Empirical Analysis of Transaction Costs in the Japanese Stock Market*

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* The information and views in this paper are those of the authors and do not reflect the opinions of Nomura Asset Management Co., Ltd.

Contents

Abstract

Over recent years, it is said that the trading environment in stock markets has undergone significant changes against the backdrop of institutional reforms and technological advances, further decreasing transaction costs. The limitations of transaction data, however, have placed restrictions on empirical studies of the transaction costs of institutional investors in the Japanese market. In this paper, actual transaction data of institutional investors from more than ten years are used to analyze the recent steady declines in transaction costs and the key factors that determine transaction costs.

1. Introduction

Recent advances in information and communications technology have dramatically changed the market trading environment. In particular, algorithmic trading and alternative trading venues have evolved significantly as a means to reduce the transaction costs of institutional investors (Sugihara 2010).

At the same time, from an institutional perspective, the Japanese stock market has witnessed a number of turning points that have lowered transaction costs. The first was the reduction of brokerage commissions due to their deregulation in 1999. According to a survey, brokerage commissions decreased by approximately 20% as a result of deregulation.[Note1]

The second turning point was legal system reform since 2000, a leading example of which is the reform of the stock split system, as well as quotation changes in recent years. These reforms are considered to have stimulated trading activities, decreased spread, and contributed to increasing liquidity (Kohsaka 2014).

The third turning point was the growth of electronic trading with the introduction of the Arrowhead trading platform (January 2010) by the Tokyo Stock Exchange (TSE), along with the

[Note 1] First Brokerage Commission Survey (Japan Securities Dealers Association, 2000).

development of more sophisticated trading methods. These comprehensive changes in the trading environment are thought to have shifted investors towards trading smaller amounts and at higher frequencies and affected transaction costs (Uno and Shibata 2012, Arai 2012).

As regards studies on transaction costs, because of rapid acceleration of transaction and expansion of alternative trading venues, studies have been pursued on transaction costs and strategies in the U.S. and European markets that take into account electronic transactions and large-amount trading. (Note2) Studies on transaction costs can be classified broadly into two approaches. The first approach directly uses market data. For example, it uses quantitative methods to analyze market data measurements, including bid-ask spread, depth, and market liquidity indicators, as well as price fluctuations (Ohta et al. 2011). As this approach does not include information on the orders themselves, the discussion is limited to transaction costs of individual executions.

The second approach directly uses the transaction data of investors. In this case, extensive relevant data (e.g., commission, order placement method, and trading volume) associated with transaction can be utilized, allowing analyses from a variety of angles. However, as transaction data are not easily accessible, empirical studies of this kind are extremely limited. (Note3)

In this paper, the second approach is adopted to carry out empirical analyses of how much the transaction costs of institutional investors have been, and how this level has changed in the Japanese stock market. By using more than ten years of actual transaction data and shedding light on the changes in transaction costs and structural factors, this study is expected to offer valuable actual examples for Japanese market participants.

2. Research Design

(1) Data source

The transaction data used in this paper are based on actual transaction of the company we belong to. In order to assess the transaction costs of standard trading methods which institutional investors adopt, the transactions studied in this paper are limited to agency trading involving the payment of commissions and exclude basket trading often used in passive and other investments. This study covers the period between January 2003 and July 2014. From the transactions that meet all of the requirements in (1) to (3) below, 100,000 transactions were randomly selected for analysis:

(Note 2) Sugihara (2012), etc. provide a detailed overview.

(Note 3) Examples of empirical studies of the transaction costs of institutional investors include Keim (1999), Keim and Madhavan (1997), Engle et al. (2012), and Borkovec and Heidle (2010). All of the studies, however, have limited data samples. Examples of long-term data analysis include Frazzini et al. (2012). There are no similar empirical studies of the Japanese market to the extent of our knowledge. In Tanaka (2001), the market impact is estimated by artificially recreating sales and purchase data of trading entities indirectly from market data.

(1) Trades related to publicly offered investment trusts;

(2) Trades of stocks listed on the TSE first section in TOPIX 500 and Nikkei 225;

(3) Trades with 30% or less participation rate.

Here, participation rate is defined as the number of executed stocks divided by the trading volume on trading day (each main exchange).(Note4) (2) is set for analyzing stocks with relative high liquidity. Requirement (3) was set for studying standard trading methods. (3) is deemed appropriate as participation rate rarely exceeds 30% in normal trading. Institutional investors account for 70 to 80% of the trading volume in the Japanese stock market. In light of this, the above data are thought to provide an appropriate sample for understanding transaction costs in the Japanese market.

The trades examined in this study are not limited to trades on TSE and include trades executed on multiple exchanges (including dark pool and the Proprietary Trading System [PTS]). In addition, "trading volume" and "closing price" in this paper refer to the data from the main exchange of the stocks.

Analysis based on an implementation shortfall (IS) approach is used for the transaction costs assessed in this paper. The IS approach classifies all transaction costs into timing cost, market impact, commission, and opportunity cost. However, as analyzing the transaction costs of portfolio managers is not the main purpose of this paper and its purpose is to focus on transaction costs in the market, transaction costs are defined as the sum of timing cost, market impact, and commission. Regarding timing cost, the point at which a portfolio manager places an order with a trader is the measurement starting point.(Note5) Accordingly, for the *k*th order on transaction day *d*, if the stock price at the measurement starting point (if it is before market opening, the closing price of the previous day) is $P_{0,d,k}$ and average price (after taking commission into consideration) is $P_{T,d,k}$,(Note6) then the absolute value of transaction cost is defined as $|P_{T,d,k}-P_{0,d,k}|/P_{0,d,k}$. However, irrespective of whether it is a sell or buy order, any transaction cost that is disadvantageous (extra cost is incurred) to the portfolio manager is defined as being positive (+),otherwise negative (-).

