



JAPAN EXCHANGE GROUP

JPX WORKING PAPER

Analysis of Detail Breakdown Trading Data
(Margin Transactions and Short Selling)

Shumpei SAKURAI

Daiki UEHARA

Go HOSAKA

January 28, 2021

Vol. 35

This material was compiled based on the results of research and studies by directors, officers, and/or external researchers of Japan Exchange Group, Inc., its subsidiaries, and affiliates (hereafter collectively the “JPX group”) with the intention of seeking comments from a wide range of persons from academia, research institutions, and market users. The content and opinions in this material are the authors’ own and do not constitute the official view of the JPX group or any organization to which the authors belong.

Analysis of Detail Breakdown Trading Data, (Margin Transactions and Short Selling)¹

Shumpei SAKURAI, Daiki UEHARA, Go HOSAKA²

January 28, 2021

Abstract

This paper uses Detail Breakdown Trading Data to describe the characteristics of this breakdown data and the systems that are premised on its use. Using a Proof of Concept questionnaire and the analysis performed in this paper, we found that such data can be used not only for investment purposes but also by securities firms in their credit and other risk management and stock lending activities.

Our analysis found that for the First Section of the Tokyo Stock Exchange (TSE) and real estate investment trusts (REITs), the share of short sales is approximately 30%, while it is less than 20% for other markets. We also found that the share of margin purchase transactions is lower for the TSE's First Section and REITs than it is for other markets, while the share of margin sales transactions is higher. Furthermore, when we estimated end-of-week outstanding margin transactions using this breakdown data, we found that we were able to estimate outstanding margin purchase transactions with a relatively high degree of accuracy, whereas the breakdown data were not sufficient to enable us to estimate outstanding margin sales transactions.

¹The content of this article is the property of the individual authors. This article does not represent the official views of any company that participated in this research project or organization to which the authors belong.

² Information Services Department, Tokyo Stock Exchange, ,Inc.

Introduction

As more types of data have become available and analytical technologies have advanced in recent years, there has been an increase in demand for new data services to facilitate new investment opportunities and business start-ups, make business operations more efficient, and lower costs.

In light of these demands, Tokyo Stock Exchange, Inc. (hereinafter, TSE) is aiming to externally distribute its proprietary data for use by outside parties as a new data service. As part of this initiative, it has implemented a Proof of Concept program on in-house data for margin transactions and short selling and, recognizing that the data could be externally useful, started to offer this data to outside parties in April 2020 as Detail Breakdown Trading Data.

This paper uses Detail Breakdown Trading Data to describe the characteristics of the breakdown data and the systems which are premised on its use. Additionally, we perform an analysis using Detail Breakdown Trading Data, building a model that analyzes the characteristics of trading trends in the TSE market and estimates end-of-week outstanding margin transactions. Detail Breakdown Trading Data are data that were previously not disclosed to the public. To the authors' knowledge, in Japan there have been no previous analyses investigating the market's structure using such data, thus this is the first attempt.

We are sincerely grateful for all the opinions and advice that we have received from numerous people, particularly the institutional investors, financial institutions, data vendors, and others who took part in the Proof of Concept program during the implementation of this project.

1. Proof of Concept

1.1 Proof of Concept program for utilizing securities data

Due to the diversification of data and the advancement of analytical technology in recent years, there has been an increase in new data and services (hereinafter referred to as “content”) with the potential to contribute to the development of the securities market. Thus, in April 2019, the TSE launched a Proof of Concept (PoC) program to verify the possibilities of using such new content, as well as any technical issues that may arise.¹

¹“Launch of a Proof of Concept Program for Utilizing Securities Data” (Apr. 23, 2019)
<https://www.jpx.co.jp/english/corporate/news/news-releases/0060/20190423-01.html>

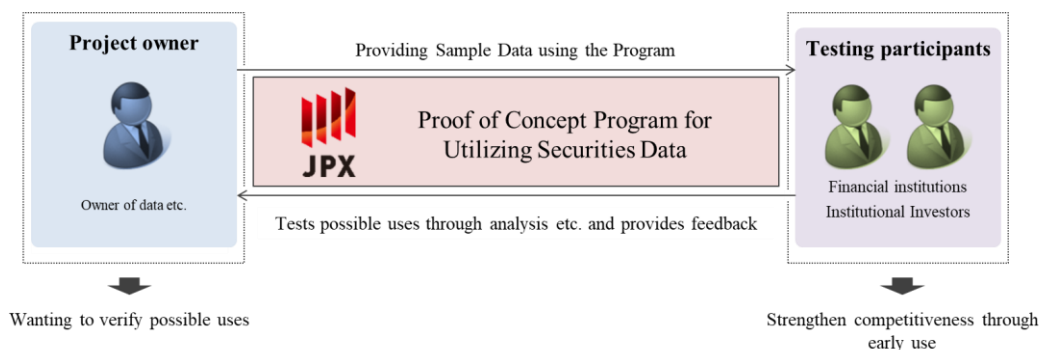


Figure 1 Proof of Concept (PoC) program for utilization of securities data

Participants in the PoC program constituted project owners (providers of new content) and PoC test participants (such as financial institutions and investors). In the project, project owners from both the Japan Exchange Group and from companies outside the Japan Exchange Group were allowed to participate. Samples of content owned and developed in-house were provided to PoC test participants, and the extensive feedback obtained from the participants on whether new content is useful to stakeholders in the securities markets made it possible to improve this content. The PoC test participants could test the possible in-house uses and effectiveness of new content.

Through these initiatives, the TSE aims to not only resolve technical issues related to new content but also contribute to the creation of new investment opportunities and businesses, the efficiency of business operations, and cost reductions.

1.2 PoC testing on margin transactions and short-selling data

Using the framework of the PoC program for utilization of securities data, from October 2019 through March 2020, the TSE implemented the following limited public PoC test on margin transaction and short-selling data, for which the TSE was the project owner.³

³“Tokyo Stock Exchange Starts Proof of Concept Testing for Margin Transaction and Short Selling Data” (Oct. 24, 2019)

<https://www.jpx.co.jp/english/corporate/news/news-releases/0060/20191024-01.html>

Total daily trading volume and value by issue using flag data at the time of the order

- For the trading volume and value of buys and sells, the total amount of new margin transactions, settled margin transactions, and other
- For the trading volume and value of sells, the total of short sales (with or without price restrictions) and actual sales

For the PoC test, the TSE provided daily data from 2014 through 2018 as the sample for the aforementioned PoC data and investigated the potential for externally using this data while receiving feedback from PoC test participants.

1.3 Description of PoC test participants

PoC test participants comprised 38 institutional investors, financial instruments business operators, and data vendors. Most of the financial instruments business operators and data vendors were domestic, while most of the institutional investors were from overseas. Among the PoC test participants, approximately one-third were Japanese corporations, while the rest were overseas corporations.

1.4 Feedback from PoC test participants

1.4.1 Data analysis findings

In investigating and analyzing how the PoC test participants would use this test data at their companies, most said that they would be able to verify the data's usefulness (its potential for being useful in their company's business).

Simultaneously, some responded that they could not find any use for this data in their analysis. Specific reasons given were that they could not fully understand the differences in the data and that the data provided during the PoC test were insufficient to make a determination on usefulness.

1.4.2 Data usage applications

The institutional investors responded that they would use the data in making investment decisions (they would use the data as inputs in their proprietary models in order to predict future supply and demand for shares).

The financial instrument business operators responded that they would use the data in credit management and other risk management areas and in their stock lending areas. In researching the use of AI by asset management companies in the West, Mikami (2020) states that the use of AI in securities lending is becoming more common, and this is making supply and demand forecasts for such asset classes as equities and bonds and the setting of lending rates more efficient and faster, thus strengthening the

stock lending business. These responses tended to address utilization in the respondents' respective fields, and we expect that using the Detail Breakdown Trading Data will speed up and increase the efficiency of the securities lending business.

The data vendors responded that they would use the data to strengthen their data offerings to their customers.

Table 1 Results of feedback on data usage applications

Usage application	Number of respondents (multiple responses possible, n = 27)
Use in investment decisions	13 companies
Use in lending business	7 companies
Use in risk management	7 companies
Other	7 companies

1.4.3 Other feedback

The PoC test provided data on trading volumes (number of shares), but some said that if the same was done using data on trading amounts (values), they would be interested in getting it.

There was also the view that it would be good if the data were furnished in a format that makes it easy to analyze (fix headings and incorrect flags).

Besides these, the TSE also received a lot of feedback and advice on the format of the data, the frequency of its delivery, how to distribute it, etc.

2. The Detail Breakdown Trading Data Service

2.1 Overview of the Detail Breakdown Trading Data Service

Incorporating the feedback from PoC test participants, the TSE launched its Detail Breakdown Trading Data Service in April 2020. During the PoC testing, the data being provided had been called margin transaction and short-selling data, but because information on trades that are not margin transactions or short sales (such as purchases and sales of physical securities) is also included, for the sake of accuracy, the TSE changed the name to Detail Breakdown Trading Data when it actually launched the service.

Below, the key points of the Detail Breakdown Trading Data Service are summarized from the authors' viewpoint. For further details, please refer to the Service Guide, Data

Specifications, and Terms and Conditions, which can be found on the TSE website.³

2.2 The internal use service and the external distribution service

The Detail Breakdown Trading Data Service consists of the internal use service, in which investors and others can obtain data directly from the TSE and use it in their in-house operations, and the external distribution service, in which data vendors and securities companies redistribute the data to their customers.

The internal use service is targeted mainly at quant investors, such that the most historical data are distributed. The external distribution service is targeted mainly at individual investors and others, such that the data are sent in a format that is aggregated to certain extent that makes it is easy to use (it is assumed that the data are read by humans).

Table 2 Data distribution for the internal use and external distribution service

	Internal use service	External distribution service
Data items (headings)	20 columns	16 columns
Historical data	From Jan. 2010	From Apr. 2015

2.3 Means of distribution

The TSE distributes the Detailed Breakdown Trading Data through the Tokyo Market Information service, which is an FTP file distribution system. Both the internal use service and the external distribution service send out daily trading data at 18:00 on the same day.

2.4 Term of user agreement

User agreements for both the internal use service and the external distribution service are for a period of one year. These are so-called subscription contracts, and the subscriber has access to both historical data and updated daily data.

