immediacy. The increased depth might indicate market-making activity of high frequency traders becomes more active as the off-exchange volume increases.

5.2 Order flow intensity and market making activity

High speed trading can be causes of two countervailing effects on liquidity, liquidity taking and provision. If orders are more concentrated in one side, higher degree of order imbalance deteriorates market liquidity. Increasing speed of trade amplifies order imbalance, thus having a permanent market impact after the trade. We investigate this by introducing trading intensity variables such as share imbalance and the persistency of runs in addition to number of trade (or size of trade).

A number of trade or size of trade which are activity measure (Jones et al., 1994). Second variable is share imbalance, which is a difference between buyer-initiated and seller-initiated shares divided by total volume over 30-minute period (Chordia et al , 2004). In the TSE which is pure order-driven market, we can determine the initiating side of trade by comparing the prevailing quotes with the price of the following trade. The elimination of three-second matching interval affects counting of the number of trades so that share volume based imbalance is appropriate in this study. Third variable is standardized length of sequence based upon the runs test. The runs test often applies to price change rather than order flow. Here we assign +1 for a buyer-initiated order and -1 for a seller-initiated order.

Based upon Fama(1965), we compute predicted value for the runs ratio given a number of trade and order imbalance ratio between buyer-initiated and seller–initiated orders and then compute the deviation of actual runs ratios from the predicted ratio divided by standard error of the runs ratio. This measure captures the persistency of one sided order flow for short time period. From the market-making points of view, a sequence of buy (or sell) trades monotonically increase inventory, it may have impact on market making behaviors. All three variables uniquely relate to intensiveness of order flow. For liquidity provision side, market making related variable is the frequency of quote updates normalized by a number of trades.

5.3 Determinants of liquidity

Here we test whether level of liquidity as well as its relation with trading measures change between December 2009 and January 2010 (referred as first period), October, November, and December 2010 (referred as second period) by the following regression analysis. The basic form of regression equations are as follow:

$$L_{i,t} = \alpha + \beta_1 \frac{QuoteFreq_{i,t}}{TradeFreq_{i,t}} + \beta_2 TradeSize_{i,t} + \beta_3 Share\,\mathrm{Im}b_{i,t} + \beta_4 RunPersistency_{i,t} + \gamma\Delta X_j + \varepsilon_i \quad (5)$$

where Li is four types of liquidity measures such as *ESPRDi* is the effective spread, *RSPRDi* is the realized spread, *MIi* the adverse selection cost and *Depth*i for average depth at the best ask and bid book; our market-making proxy is $\frac{QuoteFreq_{i,t}}{TradeFreq_{i,t}}$, normalized quote update frequency. We have three order flow

intensity proxies such as *TradeSize*i, *ShareImb*i, *RunPersistency*i. And the *X*i are stock-level control variables, including logarithmic market capitalization of stock, tick size change dummy which equals one for stocks subject to tick size change and zero for other stocks, and time of day dummies (30-minute interval). The time dummy of 10:00AM is not included in the regression.

In order to test the changes, we insert two period dummies. One for Dec 2009 which equals one for observations for December 2009 and zero otherwise. Second period dummy equals one for observations for October-December 2010 and zero otherwise. These dummies are inserted to detect a change of intercept and coefficients of $\frac{QuoteFreq_{i,t}}{TradeFreq_{i,t}}$, *TradeSize*i, *ShareImb*i, and *RunPersistency*i.

Table.8 shows the results of regressions. From the intercept and coefficients of its dummies, the effective half-spread declines 6.2BP on January 2010 compared to December 2009. The further reduction on the last three months of 2010 is 1.9BP. The realized spread and adverse selection cost show smaller changes but similar trend.

The market-making factor (quote update) shows negative coefficient on effective spread -0.0053 (=-0.0010-0.0043) for December 2009, -0.001 for January 2010 and remains almost same for the last three month of 2010. The quote update shows similar trend for the realized spread and adverse selection cost. The change between the first month and last three months in 2010 is insignificant. Quote updates relates to reduction of cost of immediacy and market-making profit.

Among the order flow intensity proxies, the size of trade has positive relation with effective spread, realized spread and adverse selection cost. The positive relation with three spread measures remains same after 2010. It means that reduction of average trade size after 2010 contributes reduction of effective spread. Order imbalance has positive relation with effective spread and adverse selection cost. This is consistent with Chordia and Subrahmanyam (2004). They state that order imbalances could be related to adverse section cost for liquidity providers. The persistency of runs is also positively correlated with adverse selection cost, but negatively correlated with effective spread and realized spread. This means that the length of runs lasts longer than theoretically predicted when competition among liquidity providers is intense.

Average depth of bid and ask book is positively correlated with quote update, size of trade, order imbalance. Only factor which is negatively correlated with the depth is the persistency of runs. It is consistent with notion that the length of sequence at same side of order is risk for liquidity providers. We confirm this relation by the fact the persistency of runs is also positively correlated with adverse selection cost. The larger the deviation of runs ratio from the predicted value, the lower the depth.

The degree of impact generated by explanatory variables cannot be assessed from the size of coefficient because the means of explanatory variables change before/after the event. In order to illustrate changes brought about by the new trading system we compute value of four components such as market-making (quote update) and order flow intensity (size of trade, order imbalance, persistency of runs).

Each amount is computed by multiplying estimated coefficients and mean values of explanatory variables for each period.

Figure 4 illustrates size and side of impact for four variables. Sample stocks are those grouped as heavy HFT influence in section 4.2. Spread reduction by market-making activities attenuates after 2010 and higher-frequency and smaller trade gradually increases three spread measures. Persistency of runs affects to adverse selection cost more than share imbalance. It reduces compensation for liquidity providers. Its effects are increasing in the new trading platform. For depth, market-making factor becomes increasingly important and the persistency of runs is negative factor to the depth.