This paper assumes that for each transaction the period between the start of execution and the end of it concludes within one day (from market opening to market closing). Transaction costs are

(Note 4) In this paper, "main exchange" is defined as the exchange with the largest trading volume. However, if there is another exchange which has a larger trading volume than the main exchange for seven consecutive days, then this exchange is redefined as the main exchange.

(Note 5) If a narrow definition of transaction cost is adopted, it is possible to analyze only the market impact in the IS approach. In this paper, the definition of transaction cost explained in the main text is adopted in order to ascertain the transaction cost actually incurred by institutional investors. At the same time, this paper assumes a transaction process in which a portfolio manager first places a transaction order with a trader, and the trader appropriately executes this transaction.

(Note 6) Average price (or average price of executions) is defined as the execution price of a series of transactions weighted by the number of the respective executed stocks (weighted average of the number of traded stocks). A single average price is calculated for a single parent order.

assessed based on this assumption. For example, if an portfolio manager trades stock A over a period of five days, in this analysis this trade is treated as five individual trades conducted on different transaction dates. Meanwhile, actual orders of individual transactions include cases in which transaction orders (parent orders) of individual stocks placed by portfolio managers are split into child orders, and the trades are executed separately. As this paper adopts an analysis method based on the IS approach, transaction costs are estimated vis-a-vis parent orders.

(2) Measuring transaction costs

As various factors affect transaction costs, a model needs to be developed in order to estimate the average transaction cost. A factor that affects transaction costs is participation rate. Liquidity of individual stocks is also considered to have direct implications on transaction costs. Taking these aspects into consideration, the following regression model is introduced below.(Note7)

$$C_{it}=\alpha+\sum_{k}\beta_k g_{itk}+\varepsilon_{it} \qquad (1)$$

Here, C_{it} is the transaction cost of transaction i on transaction date t. g_{itk} is the explanatory variable of the kth order that characterizes each transaction. As one of the explanatory variables, the following are used..

$$\begin{aligned} x_{it}&=\mathrm{Vola}_{it}\, z_{it}^{\,p} \\ z_{it}&=\text{約定株数}_{it} ／ \text{出来高}_{it} \end{aligned} \qquad (2)$$

数式内：「約定株数」の英訳＝Number of executed stocks

数式内：「出来高」の英訳＝Trading volume

Here, z_{it} is a variable that takes participation rate into consideration. x_{it} has z_{it} as an input variable. Volatility ($Vola_{it}$) and p are parameters. p is the parameter for the increasing rate of transactions costs which rise with increases in the number of executed stocks. Intercept α refers to the average transaction cost when the characteristics are adjusted.

(3) Characteristics of transaction data

Factors that affect transaction costs are: long-term properties of individual stocks; short-term market factors; and institutional elements. Indicators of long-term properties are beta, value, and momentum exposure, while indicators of short-term elements include short-term momentum, relative momentum, and relative turnover. At the time of transactions, traders and portfolio managers consider these sets of indicators as additional reference indicators of liquidity and

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(Note 7) For examples of market impact models, see for example Almgren and Chriss (2000), Almgren et al. (2005), Watanabe (2003), and Rashkovich and Verma (2012). There are various discussions on impact model estimates (Sugihara 2012). The power exponent has been estimated at around 0.1-1.0.

volatility.(Note8)

At the same time, indicators of the situation on trading day, such as intraday return and overnight return (ONR), are also concerned with short-term elements. The former represents the strength of the stock price on trading day. The latter is an indicator used for seeing the direction from the close of trading day to the opening of the next trading day. Institutional elements include differences in spread costs. These constitute the main variables utilized in the analyses below.(Note9) The definitions of the main variables are listed in **Figure 1**.

Figure 2 shows the measurement of each indicator for all transactions which are analyzed. For example, for all periods, the median of participation rate is 0.6%, and the participation rate of the top 90% is 6.7% (Panel A). In Panel B, in view of the relationship with market conditions, Periods I to IV are established to correspond roughly with bull and bear markets, and statistical values are indicated for each period. Although most indicators show no noticeable changes, fluctuations in the momentum exposure and short-term momentum (60 days) as well as decline in spread cost in recent years can be observed.

At the bottom of Panels A and B, the percentage of the transactions analyzed included in each indicator is also shown. 57% of all samples are Nikkei 225 stocks, while 56% are trades on TOPIX 400.

(Note 8) In general, it is regarded that stocks with a high β also have high volatility and high transaction costs. In addition, some have reported that market impact tends to be larger for value stocks than growth stocks (Watanabe 2003). Because momentum-related indicators tend to become market follower-type purchases, it is thought that transaction costs tend to become higher in these cases.

(Note 9) The TSE criteria were adopted for the tick size. TSE has modified the tick size in July 2000, July 2008, January 2010, and January and July 2014. The spread cost in this paper is tailored to the so-called tick spread and takes into consideration all previous quotation changes made by TSE

Figure 1

Variable	Definition
Participation rate [%]	No. of executed stocks / Trading volume on trading day (main exchange)
z (*s* months)	No. of executed stocks / Trading volume on following day (average of past *s* months)
x (*t* months, *s* months, *p*)	Volatility (measurement of past *t* months) [%, annualized rate] × $z(s)^{p}$
⊿β (60 months)	(Historical beta measured monthly over past 60 months) – 1
Size exposure	Total market price (logarithm) of stocks, normalized over TSE first section
Value exposure	Value (book-value price ratio) of stocks, normalized over TSE first section
Momentum (12 months) exposure	Stock price momentum of past 12 months, normalized over TSE first section
Relative volatility vs TOPIX (3 months)	Volatility (3 months) / TOPIX volatility (3 months) – 1
Short-term momentum (60 days) [%]	Cumulative return over past 60 days of stock *i* [%]
Relative momentum vs TOPIX (60 days) [%]	Cumulative return over past 60 days of stock *i* [%] – Cumulative return over past 60 days of TOPIX [%]
Spread cost [bps]	Tick size in TSE / Average price. For tick size, quotation in line with average price (stock price) is used.
ONR/volatility	Overnight return (ONR) / Volatility over past 3 months (day rate)
Intraday return [%]	Intraday return defined as that between opening price and closing price
Absolute value of daily price range spread [%]	Absolute value of daily price range / Closing price

Notes:
1. For all variables, measures are taken from trading day for each stock that is traded. For exposure, such as size, value, and momentum, values as of the end of the previous month are utilized.
2. Compiled by the authors. Hereinafter the same.