2.5 Use fees

For the internal use service, use fees are charged to data users. The charges differ depending on whether the service is used by a single business entity or shared by

³Detail Breakdown Trading Data Service

<https://www.jpx.co.jp/english/markets/paid-info-equities/reference/07.html>

multiple business entities.

For the external distribution service, use fees are charged to the business operator (data vendor or securities firm) that distributes the data to the data users (such as investors). The charges differ depending on whether the data are sent as a corporate-oriented service or as a service geared to individual investors. The use fees are low when the data are distributed as part of a service for individual investors such that individual investors are able to access the data.

3. Programs related to the Detail Breakdown Trading Data programs

3.1 Margin transactions

3.1.1 Definition of a margin transaction

A margin transaction is defined as sale and purchase or other transactions of Securities performed by a Financial Services Provider by granting credit to a customer.⁴

3.1.2 Characteristics of margin transactions

When entering into a new margin transaction, the investor must send a security (margin) deposit to the securities firm. The initial margin deposit must be at least 30% of the transaction value (or 300,000 yen if the 30% of the transaction value is less than 300,000 yen), thus margin transactions enable investors to leverage their margin deposits (their own funds) by approximately threefold. Further, a margin transaction sale is a type of short sale; hence, it can be used as a hedge against a price decline.

3.1.3 Standardized margin transactions and negotiable margin transactions

There are two types of margin transactions, standardized and negotiable margin transactions. For standardized margin transactions, the applicable issues and settlement periods are determined by the TSE, while for negotiable margin transactions, the transaction terms are decided by the securities firms and the investors. Securities firms use negotiable margin transactions to provide services based on various transaction terms. For example, open-ended margin transactions, which have no set settlement period, are a service provided through negotiable margin transactions. Customers entering into margin transactions have to choose whether to use a standardized or a negotiable margin transaction, and this cannot be changed later on.

⁴ Cabinet Office Ordinance on Transactions prescribed in Article 161-2 of the Financial Instruments and Exchange Act and Security Deposits for Said Transactions, Article 1

The Detail Breakdown Trading Data include data on margin transactions (data on the volume of margin transactions), and here the TSE uses the term margin transaction to include total standardized and negotiable margin transactions.

3.1.4 Margin transaction flags

As a rule, margin transactions are closed by making reverse trades. When customers close margin transactions, they need to make it clear to the securities firm that the transaction is a closing margin transaction. When sending a margin transaction order to the TSE, the securities firm must indicate whether it is a new or closing transaction by adding a margin transaction flag (indicating whether it is a new or closing transaction).

The breakdown data include data on new and closing margin transactions, and this data is compiled from the margin transaction flag data submitted with the orders.

3.1.5 Main users of margin transactions

Margin transactions, where investors borrow funds or shares from securities firms in accordance with set terms, have become very popular among individual investors. According to TSE trading statistics by type of investor, 60% of individual investors' trading value is for margin transactions. Simultaneously, the ratio for securities firms' proprietary books is less than 10%. Furthermore, Ohyama and Tsuda (2020) indicate that most margin transactions are performed by individual investors, and almost none are done by high-frequency traders (HFTs).

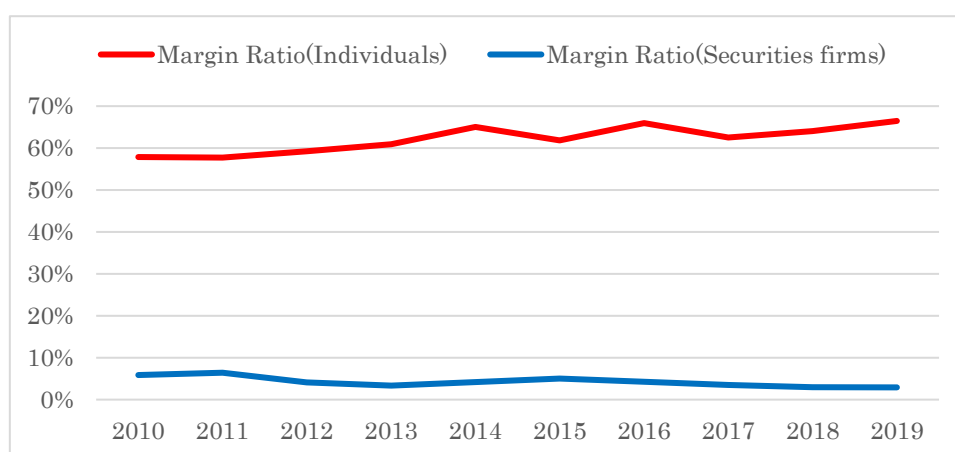


Figure 2 Share of margin transactions by individual investors and securities firms (proprietary trades) (based on transaction value)

Source: TSE statistics on margin transactions by type of investor

3.1.6 Loans for margin transactions

Securities firms need to be ready to lend funds or shares to margin transaction customers. Given that the securities firms will own the shares that were bought or the funds that were sold to their customers to put up as collateral for margin transactions, if there are both margin buy and sell transactions in the same number of shares of the same stock, the securities firm will be able to procure the necessary shares or funds using this collateral. If that is insufficient, the securities firm will lend funds or shares from its own book, and if that is still insufficient, it will procure the funds from external sources. Here, in the case of standardized margin transactions, securities firms can procure funds and shares through loan transactions with the Japan Securities Finance Co., Ltd. (JSF). In the case of negotiable margin transactions, they usually procure the funds or shares by means other than loans for margin transactions.

3.1.7 Standardized margin transaction issues and loan margin transaction issues

In its regulations, the TSE has set forth criteria that designate standardized margin transaction issues (from the customer's standpoint, issues that can be bought via margin transactions), for which securities firms can procure funding through loans for margin transactions, and loan margin transaction issues (from the customer's standpoint, issues that can be both bought and sold via margin transactions), for which securities firms can procure funds or shares.

In the Detail Breakdown Trading Data, most issues that do not use margin transaction sales are standardized margin transactions. Further, the TSE carries a list of issues eligible for standardized margin transactions and loans for margin transactions on its website.⁵

3.1.8 Margin transaction rules

When margin transactions become prevalent that they affect the price of the stock, the TSE has rules that restrict the use of margin transactions by increasing the ratio of the security deposit that must be posted when entering into a new margin trade. The TSE has published its criteria for enforcing the rules,⁶ and the rules are enforced or lifted in accordance with the criteria.

⁵List of Standardized/Loan Margin Trading Issues

<https://www.jpx.co.jp/english/listing/others/margin/index.html>

⁶Guidelines Concerning Measures to Raise the Security Deposit Ratio

<https://www.jpx.co.jp/english/markets/equities/margin-reg/index.html>

One criterion for enforcing the rules is that concerning the ratio of margin transaction volume. The breakdown data can be used to calculate the percentage of margin transaction volume, and investors and others can predict the enforcement of the rules.

3.2 Short selling

3.2.1 Definition of short selling

Short selling is defined as selling securities without owning them or by borrowing them or by entrusting a person with such a sale or becoming entrusted with such a sale (Financial Instruments and Exchange Act, Article 162(1)(i)).

Table 3 Breakdown of selling orders

Selling orders	Long sales		Sale of securities that are owned by the seller (including sales for closing margin positions)
	Short sales	Short sales that are not margin transactions	Short sales in which securities are borrowed through negotiations or agreements with the shareholders
		Short sales through margin transactions	Short sales in which the customer has borrowed the securities from the securities firm

3.2.2 Short selling and margin selling

A margin transaction sale (new margin sale) is a type of short sale. Short sales can be classified into short sales done and not done via margin transactions. As previously stated, individual investors are the primary users of margin transactions. Short sales via margin transactions are also usually done by individual investors. Moreover, closing margin sales are not short sales.

Simultaneously, short sales that are not margin transactions are primarily done by institutional investors. As an example, Okazaki (2018) reveals that market makers usually have to act as the investor's trading counterparty when they receive an order; that when investors' buying demand is high, market makers have to sell to them; and if they do not have any available inventory, they have to put in an order for a short sale. Furthermore, Ohyama and Tsuda (2020) state that most short-selling orders come from HFTs, most of these originate from those who trade most frequently and use algorithms most often, and this group puts in more make orders (orders that inject liquidity into the market) than take orders (orders that are immediately executed and use up

liquidity), so that their short selling is supplying liquidity to the market.

3.2.3 Short-selling flags

An investor selling short must indicate to the securities firm that the order is a short sale. Moreover, the securities firm must verify that the customer's transaction is a short sale and, when submitting the order to the TSE, attach a flag indicating that it is a short sale (Cabinet Office Order on Restrictions on Securities Transactions, Article 11).

In the breakdown data, sell orders are divided into long and short sales. The TSE compiles data on orders using the information from the short-sale flags attached when the orders were placed.

3.2.4 Short-selling price restrictions

In the event that the price drops by 10% or more from the standard price for a given day, on that day or the following day, short selling is prohibited at a price that is below the latest published price (last price) when the stock price is rising and that is at or below the last price when the stock price is falling (Order for Enforcement of the Financial Instruments and Exchange Act, Article 26-4). When a securities firm submits a short-selling order to the TSE, regardless of whether short-selling price restrictions have been triggered at the time it received the order, if short-selling price restrictions have been triggered, it must attach a short-selling flag to the order indicating that an order is either is subject to price restrictions or exempt from the application of price restrictions (an order that is exempt from the application of the price restrictions set forth in the Order).⁷

⁷For details, see Tokyo Stock Exchange, Inc. (2013), Japan Exchange Regulation (2019), and the statutes.

The breakdown data classify short-selling orders into those with and those without price restrictions, and the TSE compiles the data on these orders using the information from the short-selling flags.

3.2.5 Obligation to indicate and confirm short sales and exemption from price restrictions

Due to the nature of the transactions that must be indicated and confirmed as short sales and that have price restrictions, laws have been set forth regarding which transactions are exempt from the application of these restrictions.⁸

In the event that a short sale qualifies as a transaction that is exempt from the obligation to be indicated and confirmed as a short sale, the securities firm will place the order with the TSE without attaching a short-selling flag. The breakdown data, therefore, classify these as long sales.

In the event that a short sale qualifies as a transaction that is exempt from price restrictions, when placing the order with the TSE, the securities firm attaches a short-selling flag indicating exemption from price restrictions.