6. Concluding remarks

Since Arrowhead's introduction at the TSE, higher-frequency and smaller trades have been observed without a volume increase. Of the transaction-related measures, the number of quote revisions increases the most. We estimate a model that captures the relations between quote updates and transactions, and quantify an HFT effect for individual stocks in the new trading platform.

The US Securities and Exchange Commission expressed concern over the HFT effect and whether it improves liquidity or diminishes price efficiency by abrupt up and down price movements.[5] After the launch of Arrowhead in the TSE, the effective spread declined, and the compensation for liquidity provision decreased due to increased adverse selection costs. Both of these trends are more pronounced for large-cap stocks characterized by high frequency trading.

The TSE's new trading platform significantly enhanced order execution turnaround. The three-second matching cycle was eliminated, and the dissemination of trades and quotes is now carried out instantaneously and individually. We compare liquidity between December 2009 and January, October, November and December 2010 and determine the new trading platform's impact on liquidity. The increased number of trades may be the natural result of more frequent matching. Reporting trades and quote revisions individually should have a real impact on investor behavior.

Some market participants at the TSE say that quote changes have become too fast to be perceived by humans. It indicates that in the new trading platform the computerized market-making replaces human-based activity and leads to intense competition among liquidity providers. This has had a negative impact on the realized spread.

Higher adverse selection cost might imply that increasing speed of trade amplifies order imbalance, thus having a permanent market impact after the trade. We investigate this by introducing trading intensity variables such as share imbalance and the persistency of runs in addition to number of trade.

[5] US SEC(2010).

What we find is that spread reduction by market-making activities attenuates after 2010 and higher-frequency and smaller trade gradually increases cost of immediacy. Persistency of runs affects to adverse selection cost more than share imbalance and it increases risk of market-making. For depth, market-making factor becomes increasingly important and high frequency trading contributes market depth a later period of 2010.

Brokerages engaging in short-term trading for their own accounts will have difficulty avoiding reduced profitability due to increasingly intense competition with HFT, making it a challenge to remain viable without some form of HFT capability. The use of HFT remains unchanged, however, for small-cap stocks, a segment of the market where algorithmic trades cannot be said to have increased the supply of liquidity.

Several important questions remain unanswered in this study, due largely to a lack of detailed data. Beyond the observed changes, which investors change their investment behavior and in what manner are interesting questions. A growing off-exchange trading may be connected with liquidity improvement we observed in the later months of 2010. We will continue these kinds of investigation in future projects.

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Table 1. Sample stocks and tick size

We collect stocks from the TSE one month before and one month after the introduction of the Arrowhead system on January 4, 2010. We exclude the last week of December and the first week of January. As of January 4, 2010, the TSE revised the tick size table, so our sample stocks must remain within the same price range listed below during the entire sample period. We exclude stocks that traded for fewer than five days in any month and below ¥100.

Price range	Number of stocks	old tick	new tick
Below 2000	1232	¥1	same
2000～3000	46	¥5	¥1
3000～5000	35	¥10	¥5
5,000～30,000	53	¥10	same
30,000～50,000	10	¥50	same
50,000～300,000	61	¥100	same
300,000～500,000	12	¥1,000	¥500
500,000～1,000,000	8	¥1,000	same
Total	1457		

Table 2. Trading measures on December 2009 and January 2010.

This table examines the number of trades, their size, cumulative volume, number of quote revisions, and number of observations. All measures are averaged over five-minute intervals each day, over the month, and then over the stocks. Stocks are categorized into two groups, one with no changes in tick size and the other with changes in tick size. Within each group, stocks are sorted by market cap to form quintiles. Test statistics are computed as $t = \frac{\bar{x}_j - \bar{x}_d}{\sqrt{\frac{s_j^2}{n_j} + \frac{s_d^2}{n_d}}}$, where the means of each measure for December and January are $\bar{x}_d$ and $\bar{x}_j$, respectively; the standard deviations are s_d and s_j, respectively; and the numbers of observations are n_d and n_j, respectively.

Tick size	Large	2	Mid	4	small	all	Large	2	Mid	4	small	all	Large	2	Mid	4	small	all
			Dec-09						Jan-10						test stats			
									Number of Trades									
no change	15.0	7.2	4.0	2.3	1.4	5.7	23.9	9.0	4.5	2.6	1.9	7.9	8.6	3.5	2.8	2.0	2.6	9.4
changed	12.1	4.9	2.1	1.9	2.3	7.7	28.9	7.2	2.6	2.0	4.7	16.6	5.5	3.4	2.2	0.6	-	5.3
all	14.6	6.9	4.0	2.3	1.4	5.8	24.6	8.8	4.4	2.6	1.9	8.5	10.1	4.0	2.9	2.0	2.6	10.6
									Size of Trade									
no change	22.8	4.6	3.0	2.6	3.5	6.9	16.4	4.0	3.1	2.5	3.8	5.7	-2.0	-2.7	0.2	-1.2	0.8	-2.1
changed	15.4	3.1	1.7	2.8	9.5	8.8	11.5	2.2	1.5	2.6	9.4	6.6	-7.0	-3.2	-1.5	-1.4	-	-6.7
all	21.7	4.5	3.0	2.6	3.6	7.1	15.6	3.9	3.0	2.5	3.8	5.8	-2.2	-3.2	0.2	-1.3	0.8	-2.3
									Cumulative Volume in five minute									
no change	444.5	63.4	21.3	14.3	10.1	102.3	452.7	72.8	26.5	15.8	14.7	107.9	0.3	1.1	1.2	0.7	1.7	1.0
changed	187.2	23.6	5.4	10.7	30.0	98.2	237.4	21.6	5.4	9.2	48.9	121.3	1.7	-1.2	0.1	-0.9	-	1.6
all	405.6	59.1	20.8	14.2	10.2	102.0	420.1	67.4	25.7	15.7	14.8	108.7	0.6	1.1	1.2	0.7	1.7	1.2
									Quote Revisons									
no change	45.5	23.5	13.6	7.9	5.0	18.2	110.8	42.6	21.2	12.5	8.7	37.1	14.1	10.3	9.3	6.4	7.1	16.7
changed	40.1	15.8	7.1	6.4	6.0	25.6	125.1	35.0	14.1	11.7	15.3	73.4	7.5	4.9	3.5	2.2	-	7.2
all	44.7	22.7	13.4	7.9	5.0	18.7	113.0	41.7	20.9	12.5	8.7	39.4	15.9	11.2	9.6	6.6	7.2	18.0
									Number of observations									
none	247	260	281	284	290	1,362	247	260	281	284	290	1,362	-	-	-	-	-	-
changes	44	31	10	7	1	93	44	31	10	7	1	93	-	-	-	-	-	-
all	291	291	291	291	291	1,455	291	291	291	291	291	1,455	-	-	-	-	-	-

