

Market On Close Facility

April 3, 2012

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Introduction

TMX held a sell-side roundtable session on the Market-On-Close (MOC) facility after the close on Monday, March 1st. The purpose of the meeting was to solicit feedback and ideas on how to improve the MOC. TMX will host a similar session for the buy-side on Wednesday, April 18th.

We want to take this opportunity to analyze the existing behaviour of Canadian MOC facility and quantify the price impact of utilizing the facility. We calculate that it costs about 5 bps between 3:40pm to the close (or 1.6 bps in the MOC tick itself) for each % of day's volume that is submitted into the MOC facility.

We contrast the facility to some of the other MOC facilities deployed by NYSE, NASDAQ and LSE and discuss some of the pros/cons of suggested improvements.

History of MOC facility

“The popularity of the closing price as a benchmark does present some problems with trading”

Closing Price

One of the most important (and widely used) benchmarks in the industry is the closing price. There are a number of reasons for the popularity of the closing price. It is simple to calculate, it provides the price where the buyers/sellers value the stock at the end of the trading session, and it is widely published to name a few.

Due to these reasons, many participants use the closing price for valuation purposes. Index providers use closing prices for rebalancing to determine levels where stocks get added/deleted. Mutual funds use them to value portfolios and for cash inflow/outflow pricing. Portfolio managers and analysts use them for portfolio modelling and data studies that can span years due to the ease of availability.

The popularity of the closing price as a benchmark does however present some problems with trading. It is a single price point which a lot of participants want to trade at and is susceptible to volatility; ie a small amount of trading has the potential to drastically change the valuation of portfolios, indices etc. This is primarily why regulators monitor activity around the close very carefully to ensure closing prices are fair.

MOC Facility

“...everyone played the game of chicken, waiting till the very last second to trade”

The TMX MOC facility was put in place in early 2004 in order to maximize opportunity to trade at the closing price. Up until then, anyone benchmarked to the closing price was left to trade in the dying seconds of market hours. This often resulted in a ‘wild wild west’ scenario where the fastest fingers that could trade closest to the close winning (ie everyone played the game of chicken, waiting till the very last second to trade). The problem was further exacerbated on index rebalance days as funds benchmarked to the closing price would trade a large portion of the supply/demand in the final seconds of the day causing severe volatility and price dislocation. While volatility is a natural by-product of having supply/demand imbalances, it was difficult for all parties to achieve the closing price in an orderly manner.

The MOC facility was put in place to solve some of these issues:

- Maximize volume at the closing price – Allow maximum number of participants to achieve the closing price by managing the demand/supply levels around the close.
- Mitigate closing price risk – Reduce slippage from the closing price by providing a facility that guarantees the closing price.

The Canadian MOC facility

“An average of 250mm share per month traded in the MOC facility in 2011”

The Canadian MOC facility, run by the TMX, has been a fantastic success since its launch in 2004. An average of 250mm shares/month traded in the MOC facility in 2011 (approximately 4% of Canadian market volume).

Mechanics of the Canadian MOC facility

The rules of the MOC facility in Canada are straightforward. MOC orders are allowed to be submitted to the TMX between 7:00am and 3:40pm. The TMX publishes the net imbalance at 3:40pm and locks all the MOC orders submitted (ie MOC orders cannot be cancelled after 3:40pm). Only offsetting contra limit-on-close (LOC) orders are allowed after 3:40pm up until the close (these can be cancelled/modified right until the closing print). Unlike the US markets, there is no continuous retransmission of the net imbalance.

The TMX manages the supply/demand in the MOC facility and calculates a fair closing price at 4:00pm where the maximum amount of stock will trade. The visible book is swept to satisfy any net supply/demand after the LOC orders are factored in. The print price is the official closing price for the stock on the TMX.

There are features in the system to avoid large price dislocations. A price movement extension (PME) takes place when a stock's calculated closing price is greater than +/- 3% on TSX (+/- 5% on TSXV) from the VWAP during the last 20 minutes of regular market trading and the last board-lot sale price in the continuous market. This is to allow additional liquidity to be solicited across the board on stocks that might have adverse price dislocations due to an oversized MOC imbalance.