4. Description of the Detail Breakdown Trading Data

4.1 How the breakdown data are created

When submitting orders to the TSE, investors and securities firms must input data on the attributes of the order in accordance with the rules. The TSE uses this attribute data for trading and regulatory purposes. The attribute data include margin transaction flags (whether or not it is a margin transaction, whether it is a new trade or a closing trade) and short-sale flags (whether or not it is a short sale, whether it is exempt from price restrictions).

The breakdown data consist of daily trading volume and trading value by issue based on the attribute data attached when the orders are submitted to the TSE. To create the breakdown data, the TSE uses the data from the orders and the trade tickets to group the executed orders according to their attributes. The breakdown data contain data on all issues compiled into a file each day.

This enables users to access the breakdown of short sales, margin transactions, and the like in terms of daily trading volume and trading value by issue.

⁸See Restrictions on Trading (Exemption from Short Selling Restrictions)
<https://www.jpx.co.jp/english/equities/trading/regulations/02.html>

4.2 What the breakdown data headings mean

4.2.1 Internal use service

The data in the internal use service are laid out as follows.

Table 4 Layout of breakdown data (internal use service)

date	code	va_1_0_0	va_1_0_5	va_1_0_7	va_1_2_5	va_1_2_7	va_1_4_0	va_3_0_0	va_3_2_0	va_3_4_0	vo_1_0_0	vo_1_0_5	vo_1_0_7	vo_1_2_5	vo_1_2_7	vo_1_4_0	vo_3_0_0	vo_3_2_0	vo_3_4_0
20180111	XXXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX

All the data for one issue are recorded in one line. The first column gives the transaction date, and the second column gives the securities code. The headings from the third column on are numbered ①_②_③_④.

In ①, “va” means executed amount (value) and “vo” means executed volume (number of shares).

In ②, “1” means a sale and “3” means a purchase.

③ indicates margin transaction attribute data.

④ indicates short-selling attribute data.

The nine columns from va_1_0_0 to va_3_4_0 give the breakdown of the executed transaction amount (value). The nine columns from vo_1_0_0 to vo_3_4_0 give the breakdown of the executed transaction volume (number of shares)

The six columns from va_1_0_0 to va_1_4_0 give the breakdown of the executed sale amount, and the three columns from va_3_0_0 to va_3_4_0 give the breakdown of the executed purchase amount. These totals are therefore equivalent.

The nine columns from vo_1_0_0 to vo_3_4_0 give the breakdown of the executed transaction volume (number of shares). Columns vo_1_0_0 to vo_1_4_0 give the breakdown of the executed sale value, while vo_3_0_0 to vo_3_4_0 give the breakdown of the executed purchase value. These totals are therefore equivalent.

For margin transaction attribute data, “2” indicates a new transaction (a transaction that sets up a new margin position), “4” indicates a closing margin transaction (a transaction that closes an existing margin position), and “0” indicates a transaction that is not a margin transaction.

For short-selling attribute data, “5” indicates a short sale with price restrictions, “7” represents a short sale without price restrictions, and “0” indicates a transaction that is not a short sale (is a long sale or long purchase). Short sales without price restrictions

qualify as transactions that are exempt from price restrictions, while short sales with price restrictions are other short sales (short sales that are subject to price restrictions when price restrictions have been triggered).

4.2.2 External distribution service

The data in the internal use service are laid out as follows.

Table 5 Layout of breakdown data (external distribution service)

date	code	va_LongSell	va_ShortSellwoMargin	va_MarginSell_New	va_MarginSell_Close	va_LongBuy	va_MarginBuy_New	va_MarginBuy_Close	vo_LongSell	vo_ShortSellwoMargin	vo_MarginSell_New	vo_MarginSell_Close	vo_LongBuy	vo_MarginBuy_New	vo_MarginBuy_Close
20140107	XXXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX

All the data for one issue are recorded in one line. The first column gives the transaction date, while the second column gives the securities code. The headings from the third column on are numbered ①_②, and so on.

In ①, “va” is the executed amount (value) and “vo” is the executed volume (number of shares). In ②, “LongSell” means a long sale, “ShortSellwoMargin” means a short sale that is not a new margin sale, “MarginSell_New” means a new margin sale, “MarginSell_Close” means a closing margin sale, “LongBuy” means a long purchase, “MarginBuy_New” means a new margin purchase, and “MarginBuy_Close” means a closing margin purchase.

The seven columns from va_LongSell to va_MarginBuy_Close give the breakdown of the executed amount (value). The seven columns from vo_LongSell to vo_MarginBuy_Close give the breakdown of the executed volume (number of shares).

The four columns from va_LongSell to va_MarginSell_Close give the breakdown of the executed value of sales, and columns va_LongBuy to va_MarginBuy_Close give the breakdown of executed value of purchases. These totals are therefore equivalent.

The four columns from vo_LongSell to vo_MarginSell_Close give the breakdown of the executed value of sells; columns vo_LongBuy to vo_MarginBuy_Close give the breakdown of the executed value of buys. These totals are therefore equivalent.

In the margin transaction attribute data, MarginSell_New and MarginBuy_New refer to new margin transactions (trades made to set up new margin positions), while MarginSell_Close and MarginBuy_Close refer to closing margin transactions (trades made to close existing margin positions).

In the short-selling attribute data, ShortSellwoMargin means a short sale that is not a margin transaction, while MarginSell_New means a short sale done with a margin

transaction.

4.3 Notes

4.3.1 Method for recording day trades

Considering that the breakdown data gathers flag information from orders, an investor executing a day trade (e.g., entering a new margin transaction and closing that transaction on the same day) is recorded as having both bought and sold.

4.3.2 Correlation with existing data

The TSE publishes data on outstanding margin transactions and outstanding short sales as ancillary data. For margin transactions, the TSE compiles the end-of-week outstanding margin transactions from the reports filed by securities firms, and publication is scheduled for 16:30 on the second business day of each week (Tuesday). Outstanding margin transactions are shown in stock data showing end-of-week outstandings, while the breakdown data are flow data that show daily changes in outstanding margin transactions (the increase in outstandings from new margin transactions and the decline in outstandings from closing margin transactions).

For outstanding short sales, outstanding large-lot short sales reported by investors to the TSE in accordance with the law are disclosed if they constitute 0.5% or more of a listed company's shares. Outstanding short sales are stock data showing large-lot short sales, while the breakdown data is flow data showing all short sales.

5. Detail Breakdown Trading Data Analysis

5.1 Purpose of the analysis and overview

Further, we analyze the breakdown data. Here, we ascertain the general data trends and perform a fundamental analysis of their characteristics *vis-a-vis* the trading system.

The analysis uses breakdown data from January 2015 through December 2019 from the internal use service. The target issues were all issues listed on the TSE First and Second Sections, JASDAQ Growth, JASDAQ Standard, Mothers, and REITs. The breakdown data include data on both trading volume and trading value, but because the trends were substantially the same regardless of which one we used, we used data on trading volume for this analysis.

First, we explain how to read the analytical results in the following box plot. The line in the center of the box is the median. The lines at the top and bottom of the box are the third (75%) and first (25%) quartiles, respectively. For the whiskers above and below the outside of the box, the end of the whisker on the top is the value for the third quartile+1.5*IQR, and the end of the whisker at the bottom is the first quartile-1.5*IQR. IQR is defined as the first quartile and third quartile with in the four-quartile area. We considered any data exceeding the top and bottom of the ends of the whiskers as an outlier and marked these as \circ .

5.2 Analysis of short selling

5.2.1 Short-selling ratio by market segment

To get an overview of short selling, we first total the short-selling ratio by market segment. Here, the short-selling ratio on day t ($Short\ Ratio_t$) is defined as follows.

$$Short\ Ratio_t = \frac{Total\ short\ sales_t (= orders\ with\ price\ restrictions_t + orders\ without\ price\ restrictions_t)}{Total\ sell\ orders_t}$$

We compute the daily short-selling ratio for each issue. For the short-selling ratios computed on a daily basis, we calculate the median over a five-year period for each issue. For the market segment to which each issue belongs, we use the market segment to which the issue belonged for the longest period of time over the five-year period.

We calculated the short-selling ratio by market segment using the above assumptions. Figure 3 summarizes the short-selling ratio medians by market segment.

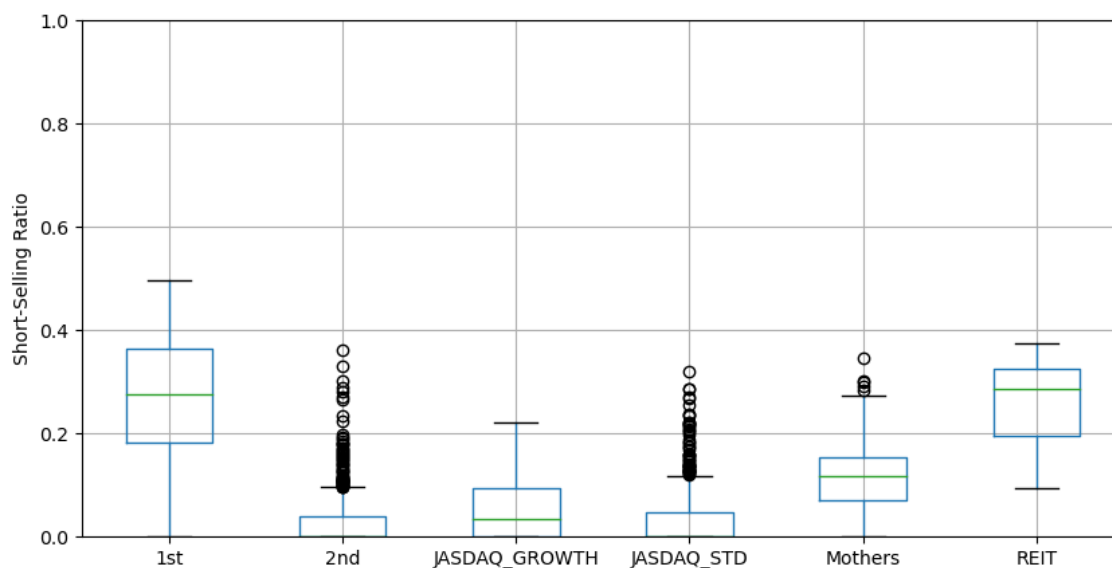


Figure 3 Distribution of the median short-selling ratios by market segment

From Figure 3, we see that the median short-selling ratio for the TSE First Section and REITs is approximately 30%. Simultaneously, we see that the short-selling ratio is low for the other market segments, at approximately 5%. These findings are similar to those of Otsuka (2012), who analyzed the period from 2010 to 2011; therefore, it seems that the long-term trend is quite similar.

