurs at the frequency of the auctions (regardless of when the order arrives at the exchange). Auction frequency can be high (e.g., once per second) or low. Continuous trading systems achieve immediacy through market orders which transact a specified amount with whatever the

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> closing call auctions addressed the specific concerns of the exchange, namely "IPO madness" and closing price manipulation. We report that the introduction of the opening auction increased the relative volume traded at the start of the day for IPO firms without any significant impact on volatility. We also find a statistically significant reduction in bid ask spreads at the end of the trading day after the introduction of call trading. This is indicative of reduced order aggressiveness at the close and hence reduced manipulation." (p 33)

[31] Falconieri, Sonia, and Albert Murphy. "From the IPO to the First Trade : Is Underpricing Related to the Trading Mechanism ?" 2004.

> "We find that the nature of demand aggregation on Nasdaq results in a much larger amount of ex ante uncertainty as to firm value. This in turn leads to Nasdaq IPOs having a larger amount of underpricing than NYSE IPOs." (p 21)

[32] The recent Facebook IPO experienced difficulties due to the Nasdaq opening auction accommodating high frequency trading: during the split second the Nasdaq took to calculate an opening price, orders were cancelled rendering the calculated price stale, and initiated a potentially infinite process of recalculation.

> "Because of a decision before to allow continuous order placement during IPOs, cancellations kept "fitting in between the raindrops", in the words of Bob Greifeld, Nasdaq's chief executive, in the five milliseconds it was taking to determine a price." Telis Demos, 'Raindrops' raise questions after Facebook IPO, *Financial Times*, 21 May 2012.

[33] Boehmer, Ekkehart, Fong, Kingsley Y.L., and Wu, Julie, "Algorithmic Trading and Changes in Firms' Equity Capital," 2012.

best price is on the other side of the book. Execution immediacy is seen as the single most important benefit of continuous trading.[34]

The reasons why immediacy may be beneficial, however, are unclear except as they relate to avoiding the risks inherent in continuous trading systems. A key benefit of immediacy is its perceived value in reducing the risk of information leakage, which is a risk that is more prevalent in a continuous trading environment.[35]

It may be that the benefit of immediacy derives from obtaining the quickest possible entry/exit of a position. However, such a benefit clearly has declining marginal utility for market participants whose strategies are not dependent upon relative speed advantages (e.g., fundamental and retail investors) and in comparison to call auctions held more frequently than once per day. Moreover, this benefit has been eroded with the entry of high frequency trading enabled by continuous trading, which both operates with relative speed advantages to other traders and, perhaps counter-intuitively, uses these advantages to seek to monopolise the top of the book. As a result, some have found that HFT activities lead to longer queues for other traders to execute their trades.[36]

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[34] Economides, Nicholas, and Robert A. Schwartz. "Electronic Call Market Trading." *The Journal of Portfolio Management* Spring (1995).

> "Issues concerning market structure, competition, fragmentation, and transparency have been debated for the past two decades by government regulators, practitioners, and academicians, never with adequate resolution. Perhaps the regulatory emphasis has been misplaced: Attention has focused primarily on the cost of immediacy in an environment structured around its provision, while the accuracy of price discovery has received little attention. Unfortunately, the provision of immediacy can impair the accuracy of price discovery." (p 16) (footnotes omitted)

[35] Economides, Nicholas, and Robert A. Schwartz. "Electronic Call Market Trading." *The Journal of Portfolio Management* Spring (1995).

> "Consequently, participants in a continuous market attempt to hide information about their orders and try to execute their trades as quickly as possible once their intention to trade has become known to others. As we note earlier, this is not an inherent demand for immediacy but a consequence of the trading process; the apparent demand for immediacy may in part be an attempt to prevent front-running." (p 13)

[36] Pragma Securities. *HFT and the Hidden Cost of Deep Liquidity*. 2012.

> "However, the existence of ultra-long queues suggests that this equilibrium is out of whack. Market makers compete en masse where there is already deep liquidity and no opportunity for price improvement because of the tick size. From a market structure perspective, the concern is that there is no practical way to opt out of interacting with these superfluous market makers, and because of the take fees charged by exchanges, directional traders are effectively forced to subsidize HFTs even though there are other directional traders they could interact with directly. This effect is most pronounced where the spread size is very large despite fundamental liquidity, i.e. for low-priced, high- volume stocks." (p 6)

A common characterisation of the comparison between call auctions and continuous trading is that of a trade-off between execution immediacy and price discovery. That is, continuous trading offers execution immediacy through market orders, while call auctions provide more reliable price discovery as the price is determined through the pooling of orders from a range of participants.[37]

4. Call Auctions, High Frequency Trading, and Market Fairness

The above section explains the benefits and limitations of call auctions which derive from its three main features: temporal aggregation of orders, multi-lateral execution and single traded price. Appropriate design of a modern call auction market can mobilise these three features to improve market fairness, and significantly curb the problematic aspects of HFT at the same time. In particular, designing an exchange with very frequent call auctions, possibly as frequent as every second, provides numerous opportunities for price discovery and provides effective immediacy for substantially all investors. However, it decreases the materiality of relative speed and latency advantages below the one second threshold.

HFT strategies rely on being relatively faster than other traders in both (i) accessing market information (processing messages sent from market) and (ii) accessing market infrastructure (sending messages to the market and achieving a response). The private value of this relative speed advantage is realised by picking

[37] Thomas, Susan. "Call Auctions: A Solution to Some Difficulties in Indian Finance." 2010.

"Table 5 summarises these differences in market quality, which comes down to a trade-off between quality of price of execution and immediacy of transaction. The table suggests that if immediacy of trade is not a priority, then call auctions offer an advantageous trading system with high price transparency, lower impact costs and lower trade price volatility."

