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

Abstract

This paper investigates the market reaction to stock splits, using a set of German firms. Similar to the findings in the U.S., I find significant positive abnormal returns around both the announcement and the execution day of German stock splits. I also observe an increase in return variance and in liquidity after the ex-day.

Apparently, legal restrictions strongly limit the ability of German companies to use a stock split for signaling. I find that abnormal returns around the announcement day are consistently much lower in Germany than in the U.S. Further, I find that abnormal returns around the announcement day are not related to changes in liquidity, but (negatively) to firm size, thus lending support to the neglected firm hypothesis.

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.

JEL-Classification: G14.

1 Introduction

There is ample empirical evidence that in the U.S. stock splits are associated with positive abnormal returns around the announcement and the execution day, and also 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/Palepu* (1989), *Rank-*

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

ine/Stice (1997)) and the liquidity hypothesis (*Baker/Powell* (1993), *Muscarella/Vetsuypens* (1996)) have received the most attention, although the empirical evidence for the latter is mixed. In addition, several studies find that the neglected firm hypothesis also provides some explanation power (*Grinblatt/Masulis/Titman* (1984), *Arbel/Swanson* (1993), and *Rankine/Stice* (1997)).

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

As do many other studies on stock splits in international capital markets, I find that there are significant positive abnormal returns around both the announcement and the ex-day of German stock splits. I also observe an increase in return variance after the ex-day. But in contrast to the empirical findings in the U.S. and other capital markets, German stock splits are associated with an increase in liquidity.

To investigate the potential influence of infrequent share trading on the detection of abnormal returns, I use two different methods of return calculation. The first method uses all available share prices, regardless of whether they were accompanied by a trade or not. The second method uses only transaction prices to calculate trade-to-trade returns, as described in *Dimson/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 *Maynes/Rumsey*'s (1993) simulation study.

The empirical results are best explained by a neglected firm effect. For institutional reasons the ability to convey a signal via stock splits is very limited in Germany. Consistently, I find that the share price reaction to stock splits is much lower in Germany than that usually found in the U.S. When I examine an additional sample of stock splits that coincide with stock dividends, I find considerably higher positive abnormal returns, which suggests that abnormal returns increase with the scope of the event to act as a signal.

Furthermore, I cannot find any evidence that the improved liquidity leads to an increase in value. This finding contrasts with the model proposed by *Amihud/Mendelson* (1986) and with the empirical findings of *Muscarella/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 insights into the relative explanation power of the theories. The findings mainly support the neglected firm hypothesis. Further, the analysis contributes to the debate about the role of liquidity in asset markets. On the methodological side, I show 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. The implications of the institutional differences to the applicability of the theories to the German case are analysed in Section 3. Section 4 describes the data and methodology. In Section 5 I discuss the empirical results. 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 without changing its book value. The increase in the number of shares is done by reducing the par value of the share accordingly. The difference between stock splits in Germany and the U.S. is largely in the fundamental role of the par value of German stocks. Most stocks issued by a U.S. corporation 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].

2 The minimum par value rule also applies to the so-called "Stückaktien" which were introduced in the German corporate code in 1998 and which are in essence merely "seemingly" no par value stocks. Those "seemingly" no par value stocks do not carry an explicit par value, but rather an implicit one, and are thus different from the "real" no par value stocks issued by U.S. companies. The implicit par value can be calculated by dividing the common stock capital by the number of shares outstanding and had to be at least 5 DM. Since 1999 the implicit par value has to be at least 1 EUR.

3 Before 1966, only very few companies, mainly insurance companies, were allowed to have par values below 100 DM. The reasons 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* (2001).

Table 1: Distribution of Par Values of German Stocks Listed in the Official Market of the Frankfurt Stock Exchange (FSE)

The column "others" contains the number of stocks with a par value above 100 DM and the special cases in which 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

Until 1998, only certain other par values were allowed above the 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. In 1994 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. *Table 1* also shows that although after the corporate code reform act of 1994 companies could have decided on a new par value below 50 DM but above 5 DM such as 10 DM or 15 DM, none has chosen to do so. All have split their stock to the lowest possible par value of 5 DM. Unlike to the U.S., there are virtually no reverse stock splits in Germany[5].

Table 2 shows that in the two periods around 1969 and 1995, there was a clustering of stock splits, whereas between 1975 and 1994 hardly any stock splits occurred. In 1994, the number of stock splits increased immediately after the change in legislation. But the response to the reduction of the minimum par value of 1966 did not peak until 1969, three years later. This deferred response was 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. A stock split increases the number of shares by reducing the par value accordingly, while 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. This loss of flexibility 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. Nevertheless, in the U.S., many empirical studies have used the CRSP classification or the split factor instead of the actual accounting treatment to distinguish between stock splits and stock dividends[6]. Other studies do not distinguish between stock splits and stock dividends at all[7]. *Rankine/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 a careful distinction between both events is crucial for assessing potential information contents.