This is probably due to the impact of short-sale settlement indication and confirmation requirements (rules prohibiting naked short sales) and the ease of procuring stock certificates from the securities lending market. In a stochastic study of the factors determining liquidity in the securities lending market, Uno, Umeno, and Morii (2009) found a positive correlation between market capitalization and stock loan inventories, and showed that this happens because share certificates supplied to the securities lending market reflect the characteristics of institutional investors' portfolios, as they are the lenders. Looking at the amount and ratio of shares owned by domestic financial institutions by segment of the Tokyo Stock Market, the proportion of institutional investor ownership was high in the market's First Section⁹ and for REITs,¹⁰ but was low for the Second Section, JASDAQ, and Mothers,¹¹ amounting to 1.6

⁹According to Tokyo Stock Exchange (2020a), share ownership by domestic institutional investors in companies listed on the TSE's First Section at the end of fiscal 2019 totaled 159.9 trillion yen, or 30.1% of the total.

¹⁰According to Tokyo Stock Exchange (2020b), as of February 2020, domestic institutional investors held 8.5 trillion yen (54.3%) of listed REITs.

¹¹ According to Tokyo Stock Exchange (2020a), as of fiscal 2019 year end, domestic

trillion yen (9.1%). Thus, the First Section and REITs, which have high ownership by institutional investors, which are major suppliers to the securities lending market, can be considered as having high short-selling ratios.

5.2.2 Orders that are exempt from short-selling price restrictions and orders that are subject to price restrictions

Furthermore, we compare orders that are exempt from short-selling price restrictions and orders that are subject to price restrictions (orders that are exempt from price restrictions are flagged with “_woPR” after the name of the market; orders that are subject to price restrictions are flagged with “_PR”). Here, looking at total daily sell orders by issue, we compare the ratio of short-selling orders that are subject to price restrictions with the ratio of orders that are exempt from price restrictions. As in the previous analysis, we use five years of data. Figure 4 below sums up the medians and distributions of these orders’ ratios by market segment.

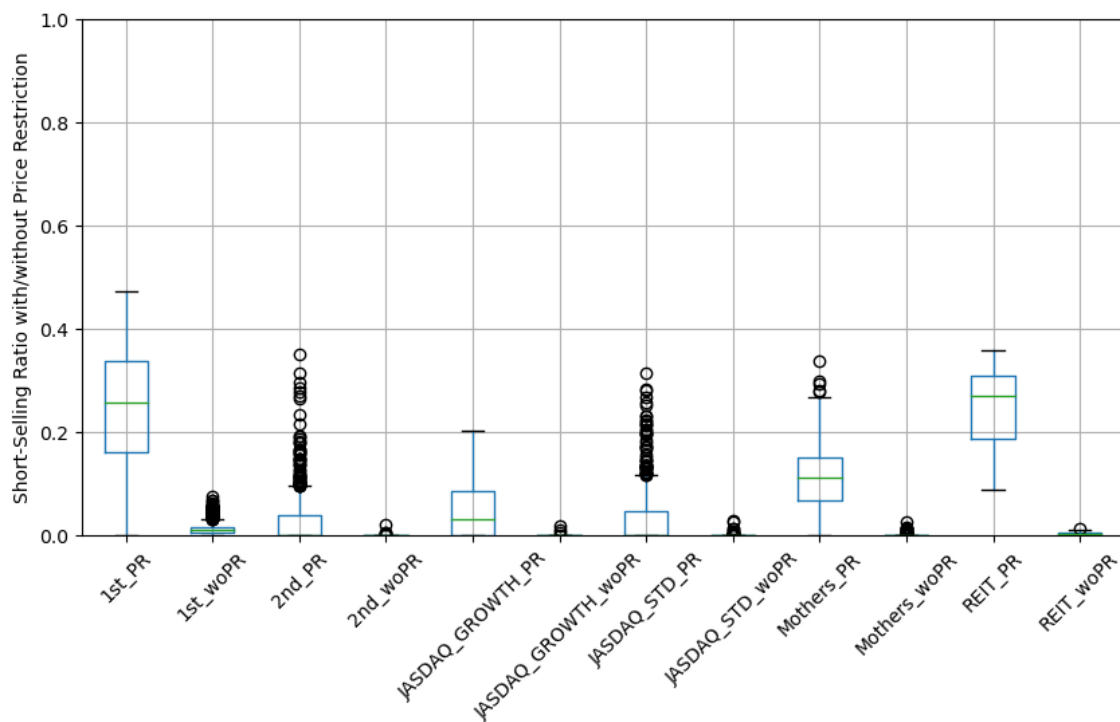


Figure 4 Distribution of short-selling orders with price restrictions (“_PR”) and without price restrictions (“_woPR”)

From Figure 4, we can see that more orders have price restrictions than those which

institutional investors held 1.6 trillion yen (9.1%) of the shares of companies listed on the TSE Second Section, JASDAQ, and Mothers.

do not. Specifically, in segments other than the TSE First Section and REITs, very few orders have no price restrictions.

We test whether the differences between the two ratios is significant. Here, we conducted a t-test by issue that involved subtracting the ratio of orders without price restrictions from the ratio of orders with price restrictions to ascertain whether the difference was significantly greater than 0. The results showed that for almost all issues (99.4%), orders with price restrictions were statistically greater, with 95% significance, than orders without price restrictions.

Short-selling price restrictions were put in place to facilitate price formation by restricting the pricing of an order when short selling can potentially accelerate the price decline of a stock in a falling market. Short sales that have a limited impact on price formation, which are exempt from price restrictions, are legally excluded as exceptions. For the market as a whole, orders with price restrictions are more common than orders without price restrictions.

5.2.3 Short-selling ratio and percent change in the stock price

Additionally, we analyze the relationship between the short-selling ratio and the percent change in the stock price. Here, we define the percent change in the stock price (r_t) from the previous day's stock price (P_t) as follows.

$$r_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

We calculate the correlation coefficient of this stock price change and the ratios of short-selling orders with and without price restrictions using five years of data. First, we calculate the correlation coefficient using the same-day stock price change and the same-day short-selling order ratio (orders without price restrictions are flagged “_woPR” after the name of the market, while orders with price restrictions are flagged “_PR”). Figure 5 shows a compilation of the correlation coefficients by market segment.

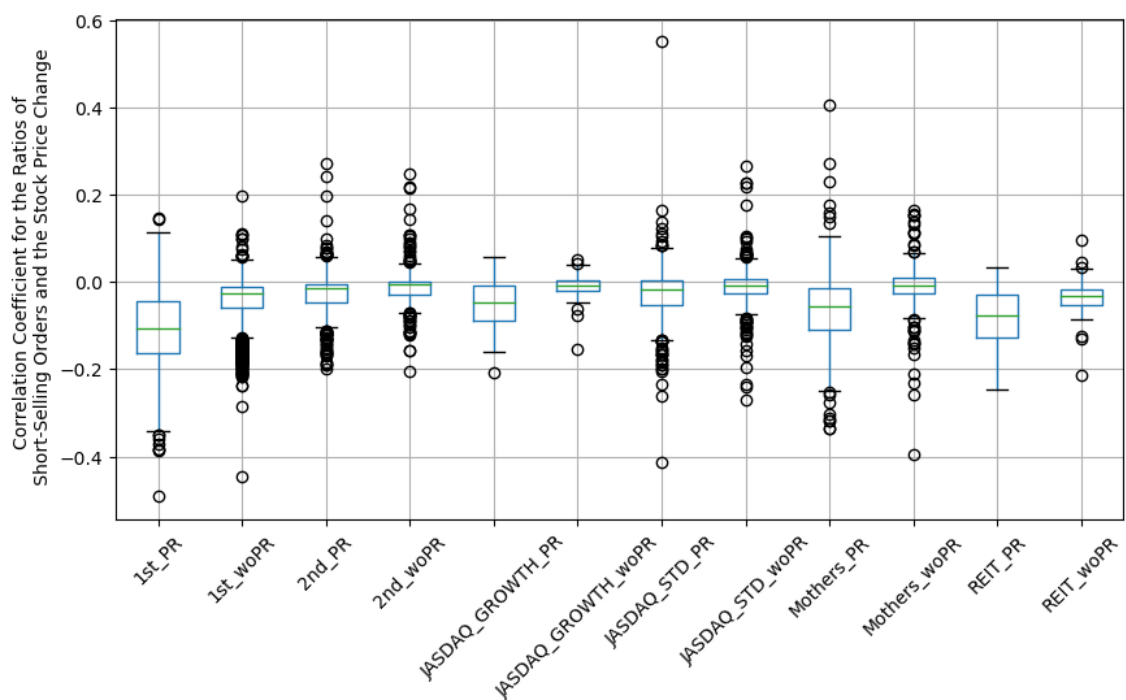


Figure 5 Distribution by market segment of the correlation coefficients for the ratios of short-selling orders without price restrictions (“_woPR”) and with price restrictions (“_PR”) and the stock price change

From Figure 5, we see that in all market segments, the correlation coefficient is usually negative. However, there are some correlation coefficients on the positive side of the distribution, although their levels are very low, showing that the correlation is not always strong.

For stock price changes, the strength of the trend may change as the price rises or falls. Then, we separate the stock price changes into positive and negative and calculate the correlation coefficient in each case. Figure 6 is a histogram summarizing our calculations of correlation coefficients for short-selling ratios and stock price change ratios, divided into increase (“pos”), decrease (“neg”), and for all issues (“all”) using all data regardless of whether the stock price went up or down. The results for “all,” when we used all the data, are the same as in Figure 5 where we added all markets.

