ANNEX F

Data Fees Methodology

The Data Fee Methodology described below will be used to determine each marketplace's relative contribution to pre- and post-trade activities. The scope of the methodology is to determine whether the professional market data fees charged by the marketplaces in Canada reflect each marketplace's share of trading activity.

The methodology consists of three steps:

1. Calculation of pre- and post-trade metrics
2. Ranking of marketplaces based on the pre- and post-trade metrics calculated in step 1
3. Assigning an estimated fee range to each marketplace.

The methodology uses the following notations for the pre- and post-trade metrics and the ranking methods:

Notation	Description
i	A transparent marketplace
m	Total number of transparent marketplaces
j	Securities traded on a transparent marketplace
J	Total securities traded on all transparent marketplaces
t	A Trade executed on a transparent marketplace
n	Total trades executed on a transparent marketplace
T	Total trades executed on all transparent marketplaces
d	A trading day
D	All trading days for the period under review

a. Pre-Trade Metrics

1. **Percent of Best Bid and Offer (BBO)**[1] - means the percent of the day for which a marketplace had a quote at the national best bid (BB) or best offer (BO) for security *j*. This metric is scaled to sum to one.

$$\%\boldsymbol{BBO_i} = \frac{BBO_i}{\sum_{i=1}^{m} BBO_i}$$

$$\boldsymbol{BBO_i} = \frac{1}{J}\sum_{\boldsymbol{j=1}}^{\boldsymbol{J}} \frac{Seconds\ at\ BB_j + Seconds\ at\ BO_j}{2 * (6.5 * 60 * 60)} * 100$$

[1] The time at BBO could be calculated in fractions of a second, given the rapidity of quoting.

This metric rewards marketplaces for being at the BBO for a longer period during the day. This metric is constructed from standard quote data. In order to ensure that the addition of each marketplace sums to one, the individual metrics for each marketplace are summed to come up with a market-wide daily percent at the BBO, and each individual marketplace's percentage is then divided by this total to scale the metric to one.

2. **Percent of Best Spread** - means the percent of the day that a marketplace was quoting the narrowest spread for security *j*. This metric is scaled to sum to one.

$$\%\boldsymbol{Spread_i} = \frac{Spread_i}{\sum_{i=1}^{m} Spread_i}$$

$$\boldsymbol{Spread_i} = \frac{\mathbf{1}}{\boldsymbol{J}} \sum_{\boldsymbol{j=1}}^{\boldsymbol{J}} \frac{Seconds\ at\ tightest\ spread_j}{6.5 * 60 * 60} * \mathbf{100}$$

This metric tends to reward marketplaces for providing liquidity at both the BB and BO, by establishing the narrowest spread on the market. This metric is also constructed from quote level data. In order to ensure that the addition of each marketplace sums to one, the individual metrics for each marketplace are summed to come up with a market-wide daily percent at the narrowest spread, and each individual marketplace's percentage is then divided by this total to scale the metric to one.

3. **$Time(value)** - means the percent of quoted-time-dollar-volume for a marketplace, out of the total time-dollar-volume for the entire market for the period, when only the BB and BO are considered. Each stock is weighted by the value traded in the period of consideration, as described in the weighting "w" below.

$$\$\boldsymbol{Time}(value)_i = \frac{\boldsymbol{Time(v)_i}}{\sum_{\boldsymbol{i=1}}^{\boldsymbol{m}} \boldsymbol{Time(v)_i}} \boldsymbol{Time(v)_i}$$

$$= \frac{\sum_{j=1}^{J} [Price_j * Volume_j * seconds\ at\ BB + Price_j * Volume_j * seconds\ at\ BO] * w_j}{\sum_{j=1}^{J} \sum_{i=1}^{m} \left(Price_j * Volume_j * seconds\ at\ BB + Price_j * Volume_j * seconds\ at\ BO\right) * w_j} * 100$$

$$w_j = \frac{\$Volume_{t,j}}{\sum_{t=1}^{T} \sum_{i=1}^{J} \$Volume_{t,j}}$$

The use of the value weighting places more emphasis on those stocks that trade heavily and less emphasis on stocks that do not trade frequently. At the extreme, a stock that does not trade at all will not be allocated any weight under this metric.

b. *Post-Trade Metrics*

1. **Percent of each marketplace's volume** - means the volume traded on each marketplace divided by the total volume traded on all marketplaces in the period.

$$\%Volume_i = \frac{Volume_i}{\sum_{i=1}^{m} Volume_i} * 100$$

This metric rewards traded volume and tends to favour those marketplaces that trade in relatively low-priced shares, as it considers only the number of shares traded, not their value. In an extreme scenario, if a marketplace traded only low-priced stocks, this metric would inflate their overall share of the entire market.

2. **Percent of each marketplace's number of trades** - means the number of trades executed on each marketplace divided by the total number of trades on all marketplaces in the period.

$$\%Number_i = \frac{Number_i}{\sum_{i=1}^{m} Number_i} * 100$$

This metric rewards those marketplaces that have a larger number of trades. This metric could be manipulated by encouraging traders to break their orders up into smaller pieces. If this were done, neither the volume nor the dollar volume traded would change, but the number of trades would increase significantly.