4 In 1998, 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.

5 The very few exceptional cases of reverse stock splits were mostly related to the par value conversion from Reichsmark to DM after the currency reform of 1948. For details see *Wulff* (2001).

6 See, e.g., *Grinblatt/Masulis/Titman* (1984), *Lakonishok/Lev* (1987).

7 See, e.g., *McNichols/Dravid* (1990).

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 relate to the total number of stocks listed at the FSE.

Year	Stock Splits		Stock dividends	
	No.	Percent of Total	No.	Percent of Total
1960	0	0.00	32	12.21
1961	0	0.00	20	7.52
1962	1	0.37	8	3.00
1963	1	0.37	7	2.60
1964	0	0.00	4	1.48
1965	7	2.57	19	6.99
1966	6	2.25	14	5.24
1967	11	4.25	16	6.18
1968	11	4.37	8	3.17
1969	94	37.30	13	5.16
1970	14	5.56	9	3.57
1971	7	2.90	11	4.56
1972	6	2.55	6	2.55
1973	6	2.60	12	5.19
1974	7	3.02	11	4.74
1975	0	0.00	7	3.07
1976	4	1.79	8	3.59
1977	2	0.92	8	3.69
1978	2	0.91	3	1.36
1979	2	0.92	6	2.75
1980	1	0.46	7	3.21
1981	3	1.38	11	5.05
1982	2	0.92	7	3.21
1983	1	0.46	9	4.11
1984	3	1.30	9	3.90
1985	0	0.00	4	1.68
1986	0	0.00	8	3.15
1987	1	0.38	10	3.77
1988	3	1.10	9	3.31
1989	0	0.00	12	4.14
1990	2	0.65	14	4.55
1991	2	0.62	7	2.18
1992	1	0.30	11	3.35
1993	1	0.30	10	2.99
1994	4	1.16	8	2.32
1995	36	10.20	11	3.12
1996	38	10.86	9	2.57
Total	279		378	

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 level of retained earnings and/or capital surplus. Because both corporate events must be approved by the annual general meeting, it happens that the same meeting decides on a stock dividend and a stock split, i.e. both events are not mutually exclusive in Germany but can occur simultaneously[8]. *Gebhardt/Entrup/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 it is in the U.S.

To date, there has been little empirical evidence on German stock splits. Both *Wulff* (1996) and *Kaserer/Mohl* (1998) examine stock splits for the period 1994 to 1995 and find cumulative abnormal returns of about 1% in a three-day announcement period from t(0) to t(+2). For larger event windows *Wulff* (1996) reports positive, albeit small, cumulative abnormal returns, but *Kaserer/Mohl* (1998) observe a reversal of the positive announcement effect by negative abnormal returns in surrounding days. *Wulff* (1996) reports an ex-day effect, while *Kaserer/Mohl* (1998) provide mixed evidence. The cumulative abnormal return of −0.19% they find for the event window [0; +5] contrasts with the positive cumulative returns of 1.11% and 1.18% in the event windows [−5; 0] and [−5; +5], respectively. Nevertheless, due to the small sample size, the results of both papers must be treated with caution.

Harrison (2000) uses a much larger sample of German stock splits that covers the period from 1974 to 1997, but investigates only the ex-date effects of German stock splits. He finds positive abnormal returns of 1.32% in the event window from t(−1) to t(+1) around the ex-day. However, by starting the observation period in 1974, *Harrison* omits the cluster of stock split events around 1969 (see *Table 2*).

I examine the announcement effect around German stock splits by using a sample of stock splits initiated by German firms between 1994 and 1996. To investigate the ex-day effect, I also examine a sample of stock splits of the period 1966 to 1993. My results are put into perspective by comparing them with indicative abnormal returns of a small sample of German stock splits that coincide with stock dividends in the period 1994 to 1996.

3 Hypotheses

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

8 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 not included in the stock split sample of this study, but are examined separately. Results are provided in *Table 6*. See also Section 4.

Grinblatt/Masulis/Titman (1984), *Asquith/Healy/Palepu* (1989), and *Rankine/Stice* (1997) hypothesize that firms signal information about their future earnings through their split announcement decision. As noted earlier, management's ability to decide on a stock split is limited by regulatory constraints in Germany. There can be no signaling content in the choice of the split factor, as *McNichols/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/Titman* (1984). Also, the signaling models of *Brennan/Copeland* (1988) and *Brennan/Hughes* (1991) are not applicable to the German case, because they are both based on specific brokerage cost schedules that 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[9].

