Appendix A – Proposed Design Report -Trading Fee Rebate Pilot Study

Design Report
for the CSA Pilot Study on Rebate Prohibition*

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Disclaimer: This document is subject to a request for comments and may change as the comments are addressed. The final design of the Pilot will be determined by the Canadian Securities Administrators (CSA).

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I. Executive Summary

The CSA has proposed a pilot study to better understand the effects of the prohibition of rebate payments by Canadian marketplaces (the Pilot). The United States Securities and Exchange Commission (SEC) has announced its intention to conduct a pilot study examining a similar set of issues (the SEC Pilot).

Rebates are often paid to market participants to attract their orders to a particular platform. The CSA has commissioned the authors of this report to develop the methodology for the Pilot, analyze the results, and complete a final research report detailing the findings of the Pilot. In this document, we propose a design and discuss the framework for the analysis of the Pilot. In particular, we cover the following issues: timing, sample construction, empirical measures, statistical tools, and anticipated challenges. We also include a list of questions for industry feedback and discuss some of the issues that have arisen in our previous discussions with the regulators and market participants.

An important feature of the Pilot is design simplicity. A complex design that tries to answer too many questions may confound the analysis and as such will be detrimental to drawing policy-relevant conclusions. Consequently, key conditions for the Pilot to be successful are as follows:

- for a group of securities selected using objective and transparent criteria (hereafter, treated securities), marketplaces are prohibited from paying fee rebates[15] to dealers, including offering discounts on liquidity removal fees if such discounts are linked to the dealers' liquidity-providing activities. For all remaining securities, the rules remain unchanged;
- the prohibition applies to all marketplaces trading equity securities;
- with respect to interlisted securities, the timing of the Pilot and the set of the Pilot securities are coordinated with the SEC;
- the Pilot matches the duration of the SEC Pilot;
- the Pilot is introduced in two stages to mitigate the effects of unexpected market-wide events that may coincide with the Pilot start date;
- in the analysis stage, a set of market quality and order routing metrics is computed using data from the Investment Industry Regulatory Organization of Canada (IIROC) Surveillance Technology Enhancement Platform (STEP) data;[16]
- a set of standard techniques is applied to examine these data; and
- the codes used in the analysis are publicly available and comments are encouraged.

The sample will be selected from corporate equity securities split into highly liquid and medium-liquid. Each treated security will be matched with a control security that has similar characteristics, i.e., firm size, share price, and trading volume. The control securities will not be treated. The sample selection will be governed exclusively by statistical considerations. We expect the sample to consist of:

[15] This will include the prohibition of rebate payments for intentional crosses.
[16] STEP offers a consolidated view of equity trading on all marketplaces.

- 50-60 highly liquid and 20-30 medium liquid interlisted securities, with an equal number of interlisted matches, and
- 60-80 highly liquid and 80-100 medium liquid non-interlisted securities, with an equal number of non-interlisted matches.

Precise quantities will be determined on the date the sample is finalized, approximately three months prior to the start of the Pilot.

In the analysis stage, we will use standard market quality metrics (e.g., quoted spreads and depths, effective and realized spreads, implementation shortfall, volatility, trade and order autocorrelation, time to execution for competitively priced limit orders, etc.). We will examine these metrics before and after rebate prohibition for the market overall and for several types of market participants separately (e.g., dealers, retail investors, institutional participants, participants using high frequency strategies, etc.). The final report will present the results with due care to preserve anonymity of the participants.

II. Details

A. Background

In its 2014 Request for Comments on Proposed Amendments to NI 23-101 Trading Rules,[17] the CSA cites several concerns regarding the maker-taker fee model. Specifically, the CSA suggests that the model may "distort transparency of the quoted spread, introduce inappropriate incentives and excessive intermediation, and create conflicts of interest" and proposes conducting a pilot study to formally examine these issues. The CSA specifically states that any pilot should "examine the impact of prohibiting the payment of rebates by marketplaces."

In proposing the Pilot design, we seek to better understand how the prohibition of rebates may affect dealers' routing practices, the level of intermediation, and standard measures of market quality. The analysis will be carried out for the market overall and for various groups of market participants separately.

In what follows, we provide a detailed description of the data, variables, and methods that will allow us to address the issues raised by the CSA. For the results to be meaningful and policy-relevant, two design features are important: sufficiently large and well-structured treatment and control samples and a staggered introduction of treatment. Furthermore, we will seek close coordination with the SEC, since trading in Canada may be affected by the final design of the SEC Pilot.