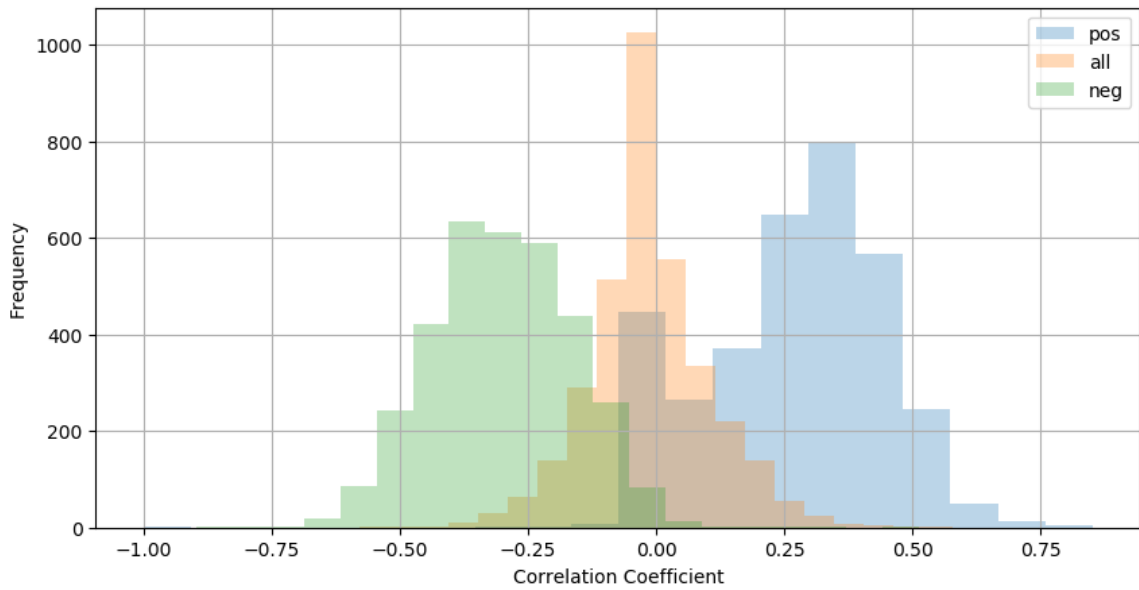


Figure 6 Histogram of the correlation coefficients for short-selling ratios and stock price changes computed by classifying the stock price changes into positive (“pos”), negative (“neg”), and using all data (“all”)

From Figure 6, we see that when the stock price change is positive, the correlation coefficient is positive, and when the stock price change is negative, the correlation coefficient is negative. In other words, we can predict that regardless of whether the stock price change is positive or negative, when the absolute value of the stock price change increases, the short-selling ratio rises, and when the absolute value of the stock price change decreases, the short-selling ratio tends to go down.

Further, Figure 7 reveals the calculation of the correlation coefficients of the absolute values of the stock price changes and short-selling ratios.

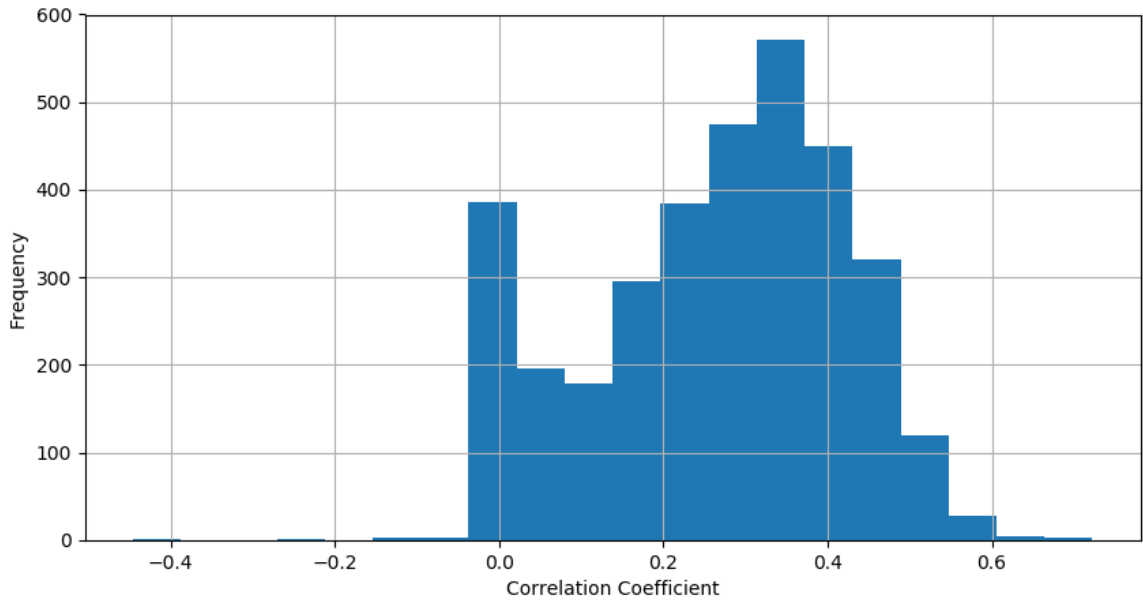


Figure 7 Histogram of the correlation coefficients of the absolute values of stock price changes and short-selling ratios

From Figure 7, we see that for most issues, the correlation coefficient is positive, and although some issues have a correlation coefficient of 0, there is a positive peak at approximately 0.3. From this analysis, we also see that when the absolute value of the stock price changes, the short-selling ratio tends to increase.

Let us discuss the causes of this. According to Ohyama and Tsuda (2020), the vast majority of short-selling orders come from HFTs, and among them, most short sales are done by those with very rapid and precise algorithms. This group submits more “make” orders (orders that inject liquidity into the market) than “take” orders (orders that use up available liquidity), thus their short-selling orders supply liquidity to the market. Moreover, in their analysis by individual issue, they emphasize that those engaged in HFT supply liquidity to the stock market without any effect on market movements, and that from the analysis of sells only and buys only, no trading activity by HFT was observed to cause the market to decline overall. Rather, normal investors’ trading activity had more of an impact on prices. Similarly, Hosaka (2014) and Uno, Goshima, and Tobe (2018) state that market making is the investment strategy of most investments done via HFT.

Trading on the TSE is competitive, so trading takes place when the buying supply and demand equals the selling supply and demand. When the absolute value of the stock price change rises, it is assumed that the supply and demand balance changes as it goes up or down; thus, short-selling orders cause more trades to be executed with HFTs who

are market makers.

5.3 Analysis of margin transactions

5.3.1 Overview of margin transactions

First, we analyze which issues are generally used in margin transactions. Figure 8 shows, on a daily basis, the percentage of issues for which margin transaction volume was not 0.

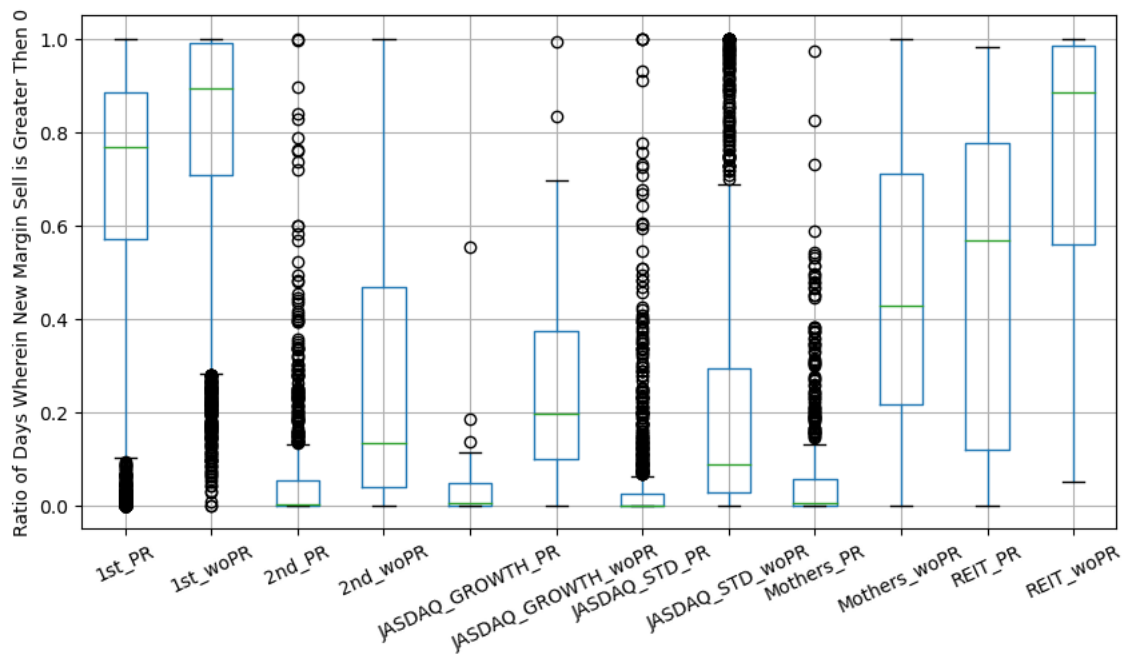


Figure 8 Distribution by market segment of the ratio of new margin sell orders with price restrictions (“_PR”) and without price restrictions (“_woPR”) where trading volume by issue was not 0 on a daily basis over a five-year period

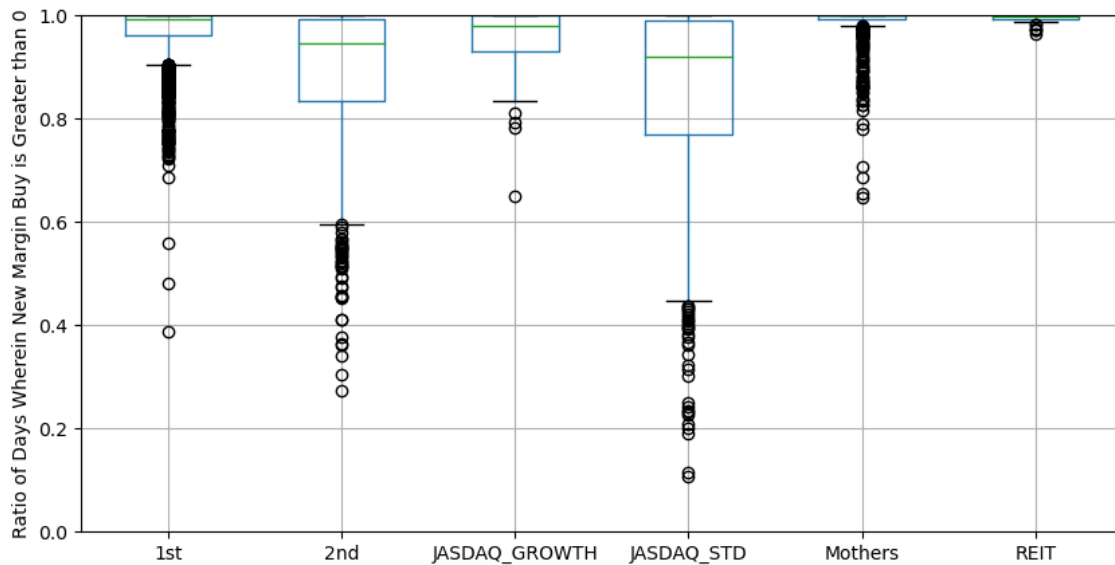


Figure 9 Distribution by market segment of the ratio of new margin buy orders where trading volume by issue was not 0 on a daily basis over a five-year period

In Figure 8 and Figure 9, for margin buys, trading volume for most issues was usually not 0, but for margin sells, with the exception of the TSE First Section and REITs, half or more of issues had trading volume of 0. In particular, we saw that trading volume was low for new margin sell orders with price restrictions except for the TSE First Section and REITs.