The liquidity hypothesis often takes the form of an optimal trading range hypothesis that states that after the share price has risen substantially, companies tend to move their share price back to an trading range perceived as optimal. Although *Lakonishok/Lev* (1987) and *Han* (1995) provide some empirical evidence on the existence of an optimal trading range in the U.S., this hypothesis contrasts with the decrease in trading activity after a split that is observed by *Copeland* (1979) and *Conroy/Harris/Benet* (1990). Focusing on an arguably signal-free sample of ADR splits, *Muscarella/Vetsuypens* (1996) show that liquidity improves after the split, and that the increase in liquidity is accompanied by wealth gains to investors. Their findings support *Amihud/Mendelson*'s (1986) model, which predicts a positive relation between equity value and liquidity. According to this model, rational investors discount illiquid securities more deeply than liquid ones because of 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 as proposed by *Arbel/Swanson* (1993) states that if little is known about a firm, its shares will trade at a discount. In the U.S., firms use the split to draw attention to themselves, thus ensuring that the company is more widely 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 cannot explain the well-documented ex-day behavior of stock splits in the U.S. capital market. Both *Malhoney/Mulherin* (1992) and *Conrad/Conroy* (1994) associate the ex-day price reaction to market microstructure phenomena. Their findings suggest that the abnormal returns around the ex-day cannot accrue to an investor, but instead are evoked by mea-

9 Due to clustering of German stock splits, there could be a signal associated with the timing of the split. Still, my sample does not show any pattern that would allow to draw a line between the timing of the split announcement and the announcement returns. See also *Wulff* (2001), p. 81.

surement errors caused by changes in the bid-ask spread. *Koski* (1998) questions these findings, showing that the increase in the post-split variance is independent from changes in the bid-ask spread. In Germany, bid-ask effects cannot account 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.

My paper extends that of *Koski* (1998) by examining another potential cause of measurement errors, which is thin trading. *Marsh* (1979) and *Dimson/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/Rumsey* (1993) support this view in their simulation study.

To my knowledge, *Schrader* (1993) and *Schmidt/Schrader* (1993) are the only studies to use trade-to-trade-returns in an event-study based on German capital market data, albeit in a different context. However, neither study provides a sensitivity analysis of the method they use, nor do they directly compare simple and trade-to-trade-returns.

4 Data and Methodology

The initial sample consists of all stock splits from 1994 to 1996 initiated 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.

Of these 110 splits, I exclude 24 cases because the split ex-date coincides with the ex-date of another corporate event of the same stock, such as a stock dividend or a rights issue. I exclude three other events because prices were unavailable. The final sample comprises 83 splits (ex-dates)[10].

I obtained announcement dates 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)*[11]. Data errors are corrected by cross-checking my data with the *Hoppenstedt*-Kurstabellen[12]. Information on whether a quoted price was accompanied by a transaction is available for all splits in the sample, but I was able to obtain detailed trading volume data for only 72 splits.

10 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.

11 The return calculations based on mid-day call auction prices ("Kassakurse") are adjusted for corporate events and dividends. Following *Campbell/Lo/MacKinley* (1997), p. 12, I use simple returns, not logarithmic returns.

12 In a few cases, missing prices in the DFDB could be filled in with stock prices obtained from the data provider *Bloomberg*.

In addition, 78 stock splits of the period from 1966 to 1993 are examined using daily stock prices. Unfortunately, there were no announcement dates and no transaction information available for them. Therefore, the use of this data is limited to providing additional evidence on the ex-day effect. *Table 3* presents descriptive statistics for the sample.

Table 3: Descriptive Statistics of the Stock Split Sample

For the period 1994 to 1996, the column "Year" refers to the year of split announcement. For the period 1966 to 1993, the column refers to the year of split execution. Mean and median pre-split stock prices are calculated from end-December prices of the year previous to the split announcement or execution, respectively. The control sample consists of all stocks traded in the official market of the Frankfurt stock exchange that did not initiate a stock split in a time period from one year before to 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)

Of the 24 cases excluded in the period from 1994 to 1996 because of confounding events, I identify a small sample of 7 stock splits that coincide with a stock dividend. I examine this sample separately to yield results that will indicate to what extent abnormal returns reflect institutional differences in the ability to convey a signal.

The price reaction to German stock splits is examined by applying the standard event study methodology described in *Brown/Warner* (1985). Market-and risk-adjusted simple daily returns are calculated as follows[13]:

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

13 In addition, my event study uses both mean and market-adjusted returns. As the findings for all return generating models are essentially the same, I report only results with market and risk-adjusted returns. The other results are available on request.

