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International trade-venue clienteles and order-flow competitiveness

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Abstract

This paper tests a generalized version of the investor clientele hypothesis of Amihud and Mendelson [J. Finan. Econ. 17 (1986) 223]. This international trade-venue clientele effect hypothesis is supported for the Canadian cross-listed firms undifferentiated and differentiated by US trade venue, except for TSE shares cross-listed on NASDAQ. The hypothesized relationship between relative holding periods (measured using shares outstanding and share float) and effective half-spreads changes after TSE decimalization, and differs if the cross-listed shares have options traded on them. The empirical findings suggest that the TSE lost (won) executed order flow relative to the AMEX and to NYSE for shares with (without) options traded on them.

JEL classification: G14; G15

Keywords: Clienteles; Order-flow competitiveness; Bid–ask spreads; Share float; Decimalization; International financial markets

1. Introduction

Amihud and Mendelson (1986) theoretically demonstrate that shares with higher bid–ask spreads are held for longer periods than shares with smaller spreads, all else held equal. This theoretical inference is supported by the finding of Atkins and Dyl (1997) that holding periods are positively associated with the size of the quoted bid–ask spread for NASDAQ

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and NYSE stocks. A generalized Amihud and Mendelson hypothesis, referred to herein as an *international trade-venue clientele effect*, is the focus of this paper which empirically examines this generalized hypothesis for a sample of Canadian firms cross-listed on the Toronto Stock Exchange (TSE) and various US trade venues.[1] This generalized hypothesis states that, in equilibrium, same-firm shares with increasing *relative* spreads across trade venues are held in portfolios with the same or expected increasing relative holding periods, and vice versa for decreasing relative spreads. Thus, a decrease in relative trade costs as measured by the effective spreads for the same-firm shares in favor of the US versus say the Toronto trade venue is expected to result in a decrease in the relative holding period or increase in the relative volume turnover on the US trade venue relative to that on the TSE.

The existence of an international trade-venue clientele effect implies a possible win-lose situation for the market shares for order-flow execution across trade venues. A smaller ratio of the holding periods between the US trade venue and the TSE for the same-firm cross-listed shares implies that trading volume or share turnover has increased on the US trade venue relative to that on the TSE. In turn, this change normally is associated with a higher decrease or lower increase in effective spreads on the US trade venue relative to the lower decrease or higher increase in effective spreads on the TSE. If the synchronized increase (decrease) in the ratio of holding periods for the shares cross-listed on the US trade venue and the TSE is associated with a synchronized increase (decrease) in effective spreads for the same-firm shares on the US trade venue and the TSE, no international trade-venue clientele effect occurs. This would suggest that markets are becoming highly competitive, and that the differentials in trade costs and holding periods across trade venues will tend to disappear. In turn, this would lead to the full integration of the Canadian and US stock markets.[2]

Related to the generalized hypothesis is the issue of the impact of the TSE decimalization on order-flow execution and trade-venue clientele behavior. Since an objective of the TSE decimalization, which occurred on April 15, 1996, was to implement a minimum quotation increment reduction (MQIR) in order to increase TSE trading volumes relative to that on competing trade venues, this event is expected to have an impact on the relative market shares of trade venues competing for the order flow of our sample of Canadian cross-listed shares.

A third issue is the impact of options trading on internationally listed same-firm shares. Various studies reviewed by Damodaran and Subrahmanyam (1992) and Coughenour and Shastri (1999) find that option trading decreases information asymmetry and enhances market efficiency for the underlying shares. In turn, all else held equal, the decrease in information asymmetry should lower bid–ask spreads. Lower bid–ask spreads should themselves be associated with shorter holding periods.

The above discussion raises three questions that are addressed in this paper:

[1] To be consistent with the literature and given that the change occurred after our sample period, we do not use the new names for the TSE and TSE300 index (namely, the TSX and S&P/TSX Composite, respectively) throughout this paper.

[2] Important studies on stock market integration between Canada and the US include Jorion and Schwartz (1986), Mittoo (1992), and Koutoulas and Kryzanowski (1994).

(1) Does an "international trade-venue clientele effect" exist for the same-firm shares cross-listed on the TSE and various US trade venues?
(2) What is the impact of the TSE decimalization on order-flow execution and trade-venue clientele behavior?
(3) Does the international trade-venue clientele effect differ depending upon whether the internationally listed same-firm shares have options traded on them?

In addressing these questions, this paper not only tests whether an international trade-venue clientele effect exists for Canadian firms cross-listed on the TSE undifferentiated by US trade venue but also differentiated by one of the three major US listing venues (NYSE, AMEX or NASDAQ). The primary reason for examining TSE shares cross-listed on the three major US listing venues on a differentiated basis is based on well-documented studies that report that the trading behavior of a stock not only changes for both domestic and international trade-venue migrations or cross-listings but the nature of the change depends upon the pair of trade venues examined. Specifically, the quoted spread declines, return volatility declines, and share turnover increases when a stock moves from the AMEX or NASDAQ to the NYSE,[3] or when shares cross-list internationally into a more liquid market, such as non-US companies listing in the US.[4] A secondary reason for our choice of firm groupings examined herein is that the trading behavior of a stock may be due to its special characteristics, its membership in a specific economic sector or market index or the characteristics of the trading mechanism where the stock trades. For example, shares that are listed on the NYSE/AMEX usually belong to traditional sectors compared to those listed on the NASDAQ, which usually are members of the high-tech sector. The largest and primarily resource-based Canadian firms tend to cross-list on the NYSE, while the smaller and primarily high-tech Canadian firms tend to cross-list on the NASDAQ. In addition, the different trading mechanisms at the NYSE/AMEX and NASDAQ may affect the trading behavior of firms in the same sector but trading on distinct trade venues differently (see Sanger and McConnell, 1986; Affleck-Graves et al., 1994).

Our empirical findings support the international trade-venue clientele effect hypothesis. The first major finding is that the ratio of effective spreads for international trade-venue pairings is positively associated with the ratio of their corresponding holding periods when the entire sample of TSE cross-listed firms is not differentiated by US trade venue. When the TSE cross-listed firms are grouped or differentiated by US trade venue, the international trade-venue clientele effect occurs for the TSE shares cross-listed on the AMEX and on the NYSE (the latter for shares with and without options traded on them), and primarily for the period before TSE decimalization that occurred on April 15, 1996. No evidence is found that the international trade-venue clientele effect occurs for the TSE shares cross-listed on the NASDAQ.

The second major finding is that, for most time lags considered, the ratio of holding periods Granger causes the ratio of effective spreads for the TSE shares cross-listed on

[3] For example, see Hasbrouck and Schwartz (1988), Kadlec and McConnell (1994), Christie and Huang (1994), and Bessembinder (1998).

[4] See Foerster and Karolyi (1998), and Doukas and Switzer (2000). In a very exhaustive survey, Karolyi (1998) reports evidence of why companies list shares abroad.

the AMEX, NYSE for shares with and without options traded on them, and NASDAQ. This supports the notion that TSE decimalization, whose objective was to reduce bid–ask spreads, was a reaction to the decreasing market share of the TSE for the executed order flow for cross-listed shares. MQIRs implemented by the AMEX, NYSE and NASDAQ after the TSE MQIR may have contributed to the decrease in relative executed order flow. However, if measured using effective spreads as the sole performance metric,[5] these events did not consistently have the desired effect of decreasing trade costs for the cross-listed shares across trade venues, since effective spreads on average increased for the cross-listed shares on the AMEX and on the NASDAQ post-TSE decimalization.

The third major finding is that the TSE shares cross-listed on the NYSE with options traded on them have smaller effective half-spreads and are associated with shorter holding periods than their non-optioned counterparts. This is consistent with the theoretical and empirical literature. Furthermore, the international trade-venue clientele effect appears to be enhanced during the post-TSE decimalization period only for the TSE shares cross-listed on the NYSE with options traded on them. In contrast, the international clientele effect weakens during the post-TSE decimalization period for the shares cross-listed on the AMEX and on the NYSE for shares without options traded on them.

The remainder of this paper is organized as follows. The hypotheses to be tested are presented in Section 2. The sample and the data are described in Section 3. The general test methodology is introduced in Section 4. The empirical results are reported and analyzed in Section 5. Section 6 concludes the paper.

2. Hypotheses

The first null hypothesis is:

Hypothesis H_0^1. Changes in the ratio of the effective spreads for same-firm share trades executed on the TSE relative to those executed on US trade venues are positively associated with changes in their corresponding ratio of holding periods, after controlling for other relevant variables.

The first null hypothesis is essentially a generalization of the clientele model of Amihud and Mendelson (1986) from a single market to an international multi-market setting. Based on the empirical findings of Atkins and Dyl (1997) that support the Amihud and Mendelson hypothesis for a domestic market setting, we expect to find support for the generalized version of the model, as is embodied in the first hypothesis. An increasing ratio of the holding periods between two trade venues occurs if the holding period for the share trades executed on the TSE increases faster than that for the US trade venue, and vice versa if it decreases faster on the TSE.[6] In turn, the ratio of the share turnover on the TSE relative

[5] However, as Kryzanowski and Zhang (2002) demonstrate, this metric ignores material changes in relative mid-spreads across trade venues post-TSE decimalization.

[6] Other possible combinations include that the holding period decreases proportionally less on the US trade venue relative to the TSE; and that the holding period for the share trades executed on the US trade venue increase

to that on the competing US trade venue decreases with an increase in the ratio of their respective holding periods. The TSE loses in terms of decreasing relative share turnover or liquidity. This relative decrease in share turnover for the TSE is associated with a higher ratio between the effective spreads for the share trades executed on the TSE relative to that on the US trade venue. Thus, whether a particular trade venue wins or loses in terms of liquidity or share turnover or trade costs depends on the direction and relative magnitude of the changes in their respective ratios.

The second null hypothesis is:

Hypothesis H_0^2. From the perspective of the TSE, TSE decimalization improved the ratio of effective spreads, and thus, the ratio of holding periods for same-firm share trades executed on the TSE relative to those executed on US trade venues.