Table 3. MT model estimation.

Using daily data for December 2009, we estimate the regression model for MT:

$$MT_t = a + b\#ofTrade_{t-1} + cDepth_{t-1} + dTick\_spread_{t-1} + e\log(CapSize_0) + f_t$$

The explanatory variables are *number of trades, depth, tick_spread,* and *log_marketcap*. The dependent variable is the frequency of quote revisions (MT). To avoid the problem of endogeneity, we use the lagged values of the first three explanatory variables and set *log_marketcap* as of the end of November.

Variables	Coefficient	Standard Error	t-value
Intercept	-38.208	0.669	-57.12
Depth(-1)	-6.773×10^{-7}	1.889×10^{-7}	-3.59
#Trade(-1)	2.115	0.008	265.73
Tspread(-1)	0.013	0.014	0.91
LogCap	2.522	0.034	63.91
Adj.R-sqr	0.881		
observations	23,470		

Table 4. Forecasting error of the Message Traffic (MT) model

Using the estimated parameters in Table 3, we compute the predicted MT for January 2010 and the difference between the predicted and the actual MT (i.e., the prediction error). We assume that the difference indicates the degree of change brought about by the HFT, which we call the "HFT effect".

				HFT effect			
		Light	2	Mid	4	Heavy	All
no tick change	Mean	-1.19	1.40	5.21	14.31	56.43	15.26
	St. Dev	1.31	0.67	1.68	4.43	38.03	27.32
	Obs.	272	272	272	273	273	1,362
	t-value	-15.0	34.7	51.0	53.4	24.5	20.6
tick change	Mean	-1.37	6.47	17.67	38.13	83.56	30.66
	St. Dev	2.16	3.78	3.98	8.80	39.56	36.86
	Obs.	18	18	18	18	21	93
	t-value	-2.7	7.3	18.8	18.4	9.7	8.0

Table 5. Spread measures.

The effective spread is the cost of immediate execution paid to the market by liquidity demanders We decompose effective spreads into a realized spread component and an adverse selection or price impact component, See equation (3) in the text.

Panel A: Stocks not affected by tick size change

	HFT Effect	Average	Difference	St.Dev	Sample	t-value
EffectiveSpread	Light	0.267	-0.031	0.129	272	-3.9
	2	0.257	-0.039	0.151	272	-4.3
	3	0.204	-0.018	0.072	272	-4.2
	4	0.140	-0.006	0.050	273	-2.1
	Heavy	0.099	-0.006	0.016	273	-6.1
Realized Spread	Light	0.079	0.017	0.144	272	2.0
	2	0.054	0.015	0.143	272	1.7
	3	0.032	0.010	0.087	272	1.8
	4	0.035	-0.001	0.080	273	-0.2
	Heavy	0.031	-0.014	0.023	273	-10.4
Adverse Selection	Light	0.187	-0.048	0.111	272	-7.1
	2	0.203	-0.054	0.141	272	-6.3
	3	0.172	-0.028	0.088	272	-5.2
	4	0.105	-0.005	0.073	273	-1.2
	Heavy	0.068	0.008	0.020	273	7.0

Note: Difference=Lj-Ld

Panel B: Stocks affected by tick size change

	HFT Effect	Average	Difference	St.Dev	Sample	t-value
EffectiveSpread	Light	0.181	-0.052	0.091	18	-2.4
	2	0.091	-0.057	0.023	18	-10.7
	3	0.080	-0.055	0.016	18	-14.6
	4	0.066	-0.062	0.011	18	-23.6
	Heavy	0.045	-0.072	0.010	21	-31.3
Realized Spread	Light	0.036	-0.001	0.098	18	-0.1
	2	0.007	-0.031	0.016	18	-8.0
	3	0.003	-0.033	0.021	18	-6.7
	4	0.007	-0.045	0.037	18	-5.2
	Heavy	0.013	-0.067	0.016	21	-19.2
Adverse Selection	Light	0.146	-0.051	0.060	18	-3.6
	2	0.083	-0.026	0.032	18	-3.5
	3	0.077	-0.022	0.026	18	-3.7
	4	0.059	-0.017	0.030	18	-2.4
	Heavy	0.033	-0.005	0.011	21	-2.1

Table 6. Determinants of spread change.

