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Abstract

This paper examines whether the stock split bubble in Japan burst not only because of the reform of the system but also because of the Livedoor shock. It is difficult to separate the effects of both events because they occurred in the same month (January 2006). We did so by dividing the samples as follows, the stock splits in the old system, the stock splits in the new system, and the news announced before and after the Livedoor shock. Empirical results reveal that restrictions on trading of newly issued shares in the old system caused the run-up in the stock price and that the Livedoor shock stalled the run-up of the split stocks. These results suggest that the stock split bubble burst not only because of the reform of the system but also because of changes in investor sentiment regarding split stocks.

JEL Classification Numbers: G14, G35

Keywords: Stock Split Bubble, The Livedoor Shock, Investor Sentiment

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1. Introduction

This paper examines whether the Japanese stock split bubble burst not only because of the reform of the system but also due to changing investor sentiment due to the Livedoor shock.

Stock splits allot new shares to existing shareholders according to their current ownership and increase the total number of outstanding stocks. Stock split announcements and execution do not affect the economic activities and fundamentals of the company. However, stock price increases on the announcement date and after ex-date, collectively known hereafter as the "stock split bubble," are frequently observed in Japan. The stock split bubble occurs not only in Japan but also in the European and American stock markets. Stock price increase because of a stock split is considered an anomaly that asset pricing theory, which includes an efficient market hypothesis, cannot explain. As a result, there have been several studies in many countries to identify the cause of such stock price increases.

Previous stock split studies have originated several hypotheses exploring abnormal returns. Greenwood (2009) discusses four hypotheses addressing the "stock split bubble" in Japan. The first hypothesis is the "signaling hypothesis" which suggests that a split announcement conveys information about the future fundamentals of a firm. The market interprets stock split announcements as good news for future performance and dividends.[1] Fama et al. (1969), the first empirical research on a stock split, report abnormal returns around the announcement date, which supports the signaling hypothesis. Many other related studies also report abnormal returns around the announcement date, which again supports this hypothesis (Lakonishok and Lev (1987), McNichols and Dravid (1987), Asquith, Healy, and Palepu (1989)).

The second hypothesis is the liquidity hypothesis. This suggests that an increase in the number of investors raises the stock prices. When a stock splits, the stock price is reduced since the number of shares outstanding increase facilitating trading by small traders. Therefore, increases in the number of investors improve the diversification of risk, allowing a stock price rise. Merton (1987) sets up a model of capital market equilibrium with incomplete information. This model indicates that increases in the shareholder base should have permanent positive effects on stock prices. Also, Amihud, Mendelson, and Uno (1999) analyze reductions in the trading unit of Japanese stocks and find significant permanent price increases as the shareholder base increases.

In Japan, it used to take approximately 50 days from ex-date to the "pay-date" on which newly issued shares are paid to shareholders. The third hypothesis focuses on decreases of liquidity during the 50 day period. The illiquidity discount hypothesis predicts decreases in price on announcement because investors require a premium for liquidity reduction and non-tradable new shares from ex-date to pay-date. Since the trading restriction continues until pay-date, the stock price will be less than the pre-announcement price. This explanation underlies Amihud and Mendelson's (1986) theory that the more illiquid the stock, the greater the discount of the stock price.

The fourth hypothesis also focuses on decreases of liquidity caused by lag in the issuing of new shares. This hypothesis, however, focuses on decreases in the number of suppliers (sellers), and

[1] The signaling hypothesis also suggests a problem for the decision-making abilities of the manager.

predicts that stock prices will temporarily rise. Hereafter, we will refer to this hypothesis as the "trading restriction hypothesis."[2] Until the reformed system of stock splits was implemented in 2006, the trading restriction that shareholders could not trade the new shares highly constrained the selling behavior of existing shareholders.

For example, in a market where investors may trade only old stocks after ex-date, investors who decide after the ex-date that the stock is overpriced can act on this view only insofar as they can sell their old holdings. Of course, positions in the new shares could be offset by taking short positions in the old shares. These short positions could then be closed by delivering the new shares on the pay-date. However, a large subset of investors, including mutual funds and insurance companies, and perhaps also small retail investors, are unlikely to short at any price. More importantly, even investors who want to short must find a counterparty from whom to borrow the shares; this becomes exceedingly difficult once the split is announced. In addition, investors who are willing to go short are also likely to be constrained by the event. To receive the new shares, shareholders must be in physical possession of the shares on the ex-date.[3]

The mechanism by which trading restrictions affect stock prices is straightforward. The stock split constrains traders who would otherwise be willing to sell from accommodating demand from investors who want to buy. Thus, there must be investors willing to trade when the restrictions are in place; otherwise, the restrictions are not binding. If this condition is satisfied, then the restrictions have the effect of removing potential liquidity suppliers from the market, increasing the price impact of a trade. The greater the desire of investors to trade during the restricted period, the larger the impact of the restrictions will be, thereby raising prices. This suggests that in this event, returns should be positively related to the degree of trading restrictions, measures of trading volume and the interaction between the restrictions and trading volume. Returns should be positive when the constraints are imposed and negative when the constraints are relieved.

