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Shareholder Wealth and Volatility Effects of Stock Splits Some Results on Data for the Helsinki and Stockholm Stock Exchanges

ABSTRACT

This event-study examines shareholder wealth and volatility effects around the announcement and execution dates of stock splits at the Helsinki and Stockholm Stock Exchanges. The research period is 1985–1997 (Helsinki) and 1988–1997 (Stockholm). Statistically significant abnormal announcement returns are found at the Helsinki and Stockholm Stock exchanges regardless of the type of return generating model used. A statistically significant ex-date effect is found at the Stockholm Stock Exchange, but not at the Helsinki Stock Exchange. An ex-date volatility shift is found in about half of the splitting stocks on both markets – both the F-test and the ARCH models together with a step dummy produced similar results. However, the null hypothesis of equal variances pre- and post-split could not be rejected for complete samples.

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1. INTRODUCTION

Stock splits are a puzzling corporate phenomenon. Stock splits[1] occur frequently; less often firms consolidate their outstanding common shares in a reverse stock split. It is widely believed that *stock splits* are purely cosmetic events because the corporation's cash flows are unaffected, each shareholder retains his proportionate ownership and the claims of other classes of security holders are unaltered.

If stock splits were purely cosmetic it would be surprising to find them associated with real effects. Yet, real effects are associated both with the announcement of the split and with its occurrence – splits are associated with statistically significant stock price revaluations and unusual volumes of trade and return variances around the announcement dates and, even more surprisingly, around the execution dates. These effects have been reported in a number of international studies.

These results imply that if managers could increase share prices by splitting their firm's stock, both undervalued and overvalued firms would choose to split their shares, thus eliminating the informational (favorable) content of the decision. However, as the persisting positive market reaction to stock splits indicates, splits must credibly signal such positive company specific information. Since the publication of the classic paper by Fama, Fisher, Jensen and Roll (1969), the *signaling* hypothesis and the *trading range* hypothesis have emerged in the finance literature as the leading explanations of stock splits.

The Nordic finance literature contains a rather limited number of studies related to shareholder wealth effects of stock distributions such as stock dividends and stock splits[2]. One of the few studies of stock splits on Nordic data is the Liljeblom (1989) doctoral thesis which is conducted on data for the Stockholm Stock Exchange during the period 1977–85. Therefore, I came to the conclusion that there is a need for a more comprehensive study of Finnish and Swedish stock splits using more recent data. More specifically, for the Finnish markets there is no previous research on the possible announcement or execution effect of stock splits. Similarly, there is no previous research on a possible volatility shift caused by stock splits. Only liquidity effects of stock splits have been studied but with a minimal sample. For the Swedish markets, the announcement effect of stock splits has been studied but not the execution effect. Also the volatility shift following stock splits has been studied for the Swedish markets but not the liquidity effects of stock splits.

1 Thanks to stock splits, the average nominal share price has been amazingly stable in most countries: for instance in the United States the average NYSE share price has fluctuated within the $30 to $40 range since the late 1930s – a period in which most consumer prices have increased by a factor of 10 and the S & P index has risen over 1500%. (Angel 1997, 59)

2 Nielsen & Svarrer (1979) on Danish data, Korhonen (1975, 1977), Berglund et al. (1987) and Löyttyniemi (1991) on Finnish data.

2. THEORY OF STOCK SPLITS

According to the *signaling hypothesis*, managers declare stock splits to convey favorable information about the current value of the firm. Managers obtain pertinent information about the future because of their expertise in making operating and investment decisions. The signaling theory was first suggested in the seminal paper of Fama, Fisher, Jensen and Roll (1969), hereafter FFJR. They argued that when a stock split is announced, the market interprets this as greatly improving the probability that dividends will be increased. Grinblatt, Masulis and Titman (1984), hereafter GMT, developed the signaling theory by arguing that in the case of ”pure splits” the signal actually comprised of two hypotheses which caused the stock price reaction. These were the *reputation* hypothesis and the *attention* hypothesis which both focus on penalties of a more indirect and immaterial kind: such as loss of reputation and the awakening of attention by analysts when in fact unfavorable earnings development is expected.