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, I estimate regression coefficients over a period of 200 days, from day −230 to day −31.

Following the trade-to-trade approach, stock returns are calculated between adjacent trades. I measure the corresponding market return over the same calendar period to match the stock return. The market model parameters for calculating abnormal trade-to-trade returns are estimated from the trade-to-trade regression 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.

As in eq. (1), I obtain abnormal trade-to-trade returns 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, I compute three test statistics. The first one is the t-test recommended by *Brown/Warner* (1985) when there is event clustering. This test takes possible cross-sectional correlation into account. The second test is the standardized cross-sectional test of *Boehmer/Musumeci/Poulsen* (1991), henceforth denoted as BMP-test. The BMP test controls for event-induced increases in variance. The third test is the nonparametric Wilcoxon signed rank test. Details of the test statistics are provided in the appendix.

I use two different methods to examine the change in variance. The first one follows *Koski* (1998), estimating pre- and postsplit variance for each security from time series return data. I compute a t-test to test the hypothesis that the paired differences have mean zero. The second method is the nonparametric test initially proposed by *Ohlson/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

Tables 4 and *5* and *Figure 1* present the results of the event study of announcement dates. At the announcement date itself, the abnormal return is very low and insignificant, but the following day shows an abnormal return of 0.47%. This abnormal return is significant according to all test statistics, even at the 1% level. Using trade-to-trade returns, the abnormal return on day +1 is even higher, yield-

Table 4: Abnormal Returns around the Announcement of German Stock Splits Based on Simple Daily Returns 1994– 1996

Mean abnormal returns (AR) and cumulative abnormal returns (CAR) are 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 are the t-test adjusted for cross-sectional correlation as proposed by Brown/Warner (1985), denoted t(BW), the t-test of Boehmer/Musumeci/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 in %	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– 1996

Mean abnormal (AR) and cumulative abnormal returns (CAR) are 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/ Marsh (1983). Test statistics are the t-test adjusted for cross-sectional correlation as proposed by Brown/Warner (1985), denoted t(BW), the t-test of Boehmer/Musumeci/ Poulsen (1991), denoted t (BMP), and the Wilcoxon signed rank test.
*Significance levels: *** 1% level, ** 5% level, * 10% level.*

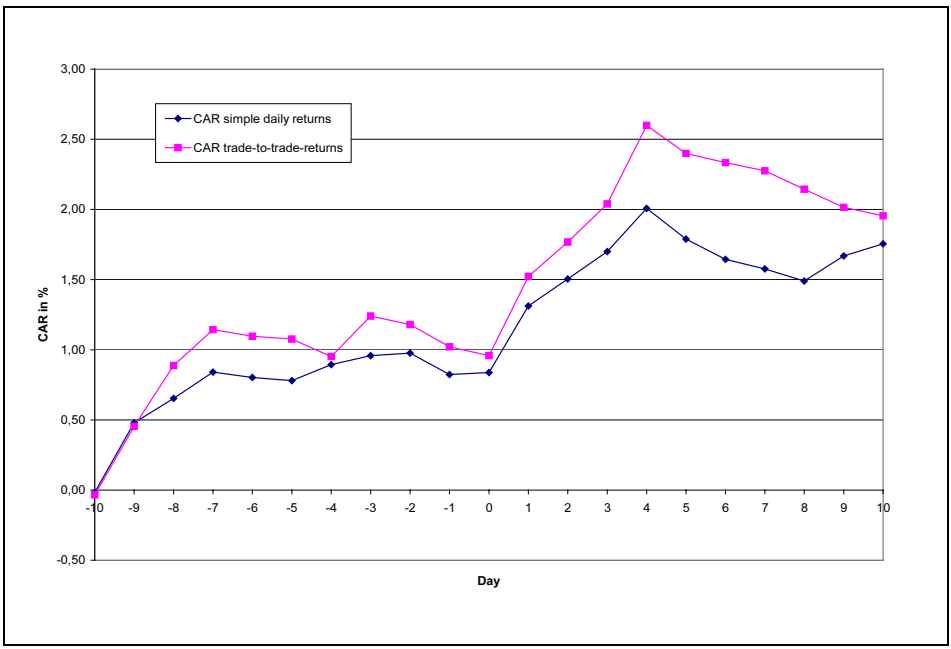
I. Event Period Abnormal Returns

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 in %	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

Figure 1: Cumulative Abnormal Returns Around German Stock Split Announcements 1994– 1996



ing 0.56%. Moreover, the BMP and Wilcoxon test statistics indicate that the results are not driven by either event-induced variance or 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% for simple daily returns and 0.80% for 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 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%[14], often even 4%[15].