3. **Percent of each marketplace's dollar volume (value)** - means the dollar volume traded on each marketplace divided by the total dollar volume traded on all marketplaces in the period. Dollar volume is the product of the price and volume of each trade.

$$\%\ \$Volume_i = \frac{\$Volume_i}{\sum_{i=1}^{m} \$Volume_i} * 100$$

$$\$Volume = Price * Volume$$

This metric takes the value of the transactions into account. This tends to avoid the biases that may be present in the volume metric. However, due to the requirement that crosses matched by a dealer be reported to a marketplace, it is possible that a marketplace being measured on this metric could provide incentives (such as trading rebates) to dealers to ensure that crosses are reported on their marketplace. In this way, the marketplace would have a much larger share of dollar volume without necessarily contributing to pre-trade price discovery.

4. **Percent of square-root dollar volume for each trade** - means the square root of

the $Volume of each trade *t* executed on each marketplace divided by the sum of the square-root of the $Volume traded on all marketplaces in the period.

$$\%\sqrt{\$Volume_i} = \frac{\sum_{t=1}^{n}\sqrt{\$Volume_{i,t}}}{\sum_{t=1}^{n}\sum_{i=1}^{m}\sqrt{\$Volume_{i,t}}} * 100$$

The square-root of dollar volume is individually constructed for each transaction. This metric is not widely published, but it is easily constructed from trade reports. This metric reduces the importance of larger trades in relation to smaller trades. This can help alleviate the problem of very large crosses inflating a marketplace's contribution to price discovery. This metric has the potential disadvantage that trades in low-priced stocks (on the order of $1 to $2) will not be reduced at all, and will consequently be disproportionately represented. If a marketplace were to trade very frequently at these very low dollar values, their contribution to price discovery would be inflated by this metric.

5. **Scope of trading on each marketplace** - means the average over the period of the number of symbols with greater than 1 traded on each marketplace on day *d*, divided by the number of symbols traded on all marketplaces for that day.

$$Scope_i = \frac{1}{D}\sum_{d=1}^{D}\frac{Number\ of\ symbols\ traded_{i,d}}{MAX\left[Number\ of\ symbols\ traded_{i,d}\right]}$$

Scope of trading provides a metric that measures the number of symbols a marketplace trades. This metric, when used in combination with other post-trade metrics, has the disadvantage of "double penalizing" marketplaces for not trading all securities. By construction, scope of trading will be very high for exchanges (such as the TSX) and will be lower for newer marketplaces that have yet to gain market share in less liquid stocks. While it does measure the "activity" of marketplaces, a marketplace that only trades in half of the total listed symbols is, by definition, penalized for not trading all of those symbols. Thus, if scope is used by itself, it can be a valuable indicator of the activity levels of marketplaces, but if it is applied in conjunction with other metrics, it may disproportionately favour existing exchanges and large ATSs.

The downside of this metric is that if a marketplace wanted to achieve a scope as close as possible to one (i.e. all listed securities would be trading on this marketplace), marketplace participants could be rewarded (through credits or discounts at market open) for becoming the "first" participant of the day in any given security. In this way, marketplaces could ensure at least one trade in every security without providing any meaningful liquidity or price discovery.

c. ***Ranking Models***

In order to rank each marketplace's contribution to price discovery we constructed two models from the pre- and post-trade metrics. While each model is constructed placing equal importance on the pre- and post-trade metrics, this was an arbitrary decision.

1. **SIP Value** – is based on the revenue distribution model used by the U.S. SIP.

$$\left[\frac{\%\sqrt{\$\boldsymbol{Volume_i}} + \%\boldsymbol{Number_i}}{\mathbf{2}}\right] * \mathbf{0.5} + \$\boldsymbol{Time(value)_i} * \mathbf{0.5}$$

This model incorporates the metrics used by the U.S. SIP to distribute revenue amongst participating marketplaces. The post-trade metrics used are equally weighted, and are composed of each marketplace's share of square root dollar volume and number of trades. Both of these post-trade metrics together are assigned a weighting of 50% of the value of the model.

The pre-trade metric used is the value weighted percent of quoted dollar-time. This is also given a 50% weighting in the final model. The weighting of this model by the value traded in each security provides a greater emphasis on those stocks that are heavily traded, rewarding marketplaces more for providing liquidity where the majority is consumed.

2. **Model 3** - differs significantly from the previous model. For the post-trade element, this model considers each marketplace's share of traded volume, share of trades and share of dollar-volume. These three elements are given equal weighting in this index. The pre-trade metrics considered are the percent of the day spent at the best spread and the percent of the day spent at the BBO. Each of these two pre-trade elements is equally weighted. The resulting pre- and post- trade metrics are then equally weighted to come up with the final index.

$$\left[\frac{\%\text{Volume}_i + \%\text{Number}_i + \%\$\text{Volume}_i}{3}\right] * 0.5 + \left[\frac{\%\text{Spread}_i + \%\text{BBO}_i}{2}\right] * 0.5$$

d. ***Assigning an estimated fee or fee range***

After calculating these ranking methods, we would use them to assess whether a marketplace's existing (or proposed) fee is related to its share of trading activity. We use the domestic reference that takes the data fees charged by each marketplace and aggregates them into a single "pool". The result is then considered to be the appropriate fee for the Canadian market, and this result is then re-distributed, based on the two ranking models, giving us four estimated fees for each marketplace.