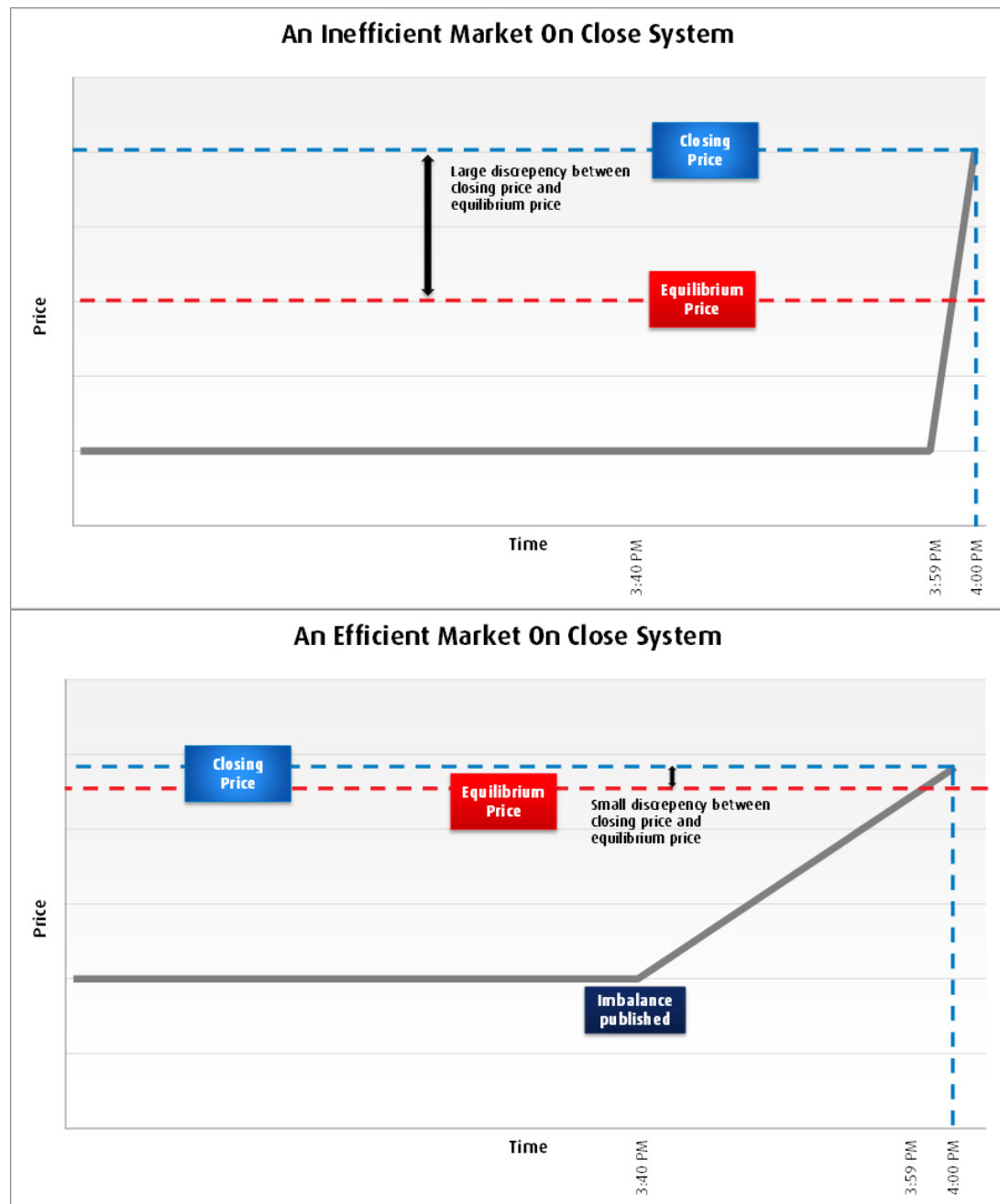
If a PME is invoked on a stock, TMX solicits for further liquidity on the stock by providing the Calculated-Closing-Price (CCP). Participants are allowed to put in offsetting orders between 4:00pm and 4:10pm on the contra side of the imbalance up to a maximum of +/- 10% on TSX (+/- 15% on TSXV) from the VWAP during the last 20 minutes of regular market trading and the last board-lot sale price in the continuous market. The PME stocks close at 4:10pm.

Stocks can only move up to a maximum of +/- 10% on TSX (+/- 15% on TSXV) after PME and any additional supply/demand is left unfilled. In an extreme case, original MOC orders themselves that were submitted prior to 3:40pm can go unfilled!

Price impact of MOC orders

In a perfectly efficient MOC facility, there should be minimal price dislocation on the closing tick but instead the stock should move to the fair value (equilibrium price) in an orderly manner after the imbalance published. This move should be less drastic than an inefficient MOC facility where there are price dislocations between the closing price and where the stock was trading immediately prior. In both cases, there is a move in the stock price approaching the close but in the efficient system, the impact is smaller.