Also, in both the U.S. and in Germany, the market reaction to stock dividends is much more pronounced than the reaction to stock splits. For example, *Gebhardt/Entrup/Heiden* (1994) report an average abnormal return of 2.47% on the anouncement day of a German stock dividend. The cumulative abnormal return in the event window [−2; +3] that they find reaches even 3.22%[16]. The comparably lower abnormal returns to stock splits that I find are to be expected from

14 See, e.g., *Ikenberry/Rankine/Stice* (1996), *Pilotte/Manuel* (1996).
15 See, e.g., *Grinblatt/Masulis/Titman* (1984), *Arbel/Swanson* (1993).
16 *Padberg* (1995) and *Kaserer/Brunner* (1997) report similar results.

a signaling hypothesis point of view, because of the institutional restrictions to use stock splits to signal information in Germany.

Table 6 provides further evidence on the extent to which institutional differences between stock splits and stock dividends can convey a signal that might be reflected in abnormal returns.

Table 6: (Cumulative) Abnormal Returns around the Announcement and Execution of German Stock Dividends Accompanied by a Stock Split 1994– 1996

Mean abnormal (AR) and cumulative abnormal returns (CAR) are around the announcement and ex-date of a sample of 7 German stock dividends, from 1994 to 1996, that were accompanied by a stock split. Abnormal returns are calculated using OLS market model regression. Test statistics are the t-test adjusted for cross-sectional correlation as proposed by Brown/Warner (1985), denoted t(BW), the t-test of Boehmer/Musumeci/Poulsen (1991), denoted t (BMP), and the Wilcoxon signed rank test.
*Significance levels: *** 1% level, ** 5% level, * 10% level.*

I. (Cumulative) Abnormal Returns (CAR) around the Announcement Date

Event Window	AR/CAR in %	t(BW)	Percentage of negative AR/CAR	t(BMP)	p-value Wilcoxon-test
Day 0	1.37	2.75**	0.00	2.62**	0.02
Day -1 to day +1	4.81	4.87***	14,29	2.71**	0.03
Day -2 to day +2	5.14	3.72***	28.57	2.54**	0.08
Day -2 to day +3	5.37	3.47**	14.29	2.71**	0.05

II. (Cumulative) Abnormal Returns (CAR) around the Execution Date

Event Window	AR/CAR in %	t(BW)	Percentage of negative AR/CAR	t(BMP)	p-value Wilcoxon-test
Day 0	1.71	3.17**	28.57	1.99*	0.16
Day -1 to day +1	0.72	0.76	28.57	0.63	0.69
Day -2 to day +2	0.77	0.60	28.57	0.78	0.47
Day -2 to day +3	1.08	0.86	42.86	1.29	0.38

The abnormal return in the sample of stock splits that coincide with stock dividends is 1.37% at the announcement date. The cumulative abnormal return in the event window [–1; +1] reaches 4.81%, increasing further to 5.14% in the event window [–2; +2]. Because of the small sample size, the results can only suggest. However, they are in line with the results of the studies focussing on "pure" German stock dividends, which suggest that abnormal returns increase with the signaling ability of the event.

Moreover, my results support those of *Rankine/Stice* (1997), who show that most of the market reaction to stock splits often stems from wrongly classified stock dividends. They interpret this result as (indirectly) supporting the signaling hypothesis proposed by *Grinblatt/Masulis/Titman* (1983), which is based on the retained earnings constraint. In both Germany and the U.S., the abnormal return to a stock split announcement is much lower if there are no signaling costs in form of diminished retained earnings. However, the abnormal return is still significant.

5.2 Abnormal Returns around the Execution Day

Tables 7 and *8* report abnormal returns for 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. However, employing trade-to-trade returns yields an abnormal return of 0.5%, which is significant at the 10% level, according to the BMP test even at the 5% level. Regardless of the return calculation method, I observe positive and partly significant abnormal returns 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. All statistical tests indicate significance. Therefore, the results cannot be attributed to either event-induced variance or outliers.

My results are similar to those of *Harrison* (2000), who reports no significant abnormal return at the execution day itself, but a cumulative abnormal return of 0.93% in the event window [−2; +3] for the period 1994 to 1996[17].

Like the announcement effect, the ex-day effect is much less pronounced in Germany compared to the U.S. This finding 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 yield essentially the same results. This finding indicates that the abnormal returns are not the result of an inappropriate treatment of thin trading. The abnormal returns are real and could have been earned by an investor. *Table 6* indicates that as for the announcement day, the abnormal returns around the ex-day are much higher in the sample of stock splits that coincide with stock dividends.