5.3.2 Ratio of margin transactions by market segment

Next, we calculate the ratio of margin transactions (new margin buys and sells) in overall buying and selling volume. Margin closing transactions are the reverse of new margin transactions. As a new margin sell is effectively the same as a closing margin buy and a new margin buy is the same as a closing margin sell, here we will focus only on new transactions. Figure 10 calculates the five-year trend by market segment.

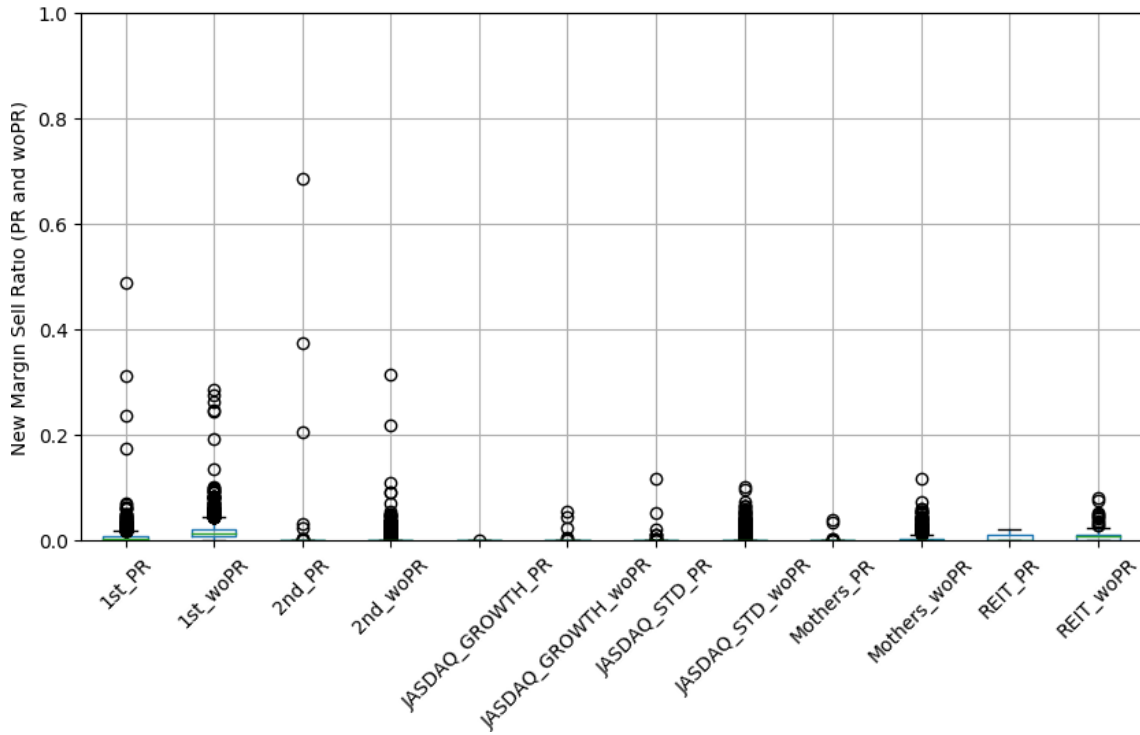


Figure 10 Distribution of the share of new margin sell orders with price restrictions (“_PR”) and without price restrictions (“_woPR”) by market segment

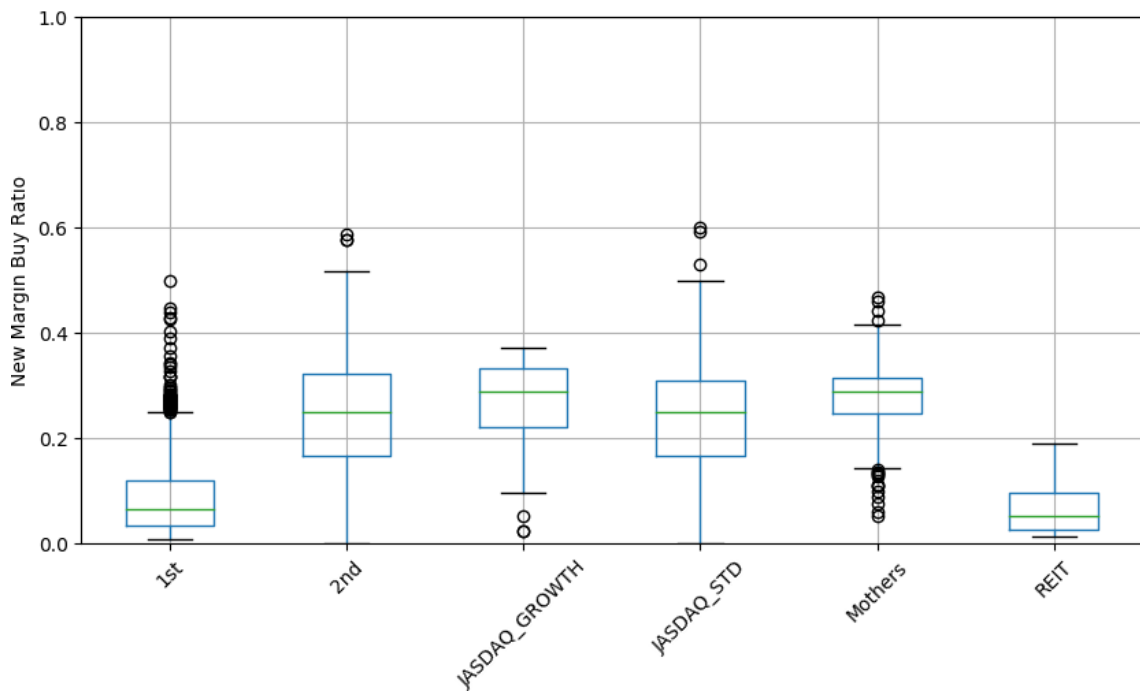


Figure 11 Distribution of the share of new margin buy orders by market segment

Looking at the share by market segment, the ratio of new margin buy orders is low for the TSE First Section and REITs. New margin sell orders are almost zero in segments other than the TSE First Section and REITs. Comparing margin buys and margin sells, we see that margin buy orders outnumber margin sell orders.

Further, for new margin sells, we compare new orders with and without price restrictions. For each issue, we calculated the difference between orders with and without price restrictions on a daily basis, and ran a t-test to ascertain whether there was a large statistical significance when the difference for each issue was 0. We found that for 86% of issues, the difference was significant at a 95% confidence level, and that orders without price restrictions were more often than not statistically significant. Short sales by individual investors using margin transactions (less than 50x the trading unit) are not subject to price restrictions.¹² Most new margin sells correspond to this type of order, therefore, it seems that orders without price restrictions are more prevalent than orders with price restrictions.

5.3.3 Margin transactions and the percent change in the stock price

5.3.3 Margin transactions and the stock price change

Figure 14 shows the distribution of the correlation coefficients of the daily stock price change and share of margin transactions by issue by market segment.

¹²Cabinet Office Order on Restrictions on Securities Transactions, Article 15(1)(ii).

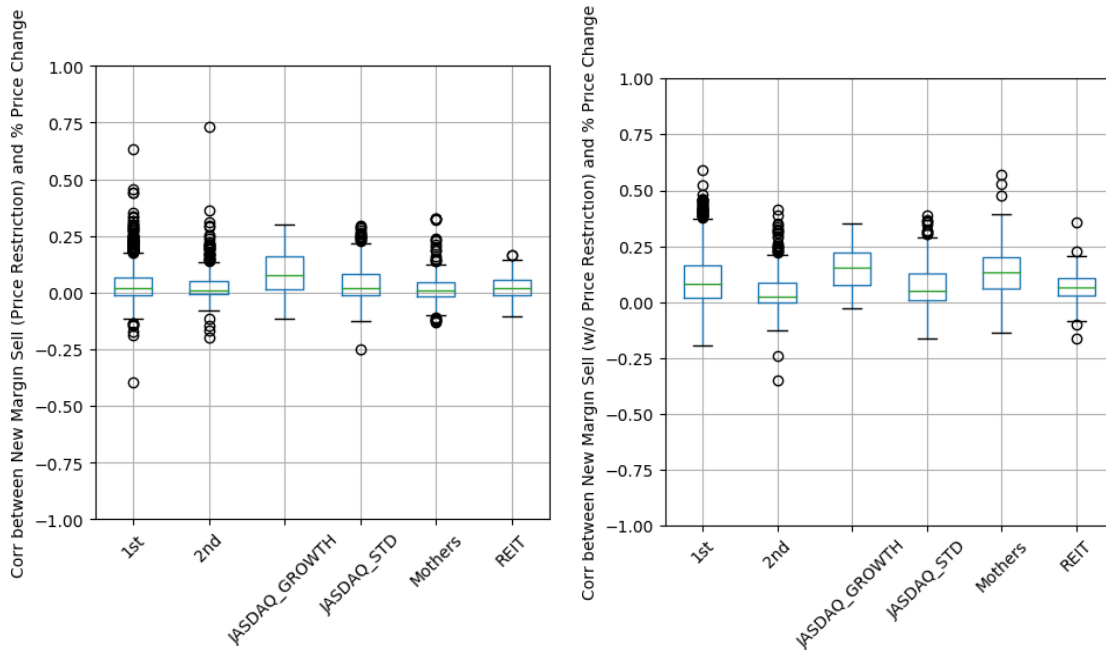


Figure 12 Distribution of the correlation coefficients of daily stock price changes and trading volume of new margin sell orders (with and without price restrictions)