This hypothesis examines the impact of incorporating a prediction of the inter-market competition model of Chowdhry and Nanda (1991) into our international trade-venue clientele effect model. Our expectation is that markets that become relatively more liquid (as proxied by lower bid–ask spreads) by lowering their MQI relative to competing trade venues can originate greater inter-market competition for order flow among suppliers of immediacy by attracting more firms or issuers and investors (i.e., higher relative share turnover or conversely lower relative investor holding periods across trade venues).

The third null hypothesis is:

Hypothesis H_0^3. From the perspective of the TSE, the ratio of the effective spreads (and thus, the ratio of the holding periods) for same-firm share trades executed on the TSE relative to those executed on US trade venues are impacted adversely if the shares have options traded on them.

Our expectation based on the empirical findings for options trading discussed above is that shares with options traded on them have lower bid–ask spreads due to a lower asymmetric information component, all else held equal. Furthermore, if informed investors prefer to trade options rather than the underlying shares and information of higher quality and precision is more prevalent in the domestic market, we would expect the ratio of trading in options relative to that in the same-firm underlying shares to increase on the TSE, and to decrease on the US trade venues for TSE-shares cross-listed on US trade venues. In other words, we would expect a greater proportion of the trading for such shares to be information based on the TSE, and to be diversification-based on the US trade venues. In turn, this suggests that trading volume will increase and holding periods will decrease for the underlying shares on the US trade venues relative to that on the TSE. Furthermore, if the relative holding periods are positively associated with the relative effective spreads (hypothesis one), then the expected effect is a loss of competitiveness for the TSE in terms of volume and trade costs relative to the US trade venues for the underlying shares with options traded on them.

while the holding period for the same-firm share trades executed on the TSE decrease. The same combinations can occur for the effective spreads.

3. Sample and data

The sample consists of 117 TSE firms of which 22 firms are cross-listed on the AMEX (all without options traded on them), 50 firms are cross-listed on the NYSE (21 with options traded on them), and 45 firms are cross-listed on the NASDAQ (only two with options traded on them). The sample includes Canadian firms that listed on the TSE and on a US major exchange before and/or after January 1, 1994. The time period examined is from January 4, 1994 to December 31, 1998. This time period provides a sufficient number of monthly observations to analyze changes in the behavior of the effective spreads and holding periods during the pre- and post-TSE decimalization periods. Daily trade information is extracted from the Canadian Financial Markets Research Centre (CFMRC) database for the TSE and from the Trade and Quote (TAQ) database for the AMEX, NYSE and NASDAQ.[7]

The numbers of shares outstanding, which are assumed to be available for trading on the three US listing venues studied herein, are also obtained from the CFMRC. The argument by Kryzanowski and Zhang (2002) that investors face no major technical difficulties in trading any amount of cross-listed shares on the TSE or on the three major US trade venues supports our assumption for the use of shares outstanding. As an alternative proxy to shares outstanding, we also use share float data in the computation of the holding periods. Since share float data are available only from the TSE for firms when they were in the TSE300 index, the subsample based on share float is much smaller in number and has a large cap bias. The subsample with share float data consists of 88 firms in total or 16, 21, 29 and 22 firms cross-listed on the AMEX, the NYSE for shares with options traded on them, the NYSE for shares without options traded on them and the NASDAQ, respectively. Although share float is more representative of the actual shares available for trade, the smaller number of firms and the incomplete data for the time periods examined herein for most firms may affect the robustness of the empirical results based on share float. Monthly averages of daily transactions are used to reduce the 'noise' that is pervasive in daily data, and to provide more efficient coefficient estimates by substantially reducing the high autocorrelation present in daily data. High autocorrelation in daily data occurs particularly on the NASDAQ, where many cross-listed shares have trading days with no trades.

The matching of the daily trades of cross-listed shares on the TSE and the AMEX, and on the NYSE and NASDAQ considers only the calendar days when both the TSE and the US listing venues simultaneously are open for trading. The sample includes only those stocks that have at least one transaction in a given month. If no trade occurs in a given month for a specific stock, the period prior to the last discontinuity is eliminated and only the sample period where no discontinuities occur up to the end of the sample period are considered. If for any reason a price is missing on a given day for which traded volume is reported, this error is corrected by using the quote mid-spread as a proxy for the missing price.

[7] Foreign issuers are not reported in the CRSP database.

4. Methodology

Two steps are followed to test the main hypothesis of whether or not an international trade-venue clientele effect exists in the data. Firstly, we test whether or not the Amihud and Mendelson (1986) relationship between effective spreads and holding periods holds for the Canadian share trades executed on the TSE and for the same-firm share trades executed on US trade venues grouped by listing venue. Secondly, based on the results obtained for the first test, we conduct formal tests of the three international trade-venue clientele effect hypotheses. Shares outstanding and share float are used for the computation of holding periods, and the results for each holding period measure for each test are examined separately.

The methodology for testing the Amihud and Mendelson (1986) clientele hypothesis is based on a modified version of the Atkins and Dyl (1997) empirical model. Unlike Atkins and Dyl, the modified model uses effective instead of quoted spreads,[8] includes the mid-spread,[9] and accounts for whether or not shares have options traded on them. This test allows for a comparison of our results using Eqs. (1) and (2) with those obtained by Atkins and Dyl (1997). The definitions of the variables as specified in Eqs. (1) and (2) facilitate the interpretation of the international trade-venue clientele hypothesis as specified in Eq. (3).

The empirical model that investigates the relationship between holding periods and effective spreads is as follows:

$$\begin{aligned} HP_{iT} = {} & b_0 + (b_1 + \gamma_{DYO} D1)DYO + (b_2 + \gamma_{DYNO} D1)DYNO + (b_3 + \gamma_{DX} D1)DX \\ & + (b_4 + \gamma_{DQ} D1)DQ + (b_5 + \gamma_{ES} D1)ES_{iT} + (b_6 + \gamma_{VAR} D1)VAR_{iT} \\ & + (b_7 + \gamma_{MS} D1)MS_{iT} + (b_8 + \gamma_{MV} D1)MV_{iT} \\ & + (b_9 + \gamma_{ES} D1)ES_{iT} * DYNO_{iT} + (b_{10} + \gamma_{VAR} D1)VAR_{iT} * DYNO_{iT} \\ & + (b_{11} + \gamma_{MS} D1)MS_{iT} * DYNO_{iT} + (b_{12} + \gamma_{MV} D1)MV_{iT} * DYNO_{iT} \\ & + (b_{13} + \gamma_{ES} D1)ES_{iT} * DX_{iT} + \cdots + (b_{17} + \gamma_{ES} D1)ES_{iT} * DQ_{iT} + \cdots \\ & + b_{21} D2_{\tau=1995} + \cdots + b_{24} D2_{\tau=1998} + \varepsilon_{iT}. \end{aligned} \tag{1}$$

In Eq. (1), HP_{iT} is the holding period in years of the average investor for firm i during month T, which is computed using shares outstanding or share float. HP_{iT} is obtained by dividing the number of shares outstanding or share float by the annualized daily trading volume for firm i. The average holding period for the common stock of firm i is calculated as HP_{iT} = [Number of Shares Outstanding or Share Float/Annualized Daily Trading Volume]. The advantage of using share float is that it is a more precise measure of actual shares available for trade than using shares outstanding. Having information on the number of investors and their individual trading volumes executed on the TSE and the US trade venues, which is presently unavailable, would allow us to determine more accurately how

[8] Effective spreads are a better proxy for actual trade costs than quoted spreads since some investor trades are inside the spread (Petersen and Fialkowski, 1994; Huang and Stoll, 1996; and Eleswarapu, 1997).

[9] Kryzanowski and Zhang (2002) find that the mid-spread is an important variable in explaining the difference in trade costs between the shares cross-listed on the TSE and the same-firm share trades executed on various US trade venues.

long an average investor on each trading venue holds the shares of the same underlying firm. Since our objective is to evaluate holding periods for the shares cross-listed across trade venues for the same firm, our measures (although somewhat noisy) provide a meaningful comparative indicator if, as we assume, the same number of same-firm shares are available for trade across trade venues. Also, it seems reasonable to assume that trading per capita is higher in the market with lower trade costs. Therefore, HP_{iT} is a fairly plausible measure of an average investor's holding period when considering longer horizons and their relationship with liquidity costs. An advantage of using this measure of holding period is that its reciprocal, or relative share turnover, serves as a better proxy for trading volume relative to other proxies (see Lo and Wang, 2000).

ES_{iT} is the daily proportional effective half-spread for firm i. It corresponds to the monthly average of the daily liquidity premium (percent) or the actual cost for shares traded. It is obtained as the monthly average of the daily absolute value of the difference of the closing price and the closing average bid–ask spread, divided by the closing price. The daily proportional effective half-spread for firm i for day k, ES_{ik}, is equal to $|P_k - MS_k|/P_k$ where P_k is the closing transaction price on day k, and MS_k is the closing mid-spread. The mid-spread corresponds to the ask quote plus the bid quote, divided by two (i.e., mid-spread $=$ [ask $+$ bid]$/2$). The monthly average of the daily market capitalization of firm i's shares is M_{iT}. It is obtained by multiplying the shares outstanding by the daily closing price. VAR_{iT} is the daily return variability of the quote mid-spread. It is equal to the monthly average of the daily variances of the mid-spread returns of firm i's stock for a period of up to one year updated to the previous day. The use of mid-spread returns in the calculation of the variance avoids volatility noise due to the bid–ask bounce. The inclusion of the mid-spread (MS_k) follows the Kryzanowski and Zhang's (2002) decomposition of trade price/cost differences between trade venues as consisting of a mid-spread differential and an effective spread differential. The dummy variables *DYO*, *DYNO*, *DX* and *DQ* indicate whether the shares are cross-listed on NYSE for shares with options traded on them, on NYSE for shares without options traded on them, on AMEX and on NASDAQ, respectively. The dummy *DYO* is equal to one for the TSE shares that are cross-listed on the NYSE for shares with options traded on them and is zero otherwise. Similar definitions follow for the dummy variables *DYNO*, *DX* and *DQ*. These dummy variables are included to control for the US listing venue.