The following regression equation is estimated.

$$\Delta L_i = \alpha + \beta_1 HFT_i + \beta_2 \frac{YenVol_{i,Jan}}{YenVol_{i,Dec}} + \beta_3 \frac{\#Trade_{i,Jan}}{\#Trade_{i,Dec}} + \beta_4 \frac{TradeSize_{i,Jan}}{TradeSize_{i,Dec}} + \gamma \Delta X_j + \varepsilon_i ,$$

where ⊿Li is $\Delta ESPRD_i = ESPRD_{i,Jan} - ESPRD_{i,Dec}$, the difference in the effective spread between December 2009 and January 2010; ⊿*RSPRD*i (realized spread) and ⊿*MI*i (market impact) are similarly defined; *HFT*i is a prediction error of the equation in Table 3; $\frac{YenVol_{i,Jan}}{YenVol_{i,Dec}}$ is the ratio of the yen volume on January 2010 to that on December 2009; similarly, $\frac{\#Trade_{i,Jan}}{\#Trade_{i,Dec}}$ is the ratio of the numbers of trades; $\frac{\#TradeSize_{i,Jan}}{\#TradeSIze_{i,Dec}}$ is the ratio of trade sizes, and the Xi are stock-level control variables, including ⊿ *tickspread*, the difference in tick spread, and ⊿*tickspread* x *tick size change dummy,* the difference in tick spread for stocks affected by tick size change, and zero otherwise.

	⊿*ESPRD*		⊿*RSPRD*		⊿*MI*	
Variable	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
ArrowheadEffect/100	0.0125	1.82	-0.0407	-3.98	0.0532	5.49
⊿*Vol*	0.0054	2.42	-0.0027	-0.81	0.0081	2.58
⊿*TradeSize*	-0.0272	-2.86	0.0157	1.11	-0.0429	-3.21
⊿*NumberofTrade*	-0.0157	-3.96	-0.0038	-0.65	-0.0119	-2.13
⊿*TickSpread*	0.0535	41.33	0.0316	16.39	0.0220	12.04
TicChangeDummyX⊿*TickSpread*	-0.0318	-8.94	-0.0165	-3.12	-0.0153	-3.05
⊿*Depth*	0.0010	0.55	0.0029	1.08	-0.0019	-0.76
Intercept	0.0228	2.53	0.0046	0.35	0.0182	1.43
Adjusted R-squared	0.561		0.173		0.129	
Observation	1,455		1,455		1,455	

Note: *t*-statistics are White heteroskedasticity-consistent standard errors & covariance.

Table 7 Liquidity change for extended period

A summary of four liquidity measures, effective spread, realized spread, adverse selection cost and average depth for months of December 2009, January , October, November and December 2010. Stocks subject to tick size change on January 2010 are excluded.

	Effective Spread				
	Dec 2009	Jan 2010	Oct 2010	Nov 2010	Dec 2010
Mean	0.2043	0.1908	0.1911	0.1841	0.1627
Median	0.1710	0.1597	0.1564	0.1474	0.1303
Std. Dev.	0.1386	0.1233	0.1355	0.1295	0.1228
Observations	1324	1324	1324	1324	1324
	Realised Spread				
	Dec 2009	Jan 2010	Oct 2010	Nov 2010	Dec 2010
Mean	0.0517	0.0524	0.0479	0.0532	0.0598
Median	0.0312	0.0314	0.0254	0.0303	0.0337
Std. Dev.	0.1051	0.0945	0.0938	0.0884	0.1150
Observations	1322	1322	1322	1322	1322
	Adverse Selection Cost				
	Dec 2009	Jan 2010	Oct 2010	Nov 2010	Dec 2010
Mean	0.1564	0.1393	0.1433	0.1309	0.1035
Median	0.1207	0.1098	0.1171	0.1017	0.0848
Std. Dev.	0.1379	0.1216	0.1050	0.1032	0.0773
Observations	1322	1322	1322	1322	1322
	Depth				
	Dec 2009	Jan 2010	Oct 2010	Nov 2010	Dec 2010
Mean	51,386	55,262	76,264	82,368	99,235
Median	4,314	4,610	4,899	4,979	5,585
Std. Dev.	417,561	421,573	840,432	967,914	1,230,798
Observations	1324	1324	1324	1324	1324

Table 8 Determinants of spread measures

The basic form of regression equations are as follow:

$$L_{i,t} = \alpha + \beta_1 \frac{QuoteFreq_{i,t}}{TradeFreq_{i,t}} + \beta_2 TradeSize_{i,t} + \beta_3 Share\,\mathrm{Im}b_{i,t} + \beta_4 RunPersistency_{i,t} + \gamma \Delta X_j + \varepsilon_i$$

where Li is four types of liquidity measures such as *ESPRD*i is the effective spread, *RSPRD*i is the realized spread, *MI*i the adverse selection cost and *Dpth*i for average depth at the best ask and bid book; our market-making proxy is $\frac{QuoteFreq_{i,t}}{TradeFreq_{i,t}}$, normalized quote update frequency. We have three order flow intensity proxies such as *TradeSize*i, *ShareImb*i, *RunPersistency*i. And the *X*i are stock-level control variables, including logarithmic market capitalization of stock, tick size change dummy which equals one for stocks subject to tick size change and zero for other stocks, and time of day dummies (30-minute interval). The time dummy of 10:00AM is not included in the regression.