Table 5: Call Auction vs. Continuous trading: A comparison (p 35-6)

Feature	Call Auction	Continuous
Price Discovery		
Disclosed Price: immediacy	Post-trade (if sealed bid)	Yes
Disclosed Price: sensitive to extremes	Post-trade (if sealed bid)	Yes
Price Discovery		
Traded Price: immediacy	No	Yes
Traded Price: sensitive to extremes	Low	High
Traded Price: volatility	Low	Higher
Traded Price: sensitive to order size	Low	High
Traded Price: vulnerable to front running	No	Yes
(Information Value Accrued by)	(Executing Traders)	(Non-executing Traders)
	The trade-off between • *Price Discovery (above) which is more efficient in call auctions; and* • *Trade Immediacy (below) achieved by continuous auctions.*	
Liquidity		
Trade Immediacy	No	Yes
Market Impact Cost Risk	Low	Present
Non-execution Risk	Low	Present

off stale orders, gaining better positions in the limit order book to interpose between natural buyers and sellers, and avoiding having orders picked off by other speed traders.

The temporal aggregation of orders arising from call auctions removes some of the relative nature of time inherent in continuous auctions as execution time is dictated by the timing of the call (that is the execution time is independent of, rather than relative to, incoming orders and the time-priority rules of the book). Thus, the relative speed advantage of high-frequency traders over other individual traders is decreased to a meaningful degree in a call auction. We note that the relative advantages of diligence, acumen, and the quality of algorithms (including processing speed) of traders are not disadvantaged in a call auction. In other words, traders would continue to compete, but different kinds of traders would not be structurally advantaged or disadvantaged.

The interposition of high-frequency traders between natural buyers and sellers is also encouraged where there are bi-lateral trades at different prices at the same or nearly the same time. The consolidation of orders and the execution of a multi-lateral transaction at a single price prevents such interposition in time periods less than the frequency of the auctions. That is, as a single price is determined for each auction, interposition can only occur between auctions. If the auction frequency was as small as one second, this would impact harmful HFT (i.e. structural latency arbitrage HFT)[38] almost exclusively.

Having call auctions at frequent intervals provides numerous opportunities for price discovery. However, as auctions can always be manipulated to some degree, frequent auctions can have an adverse effect of benefitting those who can send multiple messages to the exchange within one period. Sealing the auction, preventing access to order information during the auction period, can effectively address such attempts at manipulation.

In addition, knowledge of the timing of the call itself enables gaming behavior, particularly by HFT strategies which can engage in 'sniping' at the last instant before the call. This can be remedied by randomising the timing of the call. This has been found to effective in the Tel Aviv Stock Exchange as discussed above.

5. Sealed Bid Call Auction at Frequent Random Intervals in Detail

The following section describes ISN's proposal for a sealed bid double auction at frequent random intervals. The same features of call auctions which can be implemented to reduce market unfairness (without harming algorithmic trading that does not rest on structural unfairness) also generate wider benefits to market quality.

This approach builds upon well-established market structures successfully deployed around the world, and was proposed in conceptual form by Farmer and Skouras.[39]

The key elements of the proposal are:

[38] We distinguish between HFT that capitalises on latency differences at the expense of other traders (harmful because it undermines the perception that markets are fair) with HFT that manipulates other traders or seeks to disrupt market systems through methods such as quote stuffing (which we would consider to be illegal, not harmful).

[39] Farmer, J. D., & Skouras, S. (2012b). Review of the benefits of a continuous market vs. randomised stop auctions and of alternative Priority Rules (policy options 7 and 12). See also, Farmer, J. D., & Skouras, S. (2012a). Minimum resting times and transaction-to-order ratios - Review of Amendment 2.3.f and Question 20.

a) the mechanism transforms a continuous auction executed through a limit order book to a series of very frequent call auctions (e.g. up to once every second),
b) individual orders remain undisclosed before the auction,
c) the duration of auctions is very short (as short as one second) but the durations is randomised so that the exact time of the call is uncertain,
d) a clearing price is calculated for the auction such that the volume of instruments bought and sold is maximised.[40]

Table 2 describes one cycle of the mechanism through three time periods: Auction Open, Matching and Clearing. Period 1 'Market Open' is of randomised duration.

Table 1 Sealed Bid Call Auction Process

Time Period	Operations
Period 1 'Auction Open'	Order book opens and remains open for a random duration (in this proposals, the duration is one second plus a random extension).
	An acceptance policy determines whether or not an order, modification or cancellation is accepted in the book.
Period 2 'Matching'	The auction is called the order book closes.
	A matching policy ranks Buy (Sell) orders by price and matches them with Sell (Buy) orders (the match can be one-to-many).
	A price is calculated for the auction such that the volume of instruments bought and sold is equal and no other price results in a greater volume being bought and sold.
Period 3 'Clearing'	The auction is cleared. a. If the clearning price co-incides with an order price that is not filled entirely due to the aggregate volume rule, then it is partially filled. b. If an aggregate volume rule is in place, and the clearing price co-incides with multiple orders that are not filled entirely due to aggregate volume rule, then they are filled on a pro-rata basis.
	Auction results are published.
	Unfilled orders are cancelled unless otherwise instructed.

Table 3 below displays an illustrative case, including total Sell/Buy orders listed by price accepted in the auction, and the aggregate supply and demand. The clearing price and quantity is in bold. The same auction is displayed in Figure 1 - Buy/Sell Orders at each price, and Figure 2 – Aggregate orders, including the price and volume at which the auction is cleared. Note in this ideal case, aggregate supply and aggregate demand are equal at the clearing price and a mechanism for dealing with partially filled order is not required (see Appendix 2 for a situation in which orders may be partially filled).

