The Market Reaction to Stock Splits
- Evidence from Germany -*

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Abstract

Although stock splits seem to be a purely cosmetic event, there exists ample empirical evidence from the United States that stock splits are associated with abnormal returns on both the announcement and the execution day, and additionally with an increase in variance following the ex-day. This paper investigates the market reaction to stock splits using a set of German firms. Consistent with the U.S. findings, similar effects are observed for the sample of German stock splits. Institutional differences between Germany and the U.S. allow to disentangle the three main hypotheses on the announcement effect - signalling, liquidity, and neglected firm hypothesis – to gain further insights into their relative explanation power.

This paper argues that legal restrictions strongly limit the ability of German companies to use a stock split for signaling. Consistently, abnormal returns around the announcement day are much lower in Germany than in the U.S. Although a significant increase in liquidity can be found after the split cross-sectional tests do not lend any support to the hypothesis that price changes are positively related to liquidity changes. This is in contrast to the results of Muscarella/Vetsuypens (1996) and Amihud/Mendelson/Lauterbach (1997). The paper shows that the announcement effect to German stock splits is best explained by a neglected firm effect.

On the methodological side the effect of thin trading on event study results is examined. Using trade-to-trade returns increases the significance of abnormal returns but the difference between alternative return measurement methods is relatively small in short event periods. Thus, the observed market reaction cannot be attributed to measurement problems caused by thin trading.

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1 Introduction

There exists ample empirical evidence that in the U.S. stock splits are associated with positive abnormal returns around the announcement and the execution day and in addition with an increase in variance following the ex-day.[1] Since stock splits seem to be purely cosmetic corporate events these findings are puzzling. Several hypotheses have been put forward to explain the market reaction around the announcement day. Of those, the signaling hypothesis (Asquith, Healy, and Palepu (1989), Rankine and Stice (1997)) and the liquidity hypothesis (Baker and Powell (1993), Muscarella and Vetsuypens (1996)) have received most attention, although empirical evidence for the latter is mixed. In addition, several studies find that the neglected firm hypothesis provides some explanation power as well (Grinblatt, Masulis, and Titman (1984), Arbel and Swanson (1993), and Rankine and Stice (1997)).

Since most of these hypotheses are not applicable to the market reaction on the split ex-day, Maloney and Mulherin (1992), and Conrad and Conroy (1994) relate the ex-day behavior to market microstructure phenomena. Furthermore, Marsh (1979), Dimson and Marsh (1983), and Maynes and Rumsey (1993) maintain that event study results can be strongly affected by return measurement errors in the presence of thin trading. Since this problem has been widely ignored and has in particular never been addressed in the context of stock splits this paper aims at filling this gap using a sample of stock splits from the German capital market. German data seem to be particularly well suited for the task at hand because the proportion of infrequently traded shares is much higher in Germany than in the U.S. Also, due to institutional differences between both countries not all of the existing theories can be equally applied to the German case, thus leading to further insights into the explanation power of the competing theories.

In line with the results of many other studies on stock splits in different capital markets significant positive abnormal returns are found both around the announcement and the ex-day of German stock splits. An increase in return variance after the ex-day is observed as well.

[1] See e.g. Grinblatt, Masulis and Titman (1984), Ohlson and Penman (1985), Lakonishok and Lev (1987), Asquith, Healy and Palepu (1989), Maloney and Mulherin (1992), Pilotte and Manuel (1996) and Koski (1998).

But in contrast to the empirical findings in the U.S.- and other capital markets German stock splits are associated with a substantial increase in liquidity.

To investigate the potential influence of infrequent share trading on the detection of abnormal returns two different methods of return calculation are employed: The first one uses all available share prices regardless whether they were accompanied by a trade or not, while the second one uses only transaction prices to calculate trade-to-trade returns as described in Dimson and Marsh (1983). The market reaction is significant for both types of return calculation and even slightly more pronounced using trade-to-trade-returns, as suggested by the simulation study of Maynes and Rumsey (1993).

The empirical results are best explained by a neglected firm effect. It is argued that for institutional reasons the scope to convey a signal via stock splits is very limited in Germany. Consistent with this view, the share price reaction to stock splits is much lower in Germany than usually found in the U.S. Furthermore, no evidence can be found that the improved liquidity leads to an increase in value. This is in contrast to the model proposed by Amihud and Mendelson (1986) and to the empirical findings of Muscarella and Vetsuypens (1996) for a sample of ADR splits.

This paper contributes to the existing literature in several ways. It extends the international empirical evidence on stock splits to the German capital market. It also provides additional insight into the relative explanation power of the existing theories supporting mainly the neglected firm hypothesis. The analysis contributes further to the debate about the role of liquidity in asset markets. On the methodological side it is shown that the observed effects cannot be attributed to measurement problems caused by thin trading. Using trade-to-trade-returns increases the significance of the market reaction, but the difference between both methods is relatively small.

The outline of the paper is as follows. In Section 2 the institutional differences between German and U.S. stock splits are explained. Their implications to the applicability of the existing theories to the German case are analysed in section 3. Section 4 describes the data and methodology. In Section 5 the empirical results are discussed and section 6 concludes the paper.

2 Institutional Characteristics of German Stock Splits

In the U.S. as in Germany, stock splits increase the number of shares without leading to an inflow or outflow of cash, without changing the investment opportunities of the corporation or even changing its book value. The increase in the number of shares is simply done by reducing the par value of the share accordingly. The difference between German stock splits and its U.S. counterparts is largely due to the fundamental role of the par value of German stocks. Most stock issued by a corporation in the U.S. have a par value, but they do not need to have one. Usually the par value is very low and - most importantly - does not prevent the company from deciding on a stock split or choosing a convenient split factor.

The scope for German companies to split their stock is limited by the minimum par value requirement of the German corporate code (§ 8 Aktiengesetz). Once a company's stock is traded at the minimum par value, no further splits are possible.[2] In 1994 the minimum par value was lowered from 50 DM to 5 DM, triggering a wave of stock splits. A similar wave of stock splits had occurred when in 1966 the minimum par value was lowered from 100 DM to 50 DM.[3]

Until 1997 only certain other par values were allowed above minimum par value.[4] Before 1994 the range of possible higher par values was restricted to multiples of 100 DM, i.e. 200 DM, 300 DM etc, then it changed to multiples of the new minimum par value of 5 DM. As shown in table 1, in the years before each corporate law reform act almost all stocks were traded at the prevailing minimum par value. Between 1966 and 1994 almost all companies split stock at the same split factor of 100 %, since German corporate code did not allow any par value between 50 DM and 100 DM at that time. Furthermore, table 1 reveals that although after the corporate code reform act of 1994 companies could have decided on a new par value

[2] The minimum par value rule also applies to the „seemingly no par value stocks“ (Stückaktien) which were introduced in the German corporate code in 1997. German seemingly no par value stocks do not carry an explicit par value but an implicit one, and are thus different from the „real“ no par value stocks issued by US-american companies. The implicit par value can be calculated by dividing the common stock capital by the number of shares outstanding.

[3] Before 1965 only very few companies, mainly insurance companies, were allowed to have par values below 100 DM for reasons which are related to the Reichsmark/Deutschmark conversion of the company's capital account in 1949 after the German currency reform of 1948. For details, see Wulff (1999).