We can make an interesting point regarding the stock split system in Japan. Under the old system, it took approximately 50 days until newly issued shares were tradable. Stocks that split after January 4th, 2006, applied the new system where new shares are tradable on ex-date, completely lifting the restrictions. Such a systemic revision provides the opportunity for a natural experiment with market mechanisms, asset pricing, and investor behavior. Therefore, we can evaluate the validity of the third and fourth hypotheses by comparing stock prices before and after the systemic revision.

Figure 1 shows the average price of a split stock between October 2001 and December 2005 (pre-revision) and between January 2006 and December 2007 (post-revision), normalizing to 100, the

[2] Please note that the second hypothesis implies an increase of liquidity after pay-day, while the third and fourth hypotheses imply a decrease in liquidity before pay-date.

[3] The impact of such a restriction on the price is the same as the impact of short selling regulations, as discussed by Miller(1977), who suggests that a stock price is more affected by investors with optimistic private information, even if information that investors have about future values is normally distributed under short selling regulations. In recent papers, the views of pessimistic investors, or of investors with private information that the stock is overvalued, are not immediately incorporated into current stock prices (Diamond and Verrecchia, 1987; D'Avolio, 2002; Chen, Hong, and Stein, 2002; and Duffie, Gˆarleanu, and Pederson, 2002.)

closing price on the day before the announcement date. Also, the price after the ex-date is multiplied by the split factor to adjust split ratios. The solid line shows the average price of stocks that split before the revision; the dashed line shows the average price of stocks that split after the revision. Those lines illustrate four features of the stock split bubble. The first feature is that stock prices increase by about 5% at stock split announcement date, and continuously move up. That cumulative return is about 16% until right before ex-date. The second feature is that stock prices again rise up unusually at ex-day. The third feature is that stock prices trend upward after ex-day, but trend downward right before pay-date. The fourth feature is that stock prices remain at the same level after pay-date, but increase to about 18% higher than before the stock split announcement.

Greenwood (2009) pointed out the first three features, rising at announcement date and ex-date and lowering at pay-date, and found those phenomena can be explained by the trading restriction hypothesis. The fourth feature suggests that the increase in the stock price is also caused by reasons other than the old system, because stock prices also rise long-term without trading restrictions. This is a crucial feature about the stock split bubble in Japan. In addition, the first feature, a stock price rising at announcement date, means that the illiquidity discount hypothesis is rejected but the trading restriction hypothesis is supported.

The dashed line in Figure 1 shows the average price of stocks that split after the revision. It does not indicate the second, third, or fourth features, unlike the splits before the revision. Even though price largely rises at announcement date, immediately after that it decreases so that it drops under 100 after 10 days. In addition, price never runs up significantly. After the revision, it shows the first feature only to a limited extent. Therefore, the stock split bubble is considered to be burst with the revision remedying the lag in supply of newly issued shares. Further, the trading restriction hypothesis is important in explaining the cause of the stock split bubble.

The first aim of this paper is to strictly test the above presumptions—that one of the important factors of the stock split bubble before the revision was a temporary shortage of liquidity caused by trading restrictions. It also tests whether the signaling and liquidity hypotheses have additional validity.

The second aim is to test whether the "Livedoor shock" is one of the important factors in the stock split bubble burst. Livedoor, a famous Japanese IT company, that had been rapidly developing by overusing the stock split strategy. Mr. Takafumi Horie, the CEO, was hailed as a darling of the finance markets at that time. Many Japanese media, in particular TV stations, described him as the hero of the day. However, on January 16, 2006, Livedoor and its associated people faced a criminal investigation by Tokyo District Special Investigators for suspicion of account rigging[4]. Because of this investigation, prices crashed across the Tokyo Stock Market the next day and also in the ensuing weeks.

This paper considers whether the stock split bubble burst not only because of the revision of the system, but also because of the Livedoor shock. The latter changed investor sentiment regarding

[4] After that, Horie Takafumi was arrested for violating the Securities and Exchange Act. He was convicted of account rigging in April 2011.

stocks that split; now, a stock that splits implies a bad company because it shares a business strategy similar to Livedoor's, as opposed to being a good company because its stock price has risen thus far.[5][6] It is difficult to differentiate the effects of the revision and the Livedoor shock, because the time between the revision date and the Livedoor shock was only two weeks. This paper avoids that difficulty through the use of two samples after the revision; a split announcement date before Livedoor shock and one after.

The remainder of the paper is organized as follows. Section 2 outlines the Japanese stock-split system. Section 3 discusses the effect of the Livedoor-shock on stocks that split. Section 4 describes the methodology adopted in this paper and presents the empirical results. Section 5 is the conclusion.

2. An outline of the Japanese stock-split system

In Japan, listed companies actively split their stocks in order to increase liquidity and the number of individual investors for two reasons: stock splits have become much easier due to the revision of the Commercial Code in October, 2001,[7] and the "action program to promote lower stock investment units" in September, 2001. This activity that increased stock price at announcement date, at ex-date, and during the ensuing days became a focus of market players even though a stock split announcement and later events did not influence the fundamentals of a company. This was called the "stock split bubble."

Figure 2 shows the schedule of stock splits under the old system. This schedule applied to the splits where the base date (X) was before January 4, 2006. The base date means the date for determining shareholders who will be allotted new shares. Note that shareholders who are allotted new shares are those on the final trading day with cum rights (X-4), because settlement shall be made on the fourth day following the final trading day with cum rights. Therefore, a person who holds the stocks from ex-date (the day following the final trading day with cum rights) has no rights to receive the new shares. However, even if the person with cum rights who holds the stocks on the final trading day sells all stocks on the ex-date, he still has the rights to receive the new shares. From the ex-date, stocks trade at a lower price than on the previous day because a stock split dilutes the stock value, the amount of dilution depending on split-ratios.