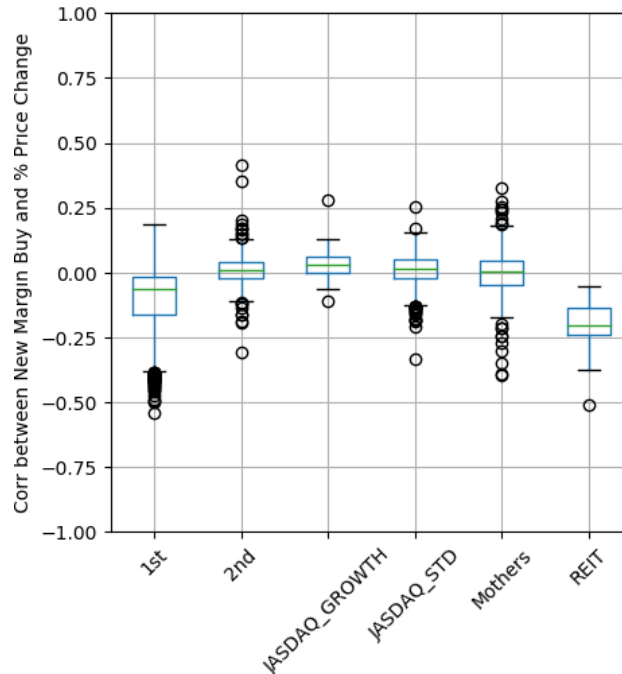


Figure 13 Distribution of the correlation coefficients of daily stock price changes and trading volume of new margin buy orders

We can see that for the TSE First Section and REITs, a correlation exists between the

volume of new margin buy orders and stock price change, but for other market segments, the correlation coefficient of the margin buy orders and stock price change is almost 0. Simultaneously, the correlation between new margin sell orders and stock price change tends to be positive, albeit slightly.

Furthermore, we compare the stock price change with long and short positions. Here, a long position is defined as the same-day trading volume of new margin buys less closing margin sells, while a short position is defined as the same-day trading volume of new margin sells less closing margin buys. We then calculated the correlation coefficients of these metrics and that day's stock price change by issue to obtain Figure 14, which is a compilation by market segment.

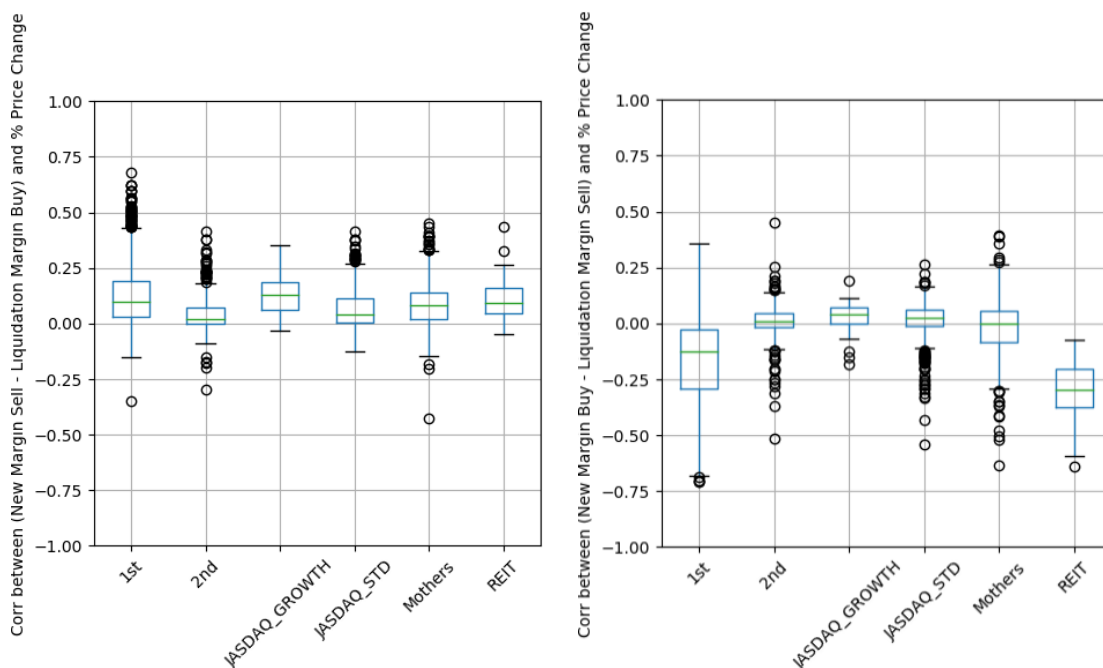


Figure 14 Correlation coefficients of the stock price change and net margin long and short positions by market segment

In Figure 14, long positions are negatively correlated with price changes. For the TSE First Section and REITs, they move in opposite directions; thus, when prices fall, new margin buys increase. However, in the other market segments, they move in the same direction; thus, when prices rise, new margin sales increase, but the correlation is too low to be easily visible. For short positions, we saw a positive correlation with price changes in all market segments and movements in opposite directions, such that when prices rise, new margin sales increase.

5.3.4 End-of-week outstanding margin transactions estimated from breakdown data

Finally, we use the Detail Breakdown Trading Data to build a model for estimating end-of-week outstanding margin transactions. The TSE publishes the outstanding margin transactions for each issue at the end of every week.¹³ It has also developed a number of technical metrics using these margin transaction balances. In TSE (2016), the major technical metrics given for margin transactions are the margin balance, which indicates concern about pressure on supply and demand (future selling pressure), and the short-selling ratio (ratio of short sales that are margin transactions) that is generally considered to have a major market-support effect through repurchases. The margin transaction balances currently being published by the TSE are weekly statistics, but the breakdown data is published daily. Therefore, we can estimate outstanding margin transactions on a daily basis by taking end-of-week outstanding margin transactions, which are a stock number, and adding or subtracting the daily flow of margin transactions recorded in the breakdown data.

Now, we analyze the end-of-week outstanding margin transactions from 2015 through 2019 to see if we can figure out the daily flow from the breakdown data. Specifically, we take the outstanding margin transactions from the end of the previous week, add each day's new margin transactions, and subtract each day's closing margin transactions to get an estimate of the outstanding margin transactions for the end of a given week. We then compare this value with the actual end-of-week outstanding margin transactions. Additionally, as factors affecting the margin balance, besides the TSE trades contained in the breakdown data, we included margin transactions in the cash settlement and proprietary trading system (PTS) markets and transactions in the ToSTNeT market. Although it is not possible to completely recreate the end-of-week outstanding margin transactions from the breakdown data alone, we investigate the extent to which we could describe it using breakdown data.

Using the breakdown data, we estimated end-of-week outstandings, calculated the error from the actual end-of-week outstanding margin transactions, and then divided the error by the actual end-of-week outstanding margin transactions. Specifically, we define the margin of error as follows.

$$\text{Margin of error} = \frac{\text{End-of-week outstanding per breakdown data} - \text{actual end-of-week outstandings}}{\text{Actual end-of-week outstandings}}$$

For all market segments except the TSE First Section, the volume of margin sell orders was low, close to 0. Given that most issues had remarkably low margin balances,

¹³Published on the JPX website as end-of-week margin transactions by issue.

we only estimated end-of-week outstanding margin transactions for the TSE First Section.

For issues traded in the TSE First Section, we derived the abovementioned margin of error for each issue and calculated the median for each issue. Table 6 shows the distribution of these medians.

Table 6 Distribution of medians and standard deviations of outstanding buys and sells

	Distribution of median and standard deviation of outstanding buys	Distribution of median and standard deviation of outstanding sells
Mean	2.95%	12.62%
Standard deviation	5.21%	49.78%
Minimum	-33.54%	0.00%
First quartile	1.57%	3.96%
Median	2.17%	8.30%
Third quartile	3.25%	15.30%
Maximum	204.15%	1978.95%

In Table 6, we were able to estimate that the median for outstanding buys has a 2.17% margin of error and the median for outstanding sells has an 8.30% margin of error. We found that we could also estimate the margin of error for the third quartile to a relatively high degree of accuracy, at 3.25%. Simultaneously, estimated outstanding sells had a higher standard deviation than estimated outstanding buys.

Further, we performed a detailed analysis to assess which issues' outstanding margin sale transactions could be estimated to a high degree of accuracy and which had a higher estimated error. We sorted the issues on the TSE First Section by their median error for outstanding sells, starting with the lowest, and classified them into four quartiles. Specifically, we used the output from Table 6 and allocated it among the following four groups.

- 1Q: Estimated error < first quartile's value (= 3.96%)
- 2Q: Value of first quartile (= 3.96%) ≤ estimated error < median (= 8.30%)
- 3Q: Median (= 8.30%) ≤ estimated error < value of third quartile (= 15.30%)

- 4Q: Value of third quartile (= 15.30%) \leq estimated error

We analyzed the market capitalization and correlation of each issue from 1Q through 4Q. For market capitalization we used the index market capitalization, based on floating shares as calculated by TOPIX. Figure 15 presents a summary of the median market capitalization for each quartile. The y-axis is divided by 10^{10} , and 1 on the y-axis means $1 * 10^{10}$ yen, or one million yen.