[40] Farmer and Skouras also suggest a pro-rata policy for filling orders of equal price in place of the common time priority policy.

Table 2 Illustration of Call Auction Book

Price	Quantity				Orders Cleared (clearing occurs at max volume)
	Sell Orders	Buy Orders	Aggregate Supply	Aggregate Demand	
$ 10.45	1,000	20,000	1,000	44,000	1,000
$ 10.49	5,000	10,000	6,000	24,000	6,000
$ 10.50	**8,000**	**10,000**	**14,000**	**14,000**	**14,000**
$ 10.51	0	4,000	14,000	4,000	4,000
$ 10.55	15,000	0	29,000	0	0

Figure 1 Buy/Sell Orders for Illustrative Call Auction

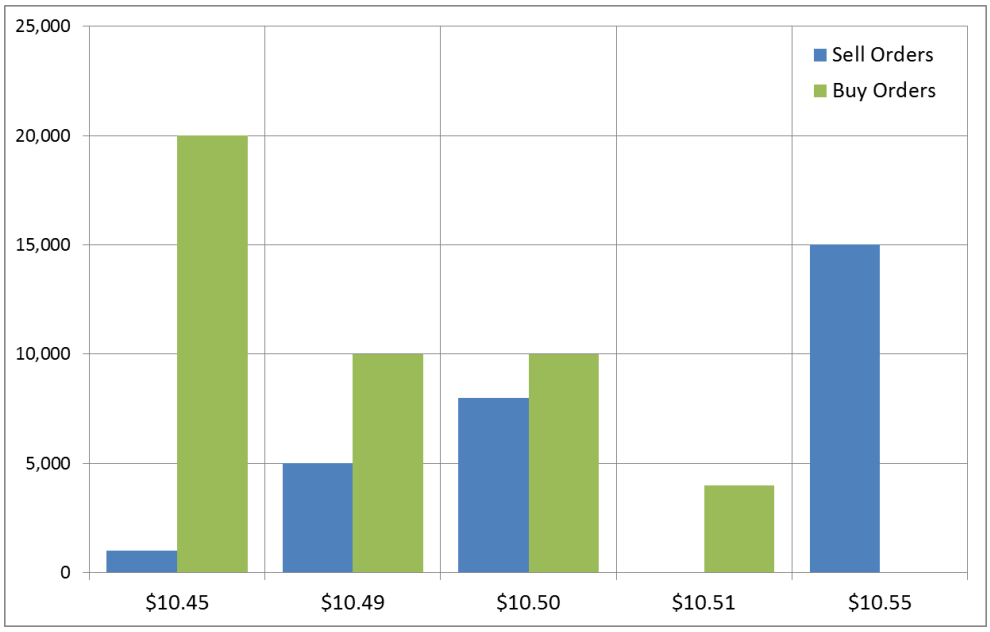
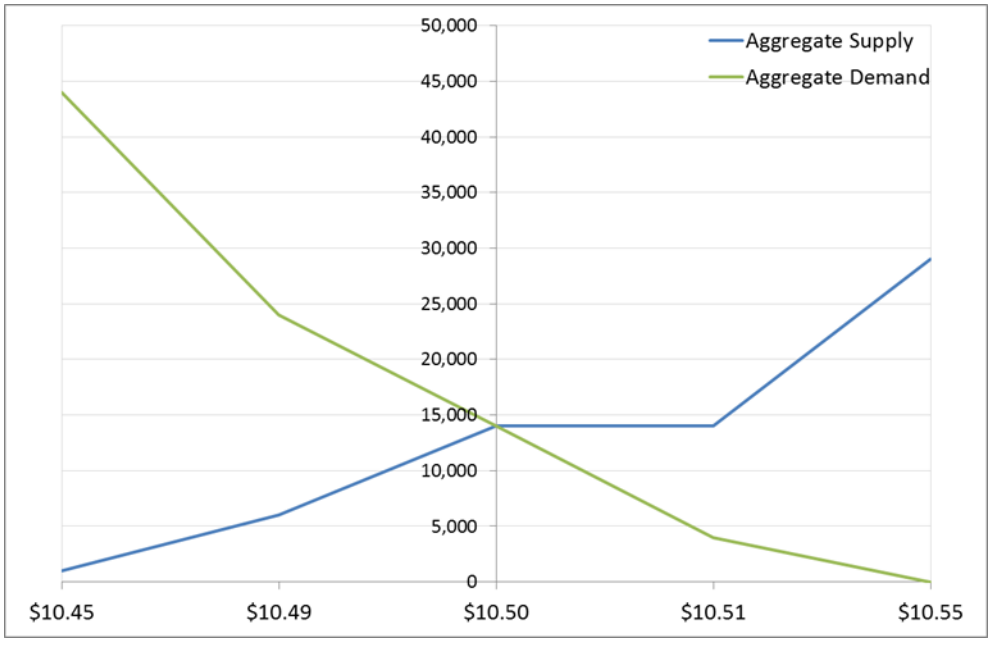


Figure 1 Aggregate Demand and Supply of Illustrative Call Auction



6. Parameters of a Call Auction

The design of a call auction involves a number of decisions and options, including:

- Duration.
- Scope of pre-trade and post-trade transparency.
- Order (including amendment and cancellation) acceptance rules.
- Clearing price calculation methodology.

These are discussed in turn below.

1. Duration

The two main variables regarding duration are whether the auction is of fixed or random length and whether the duration is relatively long or short. As discussed above, auctions with fixed durations have been found to be vulnerable to gaming behaviour, more so when bids are open. Randomising the exact length of auctions addresses this vulnerability. As the advantages of call auctions includes improving price discovery and reducing volatility through the build-up of supply and demand, the duration must be long enough for this to occur. This may be different for different stocks depending on the intensity of buy and sell interest.