Figure 2

	Panel A (All periods)				Panel B			
	Median	MAD	Bottom 10%	Top 90%	I	II	III	IV
Transaction cost [bps]	16.9	75.1	-110.1	166.4	16.2	23.9	23.6	12.3
Participation rate [%]	0.6	0.8	0.0	6.7	1.1	0.4	0.5	0.3
x (1 month, 1 month, *p*=0.5)	2.2	2.3	0.4	8.8	2.5	2.8	2.1	1.6
x (1 month, 1 month, *p*=1)	0.2	0.2	0.0	2.2	0.2	0.2	0.2	0.1
⊿β (60 months)	0.02	0.47	-0.57	0.64	-0.03	0.05	0.07	0.03
Size exposure [σ]	1.56	0.92	0.53	2.74	1.37	1.61	1.60	1.71
Value exposure [σ]	-0.06	0.53	-0.71	0.79	-0.01	-0.09	-0.04	-0.12
Momentum (12 months) exposure [σ]	0.01	0.77	-0.96	1.05	-0.15	0.23	-0.05	0.10
Volatility (3 months) [%]	30.9	10.6	19.9	49.2	28.5	39.9	30.8	30.6
Relative volatility vs TOPIX (3 months)	0.67	0.5	0.1	1.4	0.83	0.61	0.65	0.52
Short-term momentum (60 days) [%]	3.01	14.1	-14.9	24.6	3.55	-5.73	0.62	8.35
Relative momentum vs TOPIX (60 days) [%]	-0.07	11.2	-14.4	16.0	-0.21	-0.21	0.09	0.11
Spread cost [bps]	14.1	9.4	5.5	28.7	17.0	17.1	13.4	11.1
Overnight return (ONR) [%]	0.07	1.1	-1.6	1.7	0.07	0.00	0.00	0.13
ONR/volatility	3.30	57.3	-77.4	83.7	3.94	0.00	0.00	6.70
Absolute value of daily price range spread [%]	0.12	0.15	0.01	0.65	0.10	0.15	0.17	0.12
	Ratio				Ratio	Ratio	Ratio	Ratio
Nikkei 225	57%				51%	61%	61%	59%
TOPIX 100	43%				38%	45%	44%	48%
TOPIX 400	56%				61%	54%	56%	52%

Note: Panel A shows the median value, the mean absolute deviation (MAD), and the top 90% and bottom 10% values for all periods. Panel B shows the median value in each period. Period I: April 2003–March 2007; Period II: April 2007–March 2009; Period III: April 2009–October 2012; and Period IV: November 2012–July 2014.

(1) Estimation of transaction costs

In this section, in order to estimate the average transaction cost of all transactions studied, a single regression analysis is conducted by setting the explanatory variable in formula (1) to x_{it}, z_{it} or volatility. Volatility (annualized rate) and trading volume (daily average) utilize values that were measured in the last one to three months of each trade or on trading day. In this study, parameter p was set at p = 0.5,1.

The estimate results are shown in **Figure 3**. The columns for variables 1 to 3 correspond to cases where volatility or z is utilized as an explanatory variable. Intercept α is approximately 15-23 bps. A comparison of the coefficients of determination shows that explanatory power is generally the same for volatility (one month) and z (one day). While it is not indicated in the figure, results similar to **Figure 3** are obtained in cases where the measurement period of volatility is modified or the measurement period of variable z is set to one or more months.

Models 1 to 6 correspond to cases where the explanatory variable is x_{it}. Intercept α is roughly 18-23 bps. The regression coefficient is around 0.7-3.5.[Note10] If the participation rate is negligibly small, additional cost due to x_{it} is also small (1 bps or less). In turn, intercept α provides a baseline for the average transaction cost. On the other hand, if the participation rate and volatility are high level, x_{it} may approximately equal 10. In such trades, it can be construed that additional cost of approximately 10-30 bps is incurred.

From models 1 to 6, it is observed that the explanatory power tends to be higher for p = 0.5 than p = 1. It means the transaction cost tends to diminish as the number of executed stocks increases (Almgren et al. 2005).

Whether or not additional cost is incurred due to differences in participation rate also depends on the attributes of the portfolio (e.g., investment amount, trading method). Accordingly, the discussion below assumes situations where participation rate is small, and the intercept α is deemed as "average transaction cost."

It is very difficult for a single indicator to explain individual transactions with diverse characteristics. As **Figure 3** shows, the coefficient of determination of each model ranges between 0.06% and 0.27%, and the explanatory power is extremely small. The primary structural factors that can explain transaction costs are discussed in more detail in the next and following sections.

[Note 10] The applicable transactions are divided into sell orders and buy orders, and a single regression analysis is conducted for the respective transactions. The analysis results are similar to the results for all transactions. No large discrepancies in transaction costs are found between sell orders and buy orders .