B. Merits of a Canadian Pilot

Although the U.S. and the Canadian equity markets are similar, there are several key differences that may affect dealer routing decisions. Examples include the practice of retail order internalization in the U.S. and broker-preferencing in Canada. Therefore, while we expect rebate

[17] http://www.osc.gov.on.ca/en/SecuritiesLaw_csa_20140515_23-101_rfc-pro-amd.htm.

prohibition to have a similar impact on market-wide measures of market quality in both countries, changes in routing practices and the extent to which different groups of market participants are affected may differ. Consequently, a Canadian pilot, in combination with sufficiently granular data, will substantially improve understanding of the existing fee system and will be necessary for a well-informed Canadian regulatory policy.

C. Required Data

The Pilot aims to examine discretionary routing practices and the impact of fees on different groups of market participants. We will use masked data from IIROC's STEP system. In the STEP data, we will define a trader ID as the combination of the dealer ID, user ID, and account type (specialist, client, inventory, etc.). Once defined, we will use trader IDs following the classification of market participants proposed by Devani, Tayal, Anderson, Zhou, Gomez, and Taylor (2014).

III. Pilot Securities and Sample Construction

A. Background

There are about 3,800 securities listed on Canadian stock exchanges, some of which are interlisted on foreign exchanges. Trading characteristics differ significantly across securities, and in constructing the sample we must ensure that such differences do not confound the results.

First, a number of securities trade almost exclusively in rebate-free environments. Examples include CSE-listed securities, as well as TSX- and TSXV-listed securities priced under $1 that trade on the TSX, TSXV, and MatchNow. Such securities will not be included in the sample.

Second, while we expect that our analysis will provide the most statistically reliable results for the highly liquid securities, we recognize that there is significant interest in examining the impact of rebate prohibition for securities with medium activity levels. Therefore, we will analyze a sample of such securities, but caution that the resulting market quality measures may be statistically noisy. We will not examine very illiquid securities as such an analysis will not yield statistically meaningful insights. We will split the securities into two subsamples: U.S.-interlisted equities and non-interlisted equities.

B. Sample Selection and Matching Criteria

The two groups of corporate equities will be further split into highly liquid and medium liquid securities. IIROC defines a security to be "highly liquid" if it trades on average at least 100 times per day and with an average trading value of at least $1,000,000 per trading day over the past month.[18] Highly liquid securities account for more than 90 percent of the TSX market capitalization and as such are reasonably representative of the wealth invested in publicly-listed Canadian corporate equities. We will define a security as "medium-liquid" if it trades on average at least 50 times a day and with an average trading value of at least $50,000 over the past month.

[18] http://www.iiroc.ca/industry/rulebook/Pages/Highly-Liquid-Stocks.aspx

To select the treatment and control groups, we will use a procedure that finds stocks similar to each other based on a set of pre-defined characteristics and then randomly selects a stock to treat from each pair. We will use the following matching characteristics as of three months prior to the Pilot start date: listing status (single market vs. interlisted), liquidity status (highly liquid vs. medium liquid), firm size (market capitalization), price, and dollar trading volume, with the last three characteristics averaged over the month preceding the selection date. The list of Pilot securities will be made public as soon as it is finalized.

An appropriately-sized sample that is representative of the universe of Canadian publicly listed firms must include the interlisted stocks. We have submitted a comment letter to the SEC to formally request that the Pilot and the SEC Pilot are coordinated so that the interlisted stocks are treated in the same manner in Canada and the U.S.[19] For instance, if Barrick Gold, ABX, is a treated security in the Pilot, then it should also be included in Group 3 in the SEC Pilot as currently proposed. Similarly, the interlisted stocks used as controls in the Pilot must be in the control group (currently Group 4) in the SEC Pilot.

C. Matching Procedure

We will follow the approach known as *the nearest-neighbor matching*. Specifically, for each possible pair of securities *i* and *j*, we will compute the pairwise scaled matching error as follows:

$$matcherror_{ij} = \sum_{k=1}^{M} \left(\frac{C_k^i - C_k^j}{C_k^i + C_k^j} \right)^2, \tag{1}$$

where C_k is one of the above-mentioned matching characteristics, e.g., firm size, price, and trading volume. We will then sequentially select pairs with the lowest matching errors until all stocks are allocated a pair. Finally, we will randomly assign one stock in each pair for treatment and retain the other stock as a control.