[4] In 1997 companies were given the option to issue seemingly no par value stocks instead of par value stocks (see also footnote 2). Seemingly no par value stocks can carry any implicit par value above minimum par value.

below 50 DM but above 5 DM such as 10 DM or 15 DM, none has chosen to do so and all have split their stock to the lowest possible par value of 5 DM.

Table 2 shows the clustering of stock splits in the two periods around 1969 and 1995, whereas between 1975 and 1994 hardly any stock split occurred. Still, unlike 1994, when the number of stock splits increased immediately after the change in legislation, the response to the reduction of the minimum par value of 1966 had its peak in 1969, three years later. This is due to the change in the method of quoting stocks which happened in those years. Until 1969 in Germany stocks were quoted as a percentage of par value which means that a stock split would have had no effect on the price. In 1969 the method of quoting stocks was changed to DM-pricing, but already between 1966 and 1969 companies could apply to the German stock market authorities to have their shares quoted in DM, which those firms that decided on a stock split before 1969 did.

In the U.S. as in Germany stock dividends differ from stock splits in their accounting treatment. Whereas a stock split increases the number of shares by reducing the par value accordingly, a stock dividend requires a transfer from retained earnings and/or capital surplus. Thus unlike a stock split, a stock dividend can reduce the financial flexibility of a firm[5], which can be interpreted as cost of signaling and means that the signaling content of a stock dividend announcement should be much higher than that of a split announcement. Still, in the U.S. many empirical studies have used rather the CRSP-classification or the split factor than the actual accounting treatment to distinguish between stock splits and stock dividends (e.g. Grinblatt, Masulis and Titman (1984), Lakonishok and Lev (1987)). Other studies (e.g. McNichols and Dravid (1990)) do not distinguish between stock splits and stock dividends at all. Rankine and Stice (1997) show that the CRSP classification of stock splits and stock dividends matches the actual accounting treatment in only 23 % of the events in their sample. As they report an abnormal return of 0.53 % for stock splits in a three-day announcement period compared to 2.24 % for stock dividends they show that careful distinction between both events is crucial for assessing potential information contents.

In Germany the distiction between those two corporate events is clear cut. Since the minimum par value rule does not apply to German stock dividends, they occur regularly throughout the years, as shown in table 2. Also, the split factor of German stock dividends can be chosen

according to the company's amount of retained earnings and/or capital surplus. As both corporate events have to be approved by the annual general meeting, it happens that the same meeting decides on a stock dividend and a stock split. The occurrence of both events is not mutually exclusive in Germany.[6] Gebhardt, Entrup and Heiden (1994) and Padberg (1995) find that the announcement and the execution of German stock dividends is associated with similar significant positive abnormal returns as in the U.S. So far there has been only very little empirical evidence on German stock splits.[7] This paper is primarily based on a sample of stock splits initiated by German firms between 1994 and 1996. As far as the available data allow, stock splits of the period 1966 to 1993 are examined as well.

3 Hypotheses

The hypotheses most favored by researchers to explain the announcement effects around stock splits are the signaling, the liquidity and the neglected firm hypothesis. They are not mutally exclusive, but often combined.

Grinblatt, Masulis, and Titman (1984), Asquith, Healy and Palepu (1989), and Rankine and Stice (1997) hypothesize that firms signal information about their future earnings through their split announcement decision. As pointed out before, the managements' scope to decide on a stock split is limited by regulatory constraints in Germany. Specifically, there can be no signaling content in the choice of the split factor as McNichols and Dravid (1990) find for the U.S., because in Germany the split factor is largely determined by the prevailing minimum par value. Unlike stock dividends, stock splits are not associated with a reduction in retained earnings, which could otherwise act as signaling cost, as suggested by Grinblatt, Masulis, and Titman (1984). Also, the signaling models of Brennan and Copeland (1988) and Brennan and Hughes (1991) are not applicable to the German case, as they are both based on a specific brokerage cost schedules which are different in Germany. Thus, if signaling is the main driving force behind the announcement effect to stock splits and stock dividends in the U.S., the market reaction to German stock splits should be considerably lower.

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[5] See Kalay (1982).
[6] The cases in which the ex-date of the stock split coincides with the ex-date of a stock dividend of the same stock are excluded from the sample of this study. See also section 4.
[7] The only two other papers dealing with German stock splits, Wulff (1996) and Kaserer and Mohl (1997), both suffer from small sample sizes.

The liquidity hypothesis often takes the form of an optimal trading range hypothesis which states that companies tend to move their share price back towards an as optimal perceived trading range after the share price has risen substantially. Although Lakonishok and Lev (1987) and Han (1995) provide some empirical evidence on the existence of an optimal trading range in the U.S., this hypothesis is in contrast to the decrease in trading activity after a split observed by Copeland (1979) and Conroy, Harris and Benet (1990). Focussing on an arguably signal-free sample of ADR splits, Muscarella and Vetsuypens (1996) show that liquidity after the split improves which is accompanied by wealth gains to investors. Their findings support the model of Amihud and Mendelson (1986), which predicts a positive relation between equity value and liquidity. According to this model rational investors discount illiquid securities heavier than liquid ones due to the higher transaction costs and greater trading frictions they face. This hypothesis could provide explanation power to German stock split announcement effects as well.

The neglected firm hypothesis is in the context of stock splits predominantly proposed by Arbel and Swanson (1993). It states that if there is little known about a firm its shares trade at a discount. Thus, firms use the split to draw attention to ensure that information about the company is wider recognized than before. This hypothesis can be valid in the German capital market as well.

Even if there is some information content associated with stock splits, in an efficient market all information should be incorporated in the stock price on the anouncement, but no price reaction should be expected on the execution day. Therefore the hypotheses discussed above are not capable of explaining the well documented ex-day behavior of stock splits in the U.S. capital market. Both Malhoney and Mulherin (1992) and Conrad and Conroy (1994) associate the ex-day price reaction to market microstructure phenomena. Their findings suggest that the abnormal returns around the ex-day cannot be earned by an investor but are evoked by measurement errors caused by changes in the bid-ask spread. Koski (1998) questions these findings showing that the increase in variance after the stock split is independent from changes in the bid-ask spread. In Germany, bid-ask effects cannot be held responsible for the ex-day market reaction because shares are traded in an double auction system. Thus, there are no designated market makers or specialists who make bid and ask quotes.

This paper extends the work of Koski (1998) by examining another potential cause of measurement errors which is thin trading. Marsh (1979) and Dimson and Marsh (1983) suggest that inclusion of share prices without recorded trades can lead to severe distortions of event study results. To overcome this problem they propose the calculation of trade-to-trade returns. Maynes and Rumsey (1993) support this view in their simulation study. Still, to my knowledge the sensitivity of event study results to the alternative use of simple and trade-to-trade returns has never been examined before in a real case application using daily data.

