

Table 1: Prediction of timing of HFT entry

This table gives the fit coefficients of a Cox proportional hazards model estimating the time to next HFT entry for a stock on a stock-event basis. Each observation is a time to next HFT entry for a stock. The model predicts time to next entry using the explanatory variables: *Canadian volume* is the log daily Canadian trading volume for the stock (divided by 100) obtained from Compustat. *Alpha volume* is the log daily trading volume for a stock on Alpha (divided by 100). *Volatility* is a 10-day moving average of the standard deviation of a stocks closing price obtained from Bloomberg. *Alpha Relative spread* is the time-weighted average difference between the best bid and ask price divided by the midquote on Alpha (multiplied by 10,000). *TSX Relative spread* is the time-weighted average difference between the best bid and ask price divided by the midquote on TSX (multiplied by 10,000). The model is

$$timeToEntry(i, j, t) = h(t) \exp(BX_{i,j})$$

where i is the index for the stock, j is the index for the entry event, t is the time from previous entry, $h(t)$ is the baseline hazard, X is a vector of explanatory variables, and B is the vector of coefficients. The model is fit for times to entry measured in months, weeks or days. In the first three specifications, the explanatory variables are averaged over the first time increment after entry. In the next three specifications, the explanatory variables are averaged over all the time increments after entry until the increment before the next entry. The *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

	Month after			Average of months between		
	Monthly	Weekly	Daily	Monthly	Weekly	Daily
Canadian volume	-0.05 (-0.83)	-0.05 (-0.93)	0.02 -0.33	0.06 -1.37	0.05 -1.24	0.06 -1.56
Alpha volume	0.19*** -4.97	0.20*** -5.3	0.13*** -3.3	-0.02 (-0.90)	-0.02 (-0.98)	-0.04 (-1.58)
Volatility	0.14*** -2.62	0.09* -1.94	0.06 -1.37	0.00*** -3.06	0.00*** -3.21	0.00*** -3.33
Alpha relative spread	0.01 -0.91	0.01 -0.91	0.01 -0.71	-0.17*** (-3.85)	-0.20*** (-4.48)	-0.20*** (-4.62)
TSX relative spread	-0.54*** (-5.15)	-0.49*** (-5.03)	-0.34*** (-4.02)	-0.38*** (-4.58)	-0.37*** (-4.38)	-0.37*** (-4.35)
N	1109	1109	1109	1109	1109	1109
Pseudo R2	0.01	0.013	0.013	0.016	0.017	0.016

Table 2: Passive HFT competition and quoted spreads

The table reports a difference-in-differences event study on quoted spreads comparing the month before a stock-entry date of a passive HFT to the first, second and third months after the date, run separately for the second, third and fourth-and-greater HFT firms to begin trade. The *quoted spread* is the average daily difference between the best bid and best ask. Passive HFT is an HFT that uses predominantly limit orders to trade. For each treatment stock, a control is matched by Mahalanobis ranking on log market cap, log TSX volume, price, 10-day price volatility and absolute bid-ask spread during the month before the event. The regressors are *HFT*, the treatment dummy; *after*, the post-period dummy; controls for log market cap, log TSX volume, price, 10-day price volatility, and number of traders; and stock-event fixed effects. The event study is fit once using OLS and once using WLS in which the weighting is the HFT entrant's volume share during the month. The immediate one-month entry results are reported in the full table in Panel A; the second-month entry HFT coefficient is reported in Panel B and the third-month entry HFT coefficient is reported in Panel C. The *, **, *** represent statistical significance at the 10%, 5%, and 1% level. Standard errors are double-clustered by stock-event and calendar date.

	<i>OLS</i>			<i>Weighted OLS</i>		
	2nd HFT	3rd HFT	4th+	2nd HFT	3rd HFT	4th+
Panel A: Treatment effect, month 1						
HFT	-91.07*** (-3.17)	-12.75** (-2.27)	-2.07 (-1.10)	-123.12*** (-3.40)	-18.36** (-2.22)	0.63 (0.20)
Trend	5.5 (0.43)	2.32 (0.73)	3.55* (1.73)	11.12 (0.67)	-0.1 (-0.02)	1.41 (0.46)
Market cap	15.84 (0.19)	-51.93 (-0.74)	2.56 (0.20)	-48.38 (-0.37)	-13.16 (-0.31)	1.55 (0.13)
TSX volume	22.72*** (3.30)	5.56*** (3.10)	-0.04 (-0.03)	25.94*** (2.97)	7.88*** (3.06)	0.89 (0.43)
Price	-1.24 (-0.46)	-1.26 (-1.48)	-0.39* (-1.92)	-1.99 (-0.53)	-1.14 (-1.12)	-0.69*** (-2.69)
Volatility	-0.18 (-0.05)	6.49*** (3.06)	1.21** (2.26)	0.34 (0.07)	8.06*** (2.74)	1.17 (1.54)
# firms	-11.77*** (-6.61)	-2.48*** (-5.73)	-0.66*** (-5.20)	-14.25*** (-7.04)	-3.34*** (-5.53)	-1.04*** (-3.86)
FEs	Y	Y	Y	Y	Y	Y
R^2	0.565	0.681	0.767	0.588	0.647	0.741
Events	140	122	298	140	122	298
Panel B: Treatment effect, month 2						
HFT	-108.13*** (-3.48)	-7.06 (-0.90)	-4.94 (-1.42)	-142.79*** (-3.20)	-15.22* (-1.71)	-3.28 (-0.73)
Panel C: Treatment effect, month 3						
HFT	-92.63*** (-2.87)	0.13 (0.02)	-3.62 (-1.45)	-116.07** (-2.53)	-5.96 (-0.67)	-0.33 (-0.08)