IV. Empirical Measures and Analysis

A. Empirical Measures

Quoted Liquidity. The quoted spread will be computed as the difference between the Canada-wide best ask and bid prices (the CBBO). We will compute this metric in two ways: (i) across all markets and (ii) only for the markets with protected quotes. The quoted spread at time *t* for security *i* is defined as:

$$qs_{it} = ask_{it} - bid_{it}. \tag{2}$$

We will drop instances of locked markets, when the bid and the ask are equal, and instances of crossed markets, when the bid is greater than the ask.

[19] https://www.sec.gov/comments/s7-05-18/s70518-4465710-175825.pdf

Spreads usually vary in the stock price, and as such it is a common practice to compute the proportional spread as:

$$qsp_{it} = \frac{qs_{it}}{m_{it}}, \tag{3}$$

where m_{it} is the CBBO mid-quote defined as:

$$m_{it} = \frac{ask_{it} + bid_{it}}{2}. \tag{4}$$

To aggregate the spread metrics to the daily level, we will compute the *time-weighted* quoted spread on day *d* as follows:

$$twqsp_{id} = \frac{1}{\sum_t \Delta_{t,t+1}} \times \sum_t \Delta_{t,t+1}\ qsp_{it}, \tag{5}$$

where $\Delta_{t,t+1}$ is the number of time units during which the quote is active. For instance, if a quote is active from 14:35:00.002 to 14:35:08.004, then $\Delta_{t,t+1}$ = 8,002 milliseconds (ms).

Some of the stocks in our sample will likely be constrained by the minimum tick size of one cent. To account for this possibility, we will compute the fraction of the day that a stock is quoted with a one-cent spread.

We will compute *quoted depth* as the sum of the number of shares posted at both sides of the CBBO. We will compute *quoted dollar depth* as the sum of the dollar value of shares posted at both sides of the CBBO. We will time-weight both depth metrics.

Price Efficiency. The finance literature has developed a number of metrics that capture the speed with which (and the extent to which) prices incorporate new information. Generally speaking, the faster the price discovery process, the more informationally efficient are the prices.

Autocorrelation of Returns. Similarly to Hendershott and Jones (2005), we will compute the autocorrelation of midquote returns for 30-second, 1-minute, and 5-minute intervals. A lower absolute value of autocorrelation is associated with greater market efficiency as prices better resemble a random walk.

Variance Ratios. If prices are efficient and follow a random walk, the variance of midquotes is linear in the time horizon. Campbell, Lo, and MacKinlay (1997) define the scaled ratio of variances over *k* time horizons as: $|(\sigma_{tk}/k\sigma_t) - 1|$ and suggest that the closer this ratio is to 0, the more efficient is the market. We will follow the existing literature and compute the variance ratios for two intervals: 30-second to 1-minute and 1-minute to 5-minute.

Intra-Day Volatility. We will compute two volatility metrics: range-based and variance-based. The range-based metric is the daily average of the high-low price range computed over ten-minute intervals, scaled by the interval's mid-quote defined in equation (4) above. Aggregated over many securities, this metric is usually strongly correlated with overall market volatility as measured by the VIX.[20] The variance-based metric is the standard deviation of the one-minute mid-quote returns for the day.

Activity Levels. To measure market activity, we will compute several trading volume metrics such as volume at the open and close, volume during the continuous market, volume in intentional crosses, and dark volume.

We will further compute a set of order-related metrics such as the number of orders and their value, the proportion of canceled and executed orders, the proportion of executed order value, the number of orders that match or improve the CBBO, and the proportion of orders one and two cents away from the best quotes, as well as one percent and five percent of the mid-quote away from the best quotes.

We note that there are no agreed-upon economic measures that determine whether a change in market activity levels is beneficial or harmful. Therefore, volume and order submission figures must be interpreted with caution.

Effective Spreads. Effective spreads measure the costs that market participants incur when they trade. It is conventional to base the computation of effective spreads on the mid-quote of the prevailing CBBO. For security *i*, the proportional effective spread for a trade at time *t* is defined as:

$$esp_{it} = 2 \times q_{it} \times \frac{p_{it} - m_{it}}{m_{it}}, \tag{6}$$

where p_{it} is the transaction price, m_{it} is the mid-quote of the CBBO prevailing at the time of the trade, and q_{it} is an indicator variable that equals 1 if the trade is buyer-initiated and −1 if the trade is seller-initiated. The factor 2 is used to make the estimate comparable to the quoted spread by capturing the cost of a round-trip transaction.