4 Data and Methodology

The initial sample consists of all stock splits by firms listed on the official market segment of the Frankfurt Stock Exchange (FSE), the second tier market of the FSE, or on another German stock exchange from 1994 through 1996. Of these 110 splits, 24 cases are excluded because the split ex-date coincided with the ex-date of another corporate event of the same stock such as a stock dividend or a rights issue. Three other events are excluded because prices were unavailable, leaving a final sample of 83 splits (ex-dates).[8] Announcement dates could be obtained for 78 splits by searching the *Börsenzeitung*, *Bundesanzeiger*, *Frankfurter Allgemeine Zeitung*, and *Handelsblatt* for the first public announcement. Daily stock returns are calculated from the daily stock price file of the *Deutsche Finanzdatenbank (DFDB)*.[9] Data errors are corrected by cross-checking with the *Hoppenstedt-Kurstabellen*. Information whether a quoted price was accompanied by a transaction or not is available for all splits of the sample but for only 72 splits detailed data about trading volume could be obtained.

In addition, daily stock prices could be obtained for 78 stock splits of the period from 1966 to 1996 but unfortunately no announcement dates and no transaction information is available for them. Therefore the use of this data is limited to the provision of additional evidence on the ex-day effect. Descriptive statistics of the sample are presented in table 3.

[8] The sample contains 12 pairs of voting and non-voting shares of German dual-class firms. The empirical results of this paper do not change noticably, when the sample is confined to one class of share per firm.
[9] The return calculations are adjusted for corporate events and dividends.

The price reaction to German stock splits is examined by applying the standard event study methodology as described in Brown and Warner (1985). Market-and-risk adjusted simple daily returns are calculated as follows: [10]

$$AR_{i,t} = R_{i,t} - \hat{\alpha}_i - \hat{\beta}_i R_{m,t} , \tag{1}$$

where $AR_{i,t}$ is the abormal return for firm i at day t, $R_{i,t}$ denotes the return on security i at day t, $R_{m,t}$ is the return on the DAFOX which is a value-weighted index of all FSE listed shares, and $\hat{\alpha}_i$ and $\hat{\beta}_i$ are OLS estimates from the market model regression. Denoting the event date as day 0, regression coefficients are estimated over a period of 200 days, from day -230 to day -31.

According to the trade-to-trade approach, stock returns are calculated between adjacent trades. The corresponding market return is measured over the same calendar period to match the stock return. The market model parameters to calculate abnormal trade-to-trade returns are estimated from the trade-to-trade regression as described in Dimson/Marsh (1983):

$$\frac{R_{i,n_t}}{\sqrt{n_t}} = \alpha_i \frac{1}{\sqrt{n_t}} + \beta_i \frac{R_{m,n_t}}{\sqrt{n_t}} + u_{i,t} , \tag{2}$$

where R_{i,n_t} is the return on security i over the period between two recorded trades, R_{m,n_t} is the market return over the same period and n_t is the length of the return measurement interval in days, ending at day *t*.

Similar to eq. (1) abnormal trade-to-trade returns are obtained as follows:

$$AR_{i,n_t} = R_{i,n_t} - \hat{\alpha}_i - \hat{\beta}_i R_{m,n_t} . \tag{3}$$

To determine statistical significance, three test statistics are computed. The first one is the t-test recommended by Brown and Warner (1985) in the presence of event clustering to take

[10] In addition, the event study has been conducted using both mean and market adjusted returns. As the findings for all return generating models are essentially the same, only results with market-and-risk adjusted returns are

into account cross-sectional correlation. The second one is the standardized cross-sectional test of Boehmer, Musumeci and Poulsen (1991), henceforth denoted as BMP-test, which controls for event induced increases in variance, and the third one is the nonparametric Wilcoxon signed rank test. Details of the test statistics are provided in the appendix.

To examine the change in variance I employ two different methods. The first one follows Koski (1998) in estimating pre- and postsplit variance for each security from time series return data. A t-test is computed to test the hypothesis that the paired differences have mean zero. The second one is the nonparametric test initially proposed by Ohlson and Penman (1985) and also used by Dravid (1987), Dubofsky (1991) and Koski (1998). Test details are given in the appendix.

5 Empirical Results

5.1 Abnormal Returns around the Announcement of a German Stock Split

The results of the event study concerning the announcement dates are presented in table 4 and 5 and figure 1. At the announcement date itself the abnormal return is very low and insignificant, but the following day exhibits an abnormal return of 0.47 % which is significant according to all test statistics, partly even at the 1% level. Using trade-to-trade returns the abnormal return on day +1 is even higher yielding 0.56 %. Moreover, the BMP- and Wilcoxon test statistics indicate that the results are neither driven by event-induced variance nor by outliers. Abnormal returns remain positive and partly significant up to four days after the announcement. In the interval from day –2 to day +3, the cumulative abnormal return is 0.74 % from simple daily returns and 0.80 % from trade-to-trade returns. The similarity of results for both methods of return measurement shows that the price increase cannot be explained by measurement errors due to thin trading. Thus, there clearly is an announcement effect associated with stock splits in Germany. But comparable figures reported for the U.S. capital market are usually much higher. In most cases the abnormal returns in a small event window around the split announcement exceed 2 % (e.g. Ikenberry, Rankine, and Stice (1996)); Pilotte and Manuel (1996)), often even 4 % (e.g. Grinblatt, Masulis, and Titman (1984); Arbel and Swanson (1993).

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reported. The other results are available upon request.

Also, market reaction to stock dividends is much more pronounced than to stock splits both in the U.S. and in Germany. Gebhardt/Entrup/Heiden (1994) for example report an abnormal return of 2.47 % on the anouncement day of a German stock dividend. The cumulative abnormal return in the event window [-2; +3] they find reaches even 3.22 %. This finding is expected from a signaling hypothesis point of view because of the institutional restrictions to use stock splits to signal information in Germany. My results are in line with those of Rankine and Stice (1997), who show that most of the usually observed market reaction to stock splits stems from wrongly classified stock dividends. They interpret this result as (indirectly) supportive for the signaling hypothesis proposed by Grinblatt, Masulis and Titman (1983) which is based on the retained earnings constraint. The abnormal return to a stock split announcement is much lower in absence of signaling costs in form of diminished retained earnings in Germany as in the U.S., but it is still significant. Therefore further analysis of the announcement effect is provided in 5.5.

5.2 Abnormal Returns around the Execution Day

Table 6 and 7 report abnormal returns in the event window [-10; +10] around the ex-day of German stock splits. Using simple daily returns the ex-day abnormal return of 0.25 % fails to be significant, but employing trade-to-trade returns yields an abnormal return of 0.5 %, significant at the 10 % level, according to the BMP-test even at the 5 % level. Regardless of the return calculation method positive and partly significant abnormal returns can be observed on the four days preceding the split execution. The cumulative abnormal return from day –2 to +3 ranges from 0.83 % to 1.16 % depending on the return measurement. Significance is indicated by all statistical tests, therefore the results cannot be attributed to either event induced variance or outliers.

Like the announcement effect, the ex-day effect is much less pronounced in Germany compared to the U.S. This can be due to the absence of a bid-ask-effect which is at least partly held responsible for the ex-day market reaction in the U.S. Also, both return measurements employed yield essentially the same results. This indicates that the abnormal returns are not elicted by an inappropriate treatment of thin trading. The abnormal returns are real and could have been earned by an investor.