The *trading range hypothesis* suggests that splits realign per-share prices to a preferred price range[3] and therefore reduce the cost of a round lot, thus making the stock more attractive to retail investors who otherwise could not afford a round lot or were reluctant to purchase an odd lot[4]. On the other hand, wealthy investors and institutions will save brokerage costs if securities are priced high because of the fixed per-share transaction cost component. But if this reluctance may have made sense when odd-lot trades incurred higher transaction costs, it no longer makes sense because the odd-lot differential has been eliminated in more recent times[5]. (McNichols & Dravid 1990, 857–879)

Nevertheless, many investors are still reluctant to trade in odd lots. If investors are constrained to trade in round lots, the large size of a round lot may preclude some investors from considering a stock: even if they could afford it, purchasing a round lot would leave them with a poorly diversified portfolio. Since the need to realign share prices usually stems from a pre-split price run-up, the trading range hypothesis links splits more to past performance than to future. Baker & Phillips (1994) report that managers frequently justify splits on the basis that they improve liquidity and marketability[6]. (Ikenberry et al. 1996, 357–373)

3 Common folklore states that shares should trade below $100 in the NYSE. In Finland, brokers have stated that the ”optimal” tick size lies between 200–500 FIM (Helsingin Sanomat, 26.3.1998, B9).
4 A round lot refers to trading units e.g. 100 shares whereas an odd lot refers to an unequal number of shares compared to the trading unit e.g. 27 shares.
5 Transaction costs in Finland and Sweden have traditionally been proportional to the market value of the transaction, so that the fixed-cost argument does not apply to these markets either.
6 Trading ranges might also arise for other reasons, including a desire by firms to control the relative tick size at which their shares trade (Anshuman & Kalay (1993), Angel (1994)), a desire by the brokerage community to preserve commission income (Brennan & Hughes (1991)), and a desire by managers to increase ownership by individual investors (Lakonishok & Lev (1987)).

A further version of the optimal trading range hypothesis is the *new theory* of stock splits suggested by Angel (1997). According to Angel the new theory of stock splits highlights the importance of creating incentives for brokers and dealers to market a firm's stock by focusing on brokerage commissions and the tick as a percentage of stock price. Companies can modify the tick size for their firms, relative to the stock price, by splitting their stock. The tick provides an important role in simplifying the trading process. It reduces negotiating time as well as the potential costly trading mistakes. The tick also protects the time priority of those who place limit orders, and by putting a floor on the quoted bid-ask spread it provides incentives for market makers to provide liquidity. The optimal share price for a firm represents a trade-off between the incentives that a lower price creates for intermediaries through higher commissions and wider spreads and the costs to shareholders imposed by a lower price through higher bid-ask spreads. (Angel 1997, 68)

3. PREVIOUS RESEARCH

The pioneering paper by FFJR (1969) examined the behavior of cumulative abnormal returns (CARs) surrounding the execution dates of stock splits[7]. Following them, Bar-Yosef & Brown (1977) discovered that the measured excess returns caused by stock splits were in fact due to a temporary increase in the systematic risk (beta coefficient) of the stock. In the following year, however, Charest (1978) documented that some excess returns did remain regardless of how risk was measured. Subsequent literature links stock splits more directly to earnings information. Lakonishok & Lev (1987) and Asquith et al. (1989) document significant earnings increases before and after split announcements. Liljeblom (1989) confirms the presence of stock split announcement effects for stocks traded on the Stockholm Stock Exchange. Doran & Nachtmann (1988) find that analysts' pre-split earnings forecasts underestimate post-split earnings. Klein & Peterson (1989) find that analysts revise earnings forecasts upward following split announcements. McNichols & Dravid (1990) and Asquith et al. (1989) document a positive relationship between split announcement period abnormal returns and earnings forecast errors. Klein & Peterson (1989) document a positive relationship between split announcement period abnormal returns and analysts' earnings forecast revisions. Foster & Scribner (1991) find announcement effects after controlling for beta non-stationarities. Lamoureux & Poon (1987) argue that split announcement effects are due to the increase in the tax-option value of the split[8].

7 The earliest studies of stock splits by Dolley (1933) and Barker (1956 & 1957) are not explicitly discussed due to their obsoleteness.
8 Due to the opportunity of "tax-loss selling" at year end: a security with a price that fluctuates wildly presents its holder with the opportunity to realize losses short term or gains long term to re-establish short-term status.