To obtain a daily effective spread estimate, it is common to volume-weight transaction-specific estimates, i.e., for trades of volumes v_{it}, the effective spread on day *d* is the sum of the trades' effective spreads weighted by the trades' shares of total daily volume:

$$vwesp_{id} = \frac{1}{\sum_t v_{it}} \times \sum_t v_{it} esp_{it}. \tag{7}$$

The purpose of the Pilot is to understand the impact of a prohibition of rebates and we will therefore compute the "cum fee" effective spread (often referred to in the industry as the "economic" spread):[21]

[20] The CBOE Volatility Index (VIX) is a calculation designed to produce a measure of constant, 30-day expected volatility of the U.S. stock market, derived from real-time, mid-quote prices of S&P 500 Index call and put options.
[21] This measure will be computed per transaction. We caution that it will be difficult to determine precisely which fees apply; dark, lit, and post-only orders may all command different fees, market-makers may receive bulk-discounts, etc. We will apply a uniform rule by employing only the "most common" fee that applies on the specific venue.

$$cum\ fee\ esp_{it} = esp_{it} + 2 \times taker\ \ fee_{it}/m_{it}. \tag{8}$$

Price Impact and Realized Spread. It is common practice to decompose the effective spread into two components: the *price impact* and the *realized spread*. The price impact measures by how much the trade moves the price and is formally defined as:

$$primp_{it} = 2 \times q_{it} \times \frac{m_{i,t+\tau} - m_{it}}{m_{it}}, \tag{9}$$

where $m_{i,t+\tau}$ is the CBBO midpoint τ time units after the trade. The idea behind this measure is that trades reveal information about the fundamental value of the underlying security, and the market needs time to incorporate this information into prices. The time horizon τ is set according to the frequency with which a security trades and varies between one second for the frequently traded stocks to five seconds for the less frequently traded ones.

The price impact is directly related to the realized spread, which is defined as:

$$rsp_{it} = esp_{it} - primp_{it} \tag{10}$$

and is interpreted as the revenue that liquidity providers receive net of the adverse selection costs captured by the price impact. Analogously to the cum fee effective spreads, we will account for the rebates that liquidity providers are eligible to receive and will compute the cum rebate realized spreads as follows:

$$cum\ fee\ rsp_{it} = rsp_{it} + 2 \times maker\ \ rebate/m_{it}. \tag{11}$$

Implementation Shortfall. Buy-side institutions often trade amounts that are larger than the depth available at the best prices and therefore commonly slice large "parent" orders into smaller "child" orders. The child orders may move market prices away from the price prevalent at the beginning of the large trade and as such increase the total cost of the parent order. Buy-side traders therefore worry about the total cost of their parent orders, which is usually measured by the implementation shortfall (IS).

While we likely cannot identify the buy-side trades directly, we will proxy for parent orders by identifying instances where a single trader executes several trades in the same direction on a given day and trades only in that direction. The total cost associated with such a string of trades will be measured by the implementation shortfall defined as:

$$IS_{it} = q_{it} \times (\$vol_{it} - p_{i0} \times vol_{it}), \tag{12}$$

where q_{it} is +1 for a string of buys and −1 for a string of sales that begins at time t in stock i, $\$vol_{it}$ is the total dollar volume for the string, p_{i0} is the prevailing mid-quote at the time of the first trade in the string, and vol_{it} is the total share volume for the string.

A positive shortfall indicates that prices move in the same direction as the parent order. In our reporting, the aggregate shortfall will be computed in basis points of the aggregate dollar volume traded. We will consider two types of trade strings: (i) those that originate from marketable orders only and (ii) those that originate from marketable and non-marketable orders.

Passive Order Execution Quality. For retail orders and for large trade strings, we will compute the resting time of non-marketable orders. We will specifically focus on orders with prices that suggest that the submitter is interested in a timely execution. As such, we will consider only orders that are submitted at prices that match or improve the CBBO.

For large trade strings, we will also report the average fraction of volume that is traded with marketable orders. A change in this measure captures the possibility that institutional investors may change their strategies and choose to "cross the spread" more/less often.

Finally, we will examine the ratio of traded to submitted orders; this ratio captures how many orders an institution needs to submit to fill a position. We will consider only the orders submitted at prices matching or improving the CBBO. We will also compute this ratio for share volume.