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 1966 to 1993, as shown in *Table 9* and *Figure 2*. In contrast, I cannot find the negative, albeit insignificant, abnormal returns following the split execution in the 1994–1996 period in the 1966–1993 period. This comparison of evidence from two periods suggests that the slightly negative market reaction after the split completion is caused by chance, rather than attributable to the split.

Further analysis shows that the similarity between simple daily returns and trade-to-trade returns is confined only to short event windows. If longer event periods

17 Unfortunately, *Harrison* does not provide significance tests for cumulative abnormal returns around the event date.

Table 7: Abnormal Returns around the Execution of German Stock Splits Based on Simple Daily Returns 1994– 1996

Mean abnormal returns (AR) and cumulative abnormal returns (CAR) are 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 are the t-test adjusted for cross-sectional correlation as proposed by Brown/Warner (1985), denoted t(BW), the t-test of Boehmer/Musumeci/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 8: Abnormal Returns around the Execution of German Stock Splits Based on Trade-To-Trade-Returns 1994– 1996

*Mean abnormal (AR) and cumulative abnormal returns (CAR) are 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/ Marsh (1983). Test statistics are the t-test adjusted for cross-sectional correlation as proposed by Brown/Warner (1985), denoted t(BW), the t-test of Boehmer/ Musumeci/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 9: Abnormal Returns around the Execution of German Stock Splits Based on Simple Daily Returns 1966– 1993

Mean abnormal returns (AR) and cumulative abnormal returns (CAR) are around the announcement date of a sample of 78 German stock splits, from 1966 to 1993. Abnormal returns are calculated using an OLS market model regression. Test statistics are the t-test adjusted for cross-sectional correlation as proposed by Brown/Warner (1985), denoted t(BW), the t-test of Boehmer/Musumeci/Poulsen (1991), denoted t (BMP), and the Wilcoxon signed rank test.
*Significance levels: *** 1% level, ** 5% level, * 10% level.*

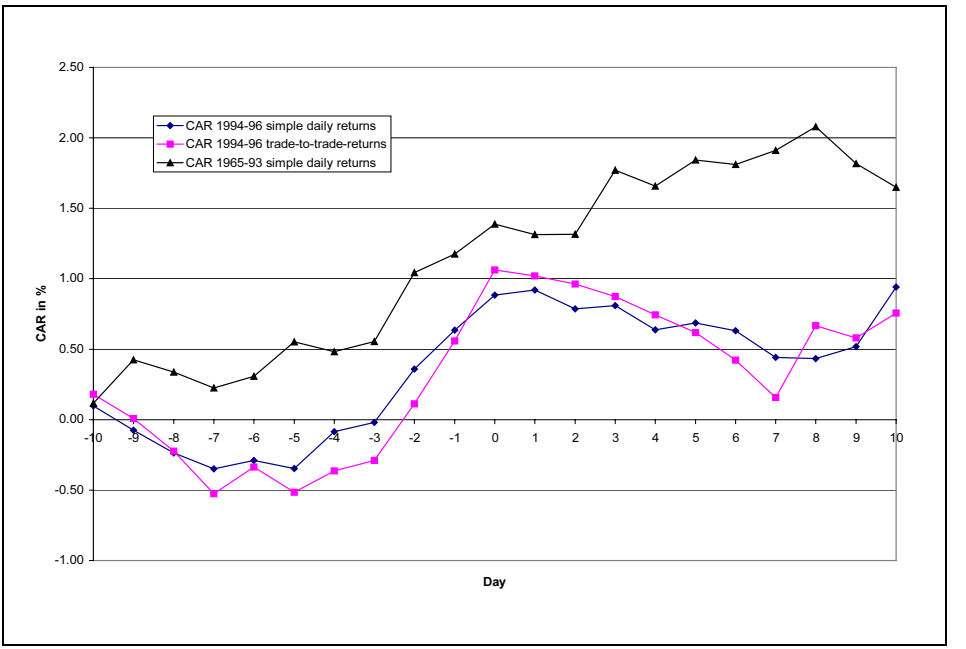
I. Event Period Abnormal Returns

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

Figure 2: Cumulative Abnormal Returns Around German Stock Split Execution Dates 1966– 1996



are studied, not only does the return generating model matter, 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 used. This result is not surprising. It relates to the well-known joint hypothesis problem in market efficiency tests[18]. *Dimson/Marsh* (1986) show that this problem can be ignored only in event studies that focus on short event periods. Therefore, my findings confirm the results of *Dimson/Marsh* (1986). However, my findings do raise doubts on results based on daily cumulative abnormal returns over relatively long event periods when researchers do not conduct sensititvity tests for the influence of the return-generating model and thin trading[19].