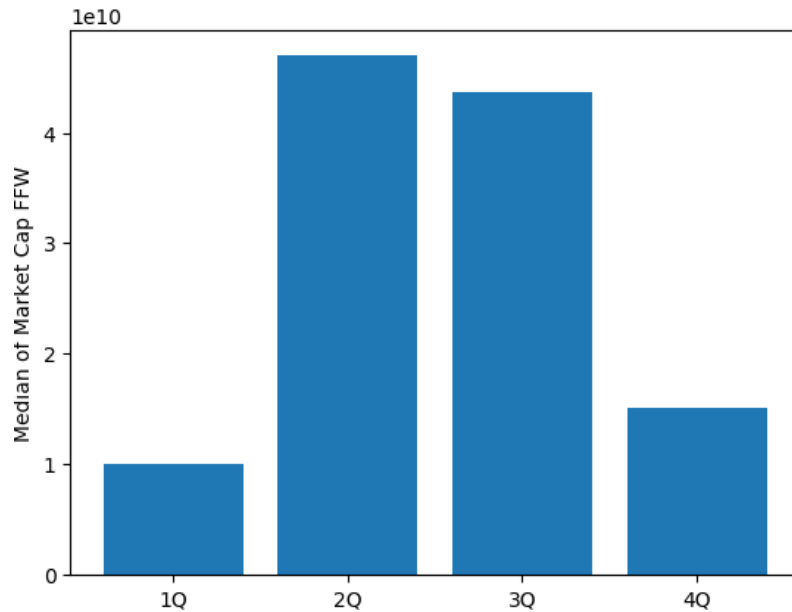


Figure 15 Median market capitalization by estimated error (unit: million yen)

Figure 15 shows that issues with a small market capitalization belong to 1Q, which has a low estimated error, and to 4Q, which has a high estimated error, while issues with a large market capitalization are in 2Q and 3Q in the middle.

Furthermore, Figure 16 shows the medians for outstanding margin transactions by issue for each quartile (in millions of yen).

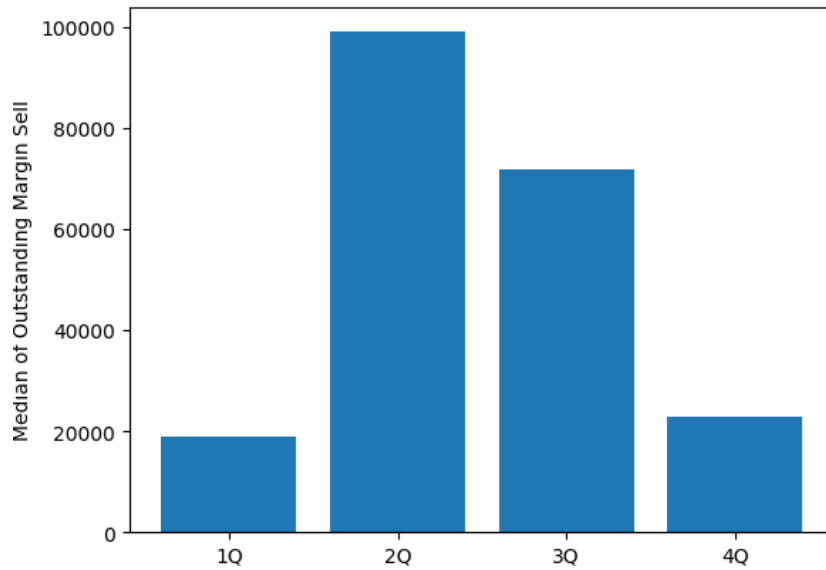


Figure 16 Median of outstanding margin sells by estimated error (unit: shares)

In Figure 16, outstanding margin transactions are low in 1Q, where the estimated error is low, and in 4Q, where it is high, while outstanding margin sells are high in the two middle quartiles.

Finally, Figure 17 computes the median new margin sell ratios (total orders with price restrictions and orders without price restrictions to total sell orders) for the issues in each.

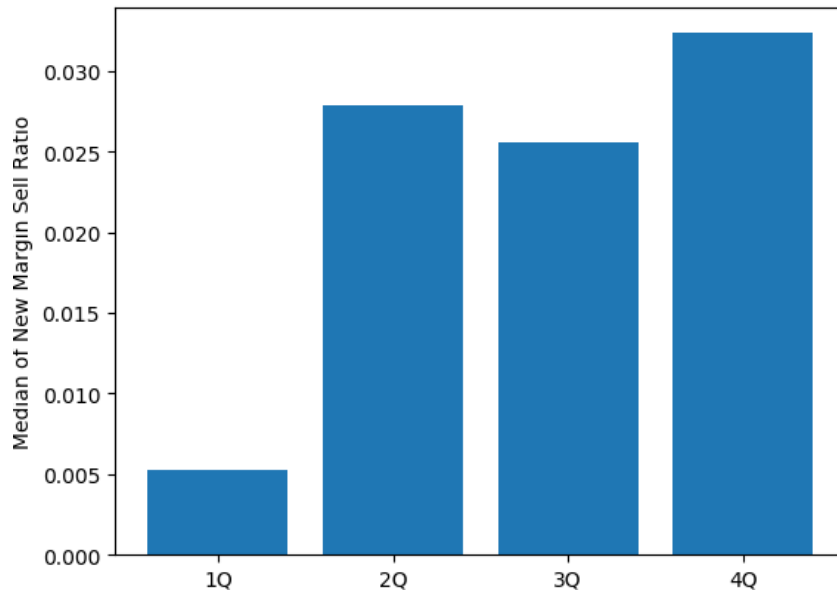


Figure 17 Median new margin sell ratios by estimated error

In Figure 17, the margin sell ratio is very low in 1Q, which has a low estimated error,

while the margin sell ratio in 4Q, which has the highest estimated error, is higher than the other quartiles.

To summarize, margin sell transactions are low when market cap is low and the margin sell ratio is low. In other words, it is easy to estimate outstanding margin transactions for small-cap stocks, because there are not many margin transactions (1Q). Large-cap stocks have high levels of margin transactions, and when calculating the estimated error, the size of the error is not remarkably large, even if there is slight estimated error (2Q). Meanwhile, we saw that for stocks with small market capitalizations and high margin sell ratios, that is, actively traded small-cap stocks, estimating the margin balance was difficult and the estimated errors were large (4Q).

Let us discuss the causes of these errors. One reason for these errors may be that the TSE handles cash-settled and ToSTNeT trades, settlement by PTS, and outstanding margin transactions on PTS. In 1Q, which has a small error, the impact of these is small because the volume of margin transactions is low. In 2Q and 3Q, the errors are not very large because both market capitalizations and the volume of margin transactions are large. Then, in 4Q, it seems that the error becomes large because these types of trades are not done in the abovementioned market segments. Comparing the four quartiles, it seems that for the TSE First Section, cash-settled and ToSTNeT trades do not differ much from quartile to quartile, so these errors are probably due to settlement by PTS. In fact, we need to conduct additional research on the margin flows for these types of trades to ascertain which ones are causing the errors. This is a topic for future research.

6. Conclusion and future topics

This paper used Detail Breakdown Trading Data to summarize the characteristics of the breakdown data and the systems that are premised on its use. It also analyzed the characteristics of trading movements in the TSE spot market and built a model for estimating end-of-week outstanding margin transactions.

The breakdown data are data on margin transactions and short-selling orders that were previously not public. Using a PoC test, we found that such data can be used not only for investment purposes but also by securities firms in their credit management and other risk management and rating work (reference data, etc. in the assignment of ratings).

When we analyzed the breakdown data, we discovered how margin transactions and short sales were trending in each market segment. The short-selling ratio and ratio of margin sell orders were higher for the TSE First Section and REITs than for the other market segments, while the ratio of margin buy orders was lower. When we analyzed the correlation between the short-selling ratio and stock price changes, we found that regardless of whether the stock price change was positive or negative, the short-selling ratio increased with the increase in the absolute value of the stock price change, and the short-selling ratio tended to decrease with a decrease in the absolute value of the stock price change. Finally, when we used the breakdown data to estimate end-of-week outstanding margin transactions, we realized that while we were able to estimate outstanding margin buy transactions with a relatively high degree of accuracy, estimation errors occurred for outstanding margin sell transactions for issues with small market caps and high margin sell ratios.

Further study on nonpublic data that affect securities markets is a topic for future research. A deeper analysis could be performed on the relationship between the breakdown data and the tone of the market. This analysis focused on the correlation between the ratio of different types of orders and price changes, but we also need to analyze why these correlations occur, whether any factor in the breakdown data besides stock price changes has more of an impact, and the causal relationships therein. Other possible topics are a more detailed analysis of the causes of the errors in end-of-week outstanding margin transactions and construction of a model that can perform more accurate estimations of outstanding margin sells and the like.

Reference Literature

- Uno, J., J. Umeno, and R. Muroi (2009), “Empirical analysis of the Japanese stock lending market: Estimation of effect of tightening of short selling regulations,” *Securities Analysts Journal*, June 2009.
- Uno, J., K. Goshima, and R. Tobe (2018), “Cluster Analysis on Trading Behavior of HFT,” Twelfth Conference of the Association of Behavioral Economics and Finance (in Japanese).
- Otsuka, T. (2012), “Short selling on the TSE and the impact of restrictions on short selling,” JPX Working Papers.
- Ohyama, A. and H. Tsuda (2020), “Analysis of the characteristics of high-frequency trading (HFT) using an algorithm criterion,” Financial Research Center Discussion Paper, Financial Services Agency (in Japanese).
- Okazaki, K. (2018), “Inaugurating a market-making system in the ETF market,” *Gekkan Shihon Shijo*, October 2018 (in Japanese).
- Tokyo Stock Exchange (2013), “Release of FAQs regarding the comprehensive overhaul of short-selling rules,” Tokyo Stock Exchange 245th Annual General Shareholders Meeting (in Japanese).
- Tokyo Stock Exchange (2016), “How to design and utilize margin transactions,” Youtube <https://finance.logmi.jp/179203>
- Tokyo Stock Exchange (2020a), “Fiscal 2019 survey on the distribution of stocks,” <https://www.jpex.co.jp/markets/statistics-equities/examination/01.html>
- Tokyo Stock Exchange (2020b) “Survey of real estate investment trust (REIT) shareholder data: February 2020” <https://www.jpex.co.jp/markets/statistics-equities/examination/03.html>
- Japan Exchange Regulation (2019), *Fifth Case Study Handbook on Internal Controls* (in Japanese).
- Hosaka, G. (2014), “An analysis of high frequency trading at the Tokyo Stock Exchange,” JPX Working Paper.
- Mikami, N. (2020), “The latest AI programs at asset servicers in North America and Europe,” *Financial Information Technology Focus*, November 2020 (in Japanese).