B. Statistical Analysis

The basis of our statistical approach is a conventional difference-in-differences analysis of a panel dataset (securities×days). Analyses of this kind usually rely on two approaches to examine the treatment effect (i.e., the effect of rebate prohibition). We discuss these approaches below using the bid-ask spread as an example.

In the first approach, the dependent variable ΔDV_{it} is the value of the bid-ask spread for the treated security *i* at time *t* less the value for the matched security. Using this dependent variable, we will estimate the following regression:

$$\Delta DV_{it} = \alpha \cdot pilot_t + controls_t + \delta_i + \varepsilon_{it}, \quad (13)$$

where $Pilot_t$ is an indicator variable set to 1 on the Pilot start date, $controls_t$ are time series controls such as the VIX, and $\underline{\delta_i}$ are security-pair fixed effects. The coefficient of interest α captures the effect of the Pilot on treated securities.[22]

In the second approach, the dependent variable DV_{it} is the value of the bid-ask spread for each security from the treatment and control groups. Using this dependent variable, we will estimate the following regression:

$$\Delta DV_{it} = \alpha_1 \cdot pilot_t + \alpha_2 \cdot pilot_t \times treated_i + \alpha_3 \cdot treated_i + controls_t + \delta_i + \varepsilon_{it}, \quad (14)$$

where $Pilot_t$ is the indicator variable set to 1 on the Pilot start date, $treated_i$ is 1 if the security is from the treatment group and 0 otherwise, $controls_t$ are time series controls such as the VIX, and $\underline{\delta_i}$ are security fixed effects. The coefficient of interest is α_2; it estimates the incremental effect of the Pilot on the treated securities. For instance, with quoted spread as the dependent variable, a positive α_2 will indicate that the spreads for the treatment group increased relative to the control group.

[22] This regression methodology is similar to that in Hendershott and Moulton (2011) and Malinova and Park (2015).

We will conduct inference in all regressions using double-clustered Cameron, Gelbach, and Miller (2011) standard errors, which are robust to cross-sectional correlation and idiosyncratic time-series persistence.[23]

Each approach will use two controls for the market-wide effects that are known to affect trader behaviour and market quality. First, we will use the U.S. volatility index, VIX, to control for the level of market-wide volatility. We acknowledge that Canada has its own volatility index, but note that this index may be directly affected by trading in the sample securities, while the U.S. VIX is less likely to be similarly affected. Second, we will use the cumulative return for the S&P GSCI commodity index. Comerton-Forde, Malinova, and Park (2018) show that this index is highly correlated with the Canadian TSX Composite index, but is unlikely to be significantly affected by trading in Canada and therefore serves as a proxy for Canadian market-wide returns.

V. Anticipated Challenges

We caution that several possible scenarios may affect our ability to deliver meaningful conclusions. First, individual firms in the sample may experience events during the Pilot that render them unusable for the subsequent statistical analyses (e.g., mergers, bankruptcies, or delistings). We will mitigate the impact of such events by building the final sample as close as possible to the start of the Pilot. This said, if one of the above-mentioned events occurs after the sample is finalized, we may omit the affected security and its match from further analyses.

Second, all securities may be affected by major market-wide confounding events. Examples are a failure of a major financial institution, a market crash, or a political event. While a staggered introduction, the use of control groups, and a sufficiently long Pilot period alleviate some of the concerns regarding such events, the CSA will reserve the right to extend the Pilot or to delay the start of the Pilot if necessary.

Third, the marketplaces may develop workarounds for rebate prohibitions that undermine the Pilot, e.g., differentiated fees, bulk discounts, new order types, new venues or order books, etc. Possible effects of such developments will be evaluated by the CSA prior to their approval, with the focus on preserving the scientific integrity of the Pilot.

VI. Timing

We propose that the Pilot match the duration of the SEC Pilot. We also propose that the Pilot proceed in two stages: (i) non-interlisted stocks first and (ii) interlisted stocks second (together with the SEC Pilot), with a three- to six-month separation between the stages, should timing of the SEC Pilot permit.