When I examine the development of the ex-day effect throughout the years, it shows signs of decrease. I can no longer find any abnormal returns in the split

18 See, e.g., *Fama* (1991).

19 This caveat also affects *Harrison*'s (2000) results. Despite the positive abnormal returns he reports for small intervals around the ex-day, he draws his conclusions from focusing on the development of cumulative abnormal returns in the event window from t(−125) to t(+125), where he can no longer detect any ex-day effect. The research on long-run stock price performance suggests that event study methodology used to detect abnormal returns in short periods around corporate events might not be appropriate for investigating the long-run performance before and after corporate events. See e.g. *Desai/Jain* (1997), *Fama* (1998), and *Steble/Ehrhardt/Przyborowski* (2000).

subsample for 1996[20]. This finding appears to be the result of a learning effect of the market that counteracts inefficient stock market valuation. Thus, I cannot rule out market inefficiency as an explanation of the ex-day effect.

5.3 Change in Variance

Table 10 documents the empirical findings on the change in variance after announcement and completion of German stock splits. Similar to the results of *Ohlson/Penman* (1985), I find no increase in variance in the period after the split announcement. Variance estimates based on trade-to-trade returns even show signs of a slight decrease, which is significant by the nonparametric test.

Table 10: Change in Variance of Simple Daily Returns and Trade-to-trade Returns

The presplit variance is estimated over the period from day –230 to –11 relative to the announcement day or ex-day, respectively. The 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 without two outliers. (Gold Zack AG and Maternus Kliniken AG are excluded.)*

Period	Method of return calculation	Mean presplit variance*	Mean postsplit variance*	Paired t-statistic	z-statistic	$\Pr\{\sigma_2^2 > \sigma_1^2\}$ in %	$\Pr\{R_2^2 > R_1^2\}$ in %
Announcement 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
1966 – 1993	Daily	1.57	2.53	4.90	2.19	81.82	51.07

* reported variances are multiplied by 10,000

In contrast, if I use simple daily returns, there is a highly significant increase in variance[21] from 2.21 before to 4.43 after the ex date of the stock split. This result is consistent with many studies from the U.S. and other countries, and also with *Harrison* (2000). However, compared to the variance increase from 3.25 to 5.46 reported by *Koski* (1998) for stock splits in the U.S.[22], the level of return variances is distinctively lower in Germany. This finding is very likely due to thinly traded securites, because often the last traded price of an illiquid share continues to be

20 Abnormal returns around split announcements remain equally high throughout the years.

21 The reported variance figures are multiplied by 10,000.

22 Similar variance levels are reported for the Canadian stock market by *Kryzanowski/Zhang* (1993). They find an increase from 3.39 to 4.37 after the completion of the stock split.

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. The level of variance estimates based on trade-to-trade returns is consistently 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, *Gold Zack AG* and *Maternus Kliniken AG*. Since they are both 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 I exclude the two outliers from the sample, I observe a significant variance increase 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 1966 to 1993 I also find an increase in variance. This increase shows that it is not confined to recent years. Unfortunately, I could not calculate trade-to-trade returns for these years. The low level of variance estimates suggests that they are even more dampened by thin trading than they are in later years. Thus, thin trading seems to affect only the level of variance estimates, but not the ability to detect a change in variance.

The findings in the German capital market show that despite institutional differences, particularly the absence of bid ask quotations, the increase in variance persists. This finding confirms *Koski*'s (1998) results. The findings also show that dealing inappropriately with infrequently traded shares is not the reason for the increase in variance.

5.4 Changes in Liquidity

Following the approach of several studies of the U.S.market, I use three measures of trading activity 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, which I define as raw (unadjusted) volume divided by shares outstanding; and the percentage of days with trades. Using these three measures as proxies for liquidity follows *Amihud/Mendelson* (1986), who show that theoretically, all three measures are increasing functions of liquidity.

Table 11 reports the empirical evidence on the change in trading activity around the ex date of a stock split. To avoid potential distortions of the estimates due to a temporarily higher trading activity around the split execution, I exclude the ten-day period surrounding the ex-day from my estimation[23]. Both volume turnover and the percentage of days without trades are significantly higher after the split. On the other hand, the mean of volume decreases after the split. Nevertheless, the

23 Estimates of the liquidity variables including the ten-day period around split execution lead to virtually the same results and are available on request.