ISN position: There does not appear to be a compelling case for any particular setting, particularly below 20 seconds.[41] ISN would not support durations below one second, insofar as these would reintroduce structural disadvantages for low frequency traders. Overall, ISN believes the duration should be established through public consultation.

Table 3 Examples of Auction Duration

Market	Auction Type	Auction Duration
Taiwan Stock Exchange	Normal Trading	30 to 45 seconds depending on liquidity.[42]
London Stock Exchange	Close	30 seconds
Singapore Stock Exchange	Open	29 mins
	Close	5 mins
Euronext	Open	1hr 45 mins
	Close	5 mins

[41] Cf., Webb, Robert, Jayaram Muthuswamy, and Reuben Segara. "Market Microstructure Effects on Volatility at the TAIFEX." Journal of Futures Markets 27.12 (2007): 1219–1243.

[42] To date, the exact determination of this period is unknown to ISN. No further detail is found on the exchange website (http://www.twse.com.tw/en/products/trading_rules/mechanism01.php#3) nor a recent publication on the exchange (See Ke, M. C., Huang, Y.-S., Liao, T. L., & Wang, M. H. (2012). The Impact of Transparency on Market Quality for the Taiwan Stock Exchange. *International Review of Economics & Finance*).

Table 4 Examples of Auction Randomisation

Market	Auction Type	Randomisation
Australian Stock Exchange	Open/close	The 3 hour opening auction is called at a random time within a 10 second window. The 10 minute closing call auction is called at a random time within a 2 minute window.
London Stock Exchange	Open/close	Very similar to the above.
Deutsche Borse (DB) AG	Open/close	30 second with random ending time

2. Transparency

Transparency refers to information about the trading process which is disseminated to traders and investors. There are two principal forms of transparency in financial markets: "pre-trade" transparency and "post-trade" transparency. Pre-trade transparency is the dissemination of information indicating trading interest such as unexecuted orders in the limit order book (and quotes in quote driven markets). Post-trade transparency refers to the dissemination of data regarding completed trades such as clearing price and volume. Modern equity market generally post some forms of pre-trade transparency continuously (e.g. the prevailing best bid-ask) and post-trade transaction details (e.g. prices and sizes) are reported immediately.[43, 44]

The effects of transparency on market quality have been the subject of various studies and the results are inconclusive.[45] In part, this may be because these studies focus on "changes in transparency in equity markets that were already quite transparent".[46] Although empirical evidence is mixed, "regulatory responses to transparency questions are often predicated on the belief that greater transparency will increase the efficiency and fairness of securities markets".[47]

[43] Bessembinder, H., Maxwell, W., & Venkataraman, K. (2006). Market transparency, liquidity externalities, and institutional trading costs in corporate bonds. *Journal of Financial Economics*, 82(2), 251–288.

[44] Equity markets generally are more transparent than other financial markets. For example, the US TRACE system

only reports execution time, traded price and coupon (i.e. post-trade transparency) for over-the-counter bond to the public at the end of the day and with 4 hours delay unless they pay for a third-party providers to get real time access. (Bessembinder & Venkataraman, 2006) and here http://www.finra.org/Industry/Compliance/MarketTransparency/TRACE/CorporateBondData/

[45] For an overview of major studies, please read Bessembinder, H., Maxwell, W., & Venkataraman, K. (2006).

[46] Bessembinder & Venkataraman (2006).

[47] Madhavan, A., Porter, D., & Weaver, D. (2005). Should securities markets be transparent? Journal of Financial Markets, 8(3), 265–287.

In the context of a call auction design, pre-trade transparency can be of different levels. There can be little pre-trade transparency (such as where bids and offers are sealed and no indicative information about the formation of the clearing price and volume is revealed) or full pre-trade transparency of all orders (something for-profit exchanges seldom if ever make publicly available for free). Other intermediate transparency indicators also exist, which include Intermediate Auction Price (IAP), Intermediate Equilibrium Volume (IEV) and Intermediate Unexecuted Volume (IUV). The IAP is an indication of the call auction price if the auction was held at that instant. The IEV and IUV indicate the volume of shares that would execute and volume that would not execute at the IAP. These intermediate measures can be displayed substantially in real time. Auctions may also have a cooling off period between the calling of the auction and the disclosure of the results.

Choosing the right level of transparency is a crucial task for regulators, market operators, and investors.

ISN position: ISN recommends that bids into the call auction be sealed. This is because pre-trade transparency, which comprises of price and quantity of all bids in this case, enables (i) some traders – particularly those who do not have a view about the value of a financial instrument – to seek to profit by gaming or exploiting the information revealed through the expression of trading interest by other market participants, and (ii) pre-trade behaviour designed to confuse or deceive other market participants.[48] For example, front-running was a threat when the full limit order book, including the broker identification, was apparent.[49] As a result, the ASX removed broker identification on 28 November 2005.[50]

The HFT phenomenon once again illustrates the problems associated with a fully transparent limit order book, and differential access thereto, in an environment where differential access can be exploited. HFT traders typically build their trading algorithm based on limit order book information such as price and quantities and by monitoring activities such as cancellation or amendment of orders. Sealing bids into the call auction (i) allows investors to bid in confidence that no "front-running" or finely detailed predictive modelling only achievable through low latency activity is possible, (ii) reduces the incentives for traders to engage in game-playing through deceptive orders (because they would not be observed), and (iii) reduces the potential for other traders to profit from the information revealed in the trading activity of others.