Table 3: Aggressive HFT competition and quoted spreads

The table reports a difference-in-differences event study on nonHFT effective spreads comparing the month before a stock-entry date of an aggressive HFT to the first, second and third months after the date, run separately for the second, third and fourth-and-greater HFT firms to begin trade. The *quoted spread* is the average daily difference between the best bid and best ask. Aggressive HFT is an HFT that uses predominantly marketable orders to trade. For each treatment stock, a control is matched by Mahalanobis ranking on log market cap, log TSX volume, price, 10-day price volatility and absolute bid-ask spread during the month before the event. The regressors are *HFT*, the treatment dummy; *after*, the post-period dummy; controls for log market cap, log TSX volume, price, 10-day price volatility, and number of traders; and stock-event fixed effects. The event study is fit once using OLS and once using WLS in which the weighting is the HFT entrant's volume share during the month. The immediate one-month entry results are reported in the full table in Panel A; the second-month entry HFT coefficient is reported in Panel B and the third-month entry HFT coefficient is reported in Panel C. The *, **, *** represent statistical significance at the 10%, 5%, and 1% level. Standard errors are double-clustered by stock-event and calendar date.

	<i>OLS</i>			<i>Weighted OLS</i>		
	2nd HFT	3rd HFT	4th+	2nd HFT	3rd HFT	4th+
Panel A: Treatment effect, month 1						
HFT	-12.48 (-0.68)	0.05 (0.01)	-3.65* (-1.73)	-0.34 (-0.01)	-0.15 (-0.02)	-4.14 (-1.53)
Trend	22.05 (1.41)	1 (0.26)	6.23*** (2.64)	42.02 (1.61)	-0.8 (-0.17)	7.21** (2.33)
Market cap	2.07 (0.03)	-220.81*** (-2.70)	-78.91*** (-3.82)	-93.91 (-0.76)	-215.82*** (-2.68)	-63.47** (-2.49)
TSX volume	16.32*** (2.60)	0.52 (0.22)	1.98 (0.59)	21.06** (2.16)	-1.01 (-0.23)	-0.07 (-0.01)
Price	0.3 (0.11)	-1.50** (-2.25)	-0.24 (-0.66)	1.97 (0.41)	-1.22 (-1.46)	-0.04 (-0.10)
Volatility	17.17 (1.40)	2.32 (1.47)	3.02*** (3.56)	18.88 (1.16)	3.26* (1.73)	3.30*** (3.26)
# firms	-7.32*** (-4.61)	-0.63*** (-4.01)	-0.53** (-2.58)	-10.13*** (-4.33)	-0.85*** (-3.64)	-0.53** (-2.04)
FEs	Y	Y	Y	Y	Y	Y
R^2	0.352	0.644	0.85	0.309	0.565	0.851
Events	39	35	267	39	35	267
Panel B: Treatment effect, month 2						
HFT	-26.09 (-0.85)	-1.15 (-0.11)	-4.77** (-1.99)	-42.4 (-0.95)	-2.55 (-0.14)	-4.03 (-1.51)
Panel C: Treatment effect, month 3						
HFT	5.01 (0.29)	-6.05 (-0.69)	-17.91*** (-3.42)	26.45 (0.81)	-15.51 (-1.11)	-13.48** (-2.37)