Table 11: Change in Trading Activity after Completion of Stock Splits 1994– 1996

Sample size is 72. 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. The post-split liquidity is calculated from the 220 trading days 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 (Wilcoxontest)
Volume	99577 (5523)	94548 (8087)	-5029 (998)	0.3262 (0.0095)
Volume turnover (in %)	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)

huge difference between the mean and median combined 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 reasoning is confirmed by partitioning the sample according to presplit liquidity (not reported here). The less-liquid shares experience 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 might be the case for many shares in the samples of U.S. stock splits, then a stock split does not further improve liquidity.

5.5 Cross-Sectional Analysis of Announcement Returns

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

$$\text{CAR} = \alpha + \beta_1(\Delta\text{LIQ}) + \beta_2(\text{SIZE}) + \varepsilon. \quad (4)$$

The dependent variable is the cumulated abnormal return over the period day −2 to day +4[24]. The explanatory variables are the change in liquidity (ΔLIQ) and the size of the split-announcing firm (SIZE). To measure the change in liquidity, I use three different variables: the difference in the logarithms of adjusted volume (ΔLOGVOL); the difference in volume turnover (ΔTURN); and the difference in the

24 I have chosen the specific length of the cumulation period to capture the full announcement effect. However, I obtain similar results using shorter cumulation intervals, regardless of the method of return measurement (i.e. simple or trade-to-trade returns). Therefore, I report only the results based on simple daily market-and risk-adjusted returns.

percentage of days with trades (ΔTDAY), where all differences are calculated as post-split minus pre-split values. I measure the variable SIZE as the natural logarithm of the market value of equity on day −10 relative to the split announcement. SIZE tests the explanation power of the neglected firm effect[25].

Table 12 reports the regression results. 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/Mendelson* (1986), which states that improvement in liquidity leads to an increase in value.

Table 12: 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 of 60 voting shares. 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

This finding contrasts with the supportive evidence of *Muscarella/Vetsuypens* (1996), and also of *Amihud/Mendelson/Lauterbach* (1997), who examine the effects on liquidity and share prices brought about by the change in the trading system of the Tel Aviv Stock Exchange. One possible reason is that *Amihud/Mendelson/Lauterbach* (1977) base their results on the cumulative abnormal return from day −5 before the announcement to day +30 after the event takes place. They ignore the influence of the return-generating model and thin trading. As noted earlier, this lacuna can lead to severe distortions.

25 For this regression only the voting shares of the dual class firms are left in the sample (cf. footnote 8). The 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.

I find another possible reason for the regression results in recent work by *Dennis/Strickland* (1998). They suggests that it is not liquidity per se, but liquidity conditional on changes in institutional ownership around stock splits, that explains abnormal announcement returns.

On the other hand, the SIZE variable is negative and significant, showing that the lower the market value of the splitting firm, the higher the abnormal return around the split announcement. This result supports the neglected firm hypothesis and is consistent with the findings of many other studies[26].

6 Conclusion

Although stock splits seem to be a purely cosmetic event, there is ample empirical evidence from the United States that stock splits are associated with abnormal returns on both the announcement and the execution day, and that there is also 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.

I identify thin trading as a potential source of measurement errors and examine its effect on event study results. Using trade-to-trade returns increases the significance of the market reaction, as predicted by *Maynes/Rumsey* (1993), but the difference between return measurement methods is relatively small for short event periods. This result changes dramatically when I use longer event periods. 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 me to disentangle the three main hypothesis on the announcement effect – the signaling, liquidity, and neglected firm hypothesis – to gain further insights into their relative explanatory power. Consistent with the argued absence of signaling content in German stock splits, I find that market reaction around the announcement day is much lower than in the U.S. If German stock splits coincide with stock dividends, the abnormal returns appear to be distinctly higher than in the case of "pure" German stock splits. This finding suggests that abnormal returns increase in proportion to the ability of the event to act as a signal.

Despite a substantial increase in liquidity after the split, I cannot find support for the liquidity hypothesis. Improved liquidity seems not to be valued by market participants in Germany. The theoretical explanation of the announcement effect that is predominantly supported by the German evidence is the neglected firm hypothesis. However, 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/Strickland* (1998) suggests that it is not liquidity per se, but liquidity conditional on changes in institutional ownership around stock splits that explains abnormal announcement returns. This finding indicates a possible direction for further research into the nature and causes of market reaction to stock splits.

26 See e.g. *Grinblatt/Masulis/Titman* (1984), *Rankine/Stice* (1997).

Appendix

This appendix gives additional details of the test statistics used.

The t-test statistic proposed by *Brown/Warner* (1985) to take cross sectional correlation into account is calculated as follows:

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

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

N_t denotes the number of shares for 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/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.

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