Chart 1: Inefficient vs efficient MOC systems

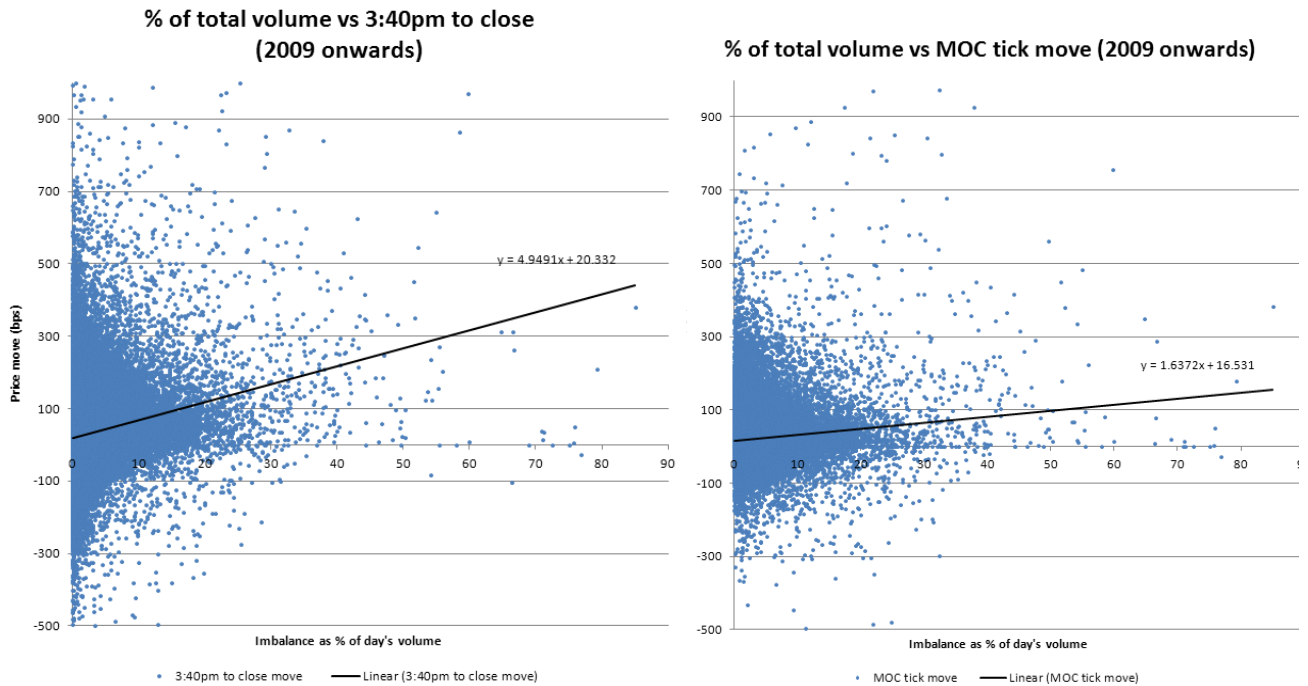


“MOC price impact is about 5 bps overall for every 1 % of daily volume placed in the MOC

We did some studies to measure the price movement of Canadian MOC imbalances. We plotted the price movement of stocks from just before imbalance dissemination to the close vs the % of the day’s volume that the imbalance represented. We used all stocks with imbalances from 2009 onwards (2008 had skewed numbers due to highly volatile markets).

We then plotted the same chart for the MOC tick move itself (ie price just prior to the MOC and the closing price).

Charts 2, 3: MOC order impact relative to their size



We note that the gradient for a linear line of best fit implies that the MOC price impact (from 3:40pm to the close) is about 5 bps overall for every 1 % of daily volume placed in the MOC. The second chart shows that the MOC tick contribution to this impact is 1.6 bps. Thus the bulk of the move takes place in the marketplace itself.

It should be clear from the scatter plot that a linear ‘line of best fit’ is not necessarily the best model for plotting MOC impact however our experience in trading in the MOC facility indicates that the numbers suggested are in the right ballpark.

In addition, we note that the y intercept (ie when nothing is placed in the MOC) is non-zero and attribute this to the average natural move of the market for the time period studied.

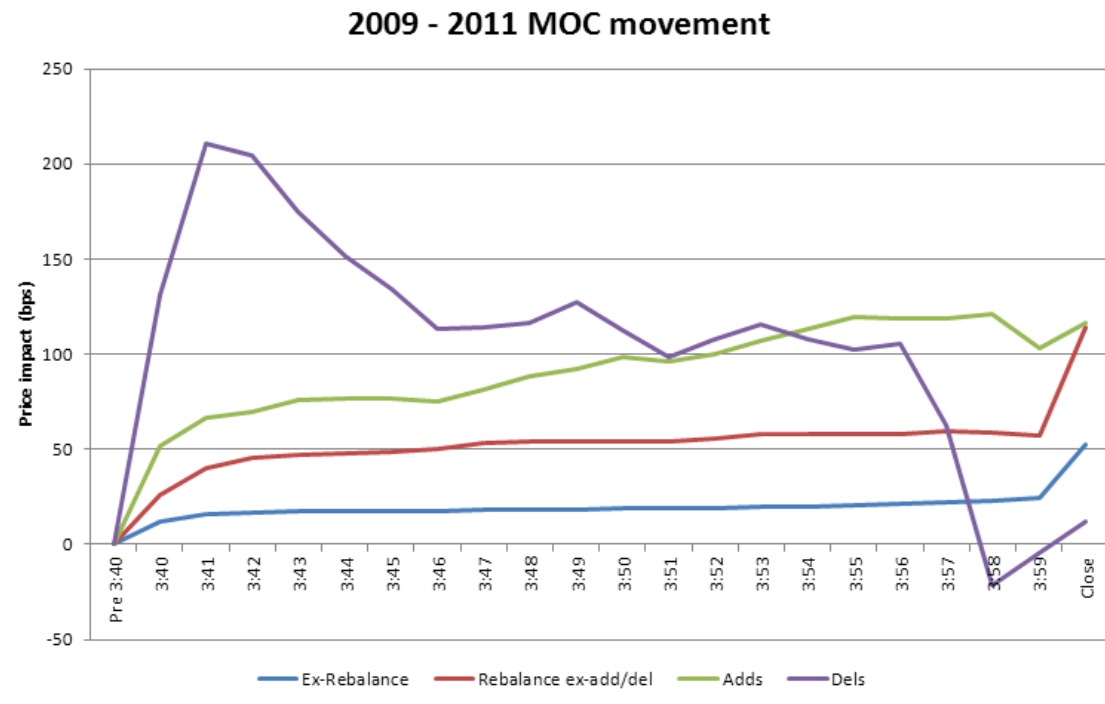
Next we looked at the trading profile of how stocks behave in the last 20 minutes of trading (after the imbalance is published) and in particular the price movement in the MOC facility itself.