Table 4: Aggressive HFT competition and nonHFT realized spreads

The table reports a difference-in-differences event study on nonHFT effective spreads comparing the month before a stock-entry date of an aggressive HFT to the first, second and third months after the date, run separately for the second, third and fourth-and-greater HFT firms to begin trade. The *realized spread for nonHFT trades* is twice the volume-weighted, signed difference between a trades price and the midquote in five seconds in basis points from the midquote for aggressive trades *not* initiated by an HFT. Aggressive HFT is an HFT that uses predominantly marketable orders to trade. For each treatment stock, a control is matched by Mahalanobis ranking on log market cap, log TSX volume, price, 10-day price volatility and absolute bid-ask spread during the month before the event. The regressors are *HFT*, the treatment dummy; *after*, the post-period dummy; controls for log market cap, log TSX volume, price, 10-day price volatility, and number of traders; and stock-event fixed effects. The event study is fit once using OLS and once using WLS in which the weighting is the HFT entrant's volume share during the month. The immediate one-month entry results are reported in the full table in Panel A; the second-month entry HFT coefficient is reported in Panel B and the third-month entry HFT coefficient is reported in Panel C. The *, **, *** represent statistical significance at the 10%, 5%, and 1% level. Standard errors are double-clustered by stock-event and calendar date.

	<i>OLS</i>			<i>Weighted OLS</i>		
	2nd HFT	3rd HFT	4th+	2nd HFT	3rd HFT	4th+
Panel A: Treatment effect, month 1						
HFT	-4.56*** (-2.84)	0.63 (0.39)	1.79* (1.89)	-8.26*** (-2.99)	1.21 (0.71)	2.19** (2.09)
Trend	3.61** (2.22)	1.23 (0.98)	-0.9 (-0.90)	5.56** (2.30)	0.83 (0.58)	-1.38 (-1.25)
Market cap	1.6 (0.11)	-81.98*** (-4.20)	-18.16*** (-2.95)	-2.96 (-0.17)	-82.34*** (-4.43)	-20.21** (-2.10)
TSX volume	-1.49 (-1.33)	-0.43 (-0.65)	-4.95*** (-2.64)	-3.28* (-1.86)	-0.81 (-0.97)	-6.62** (-2.53)
Price	0.55** (2.18)	-0.44* (-1.83)	-0.35** (-2.56)	0.49 (1.27)	-0.33 (-1.43)	-0.35** (-1.99)
Volatility	2.44 (1.28)	-0.54 (-0.69)	-0.08 (-0.36)	4.22** (2.05)	-0.13 (-0.16)	-0.03 (-0.14)
# firms	-0.15 (-1.03)	-0.16 (-1.27)	0.11 (1.35)	-0.02 (-0.08)	-0.16 (-0.97)	0.22* (1.68)
FEs	Y	Y	Y	Y	Y	Y
R^2	0.205	0.114	0.428	0.2	0.109	0.417
Events	39	35	267	39	35	267
Panel B: Treatment effect, month 2						
HFT	-10.05** (-2.00)	-0.75 (-0.44)	2.04** (2.17)	-15.97* (-1.80)	-1.79 (-0.93)	1.59 (1.57)
Panel C: Treatment effect, month 3						
HFT	-7.40* (-1.92)	-3.28 (-1.47)	1.67 (1.44)	-15.35** (-2.14)	-5.32* (-1.74)	2.18 (1.45)

Table 5: Aggressive HFT competition and inside depth

The table reports a difference-in-differences event study on inside depth comparing the month before a stock-entry date of a aggressive HFT to the first, second and third months after the date, run separately for the second, third and fourth-and-greater HFT firms to begin trade. *Inside depth* is the sum of the quantity of limit orders outstanding at the best-bid and best-ask prices. Aggressive HFT is an HFT that uses predominantly marketable orders to trade. For each treatment stock, a control is matched by Mahalanobis ranking on log market cap, log TSX volume, price, 10-day price volatility and absolute bid-ask spread during the month before the event. The regressors are *HFT*, the treatment dummy; *after*, the post-period dummy; controls for log market cap, log TSX volume, price, 10-day price volatility, and number of traders; and stock-event fixed effects. The event study is fit once using OLS and once using WLS in which the weighting is the HFT entrant's volume share during the month. The immediate one-month entry results are reported in the full table in Panel A; the second-month entry HFT coefficient is reported in Panel B and the third-month entry HFT coefficient is reported in Panel C. The *, **, *** represent statistical significance at the 10%, 5%, and 1% level. Standard errors are double-clustered by stock-event and calendar date.