The sign of the estimated coefficient of ES_{iT} is expected to be positive because higher spreads imply higher transaction costs that in turn are expected to encourage investors to hold the stock longer (i.e., trade less). The sign for the coefficient of VAR_{iT} is expected to be negative since higher volatility normally implies heterogeneity in trader beliefs that may encourage share trading and therefore shorter holding periods. Higher volatility also may be attributable to private information (Stoll and Whaley, 1990; Chalmers and Kadlec, 1998). The sign of the mid-spread, MS_{iT}, is expected to be negative, based on the direct relationship of mid-spread with price, which normally is negatively correlated with effective spreads. That is, higher mid-spreads may be associated with lower effective spreads, which may induce higher trading volumes, and therefore lower holding periods. The estimated coefficient of MV_{iT} is expected to be positive since large firms are well known, mature, stable, low risk, with low volatility in cash flows, and have a long listing history (Atkins and Dyl, 1997).

The Seemingly Unrelated Regression, or SUR, approach on cross-sectional and time series data is used to identify holding period determinants. By adding dummy time variables to Eq. (1), we account for the possibility of a shift in the relationship between holding periods and effective half-spreads post-TSE decimalization for the same-firm share trades executed on the TSE, and on the US trade venues grouped by listing venue. One important advantage of using the SUR regression approach is that the regression coefficients are estimated simultaneously for the share trades executed on the TSE and the US trade venues. The SUR system also accounts for heteroscedasticity and autocorrelation in the regression residuals across firms.[10] The dummy variable $D1$ equals one from the date of the TSE decimalization (15 April 1996) until the end of 1998, and is equal to zero otherwise. This dummy variable is used to facilitate a test of our second hypothesis by assessing whether the relationship between holding periods and proportional effective half-spreads, return variances, mid-spreads and market equity values change significantly for the period after the TSE decimalization. $D2_\tau$ is a dummy variable used to determine whether the relationship between effective half-spreads and holding periods is related to time-specific events for each year τ ($\tau = 1995, \ldots, 1998$) during our sample period. All of the other variables are defined as before. The natural logs of all the variables, except the dummies, are used in obtaining the estimates of the equation parameters.[11]

Equation (1) is used to estimate the coefficients for the overall sample period and simultaneously for all four US trade-venue classifications. However, since holding periods and bid–ask spreads are likely to be simultaneously determined, the instrumental variables used by Atkins and Dyl (1997) in addition to the mid-spread are used to estimate the ES_{iT} in Eq. (1) using SUR. Specifically:

$$\begin{aligned} ES_{iT} = {} & c_0 + (c_1 + \lambda_{DYO} D1)DYO + (c_2 + \lambda_{DYNO} D1)DYNO + (c_3 + \lambda_{DX} D1)DX \\ & + (c_4 + \lambda_{DQ} D1)DQ + (c_5 + \lambda_{ES} D1)ES_{iT-1} + (c_6 + \lambda_{VAR} D1)VAR_{iT} \\ & + (c_7 + \lambda_{MS} D1)MS_{iT-1} + (c_8 + \lambda_{MV} D1)MV_{iT} \\ & + (c_9 + \lambda_{ES} D1)ES_{iT-1} * DYNO_{iT} + (c_{10} + \lambda_{VAR} D1)VAR_{iT} * DYNO_{iT} \\ & + (c_{11} + \lambda_{MS} D1)MS_{iT-1} * DYNO_{iT} + (c_{12} + \lambda_{MV} D1)MV_{iT} * DYNO_{iT} \\ & + (c_{13} + \lambda_{ES} D1)ES_{iT-1} * DX_{iT} + \cdots + (c_{17} + \lambda_{ES} D1)ES_{iT-1} * DQ_{iT} \\ & + \cdots + c_{21} D2_{\tau=1995} + \cdots + c_{24} D2_{\tau=1998} + \eta_{iT}, \end{aligned} \tag{2}$$

where HP_{iT}, ES_{iT}, VAR_{iT}, MS_{iT}, MV_{iT}, and the dummy variables DYO, $DYNO$, DX, DQ, $D1$ and $D2$ are defined as before. The variance of the firm's daily returns as proxied by the variance of the mid-spread returns, the mid-spread, and the market value of the firm are used in Eq. (2) as control variables.

The second step tests whether or not an international trade-venue clientele effect exists in the data, and whether or not any effect is robust after the MQIR by the TSE and

[10] All of the regressions are adjusted for serial autocorrelation. The highly significant values of the coefficients for the serially correlated errors (some of them up to four lags) increase the adjusted R^2 of the regressions.

[11] Based on the descriptive statistics, the data exhibit skewness. SUR regression estimations with the variables expressed with natural logarithms generate consistently normalized residuals.

for cross-listed shares with and without options traded on them. The differences between holding periods across trade venues is tested after accounting for differences in effective spreads and other determinants for Canadian cross-listed share trades executed on the US trade venues and the same-firm share trades executed on the TSE. The empirical SUR regression that is used to identify the determinants of holding period differences simultaneously for the four pairs of competing trade venues for this set of tests is as follows:

$$\begin{aligned} RHP_{iT} = {} & b_0 + (b_1 + \gamma_{DYO} D1)DYO + (b_2 + \gamma_{DYNO} D1)DYNO + (b_3 + \gamma_{DX} D1)DX \\ & + (b_4 + \gamma_{DQ} D1)DQ + (b_5 + \gamma_{RES} D1)RES_{iT} + (b_6 + \gamma_{RVAR} D1)RVAR_{iT} \\ & + (b_7 + \gamma_{RMS} D1)RMS_{iT} + (b_8 + \gamma_{MV} D1)MV_{iT} \\ & + (b_9 + \gamma_{RES} D1)RES_{iT} * DYNO_{iT} \\ & + (b_{10} + \gamma_{RVAR} D1)RVAR_{iT} * DYNO_{iT} \\ & + (b_{11} + \gamma_{RMS} D1)RMS_{iT} * DYNO_{iT} + (b_{12} + \gamma_{MV} D1)MV_{iT} * DYNO_{iT} \\ & + (b_{13} + \gamma_{RES} D1)RES_{iT} * DX_{iT} + \cdots + (b_{17} + \gamma_{RES} D1)RES_{iT} * DQ_{iT} \\ & + \cdots + b_{21} D2_{\tau=1995} + \cdots + b_{24} D2_{\tau=1998} + \varepsilon_{iT}, \end{aligned} \tag{3}$$

where $RHP_{iT} = HP1_{iT} - HP_{iT}$, $RES_{iT} = ES1_{iT} - ES_{iT}$, $RVAR_{iT} = VAR1_{iT} - VAR_{iT}$, and $RMS_{iT} = MS1_{iT} - MS_{iT}$ are the holding period, effective half-spread, variance of mid-spread returns, and mid-spreads for the share trades executed on the US trade venues (the TSE), and $HP1_{iT}(HP_{iT})$, $ES1_{iT}(ES_{iT})$, $VAR1_{iT}(VAR_{iT})$ and $MS1_{iT}(MS_{iT})$ are defined as before. MV_{iT} is included to control for size. Since the variables are in natural logarithms, the differences actually correspond to the natural log of the ratios, e.g., $\ln(ES1/ES)$. If the estimated coefficient for the difference of logs or logs of ratios in effective half-spreads is positive and significant, then this implies that an increase in the ratio of holding periods reflects a relative increase in holding periods for the share trades executed on the US trade venue and the same-firm share trades executed on the TSE, and that this is associated with a relative increase in the ratio of their respective effective half-spreads. The previous sentence holds if increase is replaced by decrease throughout.

Equation (3) is a more relevant model to determine whether the Amihud and Mendelson's relationship between holding periods and effective half-spreads occurs in an international cross-listed share context than examining this relationship for each trade venue separately. The reason is that an event that may affect the trading behavior of the cross-listed shares on one trade venue is also likely to affect the trading behavior of the same-firm share trades executed on another trade venue, although not necessarily by the same magnitude or in the same direction.

Statistical significance is measured throughout at the 0.05 level unless noted otherwise. If an estimate or statistic is significant only at the 0.10 level, it is referred to as being marginally significant.

5. Empirical results for holding periods, effective half-spreads and executed order-flow market shares

5.1. Descriptive statistics for individual trade venues

This section briefly discusses unreported summary statistics (means) for the market values, variances of mid-spread returns and mid-spreads for trades executed on the TSE for shares that are cross-listed on the AMEX, NYSE with and without options traded on them, and NASDAQ, and for the same-firm share trades executed on the US trade venues.[12] The discussed findings are for the entire time period of January 4, 1994 to December 31, 1998. Since the primary emphasis of this paper is on the relationship between holding periods and effective half-spreads, the comparative descriptive statistics for these two variables are examined in more detail in the next section of this paper.

For shares cross-listed on the TSE and the AMEX, the average market value is 1.59 billion Canadian dollars, or CDN. For these cross-listed shares, the average daily variance of mid-spread returns and average mid-spreads are 0.086 percent and $18.47 CDN, respectively, for share trades executed on the TSE, and 0.341 percent and $18.49 CDN, respectively, for share trades executed on the AMEX. For shares cross-listed on the TSE and the NYSE with options traded on them, the average market value is 6.9 billion CDN. For these cross-listed shares, the corresponding average daily variances of mid-spread returns and average mid-spreads are 0.066 percent and $38.30 CDN, respectively, for share trades executed on the TSE, and 0.144 percent and $38.62 CDN, respectively, for share trades executed on the NYSE. For shares cross-listed on the TSE and the NYSE without options traded on them, the average market value is 2.2 billion CDN. For these cross-listed shares, the corresponding average daily variances of mid-spread returns and average mid-spreads are 0.071 percent and $20.25 CDN, respectively, for share trades executed on the TSE, and 0.141 percent and $20.29 CDN, respectively, for share trades executed on the NYSE.