Under the old system, new shares were able to be delivered or traded from the pay-date, not from the ex-date. The pay-date was approximately 50 days after the base date because it required a certain amount of time to deliver new shares and to identify the names of shareholders kept at different

[5] Such investor behavior could be explored by a "representativeness heuristic" mentioned in Tversky and Kahneman (1974). Until 2005, a "stock split" represented a stock whose price rises; investors considered it to be good news. So the price of the split stock rose. However, after the Livedoor shock on January 16th, 2006, a "stock split" represents a bad company similar to Livedoor.

[6] We know that market participants focus interest on companies relative to stock splits after Livedoor-shock, because The Nihon Keizai Shimbun reported the sliding price of a company that split in the past in the January 17, 2006 issue of its evening edition.

[7] In the revision of the Commercial Code, the net assets per value regulation was abolished, and the unit stock system was introduced, making it possible for issuing companies to set the stock investment unit freely and flexibly by a resolution at a board of directors meeting.

securities companies. Therefore, market participants were able to trade only old stocks between ex-date and pay-date.

Figure 3 shows the schedule of stock split under the revised system. This schedule applies the splits if the base date (X) is on or after January 4, 2006. By the systemic revision, the pay-date is brought forward from approximately 50 days after the base date to the ex-date (X-3). So market participants can trade new shares on the ex-date, or the new pay-date. Thus, the trading restriction under the old system is dissolved.

3. The effect of the Livedoor shock on the stock that split

This paper suggests that stock split bubble in Japan burst not only because of the reformed system, but also because of Livedoor shock. Criminal investigation of the Livedoor Corporation had a significantly negative effect on the price of their stock. This section discusses how the Livedoor-shock also has had a negative effect on the price of the splitting firms now and on the split firm in the past. This section examines how the Livedoor shock affects the splitting and the split stocks using event study methodology where the event day is the day of the Livedoor shock, January 16, 2006.

The problem of what sample to use to confirm the fall of the Livedoor shock stock price arises. If the sample includes the stock split under both the old and new systems, it may possibly interact with the other system on the day of the Livedoor shock.

If a sample is collected from pre-revision stock splits that did not have new issues on the date of the Livedoor shock, the sample stocks of the Livedoor shock may have a negative price effect toward the pay-date (3rd feature of the stock split bubble). At this time, we cannot discriminate between the effect of the Livedoor shock and the effect of the delay of new issues under the old system. Thus, when using the pre-revision splits, we have to use the sample that is collected from the split stocks that have already issued new shares. On the other hand, samples of post-revision splits completed before the Livedoor shock include three splits. It is a very small set of samples. Thus, on using the post-revision splits, we have to use the sample that is collected from the split stocks that have been announced but not completed before the Livedoor shock.

In the remainder of this section, we show that the Livedoor shock is a significant event and affects the splits regardless of the system revision by using two separate samples: pre-revision splits and post-revision splits. One is the sample of the splits completely finished under the old system, before the Livedoor shock (referred to as A-stocks). To be more precise, the pre-revision splits sample includes the splits where the pay-day is between November 1, 2005 and December 31, 2005 under the old system. This sample, immediately following the Livedoor shock is affect by since it includes only pre-revision splits and not pro-revision. The other sample is the stocks whose splits had already been announced but had not been implemented under the new system before the Livedoor shock (referred to as B-stocks). All stocks included in this sample were applied under the revised system because they implemented the splits after the Livedoor shock.[8]

[8] Another sample is also considered created from the stocks that implement the splits under the revised

Table 1 shows the abnormal return of A-stocks on the date of the Livedoor shock. Raw returns of all the stocks were negative and averaged −4.19%. Adjusted abnormal returns by the market model are negative except for two stocks and averaged −2.36%.[9] The average standardized abnormal return was −9.94% and negatively significant. This means that the Livedoor shock had an impact on the stocks that split under the old system.

Table 2 shows the abnormal return of B-stocks on the date of the Livedoor shock. Raw returns are negative except for one stock and averaged −3.03%. Adjusted abnormal returns by the market model are negative except for three stocks and averaged −1.88%. The average standardized abnormal return was −6.77% and negatively significant. This means that the Livedoor shock had an impact on the stocks that split, the same as in the previous case.

Both samples include 10 stocks. This may cause the power of the test to be very low. Thus the abnormal returns are calculated by the market adjusted model which is an easier method than the market model. Considering the risk by deducting the average return of the corresponding sector, abnormal returns are calculated.[10] Such results are showed in Table 3. The adjusted average return of the A-stocks is −2.62%, the t-value is −21.25, and negatively significant at the 1% level. The adjusted average return of the B-stocks is −2.20%, t-value is −10.37, and negatively significant at the 1% level.

All of the results above support the conjecture that the Livedoor shock had an impact on the stocks that split.