As we mention earlier, the staggered introduction may alleviate concerns should the Pilot begin around the time of an unexpected market-wide event. For example, in July 2011, the SEC adopted

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[23] Cameron, Gelbach, and Miller (2011) and Thompson (2011) developed the double-clustering approach simultaneously. See also Petersen (2009) for a detailed discussion of (double-)clustering techniques.

a new rule that restricted some aspects of direct market access (DMA). Several research teams endeavored to analyze this event. Unfortunately, about two weeks after the DMA rule adoption, the U.S. credit rating was downgraded, creating a substantial amount of noise in the data. No research team has been able to produce meaningful conclusions, since the noise completely confounded the results. We caution that a similarly unpredictable event may confound the results of the Pilot if all stocks are introduced at once.

Our conversations with market participants suggest that they share this concern, and we received feedback that the difference between the two-stage and all-at-once alternatives is immaterial in terms of technical implementation.

VII. Communication and Transparency

We believe that transparency is integral when conducting studies and commit to providing timely and comprehensive updates to the CSA for disclosure to market participants.

For the data preparation and analysis stages of our work, we will use SAS, SQL, and Stata coding packages. In the interest of transparency, we will make all codes publicly available via GitHub (the online code depository). Comments for code improvement will be welcome; GitHub includes a comment function. Where possible, we will also provide the data (e.g., the non-proprietary data that will be used for the matching process). We believe that this level of transparency will bring added trust in the integrity of our analysis.

Further, we welcome suggestions for improvement of the proposed Pilot structure and analyses. We recognize the importance of consultation with market participants and coordination with other regulatory bodies and are prepared to consider alternative designs. We have received excellent feedback from the CSA, the members of the OSC Market Structure Advisory Committee, the Canadian Securities Traders Association, and participants at the Rotman Capital Markets Institute Panel Discussion. This report reflects this feedback.

Appendix I: A Sample Matching Procedure

This appendix provides an example of the matching procedure used to assign Canadian stocks interlisted in the U.S. into the treatment and control groups.

Trading volume, price, and market capitalization figures are the latest available from the Canadian Financial Markets Research Centre (CFMRC) database.[24] Trading volume is the average daily dollar volume, price is the closing price, and market capitalization is the product of the price and the number of shares outstanding. We use Canadian dollars for variables that require a price component.

We arrive at the matched sample using the following procedure:

1. We begin with a sample of 181 Canadian securities listed on the Toronto Stock Exchange (TSX) that are also interlisted on the NYSE, NYSE Arca, NYSE MKT, Nasdaq GM, and Nasdaq CM.

2. Among these, we identify 18 securities that trade at prices below $1 and refer to them as low-priced (LP). Price volatility in such securities is rather high, and as we mention previously, LPs are usually excluded from research samples.

3. Among the remaining securities, we identify 107 that are on IIROC's "highly liquid" list. We refer to these as HL stocks, and the remaining 56 securities are nHL (not highly liquid). We match HL stocks to HL stocks and nHL stocks to nHL stocks.

4. For each possible pair of *i* and *j* securities, we estimate a match error as follows:

$$matcherror_{ij} = \sum_{k=1}^{3} \left(\frac{C_k^i - C_k^j}{C_k^i + C_k^j} \right)^2 ,$$

   where C_k are natural logs of trading volume, price, and market capitalization as defined above.

5. From the matrix of match errors that spans all stock pairs, we then select stock pairs with the lowest errors, for a total of 53 HL pairs, 28 nHL pairs, and 9 LP pairs.

6. Finally, to assign stocks into the treated and control groups, for each pair we generate a random number between 0 and 1. If this number is below 0.5, we assign the first stock in the pair to be treated and vice versa.

Figure 1 provides an illustration of match quality. The horizontal and vertical axes represent logarithms of market capitalization, dollar volume, and stock price for pairs of securities, with a

[24] http://clouddc.chass.utoronto.ca/ds/cfmrc. In rare cases when CFMRC does not have a valid record for a security, we obtain the missing data from https://www.tmxmoney.com/en/index.html

random assignment of one member in the pair to the treatment and the other to the control group. A good match obtains if the points are on or close to the 45-degree line. A formal *t*-test shows no evidence that the treatment and control samples are different for any of the matching criteria.

Appendix II: Questions for Market Participants

1. We propose to define a security as medium-liquid if it trades at least 50 times a day on average and more than $50,000 on average per trading day over the past month. Do you believe that this definition is appropriate? If not, please provide an alternative definition and supporting data, if available, to illustrate which securities your definition captures.

2. We propose to introduce the Pilot in two stages, with non-interlisted securities first, followed by interlisted securities. Do you believe that such staggered introduction will cause material problems for the statistical analysis and the results of the Pilot? If so, please describe your concerns in detail.