The existence of an ex-day effect is not confined to the short period from 1994 to 1996, but is also observed in the years 1965 to 1993, as shown in table 8 and figure 2. In contrast, the negative albeit insignificant abnormal returns following the split execution in the 1994 –1996 period cannot be found in the former period. This comparison of evidence from two periods suggest that the slightly negative market reaction after the split completion is merely caused by chance rather than attributable to the split.

Further analysis reveals that the similarity between simple daily returns and trade-to-trade returns is confined only to short event windows. If longer event periods are studied not only the return generating model matters but also the method of return calculation. The cumulative abnormal return over the extended event window [-30; +30] differs by almost 4 % depending on the method employed. This result is not surprising and related to the well known joint hypothesis problem in market efficiency tests.[11] As Dimson and Marsh (1986) show this problem is only neglectable in event studies focussing on short event periods. Therefore our findings confirm the results of Dimson and Marsh (1986) but raise general doubts on results based on daily cumulative abnormal returns over relatively long event periods when no sensititvity tests concerning the influence of the return generating model and thin trading are conducted.

Examining the developement of the ex-day effect throughout the years it shows signs of decrease. In particular no abnormal returns can be detected in the split subsample of the year 1996 anymore.[12] This can be seen as the result of a learning effect of the market to overcome inefficient stock market valuation. Thus, market inefficiency as an explanation of the ex-day effect cannot be ruled out.

5.3 Change in Variance

Table 9 documents the empirical findings concerning the change in variance after announcement and completion of German stock splits. Similar to the results of Ohlson and Penman (1985) there is no increase in variance in the period after the split announcement.

[11] See e.g. Fama (1991).
[12] Abnormal returns around split announcements remain equally high throughout the years.

Variance estimates based on trade-to-trade returns show even signs of a slight decrease which is significant by the nonparametric test.

In contrast, there is a clear and highly significant increase in variance[13] from 2.21 before to 4.43 after the ex-date of the stock split, if simple daily returns are used. This result is in line with many studies from the U.S. and other countries, but compared to the variance increase from 3.25 to 5.46 reported by Koski (1998) for stock splits in the U.S.,[14] the level of return variances is distinctively lower in Germany. This is very likely due to thinly traded securites, because often the last traded price of an illiquid share continues to be quoted throughout the period of nontrading leading to a row of zero returns, which causes variance estimates to be downward biased. This bias is avoided by the use of trade-to-trade returns. Consistently, the level of variance estimates based on trade-to-trade returns is much higher and even exceeds the corresponding figures for the U.S. But surprisingly, the postsplit variance seems to have decreased from the presplit level according to the trade-to-trade variance estimates, although the z-statistic still indicates an significant increase. Further analysis reveals that this contradictory finding can be explained by distortions caused by two outliers.[15] Since they are both very illiquid shares, their real variance is dampened by the inclusion of zero returns if simple daily returns are used. Therefore they exert influence only when trade-to-trade returns are employed. If the two outliers are excluded from the sample, a significant variance increase is observed with trade-to-trade returns as well. Furthermore, the outlier adjusted trade-to-trade return variance estimates are now 3.05 before and 5.91 after the split and thus almost the same as in the U.S.

In the period 1965 to 1993 there is also an increase in variance to be observed, which shows that the increase is not confined to recent years. Unfortunately no trade-to-trade returns could be calculated for these years. The low level of variance estimates suggests that they are even more dampened due to thin trading than in later years. Thus, thin trading seems to affect only the level of variance estimates but not the detection of a change in variance.

The findings in the German capital market show that despite institutional differences, in particular the absence of bid ask quotations, the increase in variance persists, thereby

[13] The reported variance figures are multiplied by 10,000.
[14] Similar variance levels are reported for the Canadian stock market by Kryzanowski and Zhang (1993). They find an increase from 3.39 to 4.37 after the completion of the stock split.
[15] Gold Zack AG and Maternus Kliniken AG.

confirming the results of Koski (1998). The findings further demonstrate that inappropriately dealing with infrequently traded shares cannot be made responsible for it either.

5.4 Changes in Liquidity

Following the approach of several studies of the U.S.-market three measures of trading activity are employed to examine the liquidity changes around the ex-day of German stock splits. These measures are the volume, which is the (split-) adjusted daily number of shares traded, the volume turnover defined as raw (unadjusted) volume divided by shares outstanding, and the percentage of days with trades. Their use as proxies for liquidity is justified by Amihud and Mendelson (1986) who show that theoretically all three are increasing functions of liquidity.

Empirical evidence on the change in trading activity around the ex-date of a stock split is reported in table 10. To avoid potential distortions of the estimates due to a temporarily higher trading activity around the split execution, the ten day period surrounding the ex-day is excluded from estimation.[16] Both volume turnover and the percentage of days without trades are significantly higher after the split. On the other hand, mean of volume decreases after the split. Still, the huge difference between mean and median in combination with the significant increase of the latter suggests that the mean values are driven by outliers, which are presumably among the more liquid shares. This is confirmed by partitioning the sample according to presplit liquidity (not reported here). The less liquid shares experienced the relatively larger improvement of liquidity. This finding might reconcile the mixed evidence on liquidity in the U.S. If liquidity is already at high levels, as it might be the case for many shares in the samples of U.S. stock split papers, then a stock split does not improve liquidity any further.

[16] Estimates of the liquidity variables including the ten day period around split execution lead to virtually the same results and are available upon request.

5.5 Cross-Sectional Analysis of Announcement Returns

To inquire further into potential causes of positive abnormal returns around the split announcements, the following regression is estimated:

$$CAR=\alpha+\beta_1(\Delta LIQ)+\beta_2(SIZE)+\varepsilon. \quad (5)$$

The dependent variable is the cumulated abnormal return over the period from day -2 to day +4.[17] The explanatory variables are the change in liquidity (ΔLIQ) and the size of the split announcing firm (SIZE). To measure the change in liquidity three different variables are used, the difference in the logarithms of adjusted volume (ΔLOGVOL), the difference in volume turnover (ΔTURN) and the difference in the percentage of days with trades (ΔTDAY), where all differences are calculated as postsplit minus presplit values. The variable SIZE is measured as the natural logarithm of the market value of equity on day –10 relative to the split announcement and tests the explanation power of the neglected firm effect.[18]

Regression results are shown in table 11. None of the liquidity variables is significant. ΔLOGVOL and ΔTDAY even have the wrong sign. Therefore I cannot find any support for the model of Amihud and Mendelson (1986) stating that improvement in liquidity leads to an increase in value.

This finding is in contrast to the supportive evidence of Muscarella and Vetsuypens (1996), but also of Amihud, Mendelson and Lauterbach (1997) examining the effects of the change in the trading system of the Tel Aviv stock exchange on liquidity and share prices. One possible reason is that latter results are based on the cumulative abnormal return from day –5 before the announcement to day +30 after the event has taken place, ignoring the influence of the return generating model and thin trading. As pointed out before this can lead to severe distortions.

[17] The specific length of the cumulation period has been chosen to capture the full announcement effect. Still, similar results werde obtained using shorter cumulation intervals regardless of the way of return measurement. Therefore only the results based on simple daily market-and risk-adjusted returns are reported.

[18] Regression is run leaving only the voting shares of the dual class firms in the sample (cf. footnote 8). Market value of equity of dual class firm used in the regression is the sum of the market value of both classes of shares outstanding.