Figure 3

	VAR 1		VAR 2		VAR 3		Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value
Intercept α [bps]	15.1	***16.3***	21.4	***47.6***	22.9	***55.7***	18.4	***34.7***	21.4	***48.4***	19.3	***39.8***	23.2	***57.0***	19.1	***38.7***	23.1	***56.8***
Volatility (1 month) [%]	0.3	***10.5***																
z (1 day)			108.0	***11.4***														
z (1 month)					33.3	***8.5***												
x (1 month, 1 day, *p*=0.5)							1.5	***15.5***										
x (1 month, 1 day, *p*=1)									3.5	***12.8***								
x (1 month, 1 month, *p*=0.5)											1.2	***16.4***						
x (1 month, 1 month, *p*=1)													0.7	***7.9***				
x (3 months, 3 months, *p*=0.5)															1.2	***16.1***		
x (3 months, 3 months, *p*=1)																	0.7	***7.9***
Coefficient of determination R^2 [%]	0.11		0.13		0.07		0.24		0.16		0.27		0.06		0.26		0.06	

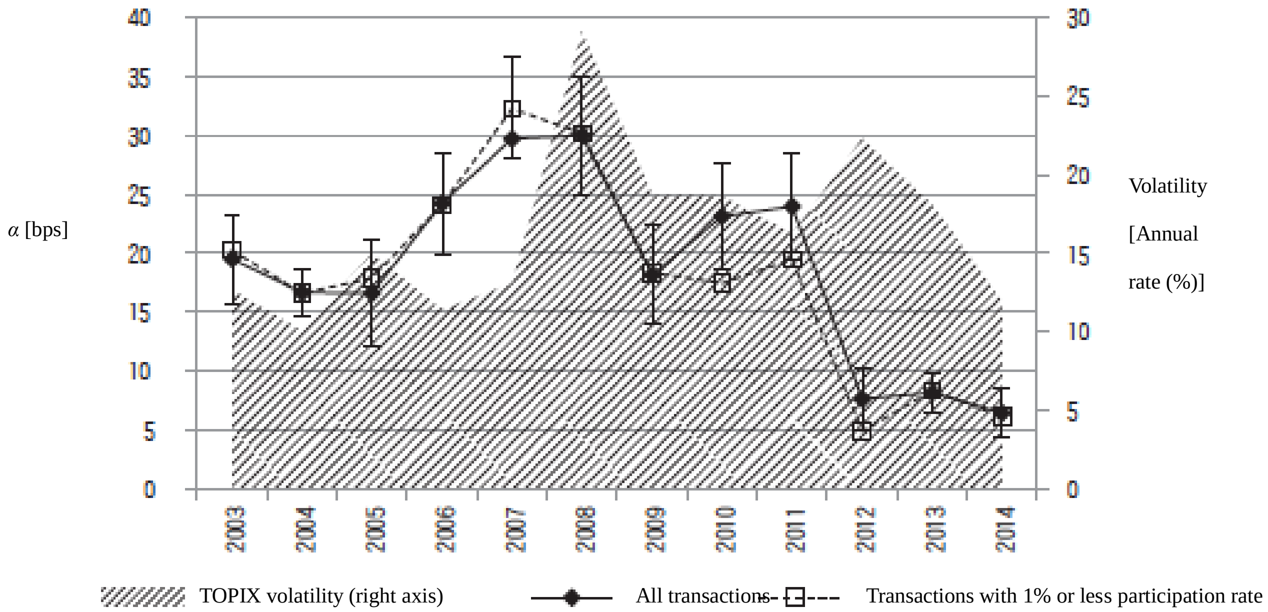
Note: The argument of the explanatory variable *x* (volatility *t*, trading volume *s*, *p*) represents the volatility measurement period *t* and the trading volume measurement period *s*. *t* values with a significance level of 10% or lower are shown in bold (hereinafter the same).

(2) Changes in transaction costs

The changes in transaction costs in the Japanese stock market can be observed by assessing transaction costs in a time series. In the discussion below, model 3 (**Figure 3**), which have the highest coefficient of determination, is adopted as the estimation model. We already know that other models also yield similar results.

Figure 4 shows the trends in intercept α when a regression analysis is conducted for transaction data from each fiscal year. The TOPIX volatility in each fiscal year is also indicated in the same figure. As this figure shows, although the average transaction cost generally had remained at the same level until FY2011 except FY2007-2008, the average transaction cost has fallen considerably in recent years (a decreasing trend in transaction cost is also observed in **Figure 2**, Panel B). A comparison of FY2003 and FY2013 shows the average transaction cost has fallen by approximately 11 bps, a statistically significant difference (*t* value = 5.2). **Figure 4** also illustrates the results if the analyzed trades are those that have a participation rate of 1% or lower. It shows that even when participation rate is low, there is no major change in the overall trend. In addition, similar results are found when other model parameters are modified. Therefore, the decline in transaction cost is considered a robust result not dependent on the other models.

Figure 4



Note: This figure shows the results of a regression analysis of a sample split by fiscal year. It represents the trends in the intercept α. The error range represents the 95% confidence interval (in the case of all transactions). Between January 2003 and July 2014.

The impacts of commission reduction could be regarded as one of the factors that are lowering the average transaction cost. However, the margin decline of the commission during the same period is around 3 bps in general. (Note11) Therefore, the reduction in commission in traditional method of transaction is relatively small. Several environmental factors are behind the decline in the average transaction cost, which are discussed in the final chapter.

The increase in the average transaction cost between FY2007 and FY2008 is an abnormality. The confusion in the financial market, exemplified by the global financial crisis, led to this increase. In fact, the rise is closely in line with the increase in volatility in TOPIX.

While the study has demonstrated the steady decline in the average transaction cost in the domestic market, is the decline in the average transaction cost a trend seen throughout the market? To examine this, the same study as above was conducted by focusing the universe to each index (Nikkei 225, TOPIX 100, and TOPIX Mid400). As shown in **Figure 5**, a long-term downward trend

(Note 11) According to the Japan Securities Dealers Association, the average commission of institutional investors is approximately 10 bps (if the execution price is 300 million yen, 2005 survey). According to a (Japanese market) survey of Greenwich Associates, the average commission as of 2004 was 14 bps but declined to 11.4 bps by 2014. On the other hand, in the same survey on electronic trading, the average commission decreased from 7.9 bps (2009) to 6.5 bps (2014). Goldstein et al. (2009) study commissions in the United States. Another study has demonstrated worldwide decreases in the commissions in some alternative trading venues (Borkovec and Heidle 2010).

in the average transaction cost can be observed in all universes. A similar trend is observed even when the index is TOPIX Core 30 or TOPIX Large 70. Based on the above, it can be said that changes in the trading environment of the Japanese stock market have clearly decreased transaction costs.