Brennan & Copeland (1988) assume that managers use stock split announcements to communicate their private information about the firm's prospects to investors. Arbel & Swanson (1993) document that the degree of market anticipation of the split announcement is related directly to the amount of information available about the stock because the magnitude of the announcement effect at the time of the announcement is greater for information-poor stocks than for information-rich stocks.

The ex-date effect of stock splits has been explained by market microstructure anomalies, e.g. by the bid-ask spread and price discreteness. Blume & Stambaugh (1983) show that the bid-ask spread causes an upward bias in rates of return. Gottlieb & Kalay (1985) show that rounding continuous prices to discrete price levels causes an increase in the variance of observed returns. Amihud & Mendelson (1987) and Kaul & Nimalendran (1990) show that measured return variances are also biased upward by the bid-ask spread. Also various other authors have suggested that these and other measurement effects may be responsible for the ex-date effect, e.g. Ohlson & Penman (1985), Dravid (1989), Conroy et al. (1990), Dubofsky (1991), Maloney & Mulherin (1992), Kryzanowski & Zhang (1993) and Conrad & Conroy (1994). In a more recent paper, Desai & Jain (1997) studied long-run common stock returns following stock splits and reverse splits. Their results suggest that the market under-reacts to the information conveyed in the stock split and reverse split announcements.

Regarding return variance effects of stock splits Ohlson & Penman (1985) and Dravid (1987) show that stock return volatility increases after stock splits. Klein & Peterson (1988) find evidence of increased volatility and market inefficiency in call option prices around the announcement and ex-dates of large stock splits in that call options do not reflect underlying stock price volatility increases until the ex-date. Schwartz & Whitcomb (1977) and Gottlieb & Kalay (1985) show that when continuous prices are rounded to discrete price levels, the variance of returns computed using the rounded prices exceeds the variance of unrounded returns. Amihud & Mendelson (1987) and Kaul & Nimalendran (1990) show that the bid-ask spread introduces an upward bias in measured return variances. Dravid (1989) and Conroy et al. (1990) find that bid-ask spreads increase in percentage terms subsequent to splits and impose a liquidity cost on investors: therefore, stock splits act as a valid signal. More recently, Desai et al. (1998) find a significant increase in volatility after stock splits even after controlling for microstructure biases. Furthermore, Koski (1998) finds only some evidence that the bid-ask spread contributes to the volatility increase and also concludes that price discreteness (measurement effects) does not either generate the volatility increase.

Investors are therefore willing to pay for a "tax-option" component of a security. Thus, securities with higher volatilities will have higher values, ceteris paribus (Lamoureux & Poon 1987, 1350).

4.1 Data description

This study is based on daily returns[9] of individual stocks and on a market value-weighted market index for stocks listed on the Helsinki and Stockholm Stock Exchanges during the period 1985–1997 (Helsinki) and 1988–1997 (Stockholm). Returns are measured by logarithmic price differences adjusted for cash dividends, stock dividends and rights issues assuming that all proceeds from a given stock were reinvested in the same stock at zero transaction cost.

The announcement and execution dates for stock splits were collected from a combination of sources. The primary source for the identification of Finnish companies that have undertaken a stock split during the research period of 1985–1997 was the *Pörssitieto 1997* book by Gunhard Kock which includes detailed share histories of all listed Finnish companies. The earlier announcements of stock splits were also checked from the Event Data Base of the Helsinki School of Economics (Department of Accounting and Finance) and from the *Datastream* system. The actual announcement and ex-dates were obtained directly from press releases to the stock market obtained from *Helecon Enterprise* and from the www-on-line service of the Helsinki Stock Exchange[10]. Furthermore, these announcement dates were verified from *Kauppalehti on-line's*[11] news article database. For three companies[12], which split their stock during the 1980's, calling the companies directly also verified the announcement and ex-dates.

The primary source of information for the identification of Swedish companies that have undertaken a stock split during the research period of 1988–1997 were the earlier master's theses of Hovmöller & Wasing (1997) and Olsson & Söderblom (1996). For the years 1996–1997 the primary source was the www-on-line service of the Stockholm Stock Exchange[13]. Furthermore, the Datastream system supported the other sources. In addition to the earlier master's theses the announcement dates for the Swedish companies were verified from the www-online service of *Affärsdata*[14] which contains a news article archive of some 30 major Swedish newspapers and news agencies with over a million articles.