4. Empirical method

4.1 The calculation of abnormal return

The basic sample is comprised of all Tokyo Stock Exchange (TSE) common stocks that split with a factor greater than 1.5 from October 2001 to December 2007.[11] Their ex-date and pay-date were collected from TSE. The announcement date was collected from The Nihon Keizai Shimbun. In order to avoid effects other than the stock split, stocks with a dividend that changed from announcement date to pay-date were deleted from the sample. The corresponding price data and financial data were obtained from the Nikkei Economic Electronic Database System (NEEDs).

To calculate the abnormal returns, we use the event study methodology with a market model. The event study methodology calculates the degree of abnormal returns around the event date. This paper calculates abnormal return by following Campbell, Lo, and MacKinlay (1997).

To calculate the abnormal return, we use following market model:

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system before the Livedoor shock. However, only three companies implemented stock split from the revision date (January 4, 2006) to the Livedoor shock (January 17, 2006). So, such a sample is not sufficient for the test.

[9] Calculation method for abnormal return using the market model is explained in the next section.

[10] Kothari and Warner (2007) reported that the power of the test is sufficiently high in this case that an event window is one day even if the sample size is less than 10. Therefore, the sample size problem may be small.

[11] Tokyo Stock Exchange, “the list of stocks that have split with a factor greater than 1.5” (the text in Japanese) http://www.tse.or.jp/rules/listing/unit/bunkatsu.pdf

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t},\ \mathrm{E}\left[\varepsilon_{i,t}\right] = 0,\ \mathrm{Var}\left[\varepsilon_{i,t}\right] = \sigma_i^2 \qquad (1)$$

where $R_{i,t}$ and $R_{m,t}$ are actual returns for security i and market return on trading day t, respectively. $\varepsilon_{i,t}$ is an error term with average 0 and volatility σ_i^2. α_i, β_i and σ_i^2 are parameters of the market model. In this paper, the estimation window for the parameters is [−135, −16] trading days prior to the split announcement. We do not include the securities if the outstanding stock volume was changed from announcement date to pay-date except by stock split, in order to avoid other events contaminating the effects of the stock splits. We use the value-weighted Tokyo Stock Exchange Section 1 index (TOPIX) for a market index.

As we calculate the abnormal return in this way, we calculate the abnormal return on event date t, $AR_{i,t}$ as follows:

$$AR_{i,t} = R_{i,t} - \hat{\alpha}_i - \hat{\beta}_i R_{m,t} \qquad (2)$$

where $\hat{\alpha}_i$ and $\hat{\beta}_i$ are estimates of α_i and β_i, respectively. This paper calculates the abnormal returns during the 15 days centering on the announcement date. In addition, it calculates the standardized abnormal returns of each company in consideration of differences of volatilities among securities by dividing the stock return by its corresponding standard deviation.

4.2 Testable hypothesis and Empirical method

This paper researches the effect of the systemic revision and the Livedoor shock on the split stock by regressing to the abnormal returns on some factors.

This paper focuses on demonstrating the trading restriction hypothesis and the change of investor sentiment by the Livedoor shock. We treat the abnormal returns on the announcement date as the dependent variable. There are three days as the candidates for the event dates related to the stock split: the announcement date, the ex-date, and the pay-date. We focus on abnormal returns of the announcement date because new expectations for the split stock impacts the stock price on that day. Even though trading restriction is suggested as an explanation of the effect on the stock price on the ex-date and pay-date, other factors cannot explain the effects on the investor's expectations and on the stock price on those days. Thus, we treat the abnormal returns on the announcement date as a dependent variable; we can see changes in the stock price and investor sentiments before and after the system revision.

To examine the fourth feature, that the stock price after the pay-date is much higher than at the announcement date, possibly caused by the Livedoor shock, we have to compare the stock return from pre-announcement to post-pay-date before the Livedoor shock with the one after. In addition, to identify the constant effect of the system revision and of the Livedoor shock, we have to compare the

return of the stock that implements the split under the new system before the Livedoor shock with the return of the stock that implements the split under new system after the Livedoor shock. But there are only three stocks that implement the split under new system before the Livedoor shock, so the corresponding sample is very small. Thus we cannot create a proper sample to indicate that the fourth feature is resolved by the Livedoor shock. In this paper, we examine the negative effect of the Livedoor shock on the stock price when a stock split is announced. Examinations of the impact of the Livedoor shock in the fourth feature are left for further research.

Trading restriction hypothesis

The trading restriction hypothesis states that abnormal returns occur because of temporary illiquidity of the stock caused by the stock split under the old system. We suspect that the greater the magnitude of trading restrictions, the greater the abnormal returns. Here we use a variable indicating the magnitude of the trading restrictions, ILL. Following Greenwood (2009), we define

$$Trading\ Restrection\ (ILL) = \left(1 - 1/split\ factor\right) \times Turnover\ (TO) \qquad (3).$$

In RHS, $\left(1 - 1/split\ factor\right)$ means the proportion of the total outstanding stock that is temporarily untradeable after the stock split. Multiplying by the average turnover, we calculate a predicted loss of turnover under trading restrictions.

We examine the investor with the expectation that the price of a split stock increases under the old system. Such a psychological effect is not necessarily proportional to the trading restriction. If such an expected price increase vanishes after the systemic revision of the stock split process, we would suspect the system revision of eliminating the positive psychological effect on the stock price.