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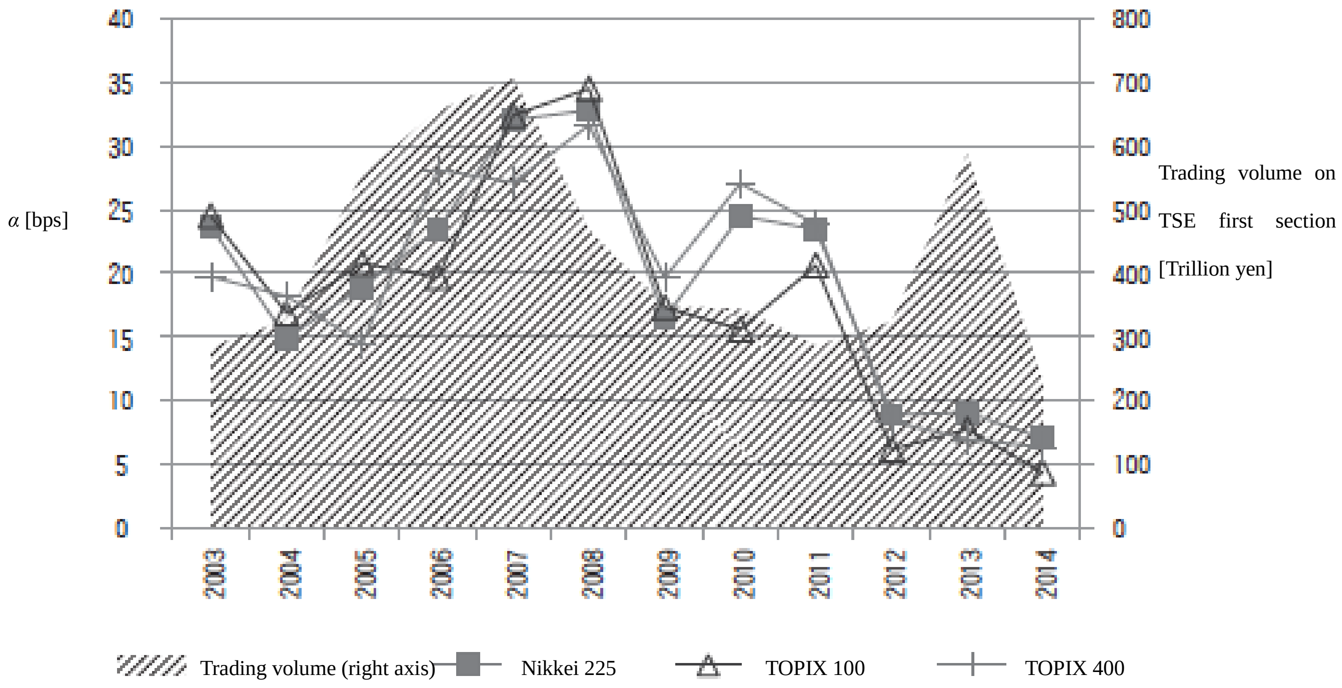
Figure 5


α [bps]
Trading volume on TSE first section [Trillion yen]
Trading volume (right axis)
Nikkei 225
TOPIX 100
TOPIX 400

4. Structural Factors of Transaction Costs

(1) Structural factors

Trade behavior is extremely diverse and is affected by a range of factors, including market environment, order timing, order method, and ask-bid spread. Here, structural factors that affect transaction costs in the Japanese market are examined.

In this section, the indicators shown in **Figure 1** are applied to formula (1), and structural factors are studied by performing a multiple regression analysis. **Figure 6** shows the results of a regression analysis performed for each trade classified into buy and sell transactions.[Note13] In performing the multiple regression analysis, the difference in average cost by fiscal year was taken into consideration (**Figure 4**), and analysis was conducted by introducing fiscal year flag in place of the single intercept α. In the figure, the average value of the coefficient (and t value) for each fiscal year flag is shown as an intercept. The significance of the standard error for each variable was studied by adopting clustered and robust standard errors (Petersen 2009, Ota 2013). For variables other than x and ⊿β, multiple regressions were performed using normalized variables.

In model A, variables such as ⊿β, size, value, and momentum exposure were adopted as explanatory variables. The results were generally similar for sell orders and buy orders, and no statistical significance was observed in many variables. For example, variables related to value and momentum exposure as well as momentum related variables had no statistical significance. Thus, such variables are unrelated to transaction costs. On the other hand, ⊿β showed a statistically significant positive coefficient in both sell and buy transactions. This illustrates that stocks with high beta incur additional cost on average.

The coefficient of determination in model A is 3.9-4.7% (sell, buy) and is a significant improvement compared to the results of the single regression. However, the introduction of fiscal year flag was the major reason behind the increase in the coefficient of determination, and the various indicators had limited impact on the improvement of the explanatory power.

Model B shows the results when short-term momentum, relative volatility, and spread cost are added as explanatory variables. No statistically significant results were obtained for short-term momentum and relative volatility vs TOPIX.

[Note 13] In addition to the variables listed in Figure 1, we also looked at what would happen if the measurement period of each variable was modified within a period of 5-60 days as well as variables not referred to in the main text (e.g., past relative momentum, past relative trading volume, and growth exposure). However, in both cases, the results were either similar to the results presented in the main text or no statistical significance was found.