Another possible reason for the regression results is contained in recent work by Dennis and Strickland (1998). They suggests that it is not liquidity per se but liquidity conditional on changes in institutional ownership around stock splits which explains abnormal announcement returns.

On the other hand, the SIZE-variable is negative and significant, stating that the abnormal return around the split announcement is the higher the lower the market value of the splitting firm. This result supports the neglected firm hypothesis and is consistent with the findings of many other studies, e.g. Grinblatt, Masulis and Titman (1984) and Rankine and Stice (1997).

6 Conclusion

Although stock splits seem to be a purely cosmetic event, there exists ample empirical evidence from the United States that stock splits are associated with abnormal returns on both the announcement and the execution day, and additionally with an increase in variance after the ex-day. Using a data set of German stock splits I show that similar effects occur in the German capital market as well.

Thin trading is identified as a potential source of measurement errors and its effect on event study results is examined. Using trade-to-trade returns increases the significance of the market reaction as predicted by Maynes and Rumsey (1993) but the difference between return measurement methods is relatively small in short event periods. This changes dramatically when longer event periods are considered. Then the already existing difference between return generating models is magnified by adjusting for thin trading.

Institutional differences between Germany and the U.S. allow to disentangle the three main hypotheses on the announcement effect - signaling, liquidity and neglected firm hypothesis – to gain further insights into their relative explanation power. Consistent with the argued absence of signaling content in German stock splits market reaction around the announcement day is much lower than in the U.S. Despite a substantial increase in liquidity after the split no support for the liquidity hypothesis can be found. Improved liquidity seems not to be valued by market participants in Germany. The theoretical explanation of the announcement effect which is predominantly supported by the German evidence is the neglected firm hypothesis.

Still, the unfavorable evidence on the liquidity hypothesis does not necessarily mean that there is no link between equity value and liquidity. Recent work by Dennis and Strickland (1998) suggests that it is not liquidity per se but liquidity conditional on changes in institutional ownership around stock splits which explains abnormal announcement returns. This indicates a possible direction for further research into the nature and causes of market reaction to stock splits.

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Table 1: Distribution of Par Values of German Stocks Listed in the Official Market of the FSE

The column „others“ contains the number of stocks with a par value above 100 DM and the number of special cases when a stock still carries a Reichsmark par value or an odd DM par value for reasons related to the Reichsmark/Deutschmark conversion of the company's capital account in 1949 after the German currency reform of 1948.

Year	No. of stocks with a par value of				Percentage at minimum par value	Total no. of stocks
	5 DM	50 DM	100 DM	others		
1960	0	6	231	25	88.2	262
1961	0	6	235	25	88.3	266
1962	0	6	239	22	89.5	267
1963	0	6	239	24	88.8	269
1964	0	6	237	27	87.8	270
1965	0	6	247	19	90.8	272
1966	0	11	240	16	4.1	267
1967	0	22	221	16	8.5	259
1968	0	32	204	16	12.7	252
1969	0	112	125	15	44.4	252
1970	0	131	106	15	52.0	252
1971	0	139	88	14	57.7	241
1972	0	144	78	13	61.3	235
1973	0	150	68	13	64.9	231
1974	0	160	61	11	69.0	232
1975	0	158	60	10	69.3	228
1976	0	164	54	5	73.5	223
1977	0	164	49	4	75.6	217
1978	0	170	46	4	77.3	220
1979	0	170	44	4	78.0	218
1980	0	171	43	4	78.4	218
1981	0	174	40	4	79.8	218
1982	0	177	37	4	81.2	218
1983	0	185	30	4	84.5	219
1984	0	202	27	2	87.4	231
1985	0	209	27	2	87.8	238
1986	0	226	26	2	89.0	254
1987	0	239	24	2	90.2	265
1988	0	249	21	2	91.5	272
1989	0	265	23	2	91.4	290
1990	0	283	23	2	91.9	308
1991	0	301	18	2	93.8	321
1992	0	309	17	2	94.2	328
1993	0	316	17	2	94.3	335
1994	4	324	15	2	1.2	345
1995	55	280	16	2	15.6	353
1996	97	240	16	2	27.3	355

Table 2: Distribution of Stock Splits and Stock Dividends of German Stocks Listed in the Official Market of the FSE

In the "Percent of total"-column the absolute number of stock splits and stock dividends are related to the total number of stocks listed at the FSE.

Year	Stock Splits		Stock dividends	
	No.	Percent of Total	No.	Percent of Total
1960	1	0.4	34	13.0
1961	0	0.0	21	7.9
1962	0	0.0	10	3.7
1963	1	0.4	7	2.6
1964	0	0.0	4	1.5
1965	2	0.7	20	7.4
1966	6	2.2	15	5.6
1967	11	4.2	16	6.2
1968	11	4.4	8	3.2
1969	94	37.3	13	5.2
1970	14	5.6	9	3.6
1971	7	2.9	11	4.6
1972	6	2.6	6	2.6
1973	6	2.6	12	5.2
1974	7	3.0	11	4.7
1975	0	0.0	7	3.1
1976	4	1.8	10	4.5
1977	2	0.9	8	3.7
1978	2	0.9	3	1.4
1979	2	0.9	6	2.8
1980	1	0.5	7	3.2
1981	3	1.4	11	5.0
1982	2	0.9	7	3.2
1983	1	0.5	9	4.1
1984	3	1.3	9	3.9
1985	0	0.0	4	1.7
1986	0	0.0	8	3.1
1987	1	0.4	10	3.8
1988	3	1.1	9	3.3
1989	0	0.0	12	4.1
1990	2	0.6	14	4.5
1991	2	0.6	7	2.2
1992	1	0.3	11	3.4
1993	1	0.3	10	3.0
1994	4	1.2	8	2.3
1995	38	10.8	11	3.1
1996	38	10.7	9	2.5
Total	276		387	

Table 3: Descriptive Statistics of the Stock Split Sample

Year refers to the year of split announcement. In cases, where no announcement date could be determined, it is assumed that split announcement and execution are in the same year. Mean and median pre-split stock prices are calculated from end-december prices of the year previous to the split announcement. The control sample consists of all stocks traded in the official market of the Frankfurt stock exchange which have not initiated a stock split in a time period of one year before and four years after that year from which the end-december price is taken.

Year	No. of observations	Split factor	Mean pre-split stock price (median)	Mean stock price control sample (median)
1996	39	900 %	571.73 (390.00)	479.41 (325.00)
1995	36	900 %	506.11 (421.75)	547.85 (410.00)
1994	8	900 %	766.59 (698.00)	598.61 (456.25)
1966-93	78	100 %	477.88 (450.00)	386.12 (272.00)

Table 4: Abnormal Returns around the Announcement of German Stock Splits Based on Simple Daily Returns 1994-96

Mean abnormal returns (AR) and cumulative abnormal returns (CAR) around the announcement date of a sample of 78 German stock splits, from 1994 to 1996. Abnormal returns are calculated using an OLS market model regression. Test-statistics used are the t-test adjusted for cross-sectional correlation as proposed by Brown and Warner (1985), denoted t(BW), the t-test of Boehmer, Musumeci and Poulsen (1991), denoted t (BMP), and the Wilcoxon signed rank test.
Significance levels: *** 1 % level, ** 5 % level, * 10 % level.