	Effective Spread		Realized Spread		Adverse Selection		Depth	
Variable	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
Intercept								
C	0.2404	264.1	0.0389	21.8	0.1900	109.3	-267.652	-18.6
DMY09D	0.0622	46.7	0.0132	5.2	0.0466	18.5	69.618	4.6
DMY10OND	-0.0187	-21.3	-0.0138	-7.7	-0.0031	-1.8	-261.039	-10.8
Market-making factor								
Quote update	-0.0010	-17.9	-0.0004	-4.3	-0.0005	-4.8	15.132	16.7
dummy for Dec 2009	-0.0043	-46.7	-0.0015	-7.8	-0.0026	-13.8	3.911	3.6
dummy for Oct-Dec 2010	0.0001	2.6	-0.0001	-0.5	0.0001	1.2	9.287	7.0
Trade intensity								
Trade size	0.0019	159.8	0.0011	50.8	0.0007	34.9	7.145	38.4
dummy for Dec 2009	0.0001	8.9	0.0002	8.5	-0.0001	-3.6	2.455	8.2
dummy for Oct-Dec 2010	-0.0004	-21.9	-0.0002	-5.6	-0.0002	-9.1	-0.702	-2.8
Imbalance								
Order imbalance	0.0399	30.9	-0.0064	-2.3	0.0471	16.8	162.098	14.4
dummy for Dec 2009	0.0012	0.6	-0.0022	-0.6	0.0036	0.9	-89.776	-6.8
dummy for Oct-Dec 2010	0.0095	6.5	0.0186	6.0	-0.0093	-3.0	210.452	10.6
Runs Persistency								
Runs Persistency	-0.0014	-7.2	-0.0064	-14.1	0.0050	11.1	-13.094	-5.1
dummy for Dec 2009	-0.0008	-2.7	-0.0024	-4.2	0.0020	3.5	-45.344	-10.6
dummy for Oct-Dec 2010	0.0016	7.6	0.0007	1.4	0.0011	2.3	-14.473	-3.3
TMF1	0.0357	70.1	-0.0138	-14.8	0.0495	52.5	-86.667	-18.9
TMF2	0.0073	17.2	-0.0042	-4.8	0.0110	12.7	-18.699	-4.1
TMF4	0.0017	3.7	0.0073	7.5	-0.0080	-8.3	23.265	4.4
TMF5	-0.0038	-9.2	-0.0085	-10.2	0.0052	6.2	-23.690	-5.2
TMF6	-0.0105	-24.9	0.0080	8.6	-0.0177	-19.2	22.798	4.4
TMF7	-0.0099	-22.2	0.0117	12.6	-0.0212	-23.1	20.620	3.9
TMF8	-0.0096	-23.7	0.0151	18.4	-0.0245	-30.5	14.424	2.8
TMF9	-0.0030	-6.9	0.0245	27.0	-0.0294	-33.3	-8.814	-1.8
TICF	0.0190	61.0	0.0078	14.0	0.0101	17.9	8.030	2.5
LOG of Cap on Nov 2009	-0.0379	-282.4	-0.0043	-16.7	-0.0313	-122.4	-24.325	-9.6
Observation	774,556		728,699		728,699		774,567	
Adjusted R-squared	0.3594		0.0320		0.0740		0.0792	

Note: *t*-statistics are White heteroskedasticity-consistent standard errors & covariance.

Figure 1. Effective spread (daily, tick range).

Daily movement of effective spread is computed as an average of effective spread for stocks belong to each price range defined in Table 1. Stocks moves in and out of the price ranges are excluded. The title of the chart indicates size of tick (before and after the Arrowhead).