The decision by ASX to remove broker identification was also partly due to concerns regarding special access to information. Brokers were supposedly the only group of market participants to see this information. However, there was evidence and concern that brokers disclosed these data to at least some

[48] Post-trade transparency, in our opinion, is less of a concern as long as it is provided on an equal and fair basis. This type of information reflects a market clearing price for a financial instrument. This informs other market participants and the public about the price a willing buyer and seller agreed was fair.

[49] Foucault et al. (2007) argue that in a completely transparent limit order market where brokers' IDs are available, uninformed traders can infer information about price direction from the orders submitted by informed traders. They then can front-run informed traders by setting up more competitive quotes and distort the efficiency of the market. See: Foucault, T., 1999 "Price formation in a dynamic limit order market, *Journal of Financial Markets"* 2, 99-134.

[50] As reviewed in Lepone and Li (2011), empirical studies on this event generally agree that market quality (often measured by reduction in bid-ask spreads however) improved. This study further documents a reduction in execution costs for informed traders following the change. http://www.ipedr.com/vol11/31-W00004.pdf

of their clients.[51] This created an uneven playing field of information access among investors, and hence was detrimental to market fairness. The same issue is present in the case of HFT, where a very small subset of market participants is able to receive and utilise market information faster than others. By sealing bids, the significance of sub-second speed and latency advantages are reduced, which improves market fairness and integrity.

We recognise that we are proposing sealed bid call auction to be implemented in a public exchange. However, the public's interest in the activity on markets today is substantially, if not entirely, in trading results. Markets should remain informative, but requiring publication of information that is not useable by the public *qua* public, but is useable by a small subset for private gains through an inscrutable market system, is a shallow notion of "transparency", as well as disadvantages public investors who transparency is designed to benefit.

In practice, markets that operate call auctions provide varying levels of pre-trade transparency. This reflects the fact that there is no consensus on the effects of pre-trade transparency on market quality.

The table below provides examples of some exchanges and dark pools which utilise a call auction mechanism and the level of pre-trade transparency provided.

[51] Duong & Kalev (2008) examine the impact of the move to anonymous trading on the order book informativeness and document a significant improvement. They also reference a few ASX Consultation Papers in 2003 and 2005 regarding the motivation to remove broker ID (these ASX papers are no longer available on the ASX website). The authors explain that the motivations to move to an anonymous trading market were:

> "The main reason for the ASX to stop disclosing broker IDs is that exposing broker IDs fosters front-running activities. These activities suppress liquidity and impose extra costs on investors. This results in investors seeking execution outside the central market (the limit order book), which in turn, impairs the overall market liquidity (Australian Stock Exchange, 2005). In addition, constant breaches in the confidentiality agreement required by the SEATS access are also a major driver behind the move to anonymity. Although the release of broker IDs information to third parties is strictly prohibited, institutional clients and very high net worth individuals often request and receive this information from their brokers (Australian Stock Exchange, 2005). This creates an information advantage for those investors using full advisory broking services over those investors making their own trading decisions (Australian Stock Exchange, 2003)"

http://w3.unisa.edu.au/commerce/docs/seminars/petko%20kalev%20-%20order%20book%20slope%20and%20price%20volatility%20-%20information%20content%20april%2027%202010.pdf

Table 5 Examples of Variation in Pre-Trade Transparency

Market	Market Type	Pre-trade transparency
London Stock Exchange	Public exchange	The full order book is displayed in real time during the auction phase.
Euronext	Public exchange	The best five orders around the market clearing price are displayed in real time during the auction phase.
Deutsche Borse (DB) AG	Public exchange	Indicative auction price or the best bid and/or ask is displayed in real time during the auction phase.
NYSE	Public exchange	Indicative auction price or the best bid and/or ask is displayed in real time during the auction phase
Taiwanese Stock Exchange	Public exchange	During the close auction, reference best bid/ ask price is provided since February 20, 2012.[52][53]
POSIT Match[54]	Dark pool	No pre-trade transparency.
IDX[55]	Dark pool	No pre-trade transparency.
AX Trading[56]	Dark Pool	Call auctions are run whenever there is an "order" from participants to buy or sell a registered stock. The auction initiator decides the level of transparency he prefers: it can be a sealed auction (no information provided) or a disclosed auction (e.g. side, size range, price range Initiator Profile, etc.). The auction initiator can also specify whether the auction is public to all participants or only target a subset of investors (for example, only registered holder of the stock).

[52] Huang & Tsai (2008) document that the Taiwan Stock Exchange used to implement a close call auction for their closing session. For the 5 minute period, the order book was fully opaque. This, according to the study, led to decline in market liquidity in the last session. Note that Taiwan Stock Exchange is dominated by retail investors. See Huang, Y. C., & Tsai, P. L. (2008). Effectiveness of Closing Call Auctions: Evidence from the Taiwan Stock Exchange. Emerging Markets Finance and Trade, 44(3), 5–20.

[53] http://www.twse.com.tw/en/products/trading_rules/mechanism01.php#3

[54] POSIT Match offers scheduled call auctions http://www.itg.com/darkpool/ITGhasanswers.pdf

[55] IDX operates scheduled matching call auctions. http://www.orie.cornell.edu/EB9F5354-0922-446C-A839-C56581085783/FinalDownload/DownloadId-57C9226E9FFB69B8C72BDF4294C4DF83/EB9F5354-0922-446C-A839-C56581085783/engineering2/customcf/iws_events_calendar/files/darkpool_0.pdf

[56] AX Trading mechanism explained http://axtrading.com/index.php?option=com_content&view=article&id=48&Itemid=55

3. Acceptance Policy

The acceptance policy applies to orders, modifications and cancellations. Regarding orders, the acceptance policy in the Australian context could be the same as the central limit order book currently used by the ASX (and Chi-X). Along with transparency, the acceptance policy can influence when orders are sent to the auction. Accepting modifications and cancellations while the auction is open can encourage orders to be sent early. However, when auction durations are fixed, modifications and cancellations can be used to manipulate the auction.