With respect to shares traded on the TSE and NASDAQ, the average market capitalization is 429 million CDN. For these cross-listed shares, the average market variances and average mid-spreads are 0.142 percent and $11.65 CDN, respectively, for share trades executed on the TSE, and are 0.624 percent and $11.73 CDN, respectively, for share trades executed on the NASDAQ. All of these results indicate that the average market variances and the average mid-spreads are higher for the share trades executed on the US trade venues compared to the share trades executed on the TSE for our sample of Canadian cross-listed firms. Whether this has an impact on the holding periods for individual or across trade venues is examined using regression techniques in Sections 5.3 and 5.4 of this paper, respectively.

5.2. Comparative statistics for various pairings of the TSE with a US trade venue

In this section, the ratios of holding periods and of effective half-spreads for cross-listed share trades executed on each US trade venue relative to those executed on the TSE

[12] Medians and standard deviations also were computed. The tables are available upon request.

between the pre- and post-TSE decimalization periods are analyzed.[13] The results using shares outstanding and share float for holding period computations are reported in Tables 1 and 2, respectively. The latter portion of each panel in Tables 1 and 2 reports the ratios of the average means, medians and variances of effective half-spreads, ES^{US}/ES^{TSE}, and holding periods, HP^{US}/HP^{TSE}, for the share trades executed on each member of the various pairings between the TSE and the AMEX, NYSE for shares with and without options traded on them, and NASDAQ. Also, the last row of each panel of Tables 1 and 2 reports the *p*-values of the differences in the ratios of the means, medians and variances of effective half-spreads and holding periods between the pre- and post-TSE decimalization periods. That is, the last row of each panel reports the *p*-values of the differences in (ES^{US}/ES^{TSE}) and in (HP^{US}/HP^{TSE}) for the pre- and post-TSE decimalization periods. To

Table 1
Effective half-spreads and holding periods based on shares outstanding for Canadian firms with same-firm share trades executed on the TSE and on US trade venues

Period	Trade venue	Effective half-spread (percent)			Holding periods (years)		
		Mean	Median	Std. dev.	Mean	Median	Std. dev.
A. CDN share trades executed on the TSE and the AMEX (22 firms without options traded on them)							
	TSE	0.608	0.615	0.072	6.97	6.67	2.38
Pre-dec.	AMEX	0.548	0.561	0.058	50.13	47.32	18.43
	p-value for difference	0.001***	0.001***	0.251	0***	0***	0***
	TSE	0.953	0.778	0.409	7.05	6.54	2.52
Post-dec.	AMEX	0.792	0.585	0.376	42.19	39.29	13.02
	p-value for difference	0.105	0.034**	0.637	0***	0***	0***
	TSE	0.792	0.678	0.347	7.01	6.64	2.43
1994–1998	AMEX	0.678	0.567	0.301	45.90	42.01	16.14
	p-value for difference	0.056*	0.001***	0.280	0***	0***	0***
Pre-dec.	AMEX/TSE	0.917	0.904	0.175	7.85	6.85	3.56
Post-dec.	AMEX/TSE	0.834	0.826	0.112	6.67	5.71	3.17
	p-value for difference	0.029**	0.079*	0.022**	0.181	0.108	0.541
B. CDN share trades executed on the TSE and the NYSE (21 firms with options traded on them)							
	TSE	0.282	0.279	0.022	2.44	2.32	0.57
Pre-dec.	NYSE	0.326	0.312	0.045	9.45	9.42	4.20
	p-value for difference	0***	0***	0***	0***	0***	0***
	TSE	0.295	0.275	0.067	6.04	4.89	3.17
Post-dec.	NYSE	0.227	0.228	0.048	10.20	10.08	2.63
	p-value for difference	0***	0***	0.062	0***	0***	0***
	TSE	0.289	0.279	0.051	4.36	3.06	2.95
1994–1998	NYSE	0.273	0.276	0.068	9.85	9.66	3.44
	p-value for difference	0.140	0.310	0.032**	0***	0***	0***
Pre-dec.	NYSE/TSE	1.158	1.155	0.155	3.96	3.39	1.99
Post-dec.	NYSE/TSE	0.803	0.736	0.252	2.04	1.91	0.93
	p-value for difference	0***	0***	0.010**	0***	0***	0***

(*continued on next page*)

[13] Similar but unreported statistics are obtained for all of the other control variables. The main inferences about the relationship between holding periods and effective half-spreads do not change significantly if they are included.

Table 1 (*Continued*)

Period	Trade venue	Effective half-spread (percent)			Holding periods (years)		
		Mean	Median	Std. dev.	Mean	Median	Std. dev.
C. CDN share trades executed on the TSE and the NYSE (29 firms without options traded on them)							
	TSE	0.534	0.533	0.079	2.57	2.53	0.63
Pre-dec.	NYSE	0.646	0.638	0.087	18.48	8.59	18.44
	p-value for difference	0***	0***	0.613	0***	0***	0***
	TSE	0.481	0.493	0.116	4.31	3.99	1.39
Post-dec.	NYSE	0.488	0.492	0.066	38.41	37.54	10.74
	p-value for difference	0.752	0.643	0.002***	0***	0***	0***
	TSE	0.506	0.509	0.103	3.50	3.20	1.40
1994–1998	NYSE	0.562	0.552	0.110	29.11	28.51	17.80
	p-value for difference	0.005***	0.018**	0.646	0***	0***	0***
Pre-dec.	NYSE/TSE	1.217	1.200	0.102	7.04	3.81	6.89
Post-dec.	NYSE/TSE	1.074	0.983	0.304	9.51	8.77	3.47
	p-value for difference	0.021**	0.006***	0***	0.079*	0.001***	0.001***
D. CDN share trades executed on the TSE and the NASDAQ (45 firms, 2 with options traded on them)							
	TSE	0.994	1.016	0.113	5.13	5.11	2.23
Pre-dec.	NASDAQ	1.782	1.758	0.230	28.79	15.43	34.06
	p-value for difference	0***	0***	0.001	0***	0***	0***
	TSE	1.280	1.175	0.322	7.44	7.09	2.00
Post-dec.	NASDAQ	1.851	1.673	0.414	29.27	23.98	18.06
	p-value for difference	0***	0***	0.170	0***	0***	0***
	TSE	1.146	1.075	0.285	6.36	6.33	2.40
1994–1998	NASDAQ	1.819	1.742	0.339	29.05	20.27	26.50
	p-value for difference	0***	0***	0.180	0***	0***	0***
Pre-dec.	NASDAQ/TSE	1.808	1.735	0.257	6.34	3.67	6.61
Post-dec.	NASDAQ/TSE	1.468	1.422	0.203	4.18	3.03	2.80
	p-value for difference	0***	0***	0.214	0.096*	0.220	0***

Notes. The overall sample is 117 TSE cross-listed firms on US trade venues. The pre- and post-TSE decimalization periods and the entire time period consist of 28, 32 and 60 months each, respectively. The observations correspond to the monthly averages across all of the shares of the daily effective half-spreads and the annualized daily holding periods. The 'p-value for difference' rows report the p-values for the tests of the differences in means (t-test) and medians (Wilcoxon/Mann–Whitney test). The last rows report the p-values of the difference between $(ES^{US}/ES^{TSE})^{\text{pre-decimalization}}$ and $(ES^{US}/ES^{TSE})^{\text{post-decimalization}}$, and between $(HP^{US}/HP^{TSE})^{\text{pre-decimalization}}$ and $(HP^{US}/HP^{TSE})^{\text{post-decimalization}}$, respectively.

* Significant at the 10% level.
** Idem., 5%.
*** Idem., 1%.

provide a clearer picture of the comparative ratios, the first portions of Tables 1 and 2 also include the holding periods and effective half-spreads for cross-listed share trades executed on the TSE relative to those executed on the AMEX, NYSE and NASDAQ for the pre- and post-TSE decimalization periods, and for the entire time period.

As such, this section of the paper provides a preliminary overview of the changes in effective spreads, holding periods and their respective ratios, which occurred after the TSE decimalization. Before the TSE decimalization and adjusting for the exchange rate, the share trades executed on the TSE had an implicit cost advantage relative to the same-firm share trades executed on the US trade venues due to their lower absolute tick size when expressed in Canadian or in US dollars.[14]

Based on the results reported in panel A of Table 1, the ratio of effective half-spreads for AMEX and TSE trades, ES^{US}/ES^{TSE}, decreases significantly (p-value of 0.029) from 0.917 to 0.834 post-TSE decimalization. The value of the ratio of holding periods for the AMEX and TSE trades, HP^{US}/HP^{TSE}, changes insignificantly from 7.85 to 6.67 post-TSE decimalization. Panel A of Table 2 reports that the changes in the ratios of effective half-spreads and holding periods for AMEX and the TSE have the correct sign but are not significant when the smaller sample using share float is examined.

These results suggest that the TSE lost trade cost competitiveness to AMEX post-TSE decimalization, although the ratios of holding periods and volume turnover remained approximately unchanged in both trade venues for the TSE shares cross-listed on AMEX.

Table 2
Effective half-spreads and holding periods based on share float for Canadian firms with same-firm share trades executed on the TSE and on US trade venues

Period	Trade venue	Effective half-spread (percent)			Holding periods (years)		
		Mean	Median	Std. dev.	Mean	Median	Std. dev.
A. CDN share trades executed on the TSE and the AMEX (22 firms without options traded on them)							
	TSE	0.608	0.615	0.072	4.83	4.46	1.61
Pre-dec.	AMEX	0.548	0.561	0.058	37.98	33.07	14.70
	p-value for difference	0.001***	0.001***	0.289	0***	0***	0***
	TSE	0.759	0.625	0.269	5.18	4.47	2.47
Post-dec.	AMEX	0.685	0.501	0.347	37.23	35.32	11.30
	p-value for difference	0.347	0.041**	0.160	0***	0***	0***
	TSE	0.689	0.629	0.215	5.01	4.46	2.10
1994–1998	AMEX	0.621	0.548	0.264	37.58	33.12	12.89
	p-value for difference	0.125	0.001***	0.114	0***	0***	0***
Pre-dec.	AMEX/TSE	0.916	0.904	0.174	8.55	7.87	4.05
Post-dec.	AMEX/TSE	0.877	0.850	0.152	8.29	7.63	3.81
	p-value for difference	0.359	0.500	0.485	0.800	0.830	0.752
B. CDN share trades executed on the TSE and the NYSE (21 firms with options traded on them)							
	TSE	0.272	0.272	0.025	2.06	1.97	0.31
Pre-dec.	NYSE	0.323	0.312	0.048	8.84	8.77	4.47
	p-value for difference	0***	0***	0.001***	0***	0***	0***
	TSE	0.184	0.171	0.044	1.91	1.80	0.47
Post-dec.	NYSE	0.200	0.207	0.046	10.24	10.66	2.58
	p-value for difference	0.158	0.251	0.755	0***	0***	0***
	TSE	0.225	0.237	0.057	1.98	1.91	0.41
1994–1998	NYSE	0.258	0.259	0.078	9.59	10.07	3.63
	p-value for difference	0.011**	0.058*	0.021**	0***	0***	0***
Pre-dec.	NYSE/TSE	1.186	1.162	0.132	4.39	4.15	2.40
Post-dec.	NYSE/TSE	1.140	0.937	0.378	5.54	5.67	1.42
	p-value for difference	0.541	0.339	0***	0.026**	0.026**	0.007***

(*continued on next page*)

[14] We thank the referee for pointing this out. The average exchange rates during the pre-, post-TSE decimalization and the overall 1994–1998 period are 1.369, 1.416 and 1.39 CDN/USD, respectively.