The chart below shows the price impact of the MOC facility after the imbalance is published. The performance is weighted by ‘imbalance as a percentage of day’s volume’ and spans 3 years of data (2009 – 2011). We split up the chart into the following categories: rebalance adds, rebalance deletes, rebalance ex-add/deletes, ex-rebalance dates to highlight the distinct use cases for the MOC facility. As expected, the impact is the greatest on rebalance dates and in particular on the rebalance names.

“bigger orders relative to % of daily volume tend to have a disproportionate higher amount of impact on the MOC tick itself”

It is interesting to note that after we weight the securities by their order size (relative to day’s volume), the MOC impact is roughly half of the total impact from imbalance dissemination. This is bigger than what the original study (price impact vs order size) suggested and there is a very good reason for this. The relationship is clearly not linear and we believe that the heavier weighted stocks (ie the bigger orders relative to % of daily volume) tend to have a disproportionate amount of impact on the MOC tick itself (rather than from 3:40pm to the close).

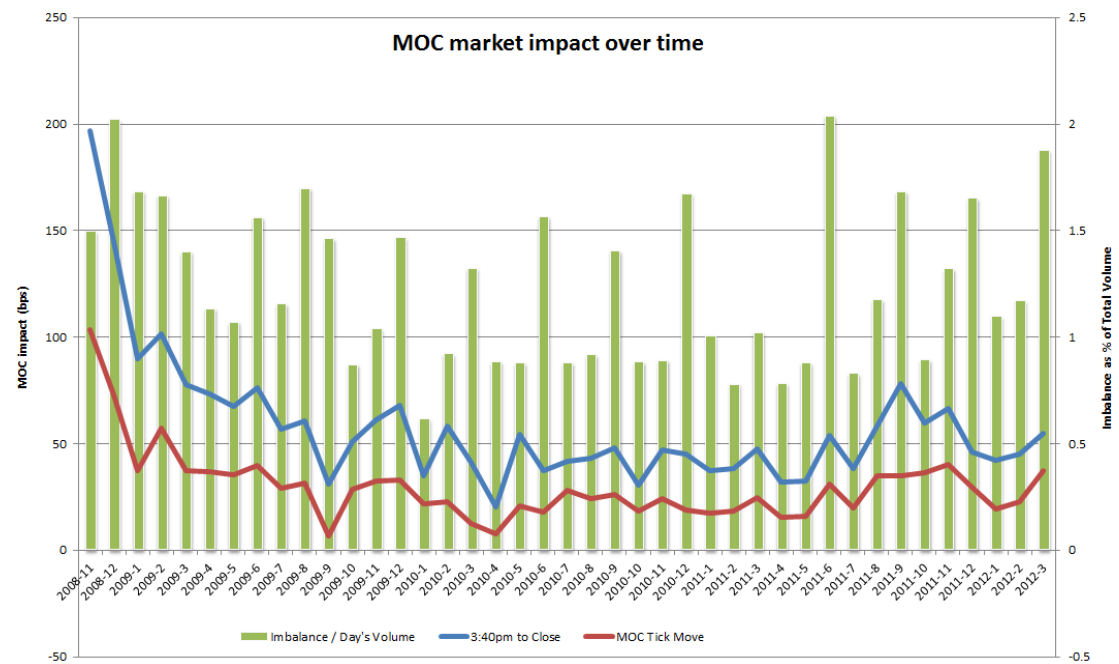
Chart 4: MOC movement for 2009 – 2011 time period



Lastly, we looked at the level of MOC activity in terms of the average size of order relative to day’s volume and calculated the average impact of stocks (weighted by ‘imbalance as a percentage of day’s volume’).

The chart below shows how the impact has changed over time as well as the average MOC order size (relative to day’s volume) that is being submitted to the facility.

Chart 5: MOC market impact over time



“imbalances are often a direct extension of market movement for that day”

Admittedly, our impact numbers in this chart are somewhat exaggerated as we do not factor out any market movement (since the MOC names make up the majority of the market itself). In reality, imbalances are often a direct extension of market movement for that day (ie high correlation of buy-side imbalances on up days and vice-versa) and as such some of the impact is just the market’s natural movement near the close.