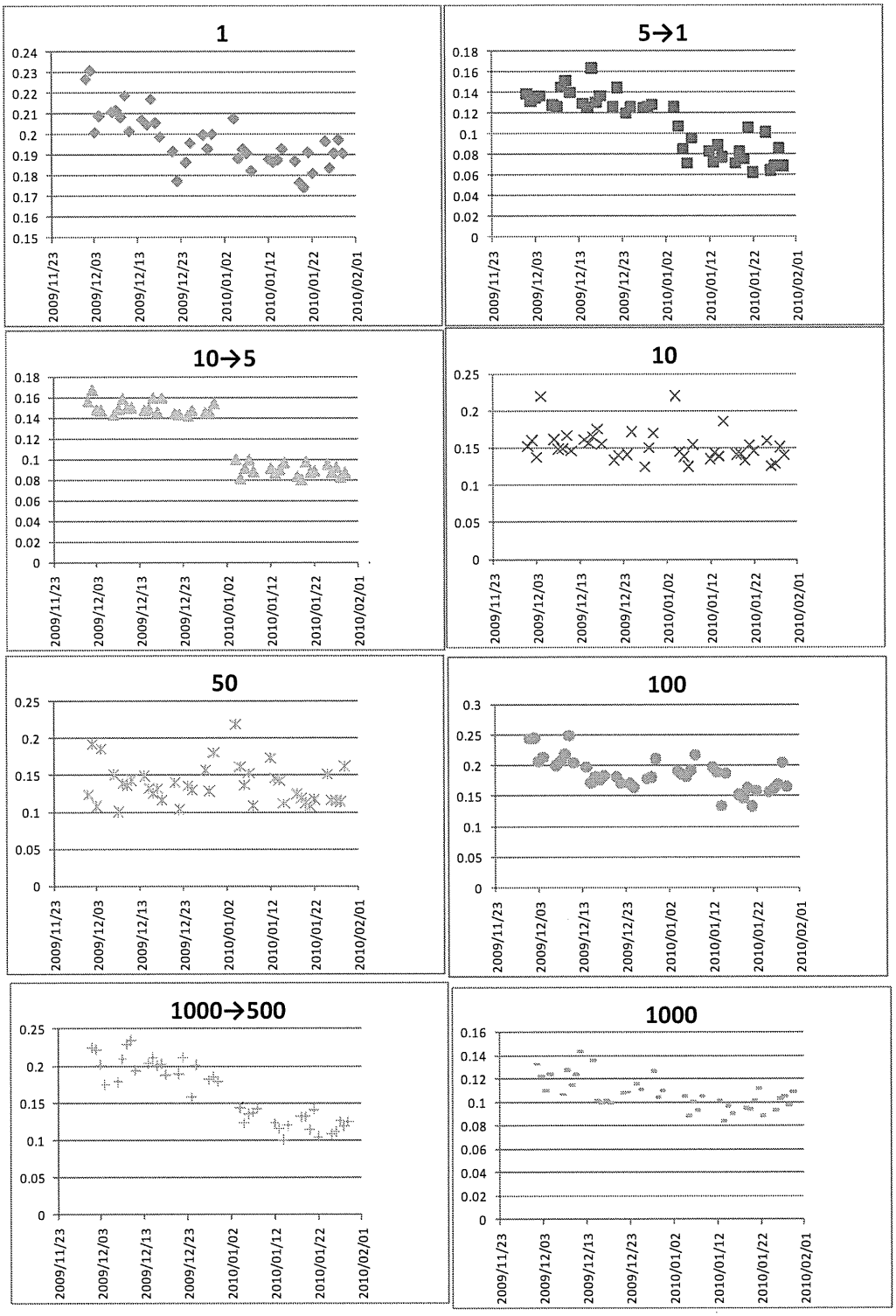


Figure 2. Percentage changes in depth

Depth is computed as an average of best ask-book and bid-book for individual stocks. Then we compare them between December 2009 and January 2010.

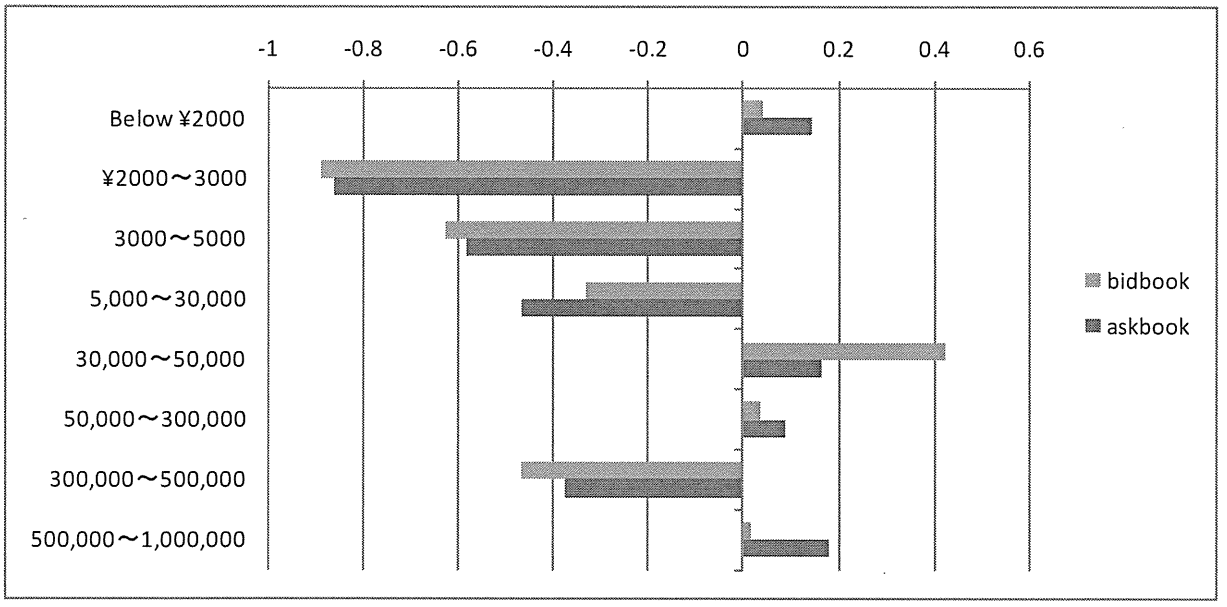
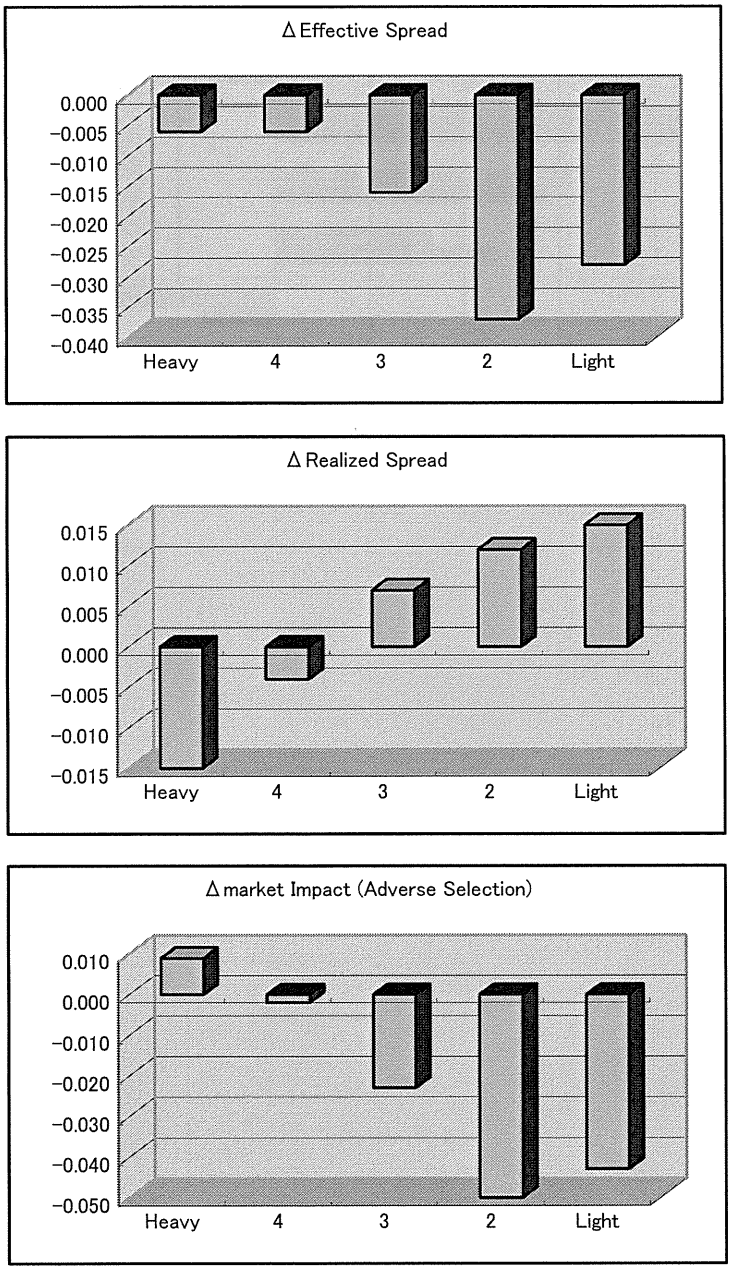
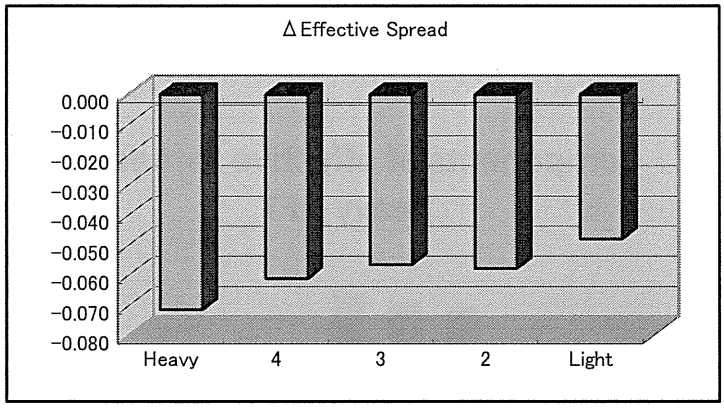