Table 2 (*Continued*)

Period	Trade venue	Effective half-spread (percent)			Holding periods (years)		
		Mean	Median	Std. dev.	Mean	Median	Std. dev.
C. CDN share trades executed on the TSE and the NYSE (29 firms without options traded on them)							
	TSE	0.534	0.533	0.079	2.30	2.28	0.59
Pre-dec.	NYSE	0.646	0.638	0.087	15.65	6.08	17.25
	p-value for difference	0***	0***	0.613	0***	0***	0***
	TSE	0.481	0.493	0.116	3.32	3.26	0.88
Post-dec.	NYSE	0.488	0.492	0.066	30.92	29.16	9.55
	p-value for difference	0.752	0.643	0.002***	0***	0***	0***
	TSE	0.506	0.509	0.103	2.84	2.75	0.91
1994–1998	NYSE	0.562	0.552	0.110	23.79	23.92	15.59
	p-value for difference	0.005***	0.018**	0.646	0***	0***	0***
Pre-dec.	NYSE/TSE	1.217	1.200	0.102	6.78	3.46	7.30
Post-dec.	NYSE/TSE	1.074	0.983	0.304	9.85	9.34	3.96
	p-value for difference	0.021**	0.006***	0***	0.044**	0***	0.002***
D. CDN share trades executed on the TSE and the NASDAQ (45 firms, 2 with options traded on them)							
	TSE	0.810	0.801	0.097	2.61	2.50	0.67
Pre-dec.	NASDAQ	1.484	1.441	0.302	46.19	24.53	60.33
	p-value for difference	0***	0***	0***	0***	0***	0***
	TSE	0.785	0.722	0.272	2.72	2.43	1.70
Post-dec.	NASDAQ	1.455	1.326	0.389	41.22	34.62	25.22
	p-value for difference	0***	0***	0.049**	0***	0***	0***
	TSE	0.797	0.778	0.208	2.67	2.46	1.32
1994–1998	NASDAQ	1.469	1.409	0.349	43.53	29.91	41.60
	p-value for difference	0***	0***	0***	0***	0***	0***
Pre-dec.	NASDAQ/TSE	1.841	1.776	0.369	19.61	11.83	23.22
Post-dec.	NASDAQ/TSE	1.903	1.880	0.283	17.17	14.98	10.09
	p-value for difference	0.469	0.482	0.165	0.593	0.245	0***

Note. The sample for which share float data are available is 88 TSE cross-listed firms on US trade venues.
* Significant at the 10% level.
** Idem., 5%.
*** Idem., 1%.

Section 5.4 of the paper, which is based on regression analysis, provides more evidence on whether this conjecture cannot be rejected after controlling for other relevant variables and using our two measures of holding periods.

Panel B of Table 1 reports that the values of the ratios ES^{US}/ES^{TSE} and HP^{US}/HP^{TSE} decrease from 1.158 and 3.96 to 0.803 and 2.04, respectively, post-TSE decimalization for TSE shares cross-listed on the NYSE for shares with options traded on them. These differences are statistically significant (both with p-values of 0.000). Panel B of Table 2 reports similar ratios for the 21 firms with share float data. The values of the ratios ES^{US}/ES^{TSE} and HP^{US}/HP^{TSE} now decrease and increase from 1.186 and 4.39 to 1.14 and 5.54, respectively, although only the change in the latter ratio is significant. When using shares outstanding, the trade cost advantage, as measured by the effective half-spread, decreased post-TSE decimalization for share trades executed on the TSE (which marginally increased) relative to the same-firm share trades executed on the NYSE for shares with options traded on them (which significantly increased).

Based on the results reported in panel C of Table 1 for TSE shares cross-listed on the NYSE for shares with no options traded on them, the values of the ratios ES^{US}/ES^{TSE} and HP^{US}/HP^{TSE} decrease and increase to 1.074 and 9.51 from 1.217 and 7.04, respectively, from the pre- to post-TSE decimalization periods. The differences are statistically significant with p-values of 0.021 and 0.079, respectively. Panel C of Table 2 reports similar values for the ratio ES^{US}/ES^{TSE} using a share float computation of holding periods. The value of the ratio HP^{US}/HP^{TSE} increases to 9.85 from 6.78 and is statistically significant. Although 29 firms are represented in both tables, the discrepancies in the values of the ratios HP^{US}/HP^{TSE} are due to less data or monthly observations available for share float compared to that for shares outstanding.

Finally, panel D of Table 1 reports the results for TSE shares cross-listed on the NASDAQ. The values of the ratios ES^{US}/ES^{TSE} and HP^{US}/HP^{TSE} decrease from 1.808 and 6.34 to 1.468 and 4.18, respectively, post-TSE decimalization. Each difference is statistically significant with a p-value of 0.000 and 0.096, respectively. This result is similar to that obtained for the TSE shares cross-listed on NYSE with options traded on them (see panel B of Table 1). Over the entire time period, the mean effective half-spreads are about 60 percent higher for the same-firm share trades executed on the NASDAQ.[15,16] Panel D of Table 2 reports similar descriptive statistics using share float for 22 firms. The ratios ES^{US}/ES^{TSE} and HP^{US}/HP^{TSE} are not statistically significant. A comparison of the panels D of Tables 1 and 2 indicates that the advantage in trade cost and executed order flow for the share trades executed on the NASDAQ appears to be determined by the non-TSE300 index firms or firms with no available share float data. As noted earlier, these non-index firms are much smaller than index firms in terms of market capitalization.

5.3. Determinants of holding periods for individual trade venues

Table 3 reports the results for the relationship between holding periods and effective half-spreads, market values, return variances, and mid-spreads for same-firm share trades executed on the TSE and on the US trade venues. It includes the regression results with holding periods computed separately with shares outstanding and share float, for share trades executed on the TSE and the same-firm shares trades executed on AMEX, NYSE for shares with and without options traded on them, and NASDAQ. To simplify the presentation of the results, Table 3 does not include the coefficient estimates of the dummy variables that control for the constant portion of each US listing venue and the time spe-

[15] According to Chordia et al. (2001), the TAQ database reports ‘autoquotes’ (passive quotes by dealers who officially do not make the market) which inflates the bid–ask spread. They indicate this may add up to $1/4$ point on either side of the quote, mostly for the less traded shares. These ‘autoquotes’ are not specifically identified in the TAQ database. Even though the Canadian cross-listed shares on the NASDAQ are traded less in the US relative to their trading on the TSE, it is unlikely that the impact of ‘autoquotes’ on the effective spreads used herein has materially changed the inferences drawn herein. However, this is an empirical issue that is beyond the scope of this study.

[16] Neglect of fiduciary duty by investment dealers on NASDAQ also may be a possible explanation for this difference. Christie et al. (1994) find that NASDAQ dealers implicitly collude to inflate bid–ask spreads. In addition, payment for order flow, preferencing of orders, and internalization of order flow are more pervasive practices in dealer markets. For an interesting review of these practices, see Macey and O’Hara (1997).

cific events. For most regressions, these unreported coefficient estimates are significant. Columns 1 and 2 in panel A of Table 3 report the regression results of the simultaneous relationship between holding periods computed using shares outstanding and share float, respectively, with effective-half spreads after controlling for the other variables for TSE-executed trades. Columns 3 and 4 report the simultaneous regression results for the same relationship using shares outstanding and share float, respectively, for the share trades executed on the US trade venues. Based on the column 1 values, the positive relationship between holding periods based on shares outstanding and effective half-spreads holds and is significant for the share trades executed on the TSE for the firms cross-listed on the AMEX and NASDAQ during the pre- and post-TSE decimalization periods. The same relationship holds only during the pre- and the post-TSE decimalization periods for the share trades executed on the NYSE with shares without (marginal significance) and with options traded on them, respectively.