I. Event Period Abnormal Returns

Event date	AR in %	t(BW)	Percentage of negative AR	t(BMP)	p-value Wilcoxon-Test
-10	-0.02	-0.09	48.72	0.29	0.46
-9	0.50	2.92***	41.03	3.07***	0.01
-8	0.17	1.02	44.87	1.73*	0.27
-7	0.19	1.11	48.72	1.32	0.32
-6	-0.04	-0.23	58.97	0.31	0.34
-5	-0.02	-0.13	51.28	-0.19	0.80
-4	0.11	0.67	54.55	0.37	0.77
-3	0.06	0.38	49.35	0.85	0.76
-2	0.02	0.11	46.15	0.63	0.75
-1	-0.15	-0.90	57.69	-1.15	0.23
0	0.01	0.08	46.15	-0.19	0.80
1	0.47	2.79***	47.44	2.57**	0.10
2	0.19	1.14	43.59	1.66	0.23
3	0.20	1.15	51.28	1.55	0.48
4	0.31	1.81*	42.31	1.82*	0.11
5	-0.22	-1.29	57.69	-0.84	0.17
6	-0.14	-0.85	51.28	-0.50	0.41
7	-0.07	-0.40	57.69	0.02	0.51
8	-0.09	-0.51	51.28	0.22	0.43
9	0.18	1.06	46.15	0.86	0.27
10	0.09	0.51	50.00	0.72	0.91

II. Cumulative Abnormal Returns (CAR)

Event Window	CAR	t(BW)	Percentage of negative CAR	t(BMP)	p-value Wilcoxon-test
Day –1 to day +1	0.33	1.14	51.28	1.16	0.51
Day –2 to day +2	0.55	1.44	51.28	1.90*	0.23
Day –2 to day +3	0.74	1.78*	46.15	2.15**	0.12

Table 5: Abnormal Returns around the Announcement of German Stock Splits Based on Trade-To-Trade Returns 1994-96

Abnormal and cumulative abnormal returns around the announcement date of a sample of 78 German stock splits, from 1994 to 1996. Abnormal returns are calculated using the trade-to-trade regression of Dimson and Marsh (1983). Test-statistics used are the t-test adjusted for cross-sectional correlation as proposed by Brown and Warner (1985), denoted t(BW), the t-test of Boehmer, Musumeci and Poulsen (1991), denoted t (BMP), and the Wilcoxon signed rank test.
Significance levels: *** 1 % level, ** 5 % level, * 10 % level.

I. Event Period Abnormal Returns

Event date	AR in %	t(BW)	Percentage of negative AR	t(BMP)	p-value Wilcoxon-test
-10	-0.03	-0.16	43.75	0.41	0.42
-9	0.49	2.23**	39.39	2.34**	0.02
-8	0.43	1.98*	43.08	1.52	0.34
-7	0.26	1.17	47.54	1.27	0.36
-6	-0.05	-0.21	53.85	0.30	0.66
-5	-0.02	-0.09	50.00	-0.08	0.99
-4	-0.12	-0.57	57.81	-0.26	0.45
-3	0.29	1.32	48.48	1.41	0.51
-2	-0.06	-0.28	48.48	0.41	0.93
-1	-0.16	-0.72	56.34	-1.33	0.23
0	-0.06	-0.29	47.06	-0.55	0.98
1	0.56	2.58**	40.32	2.68***	0.03
2	0.25	1.13	41.54	1.49	0.34
3	0.27	1.24	50.77	1.55	0.61
4	0.56	2.56**	40.63	1.97	0.06
5	-0.20	-0.91	58.46	-0.60	0.18
6	-0.07	-0.30	55.38	-0.62	0.31
7	-0.06	-0.26	55.56	-0.04	0.45
8	-0.13	-0.60	53.85	-0.48	0.27
9	-0.13	-0.59	46.27	1.22	0.29
10	-0.06	-0.28	53.85	-0.05	0.56

II. Cumulative Abnormal Returns (CAR)

Event Window	CAR	t(BW)	Percentage of negative CAR	t(BMP)	p-value Wilcoxon-test
Day -1 to day +1	0.34	0.90	48.39	1.18	0.28
Day -2 to day +2	0.53	1.08	50.77	1.79*	0.19
Day -2 to day +3	0.80	1.49	47.69	1.86*	0.22

Table 6: Abnormal Returns around the Execution of German Stock Splits Based on Simple Daily Returns 1994-96

Mean abnormal returns (AR) and cumulative abnormal returns (CAR) around the execution date of a sample of 83 German stock splits, from 1994 to 1996. Abnormal returns are calculated using an OLS market model regression. Test-statistics used are the t-test adjusted for cross-sectional correlation as proposed by Brown and Warner (1985), denoted t(BW), the t-test of Boehmer, Musumeci and Poulsen (1991), denoted t (BMP), and the Wilcoxon signed rank test.
Significance levels: *** 1 % level, ** 5 % level, * 10 % level.

I. Event Period Abnormal Returns

Event date	AR in %	t-(BW)	Percentage of negative AR	t(BMP)	p-value Wilcoxon-Test
-10	0.10	0.57	53.01	0.72	0.96
-9	-0.17	-1.01	62.65	-1.37	0.06
-8	-0.16	-0.94	57.83	-0.33	0.20
-7	-0.11	-0.67	61.45	-0.17	0.26
-6	0.06	0.35	49.40	0.56	0.57
-5	-0.06	-0.33	55.42	-0.56	0.19
-4	0.26	1.52	49.40	0.95	0.48
-3	0.07	0.38	48.19	0.57	0.72
-2	0.38	2.21**	42.17	2.06**	0.08
-1	0.28	1.62	39.76	1.84*	0.20
0	0.25	1.44	43.37	1.00	0.29
1	0.04	0.21	61.45	0.87	0.38
2	-0.13	-0.78	59.04	-0.87	0.07
3	0.02	0.13	45.78	0.53	0.52
4	-0.17	-1.00	51.81	-0.63	0.71
5	0.05	0.29	55.42	-0.72	0.31
6	-0.06	-0.33	60.24	-0.92	0.04
7	-0.19	-1.10	68.67	-1.30	0.00
8	-0.01	-0.04	61.73	-0.52	0.25
9	0.08	0.49	53.09	0.39	1.00
10	0.42	2.46**	54.32	1.00	0.77

II. Cumulative Abnormal Returns (CAR)

Event Window	CAR in %	t-(BW)	Percentage of negative CAR	t(BMP)	p-value Wilcoxon-Test
Day -1 to day +1	0.56	1.89*	45.78	1.99*	0.23
Day -2 to day +2	0.81	2.10**	43.37	2.01**	0.08
Day -2 to day +3	0.83	1.97*	39.76	2.10**	0.04

Table 7: Abnormal Returns around the Execution of German Stock Splits Based on Trade-To-Trade-Returns

Abnormal and cumulative abnormal returns around the announcement date of a sample of 78 German stock splits, from 1994 to 1996. Abnormal returns are calculated using the trade-to-trade regression of Dimson and Marsh (1983). Test-statistics used are the t-test adjusted for cross-sectional correlation as proposed by Brown and Warner (1985), denoted t(BW), the t-test of Boehmer, Musumeci and Poulsen (1991), denoted t (BMP), and the Wilcoxon signed rank test.
Significance levels: *** 1 % level, ** 5 % level, * 10 % level.