	<i>OLS</i>			<i>Weighted OLS</i>		
	2nd HFT	3rd HFT	4th+	2nd HFT	3rd HFT	4th+
Panel A: Treatment effect, month 1						
HFT	-5617.7 (-1.59)	-3077.88 (-1.16)	-1423.38 (-0.72)	-2743.90* (-1.82)	-1685.52 (-1.10)	-1406.11 (-1.07)
Trend	2852.92 (1.02)	1497.93 (0.55)	-725.98 (-0.34)	1398.57 (1.27)	1073.02 (0.70)	-104.48 (-0.07)
Market cap	12467.73 (0.97)	1595.85 (0.37)	-736.96 (-0.21)	5173.65 (0.77)	3285.91 (1.21)	1691.78 (0.64)
TSX volume	-1379.14** (-2.45)	1625.07*** (3.03)	3010.55*** (3.69)	-1103.15*** (-3.35)	824.99** (2.44)	1796.75*** (3.00)
Price	-186.27 (-0.55)	-161.37 (-0.73)	45.76 (0.52)	-112.27 (-0.70)	-32.03 (-0.42)	46.77 (0.92)
Volatility	-1786.35 (-1.18)	-1442.64 (-1.27)	-145.06 (-1.25)	-584.14 (-1.04)	-797.9 (-1.44)	-76.47 (-0.97)
# firms	408.52*** (3.61)	95.15 (0.71)	-264.45*** (-4.43)	264.12*** (4.66)	106.17 (1.33)	-141.29*** (-3.24)
FEs	Y	Y	Y	Y	Y	Y
R^2	0.856	0.874	0.62	0.852	0.877	0.611
Events	39	35	267	39	35	267
Panel B: Treatment effect, month 2						
HFT	-98.2 (-0.02)	-4300.75 (-1.47)	1770.63 (1.20)	378.02 (0.19)	-2456.62 (-1.46)	547.8 (0.61)
Panel C: Treatment effect, month 3						
HFT	7415.76 (1.04)	-2523.59 (-1.36)	3979.11** (1.99)	655.53 (0.23)	-1341.38 (-1.05)	1908.59 (1.58)

Table 6: Aggressive HFT competition and HFT incumbent effective spreads

The table reports a difference-in-differences event study on the effective spreads of HFT incumbents comparing the month before a stock-entry date of an aggressive HFT to the first, second and third months after the date, run separately for the second, third and fourth-and-greater HFT firms to begin trade. *HFT incumbent effective spread* is the effective spread of trades in which an incumbent HFT firm (*i.e.* not the entrant in the treatment stock) is the passive counterparty. Aggressive HFT is an HFT that uses predominantly marketable orders to trade. For each treatment stock, a control is matched by Mahalanobis ranking on log market cap, log TSX volume, price, 10-day price volatility and absolute bid-ask spread during the month before the event. The regressors are *HFT*, the treatment dummy; *after*, the post-period dummy; controls for log market cap, log TSX volume, price, 10-day price volatility, and number of traders; and stock-event fixed effects. The event study is fit once using OLS and once using WLS in which the weighting is the HFT entrant's volume share during the month. The immediate one-month entry results are reported in the full table in Panel A; the second-month entry HFT coefficient is reported in Panel B and the third-month entry HFT coefficient is reported in Panel C. The *, **, *** represent statistical significance at the 10%, 5%, and 1% level. Standard errors are double-clustered by stock-event and calendar date.

	<i>OLS</i>			<i>Weighted OLS</i>		
	2nd HFT	3rd HFT	4th+	2nd HFT	3rd HFT	4th+
Panel A: Treatment effect, month 1						
HFT	4.22 (1.28)	1.51 (0.67)	-1.03 (-1.03)	11.47 (1.26)	2.24 (0.93)	-0.74 (-0.66)
Trend	-2.38 (-0.86)	-0.92 (-0.49)	1.65 (1.52)	-2.01 (-0.60)	-2.11 (-0.99)	1.34 (1.10)
Market cap	-16.18 (-0.93)	-141.88*** (-2.68)	8.37 (1.05)	-39.13 (-1.50)	-147.66*** (-3.01)	2.91 (0.28)
TSX volume	1.42 (0.94)	1.07 (1.09)	0.31 (0.20)	1.42 (0.79)	1.26 (1.03)	0.56 (0.33)
Price	0.21 (0.29)	0.22 (0.73)	-0.02 (-0.15)	-0.58 (-0.45)	0.15 (0.44)	-0.04 (-0.33)
Volatility	5.77 (1.13)	-0.34 (-0.52)	-0.06 (-0.22)	5.89 (0.99)	-0.42 (-0.62)	-0.01 (-0.03)
# firms	-1.10* (-1.72)	-0.23* (-1.83)	-0.04 (-0.61)	-1.29* (-1.74)	-0.15 (-0.81)	-0.05 (-0.69)
FEs	Y	Y	Y	Y	Y	Y
R^2	0.213	0.438	0.682	0.188	0.409	0.667
Events	39	35	267	39	35	267
Panel B: Treatment effect, month 2						
HFT	-2.65 (-0.38)	-1.34 (-0.47)	-1.84 (-1.26)	-4.48 (-0.41)	-0.77 (-0.17)	-2.1 (-1.14)
Panel C: Treatment effect, month 3						
HFT	5.28 (0.88)	-5.24 (-1.60)	-4.44** (-2.18)	11.61 (1.32)	-9.28* (-1.83)	-4.54** (-2.06)