The negative and significant dummy shift variable estimates for the post-TSE decimalization period imply that the clientele effect declines for the share trades executed on the

Table 3

Summary results for regressions of the holding periods on the effective half-spreads for Canadian firms with share trades executed on the TSE and on US trade venues

Variables	Share trades executed on the TSE				Share trades executed on US trade venues			
	(1) Shares outstanding		(2) Share float		(3) Shares outstanding		(4) Share float	
	Coef.	*p*-value	Coef.	*p*-value	Coef.	*p*-value	Coef.	*p*-value
CONSTANT	2.5108	0***	2.2664	0***	−2.9023	0***	−3.1657	0***
DYO ∗ *D*1	−1.0888	0.002***	−1.1267	0***	−1.4996	0***	−1.6871	0***
DYNO	−2.2320	0.006***	−0.0621	0.896	1.3659	0.160	3.3646	0.008***
DYNO ∗ *D*1	−0.8389	0.023**	−0.1128	0.787	2.1650	0***	1.5643	0.003***
DX	−5.9580	0***	−1.5320	0***	1.4768	0.085*	4.4795	0***
DX ∗ *D*1	0.4655	0.177	−0.5634	0.125	−1.0970	0***	−0.6081	0.102
DQ	−1.9616	0.003***	−2.4326	0***	0.8803	0.268	3.0960	0.070*
DQ ∗ *D*1	0.1335	0.610	−0.4490	0.358	−0.3104	0.200	−0.0989	0.922
ES	−0.4363	0***	−0.2773	0***	0.0545	0.224	0.0767	0.185
ES ∗ *D*1	0.5622	0***	0.4743	0***	−0.0152	0.764	−0.0253	0.693
VAR	0.1542	0***	−0.0785	0.036**	−0.0457	0.081*	−0.0844	0.017**
VAR ∗ *D*1	−0.0868	0.013**	−0.0361	0.345	−0.0168	0.561	0.0359	0.344
MS	0.0025	0.983	0.1809	0.011**	−1.6380	0***	−1.0319	0***
MS ∗ *D*1	−0.0579	0.492	0.0226	0.760	0.2844	0.006***	0.2727	0.036**
MV	−0.2121	0.019**	−0.3044	0***	1.1252	0***	0.8726	0***
MV ∗ *D*1	0.2307	0***	0.2015	0***	0.0482	0.376	0.1030	0.052*
ES ∗ *DYNO*	0.1344	0.099*	0.4409	0***	0.1541	0.060*	0.1327	0.196
ES ∗ *DYNO* ∗ *D*1	−0.3795	0***	−0.3435	0***	0.2313	0.010***	0.0851	0.446
VAR ∗ *DYNO*	−0.3574	0***	−0.2480	0***	−0.2907	0***	−0.1056	0.251
VAR ∗ *DYNO* ∗ *D*1	0.1693	0.009***	0.3997	0***	0.3296	0***	0.0027	0.977
MS ∗ *DYNO*	−0.9370	0***	0.0219	0.875	1.0766	0***	0.9045	0***
MS ∗ *DYNO* ∗ *D*1	0.4730	0***	−0.0634	0.651	0.4144	0.007***	0.1400	0.464
MV ∗ *DYNO*	0.5925	0***	−0.0845	0.298	−0.5733	0***	−0.6267	0.001***

(*continued on next page*)

Table 3 (*Continued*)

Variables	Share trades executed on the TSE				Share trades executed on US trade venues			
	(1) Shares outstanding		(2) Share float		(3) Shares outstanding		(4) Share float	
	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
$MV * DYNO * D1$	−0.2355	0.002***	0.0404	0.620	−0.4222	0***	−0.3993	0***
$ES * DX$	1.1407	0***	0.5017	0***	0.2388	0***	0.0288	0.724
$ES * DX * D1$	−0.8993	0***	−0.1948	0.014**	−0.3229	0***	−0.2260	0.022**
$VAR * DX$	−0.1858	0***	−0.2490	0***	0.0752	0.067*	0.1621	0.003***
$VAR * DX * D1$	0.0755	0***	0.2925	0***	0.0375	0.420	0.0699	0.248
$MS * DX$	−0.7730	0***	−0.7191	0***	0.5915	0.002***	0.3793	0.155
$MS * DX * D1$	0.7264	0***	0.2328	0.093*	−0.1565	0.297	0.0243	0.901
$MV * DX$	1.3150	0***	0.3977	0***	−0.1364	0.296	−0.4947	0.013**
$MV * DX * D1$	−0.6232	0***	−0.0100	0.909	0.0089	0.887	−0.0819	0.319
$ES * DQ$	0.7717	0***	0.5736	0***	0.1026	0.039**	0.5731	0***
$ES * DQ * D1$	−0.5860	0***	−0.3085	0.001***	−0.0196	0.734	0.0482	0.665
$VAR * DQ$	−0.1513	0.006***	−0.2089	0***	0.1250	0.002***	0.3162	0***
$VAR * DQ * D1$	0.2024	0***	0.2614	0***	−0.0135	0.749	−0.1723	0.031**
$MS * DQ$	0.0199	0.895	−0.0367	0.777	0.2390	0.121	−0.1844	0.614
$MS * DQ * D1$	0.4506	0***	−0.1391	0.299	0.1012	0.443	0.7098	0.035**
$MV * DQ$	0.2650	0.038**	0.2420	0.004***	−0.0142	0.905	0.1842	0.532
$MV * DQ * D1$	−0.3225	0.001***	0.0816	0.379	−0.1233	0.117	−0.4976	0.046**
R^2 adj.	0.628		0.683		0.857		0.878	

Notes. This table reports the results of the regressions of the holding period (HP_{iT}) on the proportional effective bid–ask half-spread (ES_{iT}), mid-spread return variance (VAR_{iT}), the mid-spread (MS_{iT}) and market value (MV_{iT}), simultaneously. The variables are as in Eqs. (1) and (2), Section 3.

* Significant at the 10% level.

** Idem., 5%.

*** Idem., 1%.

TSE for the firms cross-listed on the AMEX and NASDAQ, and disappears for share trades executed on the TSE for firms cross-listed on the NYSE with shares without options traded on them. In contrast, a highly significant and positive dummy variable estimate indicates that the clientele effect increases for the share trades executed on the TSE for firms cross-listed on the NYSE for shares with options traded on them. Except for the share trades executed on the TSE for firms cross-listed on the NYSE for shares with options traded on them, most control variables appear to have the expected sign during the pre- and post-TSE decimalization periods.

Based on column 2 of Table 3, the positive relationship between holding periods based on share float and effective half-spreads holds during the pre-TSE decimalization period for the share trades executed on the TSE for the shares cross-listed on the NYSE without options traded on them, the AMEX and NASDAQ. The clientele effect also holds during the post-TSE decimalization period for the share trades executed on the TSE for the firms cross-listed on each of the US trade venues. However, the relationship weakens during the post-TSE decimalization period for all trade venues except the NYSE for shares with options traded on them, as reflected in the significant and negative coefficient estimates of their dummy shift variables.

The Amihud and Mendelson's relationship between holding periods based on shares outstanding and effective half-spreads holds during both the pre- and post-TSE decimalization periods only for the TSE cross-listed firms with share trades executed on the AMEX, and on the NYSE for shares without options traded on them based on column 3 of Table 3. The signs and significance of the coefficient estimates of the control variables do not appear to follow a consistent pattern for the TSE cross-listed share trades executed on each of the US trade venues as is the case for the same-firm share trades executed on the TSE. Similarly, based on the column 4 results reported in Table 3, the relationship between holding periods based on share float and effective half-spreads holds during the pre- and post-TSE decimalization periods only for the TSE cross-listed firms with share trades executed on the NASDAQ.

With respect to the regression results reported in columns 1 to 4 of Table 3, the relationship between holding periods and effective half-spreads seems to be stronger for both the shares outstanding and share float measures of holding periods and for the cross-listed share trades executed on the TSE relative to the same-firm share trades executed on the US trade venues. In contrast, the relationship appears to be less significant for the cross-listed share trades executed on US trade venues when holding periods are measured using share float (see column 4 of Table 3). All of the regressions reported in Table 3 are statistically significant with the lowest adjusted R^2 value being 0.628 and 0.857 for the share trades executed on the TSE and on the US trade venues, respectively. In general, these results corroborate the Amihud and Mendelson's (1986) hypothesis when either shares outstanding or share float are used to compute holding periods. These empirical results are consistent with those reported by Atkins and Dyl (1997) for their NYSE and NASDAQ samples when only shares outstanding are used in computing holding periods.

5.4. Determinants of holding period differences for pairs of competing trade venues

The regression results for Eq. (3), which are used to identify the determinants of holding period differences for the overall sample undifferentiated by US trade venue, are reported in Table 4. Column 1 of Table 4 reports the regression results for the relationship between the ratio of holding periods computed using shares outstanding and the ratio of effective-half spreads, after controlling for the other variables, for the share trades executed on the US trade venues and the TSE, respectively. Column 2 of Table 4 reports the same types of results for holding periods calculated using share float. These regressions are run to determine whether the posited relationship between holding period and effective half-spread ratios consistently holds during the pre- and post-TSE decimalization periods for trades undifferentiated by the cross-listing US trade venue. Columns 3 and 4 of Table 4 report the regression results for the same relationship estimated simultaneously for the US trade venues when holding periods are measured using shares outstanding and share float, respectively. By simultaneously including the US trade venues in the same regression, the results provide detailed information about the direction, the magnitude and the significance of the postulated relationship for each trade venue after controlling for the other variables.

Based on columns 1 and 2 of Table 4, the international clientele relationship holds during the pre- and the post-TSE decimalization period for holding periods measured using shares outstanding and share float, respectively. The control variables carry their expected

Table 4
Summary results of the regressions of the ratios of holding periods on the ratios of effective half-spreads for Canadian firms with share trades executed on the TSE and on US trade venues