To study this effect, we use a dummy variable for the post-revision split stock. *D* equals 1 if the ex-date is after revision and zero otherwise. If the stock price is increased by the psychological effect and this effect is reduced or eliminated by the revision, then we would expect the effect of *D* on the stock price to be negative.

Note that the dummy variable, *D*, is assigned on the basis of the ex-date, while the dependent variable is the abnormal return on the announcement date. Although the basis date is different, it is correct to believe that whether the ex-date is before or after the system revision, the date affects the stock price at announcement date because investors know the stock split and the ex-date at the announcement date.

The trading restriction hypothesis implies that *ILL* has an impact on stock return on the announcement date under the old system, but not so under the new system. So, one would expect that the Coefficient of *D_ILL*, defined by the cross term of *D* and *ILL*, cancels out the coefficient of *ILL* under the new system.

Greenwood (2009) introduces turnover (*TO*) as a variable relaxing trading restriction. We suspect that the more turnover there is before announcement of a stock split, the lesser will be the effect of the restriction by stock split, so that a rising stock price can be suppressed. We expected the effect of

turnover on stock price to be negative. As with *ILL*, we expect this effect does not appear after revision. Thus, we expect that the Coefficient of *D_TO*, defined by cross term of *D* and *TO*, cancels out the coefficient of *TO* under the new system.

The Livedoor shock hypothesis

Next, we consider the Livedoor shock hypothesis which states that expectations for rising prices due to a split stock vanished because of the Livedoor shock (January 17, 2006). If so, price increases at the announcement date after the Livedoor shock should disappear. To study this effect, we use a dummy variable (*D_LS*) for a split stock announced after the Livedoor shock. *D_LS* equals 1 if the announcement date is after the Livedoor shock and zero otherwise. If the expectation of price increases caused by a by stock split vanishes after the Livedoor shock, then we would expect the effect of *D_LS* on stock price to be negative.

Signaling hypothesis

In addition, this paper briefly tests the validity of the signaling and liquidity hypotheses. The signaling hypothesis states that the announcement of the split conveys good information about future performance of the company. We use the growth rate of operating profit at the last accounting period (*CE_L1*), at the current accounting period (*CE_0*), and at the next accounting period (*CE_1*) as explanatory variables. Each of them is expected to have a positive effect on the stock price.

Liquidity hypothesis

To test the liquidity hypothesis, we use the growth rate of the daily average turnover between the before announcement and the after pay-date as an explanatory variable (*AR_TO*). To be more precise, we use a growth rate that divides the average turnover between the pay-date and after 15 business days by the average turnover during the estimation period. Such an effect on improved liquidity is an expected positive effect on the stock price.[12]

Using the above setting, we regress to the following equation:

$$\begin{aligned} AR_i = & const. + \beta_1 \cdot D_i + \beta_2 \cdot D\_LS_i + \beta_3 \cdot ILL_i + \beta_4 \cdot D\_ILL_i + \beta_5 \cdot TO_i \\ & + \beta_6 \cdot D\_TO_i + \beta_7 \cdot CE\_L1_i + \beta_8 \cdot CE\_0_i + \beta_9 \cdot CE\_1_i + \beta_{10} \cdot AR\_TO_i + \varepsilon_i \end{aligned} \quad (4)$$

Equation (4) is estimated by ordinary least square. The expected sign conditions of the coefficient parameters are

[12] For the proxy variable of liquidity in regressions, we use traded volume (or traded volume adjusting face amount) other than turnover. However, they have no significant impact on abnormal returns. Additionally, we use the dummy variable for the information-communications industry and the dummy variable for startup venture companies like Livedoor in regressions. However, they also have no significant impact on abnormal return.

trading restriction hypothesis:

$$\beta_3 > 0, \quad \beta_3 = -\beta_4 \tag{5}$$
$$\beta_5 < 0, \quad \beta_5 = -\beta_6 \tag{5'}$$

Livedoor shock hypothesis:

$$\beta_2 < 0 \tag{6}$$

signaling hypothesis:

$$\beta_7 > 0, \quad \beta_8 > 0, \quad \beta_9 > 0 \tag{7}$$

liquidity hypothesis:

$$\beta_{10} > 0 \tag{8}$$

5. Empirical results

Table 4 shows estimation results of equation (4). The column of Model 1 is the result of regression with all explanatory variables.

Test of trading restriction hypothesis

The coefficient of *ILL* as trading restriction (β_3) is 4.717and the t-value is 2.67. This is positively significant. The test of the coefficient condition ($\beta_3 = -\beta_4$) does not reject by F-test.[13] Thus, the trading restriction hypothesis is supported.

In addition, the coefficient of *TO* indicating the turnover is negatively significant. The test of the coefficient condition ($\beta_5 = -\beta_6$) does not reject by F-test. The coefficient of *D* indicating the post-revision is not significant. This result means that the revision did not cancel out expectations that