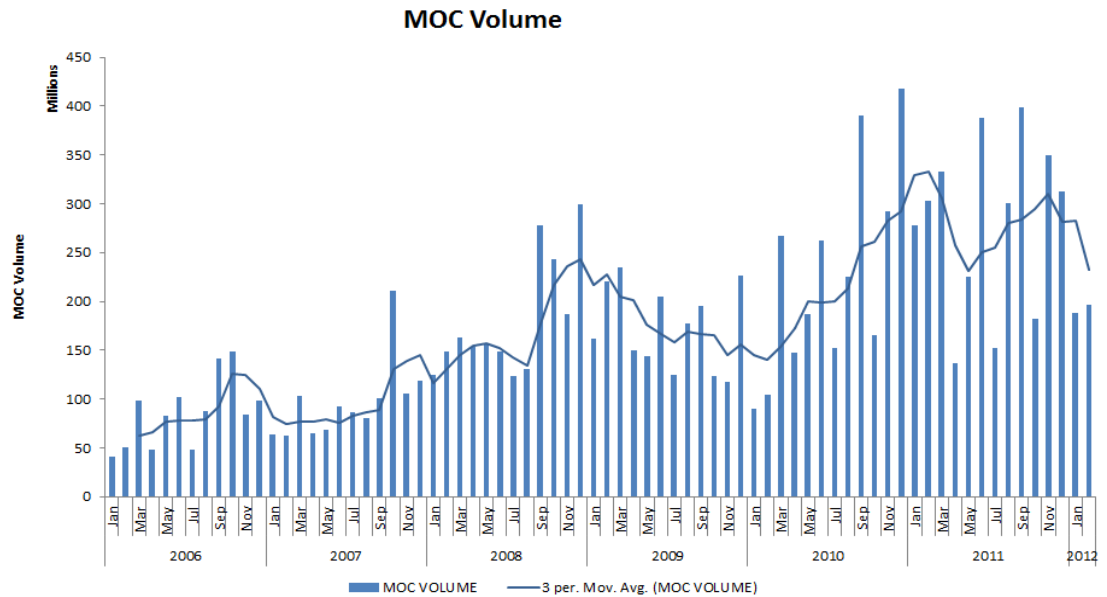
While any MOC facility will have price impact due to supply/demand, the key to a successful MOC facility is to reduce the price gaps in the MOC tick itself. As we can see in our studies, the majority of the movement takes place in the marketplace prior to the MOC tick. However, once we weight the stocks by order size (relative to day’s volume), the MOC tick impact becomes more dominant. Again, we point out that this is due to a non-linear relationship between order size vs market impact; the larger orders (relative to volumes) have a disproportionate amount of market impact.

Volume statistics of Canadian MOC facility

“TMX MOC imbalances only represented about 40% of the actual MOC volumes”

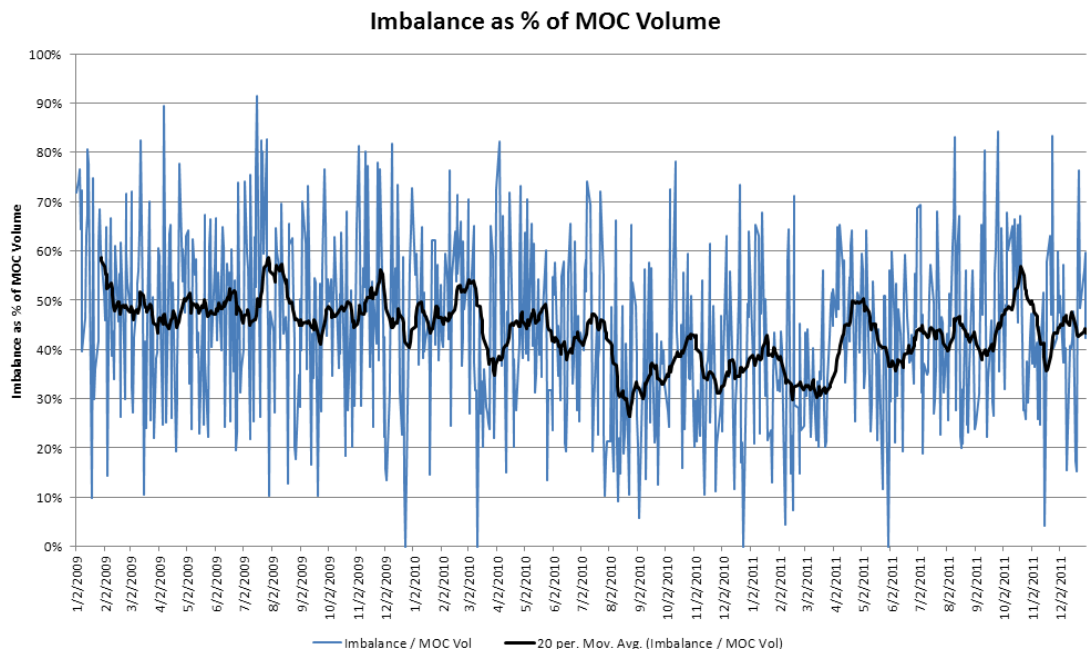
On a volume basis, the MOC facility traded an average of 250mm shares per month in 2011.

Chart 6: TMX MOC Volumes



We would point out that TMX MOC imbalances only represented about 40% of the actual MOC volumes for 2011 with the rest being matched off prior to the imbalance being published and thus not accounted for in the imbalance (see chart below). The matched trades are typically swaps and can provide a hint on the general level of swap activity in the marketplace over time (lower % on the chart represent increased swap activity as more of the MOC orders are matched pre-imbalance)

Chart 7: Imbalance as % of MOC volume (2009 – 2011)



Other major MOC facilities

We will highlight the mechanics of some of the other MOC facilities in developed markets and contrast them to the Canadian model. The key difference between US and Canadian facilities is that the US facilities allow Limit-on-close (LOC) orders prior to imbalance dissemination as well as rebroadcasting of the imbalance. In addition, they have CO (Closing offset) or IO (Imbalance only) orders which are used to stabilize the stock. We will discuss some of the pros/cons in the 'suggested improvements' section.