Variables	(1)		(2)		(3)		(4)	
	Shares outstanding		Share float		Shares outstanding		Share float	
	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
CONSTANT	−1.6630	0***	−0.1978	0.652	0.2187	0.632	0.7701	0.164
DYO ∗ *D*1	0.0512	0.622	−0.1929	0.466	−2.3924	0***	−0.8021	0.023**
DYNO	−0.2607	0.409	0.2253	0.478	−5.8394	0***	−4.1925	0***
DYNO ∗ *D*1	0.2022	0.021**	−0.0226	0.920	3.4788	0***	1.3427	0.007***
DX	−2.4624	0***	−1.8091	0***	−4.9159	0***	−3.3961	0***
DX ∗ *D*1	0.0900	0.310	0.0911	0.673	0.7561	0.014**	0.8321	0.047**
DQ	2.2140	0***	0.7507	0.149	−1.3215	0.021**	0.4095	0.702
DQ ∗ *D*1	−0.5506	0***	−0.6154	0.004***	1.6399	0***	0.1558	0.866
RES	0.1946	0***	0.1909	0***	0.0640	0.010***	0.1408	0***
RES ∗ *D*1	−0.0158	0.411	−0.0245	0.371	0.1131	0***	0.0200	0.584
RVAR	−0.0273	0.020**	−0.0607	0.011**	0.1009	0***	0.0540	0.131
RVAR ∗ *D*1	−0.0148	0.223	0.0015	0.952	−0.1685	0***	−0.1569	0***
RMS	3.6640	0***	−1.4525	0.403	19.0041	0***	12.0987	0***
RMS ∗ *D*1	−3.1852	0***	2.0492	0.240	−18.7741	0***	−11.8019	0***
MV	0.2406	0***	0.1327	0***	0.0626	0.163	0.0280	0.610
MV ∗ *D*1	−0.0181	0.131	0.0046	0.865	0.2457	0***	0.0729	0.049**
RES ∗ *DYNO*					0.6865	0***	0.2931	0***
RES ∗ *DYNO* ∗ *D*1					−0.8001	0***	−0.2406	0.002***
RVAR ∗ *DYNO*					0.4361	0***	0.2483	0.076*
RVAR ∗ *DYNO* ∗ *D*1					−0.1497	0.138	0.0296	0.833
RMS ∗ *DYNO*					−27.5542	0***	−17.0541	0.011**
RMS ∗ *DYNO* ∗ *D*1					29.7340	0***	19.8972	0.003***
MV ∗ *DYNO*					0.7085	0***	0.5121	0***
MV ∗ *DYNO* ∗ *D*1					−0.6681	0***	−0.2371	0.002***
RES ∗ *DX*					0.2556	0***	0.1981	0.001***
RES ∗ *DX* ∗ *D*1					−0.1536	0.004***	−0.1285	0.091*
RVAR ∗ *DX*					−0.3359	0***	−0.2455	0***
RVAR ∗ *DX* ∗ *D*1					0.1375	0.006***	0.1173	0.083*
RMS ∗ *DX*					−22.8580	0***	−16.9589	0.001***
RMS ∗ *DX* ∗ *D*1					22.1962	0***	17.1793	0.001***
MV ∗ *DX*					0.3949	0***	0.2371	0.011**
MV ∗ *DX* ∗ *D*1					−0.3260	0***	−0.1730	0.015**
RES ∗ *DQ*					0.0132	0.675	0.0081	0.923
RES ∗ *DQ* ∗ *D*1					0.0283	0.459	−0.1116	0.243
RVAR ∗ *DQ*					−0.0882	0.034**	−0.2892	0***
RVAR ∗ *DQ* ∗ *D*1					0.2250	0***	0.2768	0***
RMS ∗ *DQ*					−19.9245	0***	−20.7767	0***
RMS ∗ *DQ* ∗ *D*1					19.4361	0***	13.1704	0.003***
MV ∗ *DQ*					0.2809	0***	−0.1210	0.424
MV ∗ *DQ* ∗ *D*1					−0.6159	0***	−0.1675	0.259
R^2 adj.	0.857		0.881		0.855		0.879	

Notes. See Table 3.
* Significant at the 10% level.
** Idem., 5%.
*** Idem., 1%.

coefficient signs with the exception of the significant and positive estimate for the ratio of mid-spreads. This result suggests that increasing ratios of mid-spreads are related to Canadian cross-listed shares that are traded on the US trade venues to be held for longer periods compared to the same-firm shares traded on the TSE. None of the coefficients for the shift dummies are significant in these regressions.

The relationship between the ratios of holding periods based on shares outstanding and of effective half-spreads consistently holds during the pre-TSE decimalization period for the TSE shares cross-listed on AMEX, and on the NYSE for shares with and without options traded on them, as reported by the simultaneous regression results for the US trade venues in column 3 of Table 4. The shift dummies for the TSE shares cross-listed on AMEX and on the NYSE for shares with options traded on them are significantly negative and positive, respectively. This indicates that the international trade-venue clientele effect relationship weakens and strengthens post-TSE decimalization for the TSE shares cross-listed on AMEX and on the NYSE for shares with options traded on them, respectively. The negative and highly significant (-0.8001, p-value of 0.000) estimated coefficient for the shift dummy for the TSE shares cross-listed on NYSE without options traded on them fails to support the international trade-venue clientele effect hypothesis post-TSE decimalization. The same relationship is not statistically significant for the TSE shares cross-listed on the NASDAQ during both the pre- and post-TSE decimalization periods. Except for the TSE shares cross-listed on the NASDAQ, firm size, or *MV*, consistently has its expected positive coefficient for each of the pairings of the TSE with a US trade venue for both the pre- and post-TSE decimalization periods. The expected signs of the coefficient estimates for all of the other control variables do not hold consistently and significantly across the pairings of the TSE with the US trade venues during the pre- and post-TSE decimalization periods. To illustrate, the sign and significance of the estimated coefficients of the shift dummy $D1$ change between these two time periods.

Column 4 of Table 4 reports the regression results using the sample with share-float computed holding periods. The evidence for the international trade-venue clientele effect is similar to that found using shares outstanding primarily for the pre-TSE decimalization period. For the post-TSE decimalization period, the estimated coefficient of the shift dummy for the TSE shares cross-listed on the NYSE without options traded on them is less negative for holding periods measured using share float (-0.2406, p-value of 0.002) than those measured using shares outstanding (-0.8001, p-value of 0.000). This indicates that the international trade-venue clientele effect holds for the pairing of the TSE with this US trade venue during the post-TSE decimalization period but at a lower level of significance than when holding periods are measured using shares outstanding. The international trade-venue clientele effect relationship does not hold for the TSE shares cross-listed on AMEX during the post-TSE decimalization period given the marginally significant and negative coefficient estimate of the dummy shift ratio of effective-half spreads (-0.1285, p-value of 0.091). In an unreported regression, the estimated coefficient of the ratio of effective half-spreads post-TSE decimalization is an insignificant 0.0676 (p-value of 0.142). The estimated coefficients of the control variables do not consistently exhibit their expected signs across the pairings of the TSE with the US trade venues during the pre- and post-TSE decimalization periods.

The results of Table 4 can be summarized as follows. The results displayed in columns 1 and 2 are consistent with the international trade-venue clientele effect hypothesis (our first hypothesis) for the overall or undifferentiated sample during the pre- and post-TSE decimalization periods using both measures of holding periods. For the sample differentiated by US trade venue, the results displayed in columns 3 and 4 of Table 4 are consistent with the international trade-venue clientele effect hypothesis for the TSE shares cross-listed on the AMEX, and on the NYSE with and without options traded on them for both holding period measures, and primarily pre-TSE decimalization. As such, these results support our first hypothesis when the sample is undifferentiated by US trade venue and provide mixed support when the sample is differentiated by US trade venue.

Based on the results reported in Tables 1–4, five major observations are drawn from the analysis conducted to this point. The first major observation is that holding periods for the TSE cross-listed share trades executed on the US trade venues are higher than those for the same-firm share trades executed on the TSE, even when their associated effective half-spreads are lower. A possible explanation could be that participants in US trade venues for Canadian cross-listed shares are relatively less informed compared to home country investors, and relative to US domestic shares.[17] This is supported by studies that find investors concentrate their ownership and trading in domestic shares (Cooper and Kaplanis, 1994; Kang and Stulz, 1997; Huberman, 2001). Thus, US investors are likely to hold the shares of cross-listed Canadian firms primarily to further diversify the risk of their investment portfolios although some other alternative explanations may exist. For example, Lau and McInish (2003), using a sample of Malaysian stocks that are traded in both Malaysia and Singapore, find that ownership of cross-listed shares by foreign investors is not motivated by diversification benefits but by higher expected returns (i.e., higher systematic risk). Another possible explanation is the existence of higher trade costs or effective bid–ask spreads for non-US share trades executed on the US trade venues compared to those of similar matched samples for domestic US shares (Bacidore and Sofianos, 2002). Thus, Canadian cross-listed share trades executed on the TSE exhibit shorter holding periods and higher trading by relatively more informed investors compared to the same-firm share trades executed on US trade venues. These implications are consistent with the investor recognition hypothesis advanced by Merton (1987), who demonstrates that investors are more likely to own and trade shares of firms they are more informed about.

The second major observation is that the results indicate that the TSE appears to be both a winner and loser. The TSE lost comparative competitiveness as measured by effective half-spreads for the same-firm share trades executed on the AMEX and on the NYSE for shares with options traded on them post-TSE decimalization. In contrast, the TSE maintained and won comparative competitiveness to the NASDAQ and the NYSE for shares without options traded on them, respectively. Although the effective half-spreads and trading volumes are much higher for the share trades executed on the NASDAQ relative to the same-firm share trades executed on the TSE, no unambiguous inference about whether or

[17] Non-informed traders are those who do not have private information or seasoned trading skills. Normally, they trade for risk diversification motives. These long-term, passive investors seek to minimize trade costs by trading less frequently. They normally invest through mutual funds that are willing and are more likely to attract them (see Nanda et al., 2000).

not the TSE and the NASDAQ have become more integrated for their common listings is possible given the results for the entire sample of 45 cross-listed shares examined herein.[18]

The third major conclusion is that the international trade-venue clientele effect is weaker post-TSE decimalization (i.e., a rejection of our second hypothesis). A possible reason is that TSE decimalization reduced both quoted and effective bid–ask spreads for share trades executed on the TSE in the immediate weeks after its decimalization but this was not accompanied by a concurrent expected increase in trading volume.[19] One possible reason is that the reduced trade costs due to decimalization are not sufficient in themselves to cause investors to increase their trading volume proportionally for share trades executed on the TSE. Another possible reason is that the action by the TSE was essentially neutralized by increased inter-market competition for order-flow execution by US trade venues by, for example, the MQIRs by the AMEX, NYSE and NASDAQ within approximately one year after TSE decimalization.[20] These findings imply that the TSE and the major US exchanges are becoming more integrated for TSE shares cross-listed on US trade venues.

The fourth major observation is that shares that have options traded on them have smaller effective half-spreads and shorter holding periods than their non-optioned counterparts. This is consistent with our third hypothesis and most theoretical models, which demonstrate that option trading enhances liquidity by lowering effective spreads and increasing trading volume (or alternatively, lowering holding periods) in the underlying shares (Damodaran and Subrahmanyam, 1992; and Coughenour and Shastri, 1999).