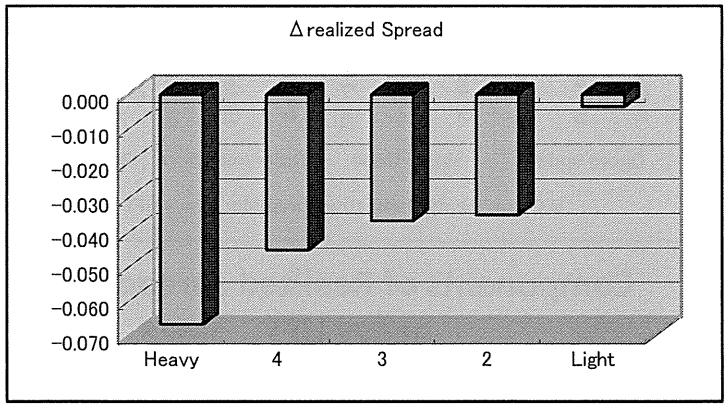
Figure 3. Spread changes by HFT effect quintiles.

Panel A: Stocks not affected by tick size change
Bar charts indicate difference in effective spread, realized spread and market impact in the Panel A of Table 5.



Panel B: Stocks affected by tick size change
Bar charts indicate difference in effective spread, realized spread and market impact in the Panel B of Table 5.