3. Several Canadian marketplaces offer formal programs that reward market makers with enhanced rebates in return for liquidity provision obligations. On the one hand, such programs may benefit liquidity. One the other hand, one of the primary objectives of the Pilot is to understand if rebates cause excessive intermediation. In your opinion, should exchanges be allowed to continue using rebates or similar arrangements for market making programs during the Pilot? Do you believe any constraints on such programs during the Pilot to be appropriate?

4. We propose to compute price impacts at the one- and five-second horizons. Do you believe that we should consider other horizons? If so, which ones?

5. We propose to compute time-to-execution for limit orders posted at the CBBO prices or improving these prices. Do you believe that we should consider different price levels? If so, which ones? Please provide supporting data and analysis, if available, to demonstrate the empirical importance of order postings at other levels.

6. We propose a number of market quality metrics. Do you believe that we should consider additional metrics? If so, please outline these metrics and provide supporting data and analysis, if available, to demonstrate their empirical importance.

7. We have had extensive discussions with a number of market participants on whether to include exchange-traded products (ETPs) in the Pilot, and some participants suggest that such an inclusion is warranted. Nevertheless, others point out that trading characteristics of ETPs are substantially different from those of corporate equities and including ETPs will present significant challenges in the matching stage and will likely confound the results in the analysis stage.

   These participants and our own research identify the following concerns:

   - most liquidity in ETPs is determined and provided by contracted market makers, and the ETP creation/redemption process represents its own source of liquidity;

- matching characteristics that we propose to use for corporate equities do not have the same meaning for ETPs. For instance, ETP fund size is not a relevant metric, and ETP trading volume is usually not correlated with quoting activity or liquidity;

- spillover effects of two types may confound the results. First, liquidity in ETPs relates to liquidity of the underlying basket of securities, and if the basket is significantly affected by the Pilot, the ETP will be affected too. Second, ETPs that follow the same baskets may be viewed not only as good matches, but also as substitutes for investment, hedging, and trading purposes. If one of them is selected to be treated, and the other is not, market participants may move between products, potentially confounding the results of the Pilot.

The above-mentioned concerns make finding matched ETP pairs a uniquely challenging task. To the best of our knowledge, there is no established procedure for matching ETPs to study their trading costs.

As such, in relation to ETP inclusion, we ask that market participants consider the following questions: Given the challenges that ETP matching presents, can the goals of the Pilot be achieved without including ETPs in the sample? If ETP inclusion is important, can you propose a way to construct a matched sample that addresses the concerns identified above?

Appendix III: Responses to Received Questions

The Capital Markets Institute held an open forum on the Pilot at the Rotman School of Management on September 12, 2018.[25] The event included a panel of industry experts who had been asked to comment on various aspects of the Pilot's design. Prior to and during the event as well as in the weeks that followed, we received a number of thoughtful questions and comments from market participants and are grateful for their time and advice. We believe that this design report addresses most of the issues raised during these discussions. We list the most common comments here for reference.

- **Inclusion of less liquid securities.** In our presentation, focusing mainly on statistical considerations, we proposed that the Pilot only examine highly liquid securities. The participant consensus however was to include a broader set of securities. The current version of the design report proposes including a set of securities with medium levels of liquidity. We caution that due to statistical noise the analysis of these securities may be inconclusive. To ensure that the less liquid securities do not contaminate the analysis of liquid securities, we will treat them separately both during the matching and the analysis stages.

- **Rebate prohibition vs. symmetric fees.** Our presentation and several market participants point out that some aspects of the current rebate economics are preserved even if rebates are prohibited. Specifically, some venues may begin charging liquidity makers no fees and charging the takers positive fees, while others may do the opposite. We believe that symmetric "take-take" fees are the only way to entirely eliminate potential conflicts of interest identified in the academic literature (Battalio, Corwin, and Jennings, 2016). The CSA has discussed the possibility of mandating symmetric fees and has decided to pursue only rebate prohibition at this time.

- **Replication of the SEC Pilot buckets.** Several participants suggested that we follow the SEC Pilot structure and use three treatment buckets with varying caps on fees. Unfortunately, there are too few Canadian securities to populate such buckets and to conduct an analysis that allows for meaningful policy advice. For instance, there are only about 100-120 highly liquid interlisted securities. Splitting them into three treatment buckets and one control bucket will result in only 25-30 securities per bucket, leading to statistical estimation problems.