The fifth major observation is that the international trade-venue clientele effect appears to be enhanced only for the TSE shares cross-listed on the NYSE with options traded on them during the post-TSE decimalization period. This is based on a declining ratio of holding periods and of effective half-spreads, and a highly significant and more positive relationship between these two ratios post-TSE decimalization. This implies that the TSE lost relative trade cost and order-flow advantage post-TSE decimalization for the share trades executed on the TSE compared to the same-firm share trades executed on the NYSE for shares with options traded on them. A possible reason for this loss in competitive position by the post-TSE decimalization is that investors who trade the underlying shares with options traded on them may tend to be long-term oriented (non-informed), and may trade primarily for diversification purposes and/or higher expected returns. Since information is more likely to originate in the domestic market, informed trading is more likely to occur in the domestic than the foreign market. Thus, informed (short-term) investors in Canada would prefer to use their information by trading options in the Canadian options markets rather than trading the underlying shares on the TSE. By trading options, informed in-

[18] A SUR regression of the ratio of holding periods measured using share float against effective spreads and the control variables with differentiation by US trade venue and a combination of TSE cross-listed firms with no share float data available was run. Based on unreported results, the estimated coefficient of the ratio of effective spreads is not significant for the NASDAQ sample of 22 firms with share float data, and positive and highly significant for the other three pairings of the TSE and the US trade venues, and for the combined sample without share float data. These results may suggest that the TSE and the NASDAQ are becoming more integrated for firms with share float data (i.e., larger cap firms that are included in the TSE300 index).

[19] See Ahn et al. (1998), Chung et al. (1996), Bacidore (1997), and McKinnon and Nemiroff (1999).

[20] The AMEX and NYSE/NASDAQ reduced their tick size from $1/8$-th to $1/16$-th for issues with prices above $ 10 US on 17 May 1997 and on 2 June 1997, respectively.

vestors can obtain lower trade costs and more leverage, avoid short sale restrictions, and profit more cheaply from their private information (Coughenour and Shastri, 1999).

5.5. Nature of the Granger causality relationship between holding periods and effective half-spreads

The theoretical and empirical literatures have not resolved whether changes in quoted and/or effective bid–ask half-spreads are a consequence of changes in stock liquidity as measured by trading volume or vice versa. Demsetz (1968), Tinic (1972) and Stoll (1978) argue that the magnitude of trading volume determines the size of the bid–ask spread. In contrast, Amihud and Mendelson (1986) suggest that the size of the spread determines holding period magnitude. Using a sample of shares listed on the NYSE and NASDAQ, Atkins and Dyl (1997) find that the Granger (1969) causality between holding periods and spreads runs in both directions. However, the non-significant change in trading volumes and the significant decrease in bid–ask spreads that most studies report after the implementation of the MQIRs by the TSE and the major US exchanges suggests that bid–ask spreads do not lead trading volumes.[21]

Since the results presented in Section 5.4 indicate that a significant relationship exists between effective half-spread differences and ratios for trade-venue pairings and for their holding period differences and ratios, this section uses Granger (1969) causality tests to examine whether holding period differences and ratios lead effective half-spread differences and ratios or vice versa, and whether feedback effects exist. The bivariate regression for the Granger causality test between the holding period or effective half-spread ratios and effective half-spread or holding period ratios is as follows:

$$RES_{iT} = \gamma_0 + \gamma_1 RES_{iT-1} + \cdots + \gamma_k RES_{iT-k} + \lambda_1 RHP_{iT-1} + \cdots + \lambda_k RHP_{iT-k}, \tag{7a}$$

$$RHP_{iT} = \gamma_0 + \gamma_1 RHP_{iT-1} + \cdots + \gamma_k RHP_{iT-k} + \lambda_1 RES_{iT-1} + \cdots + \lambda_k RES_{iT-k}. \tag{7b}$$

RES_{iT} and RHP_{iT} are equal to the ratios ES^{US}/ES^{TSE} and HP^{US}/HP^{TSE}, respectively; that is, the effective half-spread and holding period ratios between the share trades executed on the US trade venue and the same-firm share trades executed on the TSE. The letter k represents the number of months T that each variable is lagged. For robustness, the bivariate regression consisting of Eqs. (7a) and (7b) is run at various lag lengths. The Wald F-statistic tests the joint hypothesis $\lambda_1 = \cdots = \lambda_k = 0$ for each equation, where the null hypothesis is that *RHP* and *RES* do not Granger-cause *RES* and *RHP* in Eqs. (7a) and (7b), respectively.

Granger causality test results between the holding period and effective half-spread ratios for the various pairings of a US trade venue with the TSE for the samples using shares out-

[21] For the impact of the MQIR by the TSE on trading volumes and trade costs, well-documented studies are by Chung et al. (1996), Bacidore (1997), Ahn et al. (1998), and McKinnon and Nemiroff (1999). For the impact of the MQIR by the AMEX, see Ahn et al. (1996), Griffiths et al. (1998) and Ronen and Weaver (2001). Similarly for the impact of the MQIR by the NYSE, see Goldstein and Kavajecz (2000), Jones and Lipson (2001), and for the NYSE and NASDAQ see Bessembinder (1999). For an excellent survey on decimalization, see Harris (1997).

standing and share float, respectively, are examined but not reported to save valuable journal space.[22,23] We calculate the Wald F-statistics and their associated probabilities for lag lengths of 2 to 9. The unreported results show that the holding period ratios predominantly lead the effective half-spread ratios for all trade-venue pairings. These results may explain why the MQIRs implemented by the TSE and the major US exchanges did not affect trading volume significantly. Together with the results reported earlier in Tables 2 and 4, these results suggest the possibility that the decrease in the holding period ratios for share trades executed on the US trade-venue and TSE pairings Granger *cause* the relative decrease in their respective effective half-spread ratios for the same-firm cross-listed shares.

We also analyze the unreported Granger causality tests for the pairings of a US trade venue with the TSE where holding periods are measured using share float. These Granger causality tests are consistent with those found only for the TSE shares cross-listed on the NYSE with options traded on them and NASDAQ in that the ratios of holding periods Granger cause the ratios of effective half-spreads. In contrast, for the TSE shares cross-listed on the NYSE without options traded on them, Granger causality feedback seems to occur mostly at longer lag lengths. Finally, the Granger causality tests between the ratios of holding periods and effective half-spreads for the TSE shares cross-listed on the AMEX are not significant for most lags.

6. Conclusions

The main purpose of this paper was to test whether or not the empirical evidence supports the generalized version of the Amihud and Mendelson (1986) clientele hypothesis. Their hypothesis states that shares with higher bid–ask spreads are held for longer periods than shares with smaller spreads, all else held equal. When generalized to deal with same-firm share trades across multiple trade venues located in different countries, the new *international trade-venue clientele effect* hypothesis predicts that, in equilibrium, shares with increasing *relative* spreads across trade venues are held in portfolios with the same or expected increasing relative holding periods, and vice versa for decreasing relative spreads, all else held constant.

The findings reported herein for Canadian cross-listed share trades executed on the US trade venues for the overall sample of firms undifferentiated by US trade venue are consistent with the *international trade-venue clientele effect* hypothesis (our first hypothesis). When the sample is differentiated by US trade venue, the clientele effect continues to hold for the Canadian cross-listed share trades executed on the TSE, AMEX and NYSE, and not NASDAQ. The relative effective half-spreads between the Canadian cross-listed share

[22] They are available upon request.

[23] The results of a number of other Granger (1969) causality tests are also not reported. Granger causality tests are carried out between the effective spreads and holding periods for the share trades executed on the TSE that are cross-listed on the AMEX, NYSE for shares with and without options traded on them, and NASDAQ. Most of these unreported tests indicate significant feedback effects. Similarly, causality tests are conducted for the same-firm share trades for the corresponding US trade-venue samples. Effective half-spreads lead holding periods for the share trades executed on the AMEX only for lag 6. For the share trades executed on the NYSE for shares with and without options traded on them, holding periods lead effective half-spreads for most lags. For the share trades executed on the NASDAQ, feedback effects occur for lags 5 to 9.

trades executed on these US trade venues and the same-firm share trades executed on the TSE are positively associated with the same or longer relative holding periods, particularly prior to TSE decimalization that occurred on April 15, 1996. Changes in effective half-spreads appear to be the only variable that is consistently associated with changes in holding periods for the various trade-venue categories of cross-listed share trades examined herein.

The relative holding periods for the share trades executed on the US versus TSE trade venue are decreasing, and are associated with decreasing relative effective half-spreads for the TSE shares cross-listed on the AMEX and on the NYSE for shares with options traded on them. This implies that the TSE has consistently lost executed order-flow share to the AMEX and to the NYSE (the later for shares with options traded on them), and that this is due to increasing relative effective spreads for Canadian cross-listed shares. TSE decimalization did not obtain the desired outcome of avoiding the future loss of trading volume by the TSE to the US trade venues by reducing the MQI for its cross-listed shares. For the TSE shares cross-listed on the NYSE without options traded on them, the positive relationship between holding periods and effective half-spreads reverses post-TSE decimalization. The disappearance of the international trade-venue clientele effect post-TSE decimalization implies that the TSE won executed order-flow share from the NYSE for share trades of TSE shares cross-listed on NYSE without options traded on them. These results suggest that the existence of traded options on the underlying cross-listed shares may have important implications, as predicted by our third hypothesis, for the relative strength of the various trade venues competing for the same order-flow execution.

TSE decimalization increased the inter-venue competition for order-flow execution. This competition was intensified by the MQIRs implemented on the AMEX and NASDAQ approximately one year later. Counter to the prediction of our second hypothesis, these events seem to affect the magnitude, direction and significance of the relationship between holding periods and effective half-spreads differently for the share trades executed on the TSE and the same-firm share trades executed on each US trade venue. In turn, they may have weakened the international trade-venue clientele effect by reducing the materiality of effective half-spread differences between trade venues. Nevertheless, it is difficult to conclude whether or not the loss, gain or maintenance of TSE competitiveness in terms of trading volumes and effective half-spreads would have been more pronounced without the first mover action of the TSE to decimalization.

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