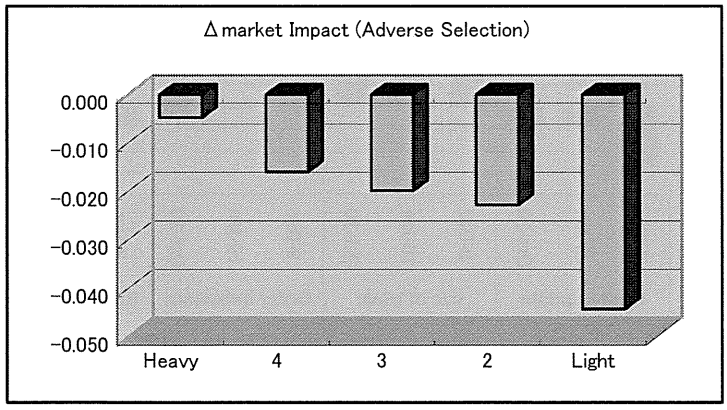
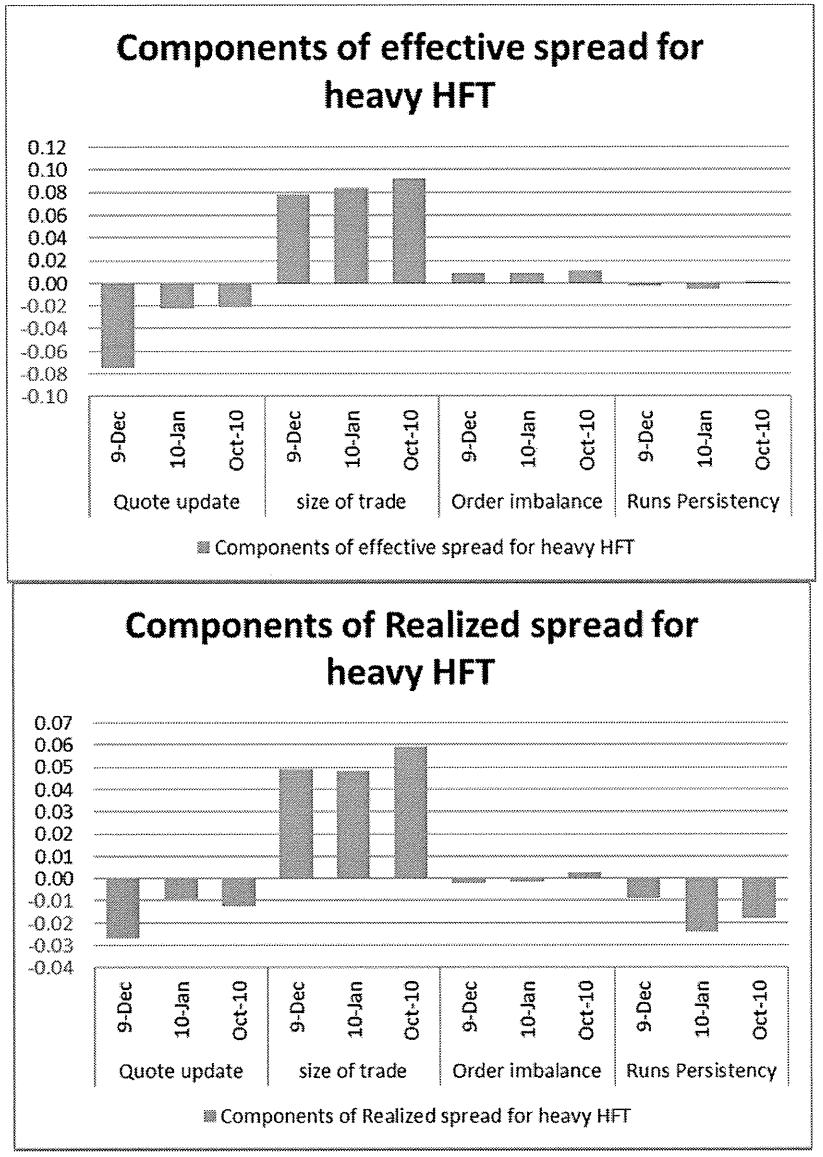
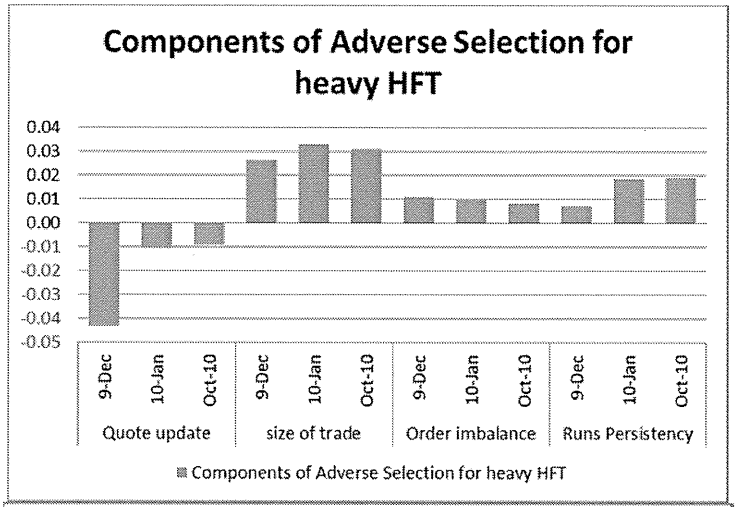
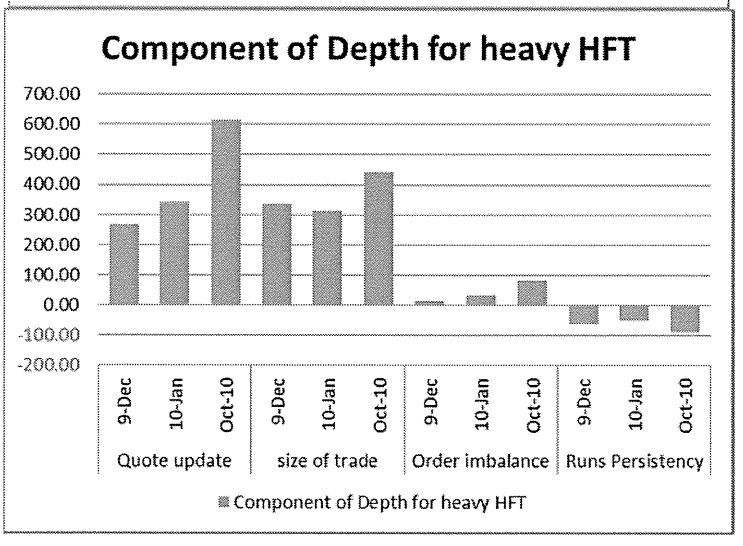


Figure 4 Decomposed effects from four proxies of market-making vs. order flow factors

The changes brought about by the new trading system are decomposed into four components such as market-making (quote update) and order flow intensity (size of trade, order imbalance, persistency of runs). Each amount is computed by multiplying estimated coefficients of the variables and mean values of explanatory variables for each period.




Components of Adverse Selection for heavy HFT
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
9-Dec
10-Jan
Oct-10
Quote update
size of trade
Order imbalance
Runs Persistency
Components of Adverse Selection for heavy HFT


Component of Depth for heavy HFT
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
-100.00
-200.00
9-Dec
10-Jan
Oct-10
Quote update
size of trade
Order imbalance
Runs Persistency
Component of Depth for heavy HFT

Stock Ownership Structure and Corporate Social Performance: Evidence from Japan

Megumi Suto
Hitoshi Takehara

Abstract

Stakeholder relationship of Japanese firms has changed significantly in globalization of stock ownership structure in the 2000s. This study investigates influences of different investor groups on corporate social performance in the late 2000s, focusing on the role of foreign investors in comparison with domestic corporate investors or relationship investors. We identify attributes of CSR in Toyo Keizai CSR database, and construct normalized CSP composite index and five dimensional indices by principal component analysis. By cross-sectional regressions of ownership structure on CSP indices after controlling firm's characteristics, we find out that increase in foreign shareholdings is positively associated with high CSP indices while increase in domestic corporate investors shows rather negative associations, though both of them show strong preferences to large-scale and matured firms. We have similar result from industry-wise analysis. The empirical results imply foreign investors, who are concerned with social aspects of activities of investees in a global viewpoint, might have played a key role as CSR driver and have influenced stakeholder management of Japanese firms. This is the first work to investigate the influence of different types of investors on corporate social performance in Japan.