I. Event Period Abnormal Returns

Event date	AR in %	t-(BW)	Percentage of negative AR	t(BMP)	p-value Wilcoxon-Test
-10	0.18	0.73	49.28	1.29	0.62
-9	-0.17	-0.71	58.21	-1.07	0.14
-8	-0.23	-0.94	60.87	-0.24	0.14
-7	-0.30	-1.24	59.09	-1.09	0.19
-6	0.19	0.78	40.91	1.52	0.26
-5	-0.18	-0.73	57.58	-1.17	0.08
-4	0.15	0.62	45.71	0.97	0.50
-3	0.07	0.30	44.29	0.78	0.67
-2	0.40	1.64	38.24	1.88*	0.06
-1	0.45	1.84*	38.24	2.31**	0.14
0	0.50	2.07**	38.03	1.69*	0.08
1	-0.04	-0.17	61.11	-0.05	0.31
2	-0.06	-0.24	57.14	-0.38	0.10
3	-0.09	-0.36	46.38	-0.19	0.75
4	-0.13	-0.54	52.78	0.01	0.93
5	-0.12	-0.51	55.56	-1.05	0.23
6	-0.20	-0.80	63.38	-1.50	0.01
7	-0.27	-1.09	66.18	-0.89	0.02
8	0.51	2.10**	57.53	-0.93	0.18
9	-0.09	-0.36	56.00	0.13	0.76
10	0.17	0.72	52.94	0.45	0.73

II. Cumulative Abnormal Returns (CAR)

Event Window	CAR in %	t-(BW)	Percentage of negative CAR	t(BMP)	p-value Wilcoxon-Test
Day -1 to day +1	0.91	2.15**	45.83	2.07**	0.15
Day -2 to day +2	1.25	2.29**	42.86	1.89*	0.12
Day -2 to day +3	1.16	1.95*	39.13	1.82*	0.06

Table 8: Abnormal Returns around the Execution of German Stock Splits Based on Simple Daily Returns 1965-93

Mean abnormal returns (AR) and cumulative abnormal returns (CAR) around the announcement date of a sample of 79 German stock splits, from 1965 to 1993. Abnormal returns are calculated using an OLS market model regression. Test-statistics used are the t-test adjusted for cross-sectional correlation as proposed by Brown and Warner (1985), denoted t(BW), the t-test of Boehmer, Musumeci and Poulsen (1991), denoted t (BMP), and the Wilcoxon signed rank test.
Significance levels: *** 1 % level, ** 5 % level, * 10 % level.

I. Event Period Abnormal Returns

Event date	AR in %	t-(BW)	Percentage of negative AR	t(BMP)	p-value Wilcoxon-Test
-10	0.12	1.03	58.44	0.31	0.74
-9	0.31	2.74***	47.44	2.66***	0.04
-8	-0.09	-0.77	61.54	-0.48	0.20
-7	-0.11	-1.01	57.69	-0.92	0.33
-6	0.08	0.74	52.56	0.19	0.90
-5	0.24	2.17**	53.85	1.01	0.50
-4	-0.07	-0.61	56.41	-1.27	0.45
-3	0.07	0.64	52.56	0.89	0.70
-2	0.49	4.33***	39.74	3.18***	0.01
-1	0.13	1.18	49.35	2.00**	0.37
0	0.21	1.88*	51.28	0.91	0.99
1	-0.08	-0.67	64.10	-0.70	0.04
2	0.00	0.03	58.97	-0.01	0.62
3	0.45	4.02***	46.15	3.03***	0.05
4	-0.11	-1.00	57.14	-0.23	0.31
5	0.19	1.66	52.56	0.80	0.66
6	-0.03	-0.30	53.85	-0.45	0.71
7	0.10	0.90	50.65	0.76	0.97
8	0.17	1.49	49.35	0.87	0.60
9	-0.26	-2.33**	66.23	-1.13	0.01
10	-0.17	-1.47	64.94	-1.31	0.02

II. Cumulative Abnormal Returns (CAR)

Event Window	CAR in %	t-(BW)	Percentage of negative CAR	t(BMP)	p-value Wilcoxon-Test
Day -1 to day +1	-0.15	-0.77	48.10	0.01	0.91
Day -2 to day +2	0.36	1.42	48.10	0.66	0.52
Day -2 to day +3	0.86	3.06***	45.57	1.40	0.19

Table 9: Change in Variance of Simple Daily Returns and Trade-to-trade Returns

Presplit variance is estimated over the period from day –230 to –11 relative to the announcement day or ex-day, respectively, while postsplit variance is calculated over the 220 trading days beginning 11 days after the event. Two methods of return calculation are employed, simple daily returns and trade-to-trade returns, denoted as TT. TT* denotes the variance estimates using trade-to-trade returns with two outliers (Gold Zack AG and Maternus Kliniken AG) being excluded.

Period	Method of return calculation	Mean presplit variance+	Mean postsplit variance+	Paired t-statistic	z-statistic	$\Pr\{\sigma_2^2 > \sigma_1^1\}$ in %	$\Pr\{R_2^2 > R_1^1\}$ in %
Announce-ment 1994 – 1996	Daily	1.88	1.97	0.60	-6.87	50.00	45.39
	TT	7.27	6.96	-0.19	-4.54	42.31	46.65
Ex-Day 1994 – 1996	Daily	2.21	4.43	6.41	7.77	80.49	53.78
	TT	8.11	7.51	-0.21	8.88	83.95	54.64
	TT*	3.05	5.91	4.11	9.06	86.08	54.75
1965 – 1993	Daily	1.57	2.53	4.90	2.19	81.82	51.07

+ reported variances are multiplied by 10,000

Table 10: Change in Trading Activity after Completion of Stock Splits 1994 – 1996

Alternative measures of trading activity for a sample of 72 German stock splits completed over the period 1994-1996. Volume is the (split-) adjusted daily number of shares traded, volume turnover measures the proportionate volume and is defined as raw (unadjusted) volume divided by shares outstanding. Pre-split liquidity measures are averaged over 220 trading days ending 11 days prior to the split execution, while post-split liquidity is calculated from the 220 trading day beginning 11 day after the completion of the split. Significance of paired differences is measured using the standard t-test for means and the nonparametric Wilcoxon signed ranks test for medians.

Variable	Presplit period: Mean (Median)	Postsplit period: Mean (Median)	Paired differences: Mean (Median)	p-values: t-test (Wilcoxon-test)
Volume	99577 (5523)	94548 (8087)	-5029 (998)	0.3262 (0.0095)
Volume turnover (in percent)	0.70 (0.53)	0.84 (0.72)	0.14 (0.09)	0.0620 (0.0001)
Percentage of days with trades	89.0 (99.5)	96.1 (100.0)	7.1 (0.5)	0.0001 (0.0001)

Table 11: Regression Results of Split Announcement Abnormal Returns

The dependent variable is the cumulative abnormal return from day –2 to +4 relative to the split announcement date calculated from simple daily returns. The explanatory variables are the difference in the logarithms of volume (ΔLOGVOL), the difference in volume turnover (ΔTURN), the difference in the percentage of days with trades (ΔTDAY), and the logarithm of the market value of equity on day –10 relative to the split announcement (SIZE). All differences are calculated as post- minus pre-split-values. P-values are in parentheses.