On the other hand, statistically significant results were found for spread cost. The regression coefficient is positive, and additional cost in line with spread cost is quantitatively captured. **Figure 6** shows an analysis using normalized variables. If a multiple regression analysis is performed without normalization, the coefficient of the spread cost is approximately 0.2. Using this coefficient, additional cost stemming from spread cost can be estimated as follows.

Figure 6

	Buy-Transactions						Sell-Transactions					
	Model A		Model B		Model C		Model A		Model B		Model C	
	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value
Intercept [bps]	23.4	***11.0***	23.3	***11.0***	19.5	***13.4***	20.2	***12.2***	20.2	***12.1***	17.2	***17.9***
x (1 month, 1 month, *p*=0.5)	1.2	***2.3***	1.2	***2.3***	1.1	***3.4***	0.9	***1.9***	0.9	***1.9***	0.9	***2.9***
⊿β (60 months)	3.8	***2.5***	2.8	1.5	3.0	***1.8***	4.2	***2.4***	2.7	1.2	1.2	0.5
Size exposure	-0.4	-0.3	-0.2	-0.2	-0.4	-0.4	-0.6	-0.8	-0.5	-0.7	-1.6	***-2.6***
Value exposure	1.5	1.5	1.5	1.6	0.3	0.5	-0.5	-0.6	-0.3	-0.3	-0.3	-0.4
Momentum (12 months) exposure	1.1	0.8					-1.3	-1.2				
Relative volatility vs TOPIX (3 months)			0.5	0.3	1.1	0.7			1.0	1.0	1.1	1.3
Short-term momentum (60 days)			-1.6	-1.1	-1.0	-0.8			0.4	0.4	0.0	0.0
Relative momentum vs TOPIX (60 days)	-0.4	-0.4					-0.5	-0.5				
Spread cost			2.2	***2.8***	1.4	1.5			1.6	***1.8***	1.7	***1.8***
ONR/volatility					35.1	***4.2***					-35.4	***-4.0***
Intraday return					51.8	***24.3***					-50.5	***-22.1***
Absolute value of daily price range spread					0.3	0.2					-0.5	-0.4
R^2 (Adjusted for degrees of freedom) [%]	4.7		4.7		27.2		3.9		3.9		26.2	

Note: Multiple regressions were performed for variables other than *x* and ⊿β using normalized variables. Clustered and robust standard errors were used for the significance test.

The average spread cost in TSE until 2008 is approximately 20 bps. However, if the above coefficient is taken into consideration, the average additional cost at the time is approximately 4 bps (= 0.2 × 20). Meanwhile, the average spread cost in TSE has declined to approximately 10 bps in 2010. Moreover, since 2014, the average spread cost of TOPIX100 stocks has decreased to a few basis points. With this, it is considered that additional cost stemming from spread cost has decreased to below 1 bps.[Note14]

Model C adds the following new explanatory variables to Model B: ONR/volatility; intraday return; and absolute value of daily price range spread. These are information on trading day and information that cannot be known in advance of the time of execution and/or the placement of order. For example, in the case of orders placed before market opening, the ONR is determined after the placement of order, and therefore, ONR/volatility is a variable that is determined after the transaction.

In **Figure 6**, for buy transactions, the regression coefficients for ONR/volatility and intraday return are positive, and additional cost is incurred when the values of both indicators are large. In other words, they are quantitative measurement results of additional cost in situations where stock prices are increasing. For sell transactions, the regression coefficients are negative contrary to purchase transactions, and the results are reasonable from the perspective of additional cost.

By adding ex-post information, the coefficient of determination in model C increased to approximately 26-27% and had high explanatory power. While not shown in the figure, intraday return and ONR/volatility have roughly the same level of contribution to the coefficient of determination.

(2) Comparison of structural factors by period

We examine in time series how the structural factors of transaction costs have evolved. Here, Periods I to IV are set to correspond roughly with bull and bear markets (same as **Figure 2**). **Figure 7** di[1]splays the estimated results for these periods using model C in the previous section.

[Note 14] Uno and Shibata (2012) provide a detailed overview of the multifaceted impacts of quotation changes and market transaction speed.

Figure 7

	Buy-Transactions								Sell-Transactions							
	I Apr. 2003–Mar. 2007		II Apr. 2007–Mar. 2009		III Apr. 2009–Oct. 2012		IV Nov. 2012–Jul. 2014		I Apr. 2003–Mar. 2007		II Apr. 2007–Mar. 2009		III Apr. 2009–Oct. 2012		IV Nov. 2012–Jul. 2014	
	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value	COEFF	*t* value
Intercept [bps]	21.3	***15.4***	20.6	***6.7***	21.8	***12.3***	4.9	***6.0***	14.3	***27.9***	27.9	***10.2***	17.1	***17.6***	9.4	***15.5***
x (1 month, 1 month, *p*=0.5)	0.7	***1.8***	0.7	1.4	1.8	***3.8***	3.3	***11.5***	0.2	0.7	1.1	***2.3***	1.7	***7.4***	2.7	***13.5***
⊿β (60 months)	7.8	***3.0***	-2.2	-0.7	-1.1	-0.2	-0.1	-0.2	2.7	0.7	-6.5	***-1.7***	-2.1	-0.6	2.7	***1.8***
Size exposure	-0.1	-0.1	-2.0	-0.5	-1.3	-0.7	2.8	***13.5***	-2.3	***-2.6***	-2.6	***-1.7***	-1.2	-1.1	0.4	0.5
Value exposure	1.6	1.4	0.2	0.3	1.9	1.4	-0.7	-0.7	-1.3	-0.8	-1.6	-1.5	0.6	0.3	0.6	1.2
Relative volatility vs TOPIX (3 months)	0.9	0.3	0.5	0.1	2.7	1.0	-0.9	***-4.5***	1.9	***1.7***	3.6	1.1	0.9	***2.9***	-0.9	-0.9
Short-term momentum (60 days)	1.7	0.8	-2.2	-0.8	-4.3	-1.5	-1.0	***-2.5***	-2.4	***-2.0***	1.2	0.8	1.8	1.1	-0.2	-0.4
Spread cost	1.3	0.9	2.1	1.3	-1.5	-0.7	-0.9	***-4.0***	1.7	***2.1***	4.1	1.6	-0.9	-0.4	-0.5	-0.4
ONR/volatility	59.3	***9.1***	45.3	***91.6***	33.7	***13.1***	-2.3	***-1.7***	-60.1	***-9.0***	-43.6	***-10.9***	-33.6	***-5.6***	1.9	***4.1***
Intraday return	53.9	***28.4***	59.3	***100.2***	48.4	***23.3***	47.2	***17.1***	-49.7	***-14.4***	-57.7	***-7.2***	-50.7	***-22.3***	-47.6	***-161.5***
Absolute value of daily price range spread	-4.8	***-2.5***	-1.7	-1.0	4.7	1.3	3.5	***4.4***	-1.9	***-2.2***	-4.1	-1.0	3.9	1.2	1.5	0.9
R^2 (Adjusted for degrees of freedom) [%]	36.6		21.9		27.1		41.3		36.7		22.5		23.1		41.3	