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[13] This statistic is calculated using the expression: $F = \left(RSSR - USSR/r\right)/\left(USSR/n-k-1\right)$ where $RSSR$ is the restricted sum of squared residuals, $USSR$ is the unrestricted sum of squared residuals, n is the number of observations, k is the number of explanatory variables, and r is the number of restrictions (in this case, $r=1$). This F statistic is distributed as $F(r, n-k-1)$. For the test of the restriction that $\beta_3 = -\beta_4$, we use the restricted sum of squared residuals from the following restricted regression model:

$$AR_i = const. + \beta_1 \cdot D_i + \beta_2 \cdot D\_LS_i + \beta_3 \cdot \tilde{ILL}_i + \beta_5 \cdot TO_i + \beta_6 \cdot D\_TO_i + \\ + \beta_7 \cdot CE\_L1_i + \beta_8 \cdot CE\_0_i + \beta_9 \cdot CE\_1_i + \beta_{10} \cdot AR\_TO_i + \varepsilon_i$$

where $\tilde{ILL}$ equals ILL if the ex-date is after revision and zero otherwise. For the test of the restriction that $\beta_5 = -\beta_6$, we use the restricted sum of squared residuals from the following restricted regression model:

$$AR_i = const. + \beta_1 \cdot D_i + \beta_2 \cdot D\_LS_i + \beta_3 \cdot ILL_i + \beta_4 \cdot D\_ILL_i + \beta_5 \cdot \tilde{TO}_i \\ + \beta_7 \cdot CE\_L1_i + \beta_8 \cdot CE\_0_i + \beta_9 \cdot CE\_1_i + \beta_{10} \cdot AR\_TO_i + \varepsilon_i$$

where $\tilde{TO}$ equals TO if the ex-date is after revision and zero otherwise.

stock prices would rise due to the stock split.

Test of the Livedoor shock hypothesis

The coefficient of *D_LS* indicating that the announcement date is after the Livedoor shock is negatively significant. This is positively significant. The test of the coefficient condition ($\beta_3 = -\beta_4$) does not reject by F-test. Thus, the trading restriction hypothesis is supported. The reasons why the stock split bubble is not seen after 2006 are revealed to be not only that the systemic revision , but also that the Livedoor affair that collapsed the myth of rising stock prices by stock split.

Test of signaling hypothesis

The coefficients of the growth rate of operating profit (*CE_L1*, *CE_0*, and *CE_1*) are insignificant and do not satisfy the conditions to support the signaling hypothesis. Thus, we do not find the results support the signaling hypothesis.

Test of liquidity hypothesis

The coefficients of the growth rate of turnover (*AR_TO*) that is a proxy variable for improving liquidity is insignificant and negative. Thus, we do not support the liquidity hypothesis.

The fact that the results do not support the signaling or liquidity hypotheses could be masked by a correlation among the three variables about the growth rate of operating profit and turnover. Thus, we use each one separately for regression. Those results are Models 3 to 6. However, none of the four results support the signaling or liquidity hypotheses. But all results support the trading restriction and the Livedoor shock hypotheses. Model 2 is the result of regression without variables related to the signaling or liquidity hypotheses. That result is robust, hence the trading restriction and the Livedoor shock hypotheses are supported.[14]

6. Conclusion

In Japan, stock splits grew rapidly after 2001. At same time, prices of the split stocks rose at the announcement and ex-date. Stock prices after pay-dates also were much higher than before announcements. These phenomena are called the "Stock Split Bubble."

Greenwood (2009) pointed out that those phenomena were attributed to the reduction of liquidity by new shares issued about 50 days after the ex-date. This paper is important to additionally demonstrate that the stock split bubble was caused by the trading restriction hypothesis and not by the signaling or liquidity hypotheses. We advocate the validity of Greenwood (2009) because we establish that the bubble phenomena vanished after the systemic revision that remedied the trading restriction of stock splits after January 4, 2006.

We demonstrate the phenomenon that a stock price after pay-date is much higher than one before its

[14] We also test the signaling hypothesis and liquidity hypothesis during pre-revision and post-revision separately, using regressions with the cross terms of *D* and *CE_L1*, *CE_0*, *CE_1*, and *AR_TO*, separately. No results supported the two hypotheses.

stock split announcement. This phenomenon would be not explained through Greenwood's (2009) trading restriction hypothesis because trading restriction is absent after the pay-date during pre-revision. We think this phenomenon is attributed to investor expectations that the price of a split stock rises. The problem here is why such an expectation vanished after 2006.

One candidate is the systemic revision. Another is the Livedoor shock, specifically that the Livedoor Corporation faces criminal investigation. Livedoor was a representative firm that enjoyed the benefit of the stock split bubble. Therefore, this criminal investigation on Livedoor destroyed the myth of the stock split bubble in investor sentiment.

This paper first demonstrates that the Livedoor affair decreased not only the price of Livedoor related companies, but also prices of stocks now splitting and those that had split in the past. Next we demonstrate the trading restriction hypothesis using data compounding both pre-revision and post-revision. The result shows that the trading restriction helped cause the bubble before revision, but had no effect on increases in stock prices after revision. Neither the signaling nor the liquidity hypotheses had any validity in our sampling period. More importantly, using the dummy variable for a stock that split after the revision, we reveal that the myth of the "stock split bubble" was destroyed by the Livedoor affair and not just the systemic revision.

We conclude that both the trading restriction and the Livedoor shock hypotheses are supported, but neither the signaling nor liquidity hypotheses are supported. However, this paper is not enough to validate the latter because our main purpose is demonstrating and testing the former. We used a simple way to validate the latter. So, we recommend further research to determine whether or not the signaling or liquidity hypotheses are supported.