The stock split and stock dividend announcements in this study are not clean from other simultaneous corporate announcements. I chose not to control for other simultaneous company specific information releases since that would have resulted in a large loss of data. This potential and typical Nordic problem of stock split and stock dividend announcements being *contaminated* by other simultaneous information releases such as announcements of proxy state-

9 These returns are based on daily trading prices. If several trading prices were recorded, the average of the highest and the lowest price was used. If no trades occurred, bid prices were used.
10 See *http://www.hex.fi*
11 See *http://www.kauppalehti.fi*
12 These were Fiskars, Kajaani and Rautakirja.
13 See *http://www.xsse.se*
14 See *http://www.ad.se*

ments, earnings per share (annual results) and dividends is thus ignored in this study. My justification for this is the following. Firstly, a large part of the data would have been lost in controlling for the simultaneous information releases since the split / stock dividend is often announced in connection with other news. Secondly, some of the early international studies of stock splits were also subject to the criticism that other information releases occurred simultaneously with the stock dividend / stock split announcement. However, in Foster & Vickerey (1978), Woolridge (1983) and GMT (1984) only pure splits were analyzed and price reactions to the announcements were still observed.

The individual daily returns for the Finnish shares and for the market value-weighted market index were obtained from the Data Base of the Helsinki School of Economics (Department of Accounting and Finance) for companies listed on the main list and from the Helsinki Stock Exchange's information services[15] for the companies listed on the brokers' list during respective splits. A similar set of data for the Swedish shares was obtained from the Datastream[16] system. The companies in the Finnish sample were listed on the main list or the brokers' list at the Helsinki Stock Exchange during their stock splits. The companies in the Swedish sample were listed on the main list, the O-list or the OTC-list at the Stockholm Stock Exchange during their splits.

The original Finnish sample consists of 13 announcements of stock splits and 6 combined announcements of stock dividends and stock splits. The average time interval between the announcement and ex-date for the Finnish companies is 76 days and the average split factor 711% indicating that Finnish companies have split quite radically. The original Swedish sample consists of 90 stock splits of which 89 are pure in the sense that they do not involve a simultaneous stock dividend. The average time interval between the announcement and ex-date for the Swedish companies is 98 days and the average split factor is 320% indicating that splits have been more common on the Swedish markets. Figure 1 shows the sample distribution of the Finnish and Swedish stock splits over the research period. However, it must be noted that trading data was not available for all of the stocks in the original samples, and therefore the actual sample sizes used for testing vary accordingly.

Having identified the announcement and ex-dates of the splits the individual stock returns were characterized according to when they occur in event time. For an event *i* the announcement date (day 0 in event time) is defined as the date of the earliest report of the stock split to the market. In other words, as the day when the company's announcement should have its first effect on the share price. It is assumed that a press release to the market makes it aware of the news. The announcements are usually made as proposals by the board of direc-

15 The help of the market information department of HEX and Säde Juselius is greatly appreciated.
16 The help of Director William Cardwell at LTT is greatly appreciated in providing the data from Datastream.

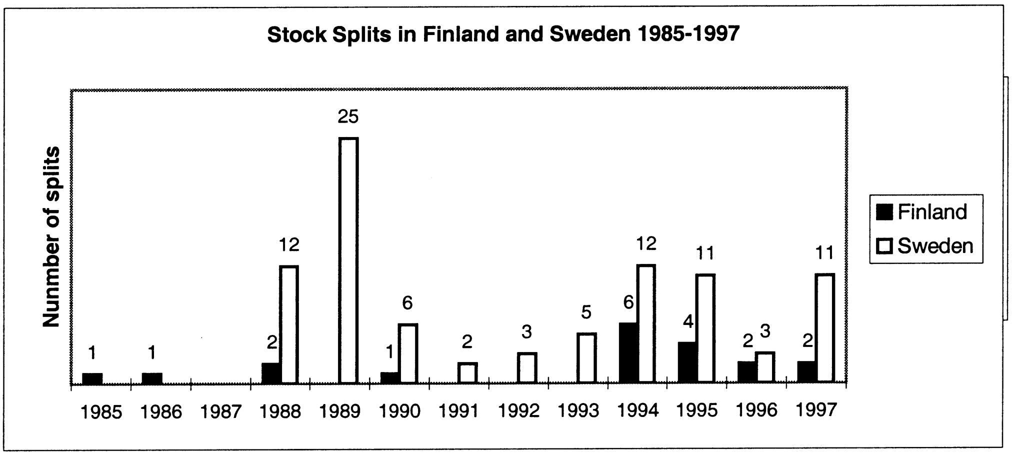

Figure 1: The figure shows a histogram of the sample splits over time. It is obvious that stock splits and stock dividends have mostly occurred during "bullish" markets i.e. during the booming years of the 1980's and during Nordic post-recession years i.e. after 1994.