NYSE

MOC, LOC and CO (Closing Offset) orders can be entered prior to 3:45pm. At 3:45pm, the Mandatory MOC/LOC Imbalance Publication is disseminated (the imbalance is calculated based on all MOC and only marketable LOC orders at the time of publishing). This is republished every 5 seconds until the close. After 3:45pm, only MOC and LOC orders that offset the imbalance will be accepted (same direction orders will be rejected similar to TMX). If there is no imbalance, all MOC and LOC orders will be rejected. CO orders, which are used to provide additional liquidity if needed, may be entered on both sides until 4:00pm. They are not guaranteed to be filled and only come into play to help reduce adverse price movements. In addition, CO orders cannot flip the imbalance.

MOC, LOC and CO orders may be cancelled before 3:45pm. From 3:45pm to 3:58pm, they may only be cancelled or reduced to correct a legitimate error. The orders may not be cancelled after 3:58pm for any reason.

MOC orders, floor broker interest entered manually by the designated market maker (DMM), limit orders in the book priced better than the closing price and LOC orders priced better than the closing transactions must be executed in whole or in part.

Limit orders in the book equal to the closing price, LOC orders equal to the closing price and CO orders can be used to satisfy residual supply/demand.

NASDAQ

MOC and LOC orders can be entered until 3:50pm. IO (Imbalance Only) orders may be entered up to the closing print. At the time of the closing print, aggressive buy/sell IO orders are repriced to the bid/ask respectively. These effectively offer the same functionality as CO orders on NYSE and cannot be used to 'flip' the imbalance.

NASDAQ disseminates imbalance information and near/far closing prices at 3:50pm and is periodically refreshed up until the close. The near closing price is the calculated closing price if the stock was to close right away (ie factors in all marketable MOC, LOC, IO orders as well as limit order book depth). The far closing price has the limit order book depth factored out (ie only consists of impact of MOC, LOC, IO orders). Needless to say, there is sufficient information in these two numbers, for anyone with an L2 quote, to make an educated guess on the size of non-marketable LOC orders that are in the book.

MOC, LOC and IO orders cannot be cancelled or modified after 3:50pm. Only IO order may be entered after 3:50pm and MOC and LOC orders will be rejected.

LSE

Unlike North American markets, LSE has no concept of MOC orders/imbances since the close is done in a visible auction market that starts at 4:30pm (similar to our opening auction).

Continuous trading on the LSE ends at 4:30pm. At this point, the closing auction begins during which time limit, auction market and hidden orders can be entered, modified and deleted until a random time between 4:35pm and 4:35:30pm. During this time period, market participants can view the market book, which typically becomes crossed. They are also given an indicative closing price and volume. Typically, the market will close after the closing auction. However there can be up to three extension periods, one market order and two price monitoring extensions if the market cannot close within pre-specified parameters.

Table 1: Comparison of MOC models

	TMX	NYSE	NASDAQ	LSE
Time imbalance is first published	3:40pm	3:45pm	3:50pm	4:30pm
Continuous publishing of imbalance information after initial imbalance is published?	No	Yes	Yes, including near/far closing prices	Yes
Can cancel orders after initial imbalance publication/during the auction period?	Yes, only orders submitted after 3:40pm	No, unless a legitimate error was made up until 3:58pm only	No	Yes
Can send MOC/LOC orders before the initial imbalance publication?	MOC only	Yes	Yes	N/A
Can send MOC/LOC orders after the initial imbalance?	LOC only, in the opposite direction of the initial imbalance.	Yes, if they are against the direction of the Mandatory MOC/LOC Imbalance Publication. CO orders may be entered on both sides up until the close.	No, only IO orders are permitted. Since they are repriced to the closing bid or offer, there is no guarantee that IO orders will be executed even if they are more aggressive than closing price.	N/A
Can orders after imbalance is published be used to flip the imbalance?	Yes	Yes	No	N/A

Suggested improvements to the Canadian MOC Facility

“We do not believe the ‘if it aint broke, don’t fix it’ mentality”

TMX hosted a sell-side roundtable on March 1st to solicit suggestions on how to improve the Canadian MOC facility. The buy-side roundtable will be held on April 18th to solicit their suggestions. We hope that there is a collective final meeting to bring all stakeholders to the same table before finalizing any changes to the MOC facility.

We do not believe the ‘if it aint broke, don’t fix it’ mentality and are always open to any changes for the positive. However, change for the sake of change is not a good thing either and we encourage the industry to be actively engaged in open dialog to discuss the pros/cons of any changes being suggested. We will discuss some of the possible improvements to the Canadian MOC facility.

Increase number of securities that are MOC eligible

The Canadian MOC facility has over 650 stocks that are MOC eligible. The stocks are primarily derived from popular (but not all) indices in Canada as well as on request. In addition, there have been a number of TSXV names added to the facility to accommodate some of the TSXV indices.