- **Staggered introduction.** We have received several distinct proposals for the staggered introduction of stocks into the Pilot, including, for instance, a step-wise lowering of rebates. We believe that the current design that proposes to treat non-interlisted securities first and interlisted securities second with the SEC Pilot, provides the best compromise between cost/risk considerations and an economically meaningful analysis.

- **Suggestions for the analysis.** Several market participants have made suggestions as to which aspects of market quality we should pay attention to. These include the cost of executing large orders, dealer routing and posting behaviors, dark trading, time to execution, and levels of

[25] Presentation slides are available at https://slides.com/ap248/cmi_csa_tickpilot_slides#/

intermediation. We are grateful for these comments and have incorporated them into the report. We are open to further suggestions that may enhance the analysis.

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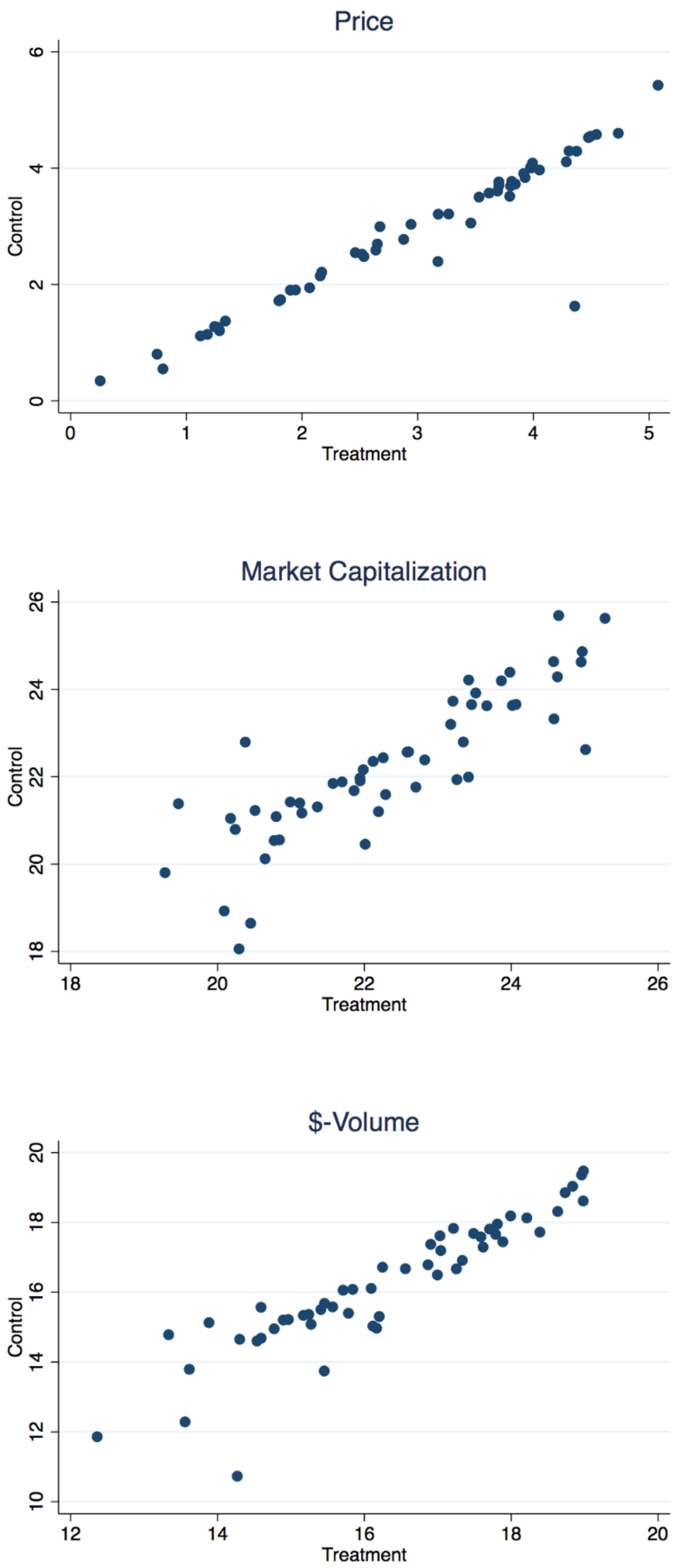
Price
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Figure 1