To encourage early (and reliable) orders, a fee schedule on orders, modification and cancellations can be developed to encourage early reliable messages, and discourage them as the auction closing nears by making messages more expensive. The utility of a fee schedule may be less for auctions of longer duration. While fee schedules are less important for random durations, a fee incentive for early orders may be beneficial.[57]

When a call auction is held concurrently with a continuous auction, the acceptance policy also dictates whether only limit orders, or both limit orders and market orders, enter into the auction.

The policy upon which orders are accepted may also stipulate how orders which are not filled are processed after the clearing of the auction. They may be cancelled or be placed directly into other trading mechanisms, which may be the next call auction or a limit order book.

A cap on the size of orders may be required if order prioritisation is done pro-rata (see next section regarding auction pricing). This would prevent institutions with large capital overwhelming the queue. Such a cap can be quite large and should not inhibit the proper functioning of markets.[58]

ISN position: ISN believes typical acceptance policies are appropriate. ISN is equivocal regarding whether a fee schedule would be worth considering to increase incentives for early and reliable submission of bids into the auction. Bids are sealed and the duration of auction is unlikely to be sufficiently long to create incentives for natural persons to engage in strategic timing of orders.

Table 6 Examples of Acceptance Policies

Market	Auction Type	Auction Duration
Shanghai Stock Exchange (SHSE)	Normal Trading	The opening auction accepts orders, modifications and cancellations for 29 minutes, then orders only for 1 minute. The closing auction accepts orders, modifications and cancellations for 5 mins and then order only for 5 mins.[59]

[57] The Arizona Stock Exchange (AZX) operated call auction trading with "time-dependent commission rates" to attract early orders between 1992 and 2001.See Economides, Nicholas, and Robert A. Schwartz. "Electronic Call Market Trading." *The Journal of Portfolio Management* Spring (1995), p 13.

[58] Farmer and Skouras (2012a) p 14.

[59] Gerace, D., Tian, G. G., & Zheng, W. (2009). Call auction transparency and market liquidity : The Shanghai experience. Asian Finance Association 2009 Conference. Brisbane, Australia: University of Queensland. (pp. 1–28).

4. Auction Price

In most call auctions, the price is calculated to be the price at which the volume of stock traded is maximised. Policies to resolve common scenarios are generally similar across exchanges. These include (a) in the presence the maximum volume being achieved at multiple prices, the price which reduces order imbalance is used, and (b) when there is no effect on order imbalance, the best price is used. When there is an order imbalance at the clearing price, common rules are (a) time priority (b) pro-rata filling of orders, or (c) pro-rata filling of orders nearest the clearing price.

ISN position: ISN supports the pricing policies generally used.

7. The Need for Intervention

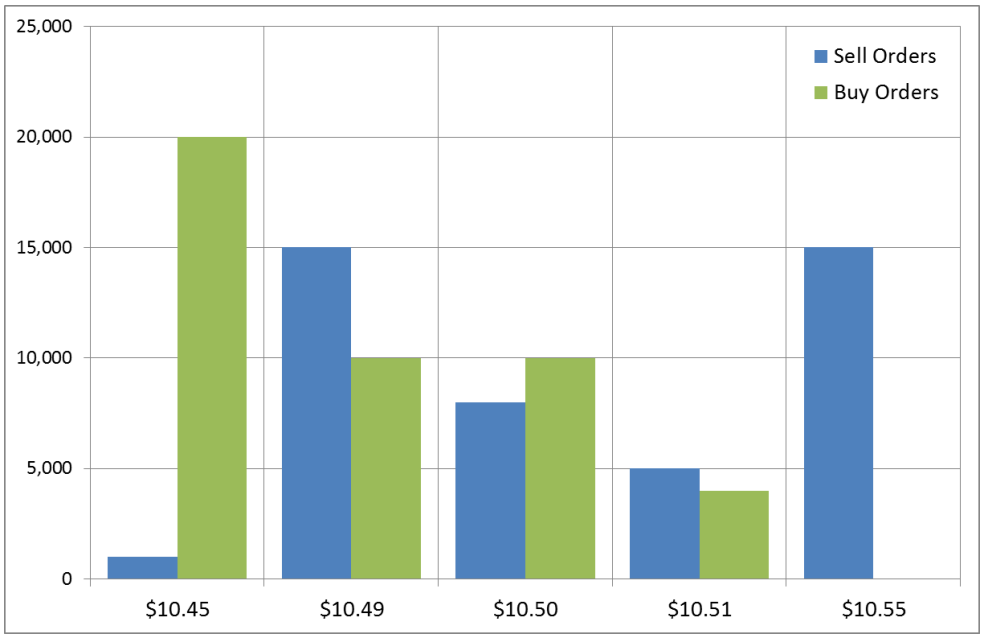
There are two reasons why intervention in market structure by public authorities is needed to practically implement the proposed sealed bid call auction: (i) existing regulatory arrangements are tailored to and support a continuous trading model, and (ii) strategic considerations undermine the ability of traders to naturally coordinate into a call auction notwithstanding that it is a welfare enhancing potential equilibrium, as discussed at length in Biais, Glosten and Spatt (2005), and citations therein.