The addition/deletion process to the facility is ad-hoc and leads to confusion for participants. It can create severe price dislocations in names that have index supply/demand but are not MOC eligible as their supply/demand will get traded near the close in the visible marketplace. The MOC facility is designed to provide an orderly way to disseminate and manage this supply/demand imbalance at the close.

We would prefer a facility that allows universal acceptance of all securities (excluding securities that trade off other fundamentals/underlying such as Prefs/ETFs as liquidity in these products disappears near the close). While this approach certainly increases the probability of price movement extensions (PMEs) being triggered on a greater number of names, this is a small nuance relative to the severe price dislocations we discussed on non-MOC eligible index add/deletes. The onus should be on the dealers to recognize what is a ‘safe’ size for the MOC (this happens today anyway) and severe price dislocations should be protected by the PME process.

Allow mixed lots in the MOC

The current Canadian MOC facility only accepts board-lot orders to be submitted into it. Allowing mixed-lots in the facility is universally agreed upon to be a good idea and will help streamline workflow for all participants.

The idea is simple; pool all odd-lot portions of orders and trade the consolidated board-lot portions in the normal MOC facility. The final net odd-lot portion gets placed to the designated RT for the stock. This takes away the manual odd-lot management near the end of the trading day which can be quite cumbersome on large rebalance days where there can be a few thousand securities trading into the close. The RT benefits as well as only the net odd-lot is placed to them whereas in the existing system

multiple odd-lots could be traded against their book in the last few seconds of the system potentially leaving them with significant overnight exposure.

Changing Price Movement Extension (PME) levels

Price movement extension (PME) takes place when a stock's calculated closing price is greater than +/- 3% on TSX (+/- 5% on TSXV) from the last 20 minutes of regular market trading and the last board-lot sale price in the continuous market. This is to allow additional liquidity to be solicited across the board on stocks that are going to gap.

PME levels work well for the most part, however there are far too many PMEs that get triggered on low dollar value stocks where the % move becomes irrelevant (eg 3% on a \$1 stock is not a whole lot of movement resulting in a meaningless PME). One suggestion is to have a maximum of either 3% or \$0.15 (to handle cases of sub-\$5 stocks) to reduce PME triggers.

There have been instances where PME levels have been adjusted for ad-hoc special situations (e.g. YLO's deletion from S&P/TSX Composite index where the PME was widened). This approach can lead to potential problems as rules are being changed mid game resulting in confusion around the process (if the changes are not disseminated properly).

MOC fees

Canada continues to be one of most expensive MOC facilities relative to global rates. Participants pay \$30 per 10,000 shares executed (including orders swept in from the visible book). Contrast this to the US pricing of between \$5.50 to \$9.50 per 10,000 shares and any orders swept in from the visible book trade for free.

To be fair, TMX caps the fee at \$30 per fill which, based on our calculations for all MOC fills in 2011, yielded savings of ~50% off the gross MOC bill. The net price however is still in the ballpark of \$15 per 10,000 shares. In basis point terms, this gap is even wider given that the median Canadian stock price is \$20 (S&P/TSX Composite) vs \$43 in the US (S&P 500).

The TMX closing price is the official listed closing price and is a widely used benchmark for valuation. Thus participants are captive and required to use the TMX MOC facility as it sets the closing benchmark.

Pre imbalance Limit-On-Close, Imbalance Republishing, Imbalance Flipping

The next three topics should really be categorized under one bucket since they are somewhat related for a properly functioning MOC facility. However, we will split the topics up for the purpose of this discussion in order to discuss their pros/cons individually.

We do suggest trading carefully on implementing some of these changes as there are laws of unintended consequences at play here. Perhaps a more detailed study of US/European MOC facilities is in order to learn from their experience and drawbacks that they have faced as a result of having some of these facets to their MOC facility.

We want to consider these changes from an index manager's perspective (by far the biggest utilizers of the MOC facility). In our conversations with index managers, it is clear that value preservation is of the utmost concern while outperformance to benchmark is secondary. We note that these two are often competing forces and outperformance is typically achieved by pushing the benchmark itself (which results in value destruction). This is particularly true in most guarantee or 'profit split' deals offered by the dealers for rebalances and is evident in the fact that rebalance names often tend to gap in the close due to large supply/demand numbers. Any outperformance is a direct result of impacting the benchmark (and causing value destruction in the process). Thus, the changes suggested should help promote value preservation and reduce the ability to impact the close.

1) Allowing Limit-On-Close orders prior to imbalance publishing

"Limit-On-Close (LOC) orders represent more choice for participants and that is a good thing"

Limit-On-Close (LOC) orders represent more choice for participants and that is a good thing. TMX currently only allows offsetting LOC orders after 3:40pm and we believe allowing them prior to 3:40pm would open the MOC facility up to a wider audience that is currently hesitant to submit market orders.

Allowing LOC orders prior to 3:40pm would also allow index managers to avoid severe price dislocations on the close which in turn helps with value preservation of the index (ie reduces the slippage of the index itself). The imbalance published at 3:40pm should be the net imbalance of all the marketable orders at that moment in time (ie don't include any LOC orders that are off-market).

While non-marketable LOC orders can potentially flip the imbalance if the stock moves (and the LOC orders become marketable), it is in theory no different than anyone putting in an offsetting LOC order.