FIGURE 1. Distribution of sample splits over time

tors and the shareholders' meeting must approve them. However, stock splits and stock dividends are hardly ever neglected by the shareholders' meeting (because the board of directors usually represents a majority of votes in the Nordic countries). This is also my justification for the fact that I define the announcement day as the day of the first public proposal of the split (event day 0). The return data for individual stocks and market indices were then collected, and sorted around the event day before proceeding with further analysis.

4.2 Valuation effects of stock split announcements

The theory of stock splits suggests that the split announcement is interpreted as a positive signal about the future prospects and dividends of the company. To ascertain the existence of such positive announcement effect on the Finnish and Swedish markets, standard event-time methodology is employed. For the days surrounding an event excess returns are estimated using three different models. The most widely used of these models is the market model. An estimate of the excess return for the common stock of the firm engaging in event *i* on day *t* is the abnormal return:

(1) $$AR_{it} = R_{it} - (\hat{\alpha}_i + \hat{\beta}_i R_{mt})$$

Where,

R_{it} = The rate of return on day *t* on the common stock of the firm engaging in event *i*

R_{mt} = The rate of return on the market value-weighted market index on day t[17]
α_i and β_i, = The Ordinary Least Squares (OLS) estimates of the market model from a regression estimated over a 200 day estimation period, beginning 250 days prior to the split announcement, used for each announcement[18]

The second model used to measure excess returns is the mean adjusted return model:

(2) $AR_{it} = R_{it} - R_i$

Where,

R_i = The average stock specific return for the estimation period, which is defined as 200 days beginning 250 days prior to the split announcement

Since the market model and a traditional market adjusted returns model (daily return on a stock – daily return on a market index) have been shown to give very similar results in earlier research, I use a variation of the market adjusted returns as a third model. I define it as market mean adjusted returns model, which I will use as a check for robustness of the excess returns. This measure will reveal how much better the splitting stocks have performed when compared to recent developments in the market[19]. I use it also because significant differences between the market model (1) and the market mean adjusted model (3) will indicate how large the *self-selection bias* has been. The excess market mean return is defined as:

(3) $AR_{it} = R_{it} - R_m$

Where,

R_m = The average return on the market value-weighted market index for the estimation period, which is defined as 200 days beginning 250 days prior to the split announcement

Portfolios of the *N* splitting securities are formed in event time. In this manner, I examine whether the split announcement generates abnormal portfolio performance. The event win-

17 For the Finnish data set the *WI-index* is used until 31.12.90, after which natural logarithmic returns on the *HEX-index* are used; for the Swedish data set natural logarithmic returns on the *Stockholm Generalindex* are used for splits occurring during 1993 and after; the *Affarsvärlden Weighted* index is used for the splits occurring prior to 1993. See Berglund et al. (1983) for a full description of the WI-index.
18 The OLS-parameters must be measured prior to event window due to the fact that the beta coefficients of splitting stocks exhibit a temporary increase at the time the split becomes effective. E.g. Brennan & Copeland (1988) documented that in the 75 days following the split, the beta remains about eighteen percent above its pre-split level.
19 Tests using the traditional market adjusted returns were also conducted and the results were practically the same as with the market mean adjusted model.

dow is a 101-day period centered on the event date[20] that follows the *t* days for which abnormal returns are computed.

I use daily pre-event returns (days –250…–51) to estimate the OLS-parameters for the market model. This method is used because there is ample evidence of beta non-stationarities around the ex-dates of stock splits. In other words, the beta coefficients exhibit temporary increases during and after ex-dates. Since the average time interval between the announcement and the execution of the split is less than 100 days for both data sets, it would be inappropriate to use post-announcement data for OLS-estimation. More reliable beta estimates can be reached by using pre-event data.