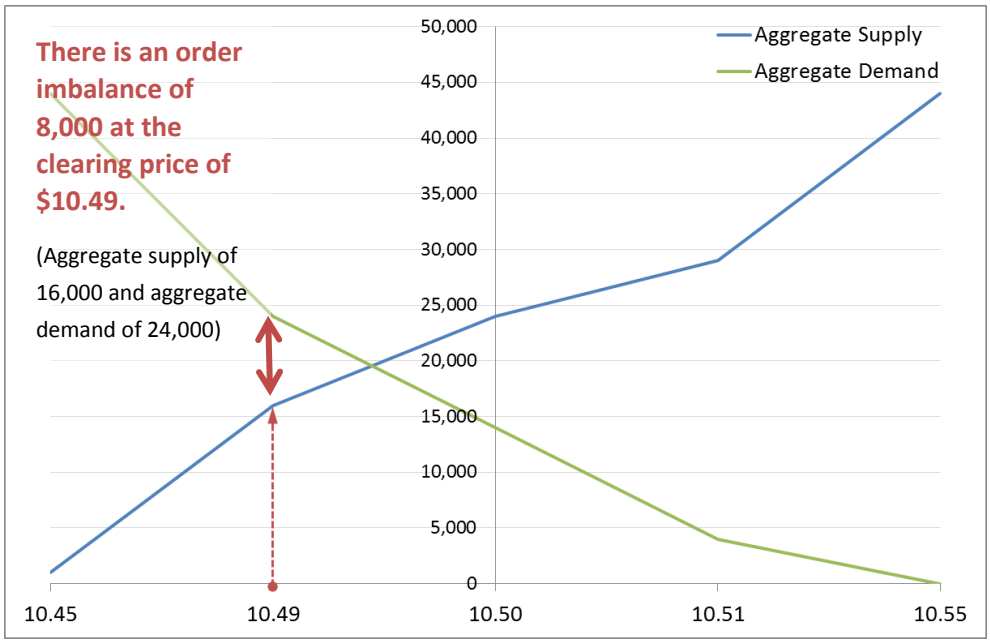
8. Appendix 1: Illustration of a Call Auction with Order Imbalance

Price	Quantity				Orders Cleared (clearing occurs at max volume)
	Sell Orders	Buy Orders	Aggregate Supply	Aggregate Demand	
$ 10.45	1,000	20,000	1,000	44,000	1,000
$ 10.49	**15,000**	**10,000**	**16,000**	**24,000**	**16,000**
$ 10.50	8,000	10,000	24,000	14,000	14,000
$ 10.51	0	4,000	24,000	4,000	4,000
$ 10.55	15,000	0	39,000	0	0

There is an order imbalance of 8,000 at the clearing price of $10.49 (aggregate supply of 16,000 and aggregate demand of 24,000). This results in a partial filling of buy orders. This can be resolved in a number of ways including:

- price-time priority for orders,
- pro-rata filling of all orders,
- pro-rata filling of orders nearest the clearing price.





9. Appendix 2: Sample of stock markets that use call auctions

Stock Market Name	Continuous trading features	Call auction features	Comments
Taiwanese Stock Exchange	No continuous trading, only call auctions	Call Auctions are used for the open, close and during normal trading hours. *Open Auction*: orders can be submitted during a 30 minute period from 8.30 a.m. to 9.00 a.m. Orders are sorted based on price priority. Orders of the same price are randomly prioritised. *Normal Trading*: call auctions are used throughout normal trading hours (9 a.m. – 1.30 p.m.) Auctions take place in 30-45 second intervals depending on liquidity. Price-time priority rule applies. *Close auction*: orders are accumulated in 5 minutes from 1.25 p.m. to 1.30 p.m. Price-time priority rule applies.	Transparency: from 31 Jan 2003, the market started disclosing aggregate unexecuted orders from the first to fifth best bid and ask prices in each periodic call. Before this, only unexecuted orders at best bid and ask are disclosed.[60] Market orders are not permitted.

[60] See Ke, M.-C., Huang, Y.-S., Liao, T. L., & Wang, M.-H. (2012). The Impact of Transparency on Market Quality for the Taiwan Stock Exchange. International Review of Economics & Finance. doi:10.1016/j.iref.2012.10.008

Bursa Malaysia[61]	Continuous trading during normal trading hours. Limit and market orders are permitted. Orders are matched based on price-time priority rule.	Call Auctions are used for both the open and close *Open Auction*: during pre-opening session orders can be posted, cancelled or modified. During the actual auction, all orders are binding. An indicative opening price is calculated and displayed during this period. *Close auction*: similar mechanism to the opening auction.

[61] See Trading Rules, Bursa Malaysia http://www.bursamalaysia.com/misc/system/assets/2409/rules_bms_brchapter7.pdf

Australian Stock Exchange (ASX)	Continuous trading during regular trading hours	Call auctions are used for both the open and close of market.
	Orders are matched based on price-time priority rule.	Auctions are designed to ensure that the price determined will clear the maximum volume traded, minimise surplus and reduce market pressure.[62]
		Auctions have full transparency in the order book.
		Open auction: Pre-opening phase takes place from 7 a.m.-10 a.m. where orders can be entered, modified or cancelled. Opening auction starts at 10am, and there are 5 batches for stocks to be matched based on alphabetical order. The time to open which stock is random up 10 seconds from the designated time.

[62] Principles to determine price at open(close) auctions on the ASX can be found here http://www.asx.com.au/products/calculate-open-close-prices.htm

	Close auction: pre-close session is from 4 p.m.-4:10 p.m. Closing auction takes place randomly between 4.10-4.12pm to determine closing prices for each stock.