Independent Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Intercept	2.1039 (0.0016)	2.0186 (0.0011)	-5.4237 (0.3251)	14.2138 (0.0077)	13.3416 (0.2221)
Δ LOGVOL	-1.0116 (0.3445)				
Δ TURN		-1.7250 (0.3293)			
Δ TDAY			6.7697 (0.1914)		0.5410 (0.9270)
SIZE				-0.5933 (0.0182)	-0.5792 (0.0510)
Adjusted R^2 p-value F-statistic	-0.0016 0.3445	-0.0006 0.3293	0.0314 0.1914	0.0823 0.0182	0.0652 0.0628

Fig.1: Cumulative Abnormal Returns Around German Stock Split Announcements 1994-96

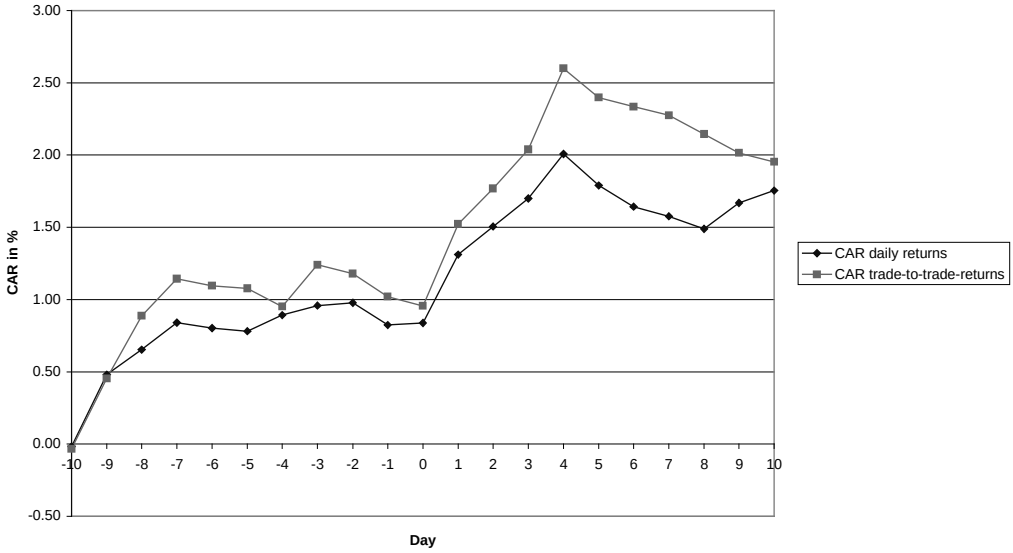
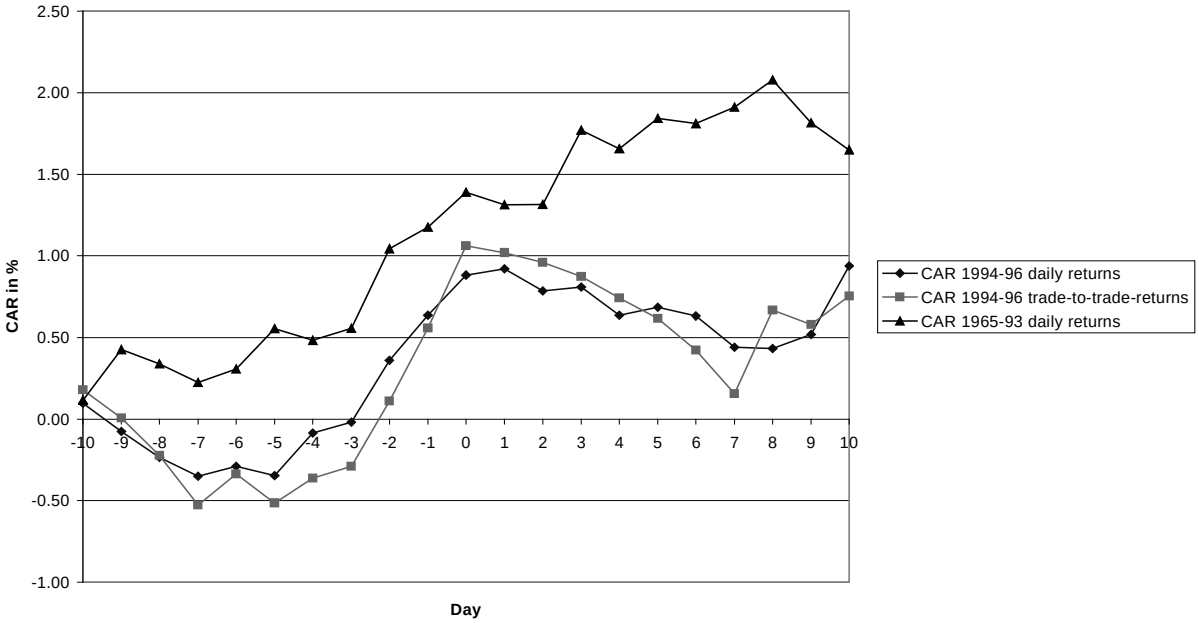


Fig. 2: Cumulative Abnormal Returns Around German Stock Split Execution Dates 1965-96



Appendix

This appendix gives additional details of the test statistics used.

The t-test statistic proposed by Brown and Warner (1985) to take cross sectional correlation into account is calculated in the following way:

$$T_t = \frac{\overline{AR}_t}{\hat{S}(\overline{AR}_t)} \tag{A.1}$$

where $\overline{AR}_t = \frac{1}{N_t}\sum_{i=1}^{N_t} AR_{i,t}$, (A.2)

$$\overline{AR} = \frac{1}{200}\sum_{t=-230}^{t=-31}\overline{AR}_t \tag{A.3}$$

and $\hat{S}(\overline{AR}_t) = \sqrt{\frac{\sum_{t=-200}^{t=-31}(\overline{AR}_t - \overline{AR})^2}{200}}$. (A.4)

N_t denotes the number of shares of which return data is available at day t.

The BMT-test statistic is calculated as

$$T_{B,t} = \frac{\frac{1}{N_t}\sum_{i=1}^{N_t} SAR_{i,t}}{\sqrt{\frac{1}{N_t(N_t-1)}\sum_{i=1}^{N}\left(SAR_{i,t} - \sum_{i=1}^{N}\frac{SAR_{i,t}}{N}\right)^2}} \tag{A.5}$$

with

$$SAR_{i,t} = \frac{AR_{i,t}}{\hat{\sigma}_i} = \frac{AR_{i,t}}{\sqrt{\frac{1}{T_{S,i}-1}\sum_{t=-230}^{t=-31}\left(AR_{i,t} - \overline{AR}_i\right)^2}} \tag{A.6}$$

The test statistic proposed by Ohlson and Penman (1985) to test the null hypothesis of no variance increase after the split is:

$$z = 2(p - 0.5)\sqrt{M} \tag{A.7}$$

with

p: proportion of positive squared return differences $R_2^2 - R_1^2$, where R_1 and R_2 denote pre- and postsplit returns;

M:number of observations.