Note: Multiple regressions were performed for variables other than *x* and ⊿β using normalized variables. Clustered and robust standard errors were used for the significance test.

First, a comparison of the intercept in Periods I and IV shows the coefficient had a decreasing trend, and that it was approximately 5-9 bps in Period IV. Individual explanatory variables with statistical significance over many periods are limited to, for example, *x*, ONR/volatility, and intraday return. As for other variables, cases were observed in which significance disappeared or the plus or minus sign reversed depending on the period.

At the same time, in Period IV, the coefficient of determination reaches as high as 40%. The increase in the explanatory power due to intraday return caused the rise in the coefficient of determination.

Compared to other periods, there were no large discrepancies in the contribution of variables, such as daily trading and ONR/volatility, to the coefficient of determination. In Period IV, trading value is large (**Figure 5**), and market volatility is slightly high. Therefore, the impacts of individual stocks during normal trading hours tend to become particularly large, and this may have caused intraday return to factor more significantly into transaction cost.

As was noted above, comparing the structural factors by period reveals that the explanatory power of the model is increasing in the recent market environment. While it is difficult to predict intraday return and daily trading in advance, these indicators could probably be used as risk indicators of transactions.

5. Conclusion

Institutional investors have consistently had the following goals in common: minimize transaction costs as much as possible and improve performance of portfolio. Especially in the case of active management, transaction costs are directly linked to the strategy and its performance of portfolio, and relate to the size of the managed assets. Therefore, transaction costs always constitute an important theme (Kuroki 2001, Chen et al. 2004).

In this paper, the transaction costs of institutional investors are studied on the basis of empirical data. The study found that the average transaction cost has decreased to approximately 7 bps in recent years (**Figure 4**). How does this level compare with transaction costs in the United States? An empirical study conducted by a U.S. asset management company reported that transaction cost was around 6 to 7 bps (2010-2011) (Frazzini et al. 2012).[Note15] By comparing the Japanese transaction cost with the U.S. case, it can be said that the two countries have the same level of transaction costs. In particular, results reveal that there have been further reductions in transaction costs since 2012. Three factors are considered to be behind the reductions.

The first is changes in the execution benchmark of market participants (Nomura Research Institute 2014). While VWAP (volume weighted average price) has traditionally been used as a benchmark in the Japanese market, recent years have seen a gradual increase in the number of institutional investors adopting the IS approach, which is becoming the mainstream method in the United States and Europe. This has given incentives to shorten the period between decision-making and trade completion, leading to a declining trend in the transaction costs based on the IS approach adopted in this paper.

The second factor is the increasing use of electronic trading. In recent years, electronic trading offered by brokers and vendors (e.g., algorithmic trading and DMA trading) has developed rapidly, and its use by trade participants has expanded every year. This resulted in a growing share of orders placed through electronic trading with low commissions, and could have led to the overall decreases in transaction costs.

The third factor is the spread of alternative trading venues, the leading examples of which are PTS and dark pool (Sugihara 2010). Taking as an example PTS, which has relatively high transparency, while the PTS share of the trading value was around 5% until approximately 2011, the share has gradually increased since then. In particular, the deregulation of PTS (exemption of the TOB 5% standard) that went into effect in October 2012 triggered the proactive use of PTS by asset management companies. In particular, deregulation enabled smart order routing of dark pools that had already been utilized actively by asset management companies. This is seen to have had a large impact on the transaction cost reductions.

[Note 15] Another report is Borkovec and Heidle (2010), which analyzes U.S. trading data from the first quarter of 2008 via Investment Technology Group, Inc. It reports that transaction cost was approximately 45 bps (highly fluid stocks; a weighted average amount that includes commission, spread, impact, and timing cost).

The advantages of using PTS include the following: (1) PTS adopts smaller quotations than TSE, and therefore, spread cost can be decreased; and (2) PTS as an alternative trading venue expands trading opportunities. Accordingly, the expanded use of PTS by asset management companies is thought to have contributed to lowering transaction costs.

These factors were underpinned by rapid advances in the systems of brokers and asset management companies in response to the implementation of Arrowhead, introduced by TSE. While a study of these factors' impacts on transaction costs is beyond the scope of the study of this paper, it will be an interesting research topic for the future. Other interesting themes for empirical research of transaction costs include the differences between the market average transaction cost estimated utilizing liquidity indicators and transaction costs utilizing execution data, differences in transaction costs depending on asset management styles, and the relationship between transaction method (e.g., order split, DMA, and algorithmic trading) and cost.