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Table 1 Abnormal return of A-stocks on the date of the Livedoor shock

Security Code	Actual Return	AR	SAR
T2395	-6.94%	-6.15%	-28.07
T2674	-1.92%	-0.78%	-4.31
T3770	-13.19%	-9.13%	-16.37
T4082	-3.44%	-0.97%	-3.85
T4295	-4.53%	-1.33%	-5.02
T4464	-3.32%	-3.09%	-21.74
T4799	-0.33%	0.67%	3.28
T6869	-1.92%	0.83%	4.88
T7741	-3.13%	-1.85%	-17.31
T7867	-3.18%	-1.79%	-10.91
	-4.19%	-2.36%	-9.94
		t-value	-31.44***

This table shows the abnormal return of A-stocks (the split stocks where the pay-date is between November 1, 2005 and December 31, 2005) on the date of the Livedoor shock (January 17, 2006). *** shows statistically significance at the 1% level.

Table 2 Abnormal return of B-stocks on the date of the Livedoor shock

Security Code	Actual Return	AR	SAR
T2593	-0.26%	1.76%	11.64
T2792	-2.16%	-0.58%	-2.50
T3387	-7.19%	-8.17%	-10.95
T3955	-1.04%	-0.77%	-5.94
T4722	0.38%	2.34%	8.95
T5727	-3.62%	-0.74%	-2.49
T7616	-3.06%	-2.72%	-13.18
T8198	-0.80%	-0.23%	-1.25
T8519	-11.51%	-10.74%	-59.79
T8570	-1.00%	1.07%	7.79
	-3.03%	-1.88%	-6.77
		t-value	-21.42***

This table shows abnormal return of B-stocks (the stocks whose splits had already been announced but had not been implemented under the new system before the Livedoor shock) on the date of the Livedoor shock (January 17, 2006). *** shows statistically significance at the 1% level.

Table 3 Abnormal return on the date of the Livedoor shock using matching portfolio approach

	Observation	AR	t	
A-stocks	33	-2.62%	-21.25	***
B-stocks	20	-2.20%	-10.37	***

This table shows the abnormal return of the A-stocks (the split stocks where the pay-date is between November 1, 2005 and December 31, 2005) and the B-stocks (the split stocks whose splits had already been announced but had not been implemented under the new system before the Livedoor shock). Abnormal returns are calculated by using market adjusted model (deducting average return of the correspond sector). *** shows statistically significance at the 1% level.

Table 4 Cross-sectional regression results for the abnormal return on announcement date

	Model 1			Model 2			Model 3			Model 4			Model 5			Model 6		
	coef.	t		coef.	t		coef.	t		coef.	t		coef.	t		coef.	t	
D	1.494	1.38		1.022	0.93		1.021	1.05		0.847	0.71		0.938	0.85		1.562	1.55	
D_LS	-2.980	-2.78	***	-2.377	-2.11	**	-2.416	-2.45	**	-2.370	-1.96	*	-2.372	-2.11	**	-2.750	-2.69	***
ILL	4.717	2.67	***	4.829	3.13	***	4.561	2.64	***	5.705	2.77	***	5.469	3.00	***	5.331	3.40	***
D_ILL	-4.366	-2.26	**	-4.598	-2.59	**	-4.152	-2.20	**	-5.292	-2.34	**	-5.231	-2.59	**	-5.075	-2.92	***
TO	-3.814	-2.72	***	-3.970	-3.28	***	-3.691	-2.70	***	-4.651	-2.85	***	-4.473	-3.11	***	-4.336	-3.50	***
D_TO	3.630	2.44	**	3.804	2.84	***	3.477	2.40	**	4.430	2.56	**	4.302	2.78	***	4.166	3.13	***
CE_L1	0.024	0.75					0.027	0.88										
CE_0	-0.100	-0.29								-0.024	-0.64							
CE_1	-0.017	-0.09											0.031	0.21				
AR_TO	-0.124	-1.65														-0.055	-1.04	
_cons	2.699	7.28	***	2.549	7.93	***	2.575	8.02	***	2.770	7.59	***	2.632	7.61	***	2.391	7.67	***
R2	0.154			0.095			0.112			0.092			0.098			0.124		
obs.	124			189			140			157			170			164		
The tests of the coefficient conditions for the trading restriction hypothesis																		
(1) $\beta_3 = -\beta_4$	0.20	(0.66)		0.07	(0.79)		0.28	(0.59)		0.19	(0.66)		0.07	(0.79)		0.12	(0.73)	
(2) $\beta_5 = -\beta_6$	0.14	(0.70)		0.08	(0.77)		0.20	(0.65)		0.14	(0.70)		0.09	(0.76)		0.12	(0.73)	

Table 4 shows estimation results of equation (4) and tests of the coefficient conditions for the trading restriction hypothesis. The dependent variable is the abnormal returns on the announcement date. *D* is the dummy variable that equals 1 if the ex-date is after revision and zero otherwise. *ILL* is the variable for illiquidity. It is calculated using equation (3). *D_ILL* is defined by cross term of *D* and *ILL*. *TO* is the variable for turnover with relaxing trading restriction. *D_TO* is defined by cross term of *D* and *TO*. *D_LS* is the dummy variable for a split stock announced after the Livedoor shock. *D_LS* equals 1 if the announcement date is after the Livedoor shock and zero otherwise. *CE_L1*, *CE_0*, and *CE_1* is the growth rate of operating profit at last accounting period, at current accounting period, and at next accounting period, respectively. *AR_TO* is the growth rate of daily average turnover between before announcement and after pay-date as explanatory variable. ***, **, and * show statistically significance at the 1% level, the 5% level and the 10% level, respectively. The test statistics of the coefficient conditions are the F statistics. P-values are in parentheses.