We note that the US MOC facilities allow LOC orders prior to imbalance publishing but on the flip side allow imbalance republishing that makes the closing facility a little more transparent.

2) Continuous imbalance republishing and locking in orders after imbalance publishing

We do not like the idea of continuous republishing of imbalances as it can cause some serious unintended consequences.

- Increases trading risk as everyone shifts their MOC orders into the last second of trading (which makes the whole republishing process pointless to begin with) and furthermore makes it a jockeying game similar to the Market on Open facility where orders are continuously being repriced based on the updated imbalance.
- Discourages participants from putting in their absolute best price in the MOC since the visible imbalance has the potential to allow gaming.
- Provides information asymmetry to HFTs who can use this information for gaming purposes. Most dealers will not ‘ping’ the imbalance in order to find out the status of the book but an HFT can conceivably use the pinging method to map out icebergs in a trading book and use the information asymmetry to their advantage.

Some of these issues can be resolved with some creative thinking while others are inherent in the act of republishing. There is a very real possibility of increasing volatility in the closing seconds of the trading session which is the main issue with continuous republishing.

Locking in any orders submitted post-publishing is one way to mitigate some of the risks but this in turn encourages orders to be submitted to the facility in the closing seconds to better gauge the market at the time (this can lead to jockeying for position as well as increase technology risk as everyone plays the game of chicken and waits to the last second to submit orders).

We also considered the NASDAQ model of near/far closing prices that are broadcast after the imbalance has been published. The near closing price provides the calculated closing price if the stock were to close right now (MOC, LOC, IO orders as well as the limit order book) while the far closing price removes the limit order book from this calculation. This information can potentially be used to figure out the off-market LOC orders which in turn can be used to gauge how far/easily a stock can be ‘pushed’ in the last few seconds to achieve a favourable closing price.

“information can be used to figure out the off-market LOC orders”

3) Imbalance flipping & CO/IO orders

Imbalances can currently only be flipped one way (ie a sell can switch to a buy and vice-versa). This makes the MOC facility a little more predictable in nature (especially on rebalance days where indexers forego putting orders in the MOC facility and place them only after 3:40pm to ‘flip’ the imbalance). This is less than ideal since it advantages one set of users of the facility to the detriment of the others. One way to get around this is to place orders in the book (ie put sell orders higher up on a sell-side imbalance to take advantage of any MOC imbalance flipping) but this is an inexact science and the closing price cannot be reasonably achieved by anyone who did not put in their sell order prior to 3:40pm in this scenario.

“As much as we want to advocate for banning imbalance flipping, we fear the ban could have some unintended consequences”

The US MOC facilities solve this problem by allowing CO or IO order types that only come into play to help minimize the price dislocation. We like this approach to minimize volatility on the closing print.

As much as we want to advocate for banning imbalance flipping, we fear the ban could have some unintended consequences. Again, let’s consider the NASDAQ model. If an indexer decides not to put

their order in the MOC facility prior to imbalance publishing (thus causing a ‘wrong way’ imbalance to come out), then they are incented to trade their balance in the visible marketplace while ‘supporting’ the stock with IO orders. Basically the same effect as an imbalance flipping is achieved but the move takes place in the closing seconds of the market instead of the MOC print itself.

Conceptual MOC Model

In summary, we are going to stick our necks out and propose a conceptual MOC model that tries to balance the needs of the participants based on the discussion in this paper. We encourage everyone to provide us their feedback and criticism/potential gotchas for this model that we might not have thought of. Hopefully we can collectively come up with a model that improves on the existing one!

Using the Canadian MOC facility as the base, here are the changes we propose:

- Allow any common stock to trade in the MOC facility (exclude stocks that derive their value from underlying/other fundamentals such as ETFs/Prefs)
- Allow odd-lots in the MOC facility
- Make the PME levels consistent across the board and widen them for stocks below \$5
- Allow Limit-on-close orders prior to imbalance publishing
- Create new CO or IO order type (similar to US markets) that allow orders to be placed on either side of the imbalance after publishing and only come into play to dampen price dislocation

We do NOT support:

- Imbalance republishing as it encourages LOC/CO/IO orders to be put in right near the close and is susceptible to gaming
- Locking in any orders submitted after imbalance publishing. This really only applies if the imbalance is being republished, since without that there is no information leakage and the participants should have the ability to change/cancel their orders.
- Removing the ability to flip an imbalance (the alternative of price movements in the closing seconds is far worse in our opinion)

Conclusion

The MOC facility is one of the most important facets of any modern marketplace. It is important to have the ability to achieve the closing price and to ensure for the process of achieving it is managed in a fair and orderly manner.

We have highlighted the mechanics and quantified the price impact of placing an order in the Canadian MOC facility. In addition, we have contrasted some of the models employed by other marketplaces.

The Canadian MOC facility is good but it's not perfect and can definitely adopt some of the lessons learnt from other marketplaces. We have highlighted one conceptual model for an improved MOC facility that borrows from the various models in the developed markets.

We commend the TMX for soliciting feedback and striving to improve their MOC facility. This will be an iterative process as feedback is incorporated to fine-tune the facility. We encourage all participants to engage in open dialog in order to collectively evolve our market microstructure.

As always, questions/comments are welcome!

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