As seen above, there remain many issues concerning transaction costs that need to be studied. Nevertheless, the empirical results in this paper are still considered significant with respect to shedding light on the situation of transaction costs in the Japanese stock market. We hope that more empirical studies will be conducted on transaction costs in Japan, and that they lead to further market transparency improvements and transaction cost reductions.

〔**References**〕

Almgren, R. and N. Chriss [2000] "Optimal Execution of Portfolio Transactions," *Journal of Risk*, 3(2), p. 5.

Almgren, R., C. Thum, E. Hauptmann, and H. Li [2005] "Direct Estimation of Equity Market Impact," preprint.

Arai, R. [2012] "Changes in Stock Market Liquidity and Transaction Costs Due to Introduction of Arrowhead: An Analysis from the Perspective of Institutional Investors," *Securities Analysts Journal*, September. (In Japanese)

Borkovec, M. and H.G. Heidle [2010] "Building and Evaluating a Transaction Cost Model: A Primer," *The Journal of Trading*, 5(2), p. 57.

Chen, J., H. Hong, M. Huang, and J. D. Kubik, [2004] "Does Fund Size Erode Mutual Fund Performance? The Role of Liquidity and Organization," *The American Economic Review*, 94(4), p. 1276.

Engle, R., R. Ferstenberg, and J. Russell [2012] "Measuring and Modeling Execution Cost and Risk," *The Journal of Portfolio Management*, Vol. 38, No.2, p. 1.

Frazzini, A., R. Israel, and T.J. Moskowitz [2012] "Trading Costs of Asset Pricing Anomalies," Chicago Booth Paper, No.14-05.

Goldstein, M.A., P. Irvine, E. Kandel, and Z. Wiener, [2009] "Brokerage Commissions and Institutional Trading Patterns," *The Review of Financial Studies*, 22(12), p. 5175.

Keim, D.B. [1999] "An Analysis of Mutual Fund Design: The Case of Investing in Small-Cap Stocks," *The Journal of Financial Economics*, vol. 51, p. 173.

Keim, D.B., Madhavan, A. [1997] "Execution Costs and Investment Style: An Interexchange

Analysis of Institutional Equity Trades," *Journal of Financial Economics*, vol. 46, p. 265.
Kohsaka, Y. [2014] "Stock Split and Market Liquidity: Effects on Trade Activities, Spread, and Shareholder Composition," Waseda Working Paper, WIF-14-002. (In Japanese)
Kuroki, F. [2001] "Size of Active Management and α," *Securities Analysts Journal*, November. (In Japanese)
Nomura Research Institute, Ltd. [2014] "Asset Management Companies' Evaluation of Brokers," *Iakyara*, Vol. 192, Special Edition, April.
Ohta, W., H. Takehara, and J. Uno [2011] *Stock Market Liquidity and Investor Behavior: Market Microstructure Theory and Demonstration*, Chuokeizai-Sha. (In Japanese)
Ota, K. [2013] "Use of Cluster-Robust Method in Panel Data Analysis," *Securities Analysts Journal*, November. (In Japanese)
Petersen, M.A. [2009] "Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches," *Review of Financial Studies*, vol. 22, p. 435.
Rashkovich, V. and A. Verma [2012] "Trade Cost: Handicapping on PAR," *The Journal of Trading*, Vol. 7, No. 4, p. 47.
Sugihara, Y. [2010] "Activities of Market Participants Related to Reducing Transaction Costs: Use of Algorithmic Trading and Alternative Trading Venues," Institute for Monetary and Economic Studies, Bank of Japan, Discussion Paper Series, 2010-J-26. (In Japanese)
--- [2012] "Progress of Studies on Execution Strategy and Transaction Costs," *Kin'yu Kenkyu*, Vol. 31, No. 1. (In Japanese)
Tanaka, T. [2001] "Empirical Study of Market Impact: Measurement of Narrowly Defined Market Impact through Reconfiguration of Entity-Level Data," Nippon Finance Association 9th Annual Meeting Proceedings. (In Japanese)
Uno, J. and K. Omura [1998] "(First) Empirical Analysis by Market Microstructure," *Securities Analysts Journal*, September. (In Japanese)
Uno, J. and M. Shibata [2012] "Impact on Trade Acceleration and Liquidity: Case of TSE Arrowhead," *Gendai Finance*, No. 31, p. 87. (In Japanese)
Watanabe, K. [2003] "Analysis of Optimal Split Execution of Japanese Stocks and Application to Transaction Cost Assessment," 2002 Study on Portfolio Management, Research Institute for Policies on Pension & Aging. (In Japanese)

Rashkovich, V. and A. Verma [2012] "Trade Cost: Handicapping on PAR," *The Journal of Trading*, Vol. 7, No. 4, p. 47.

Sugihara, Y. [2010] "Activities of Market Participants Related to Reducing Transaction Costs: Use of Algorithmic Trading and Alternative Trading Venues," Institute for Monetary and Economic Studies, Bank of Japan, Discussion Paper Series, 2010-J-26. (In Japanese)

--- [2012] "Progress of Studies on Execution Strategy and Transaction Costs," *Kin'yu Kenkyu*, Vol. 31, No. 1. (In Japanese)

Tanaka, T. [2001] "Empirical Study of Market Impact: Measurement of Narrowly Defined Market Impact through Reconfiguration of Entity-Level Data," Nippon Finance Association 9th Annual Meeting Proceedings. (In Japanese)

Uno, J. and K. Omura [1998] "(First) Empirical Analysis by Market Microstructure," *Securities Analysts Journal*, September. (In Japanese)

Uno, J. and M. Shibata [2012] "Impact on Trade Acceleration and Liquidity: Case of TSE Arrowhead," *Gendai Finance*, No. 31, p. 87. (In Japanese)

Watanabe, K. [2003] "Analysis of Optimal Split Execution of Japanese Stocks and Application to Transaction Cost Assessment," 2002 Study on Portfolio Management, Research Institute for Policies on Pension & Aging. (In Japanese)