New York Stock Exchange (NYSE) [63]	Continuous trading during normal trading hours. NYSE operates a continuous floor-based auction market. Traffic control is done via specialists/designated market makers (DMM).	*Open Call Auction*: pre-session opens at 7.30 a.m. and accept orders which can be cancelled. In fact, orders can be cancelled even after 9.30 a.m.(market opens), until the DMM opens the stock. Besides the usual limit and market orders, NYSE also allows for Immediate or Cancel Orders and Intermarket Sweep Order. Pre-trade transparency is quite complicated: • 8.30 a.m. – 9.00 a.m.: Imbalance and Paired-off information is published every 5 minutes • 9 a.m. – 9.20 a.m.: : Imbalance and Paired-off information is published every 1 minute • 9.20 a.m. – 9.35 a.m. or until open of each security: the above information is disseminated every 15 seconds. • 9:28 a.m. Indicative Opening Price is added to the information pack. • 9.30 a.m. the market opens.

[63] NYSE close and opening auction factsheet (applied to NYSE and NYSE Amex): http://www.nyse.com/pdfs/fact_sheet_nyse_open_close.pdf

Close Call Auction:

Closing order types: market on close (MOC), limit on close (LOC) and closing offset order. Note that closing orders can be entered throughout the day.

Closing offset order can be used to offset any imbalance that exists.

Pre-trade transparency:

- 3.45 p.m.: systematic imbalance of MOC and LOC are published.
- 3.45-3:59:55 p.m.: every 5 seconds the following information is published - Paired-off quantity, Order Imbalance, Closing Only Interest Price, and
- Indicative Clearing Price.
- At 3:55 p.m., d-Quotes and pegged e-quotes are added to the information pack.

NYSE Euronext - European Equities[64]	Normal trading can be carried out in one of two methods: continuous trading and call auctions. Call auctions are for smaller and less frequently traded stocks. To be considered for continuous trading, a company must satisfy turnover requirements and hire one designated market maker. The continuous trading operates in the typical manner, with a price-time priority rule.	For stocks with call auction trading method, a call auction occurs at a set time once or twice each day (11:30 a.m. and 4.30 p.m. for companies listed on NYSE Euronext, and 3pm for companies listed on NYSE Alternext). Open and close auctions on the NYSE Euronext for continuous trading stocks are fairly standard. During the pre-opening or pre-closing session, orders are accumulated without a clearing price. At opening (closing), the system calculates a mid-price or call auction so that the maximum number of shares are exchanged.

[64]See https://europeanequities.nyx.com/listings/faq/equity-price

Nasdaq[65]	Continuous trading during normal trading hours. Nasdaq is a dealer market, where participants are connected via electronic networks. Market participants trade with a dealer, not between each other.	Call auctions are used for both open and close sessions.[66] *Opening Call Auction (The Opening Cross)* Types of orders: normal limit and market orders (market orders are not accepted after 9.28am until the cross finishes), system hours orders, On-Open (OO) orders (market and limit orders that are only valid during the call), imbalance-only (IO) orders (liquidity providing orders that stabilise the crossing price) Pre-Market Trading Hours from 7:00 a.m. to 9:30 a.m. Orders can be made and cancellation is allowed. Information about limit order book shows displayed volume and limit price. 9.28 a.m.: MOO orders are no longer accepted or allowed to cancel. IO orders can be continuously submitted but not cancelled or updated. Crossing price is determined as an equilibrium price that maximises matched volumes. The Opening Cross occurs at 9:30 a.m.. All orders that are executable are executed at the Nasdaq Opening Cross price.

[65] See descriptions here http://www.nasdaqomxbaltic.com/en/exchange-information/trading/trading-3/ and here http://www.nasdaqtrader.com/trader.aspx?id=openclose

[66] Details can be found here http://www.nasdaqtrader.com/content/TechnicalSupport/UserGuides/TradingProducts/crosses/openclosequickguide.pdf

Closing Call Auction (The Closing Cross)

Types of orders: On-Close (OC) orders (market and limit on close orders – must be submitted before 3:05 p.m.), Imbalance-Only (IO) orders (liquidity providing orders that stabilise the crossing price. Can be submitted until close but no modification allowed after 3.50 p.m.)

Pre-close session is between 3:50 and 3:59:55 p.m. Information is updated continuously (information pack includes indicative clearing price, order imbalance etc.)

The closing cross occurs at 4 p.m. A single clearing price is determined.

London Stock Exchange (LSE)	Yes – for regular trading hours	Similar to the ASX, call auctions are used for both the open and close of market.[67] Auctions are designed to ensure that the price determined will clear the maximum volume traded, minimise surplus and reduce market pressure.	The time of auctions is random around a designated timeline.
	Orders are matched based on price-time priority rule.		

[67] "For London Stock Exchange, the auction period will be extended (by a maximum of 13.5 minutes) under 2 situations: (i) when the indicative auction match price breaches the price tolerance level (which are predefined percentage thresholds either side of the dynamic base price (in general equal to the last traded price)); or (ii) if market orders would remain unexecuted following the auction matching." See http://www.hkex.com.hk/eng/newsconsul/mktconsul/Documents/c_auction_e.pdf

Singapore Stock Exchange (SGX)[68]	Yes – for regular trading hours. Orders are matched based on price-time priority rule.	Like most markets, SGX operates open and close auctions. During the pre-open (close) session, orders can be placed and cancelled. Auction time is fixed where the clearing takes place. No orders are allowed to be modified or cancelled during this time.
Tokyo Stock Exchange[69]	Yes – for regular trading hours (Note that TSE has morning and afternoon trading sessions). Orders are matched based on price-time priority rule.	Call auctions are used to open and close both the morning and afternoon sessions. Orders accumulated for the open (close) auctions are ranked based on price priority only. Pre-opening quotes in the period prior to the opening auctions is provided. TSE runs fixed-time call auctions.

[68] Details can be found here http://www.sgx.com/wps/portal/sgxweb/home/trading

[69] Tokyo Stock Exchange Trading Methodology http://www.tse.or.jp/about/books/trading_methodology.pdf

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