Figure 1 the average price of split stock on pre-revision and post-revision

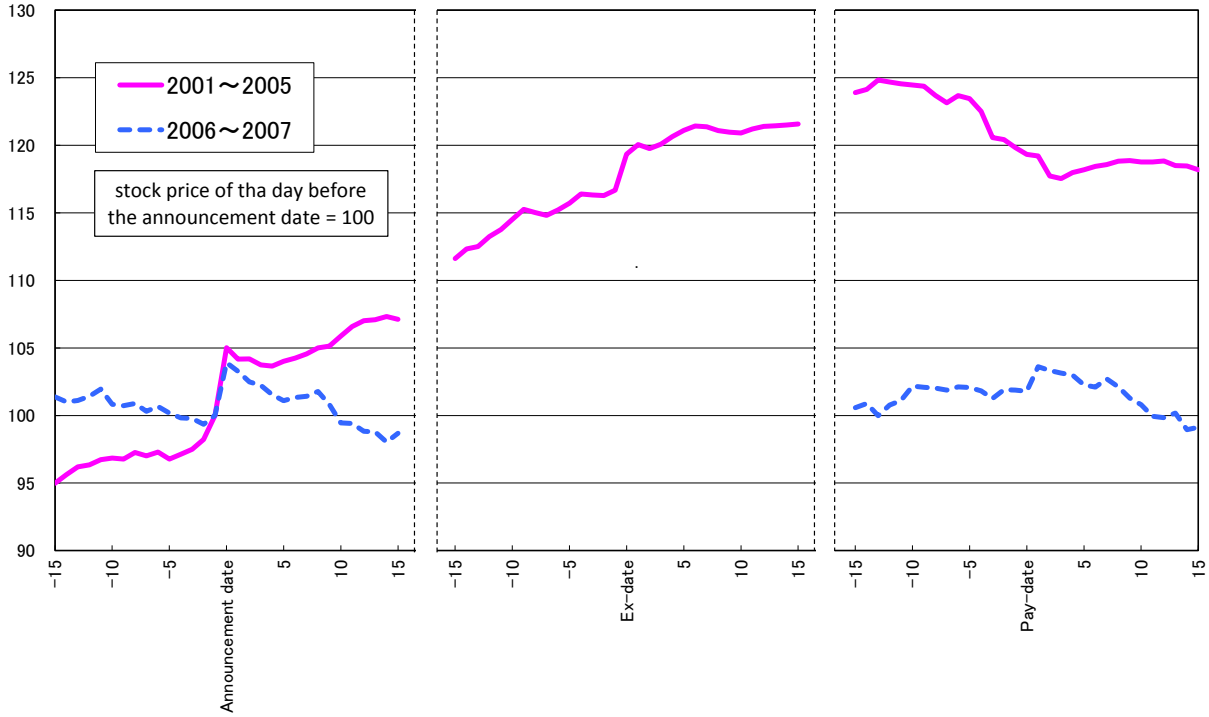

Figure 1 shows the average price of a split stock between October 2001 and December 2005 (pre-revision) and between January 2006 and December 2007 (post-revision), normalizing to 100, the closing price on the day before the announcement date. Also, the price after the ex-date is multiplied by the split factor to adjust split ratios. The solid line shows the average price of stocks that split before the revision; the dashed line shows the average price of stocks that split after the revision.

Figure 2 Schedule of the stock split on pre-revision (before 2006)

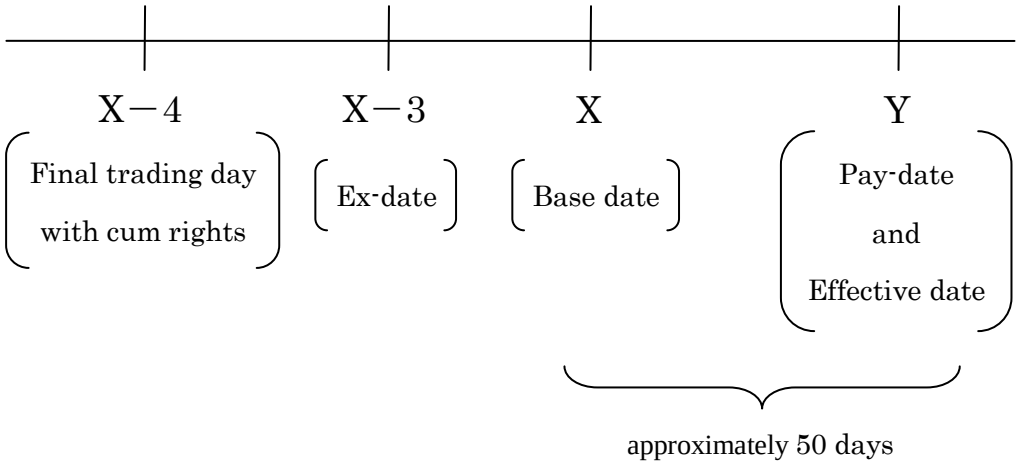

Figure 3 Schedule of the stock split on post-revision (after 2006)