However, the previous stock split studies demonstrate great disagreement concerning the selection of the beta estimation period. Defenders of the pre-announcement period refer to non-stationarities of beta coefficients and to the intercept term in an OLS-regression, which should make sure that the market model is not likely to detect abnormal returns too often compared to the situation where the post-event period would be used. The defenders of post-announcement data, on the other hand, recommend the use of post-announcement data due to the ex post self-selection bias.

For any event date *t* the mean abnormal return (*MAR*) for the portfolio of *N* securities is defined as:

$$(4) \qquad MAR_t = (1/N) \sum_{i=1}^{N} AR_{it}$$

For the portfolio of *N* securities a measure of the average cumulative stock price performance from event date *t-s* to event date *t* is the mean cumulative abnormal return (*MCAR*):

$$(5) \qquad MCAR_{t-s,\,t} = (1/N) \sum_{i=1}^{N} \sum_{q=t-s}^{t} AR_{i,\,q}$$

*MCAR*s are used to assess the average magnitude and statistical significance of stock price changes associated with stock split announcements. The significance of the daily mean cumulative abnormal returns is tested using two t-test statistics[21]. The first one is based on the time-series standard deviation of the average excess return, computed from data for event days –50…–1. The second is based on the cross-sectional event-day standard deviation divided by the number of stocks in the sample. The first one allows for cross-sectional dependence be-

20 It may be that splitting stocks do abnormally well during the test period. This *could be* part of the motivation for the split. However, there is no facile way to avoid the problem of ex post selection bias, and the methodology employed herein is standard in finance.

21 Brown & Warner (1985) have shown that, in general, methodologies based on standard parametric tests are well specified for event studies using daily returns.

tween events and is not sensitive to departures from normality as long as the average excess return is normally distributed. The second one is based on the assumption that the excess returns for each event are independent and normally distributed[22], but it allows for changes in the standard deviation during event time[23]. Hence, the second t-test statistic provides a useful check of robustness of conclusions about abnormal returns. Non-parametric tests are not used due to their sensitivity to departures from the symmetry assumption as reported by Brown & Warner (1980).

The first t-statistics (5) is calculated using abnormal returns from the specified model and standard deviations for the whole portfolio of stocks in the sample for event days (–50, –1) assuming that abnormal returns and residuals for each event day are normal, independent, and identically distributed. (Brown & Warner 1980, 251)

(6)
$$t = \frac{\frac{1}{N}\sum_{i=1}^{N} MCAR_i(Z,T)}{\sqrt{[|T-Z|+1]\left[\frac{1}{50-1}\sum_{t=-1}^{-50}\left[\left[\frac{1}{N}\sum_{i=1}^{N} MAR_{it}\right]-\overline{MAR}(-50,-1)\right]^2\right]^{1/2}}}$$

where

$$\overline{MAR}(-50,-1) = \frac{1}{50N}\left[\sum_{t=-1}^{-50}\sum_{i=1}^{N} MAR_{it}\right]$$

Z,T = Days for mean cumulative abnormal daily returns

MCAR(Z,T) = Mean cumulative abnormal daily return for company i during days (Z,T)

N = Number of stock split companies in the sample

50 = Number of trading days (–50,–1) before the announcement / ex-date used to compute standard deviations

The t-statistics has (50-1) degrees of freedom

The second t-statistics (6) is calculated using the abnormal returns from the specified model and the standard deviation from the cross-sectional standard deviation assuming that abnormal returns are cross-sectionally independent and identically distributed. (Brown & Warner 1985, 28)

22 Cross-sectional independence is a reasonable assumption if there is no clustering of event-dates. Since there is relatively little event date clustering in both samples, cross-sectional independence is assumed.

23 The time-series t-statistics could result in too many rejections of the null hypothesis in the presence of variance increases during the announcement period. It is because of the possibility of such variance increases that the cross-sectional t-statistics is calculated. See Brown & Warner (1985) for such simulations.

$$(7) \qquad t = \frac{\sum_{i=1}^{N} MCAR_i(Z,T)}{\sqrt{N\left[\frac{1}{N-1}\sum_{i=1}^{N}\left[MCAR_i(Z,T) - \overline{MCAR}(Z,T)\right]^2\right]}}$$

where

$$\overline{\text{MCAR}}\,(Z,T) = \frac{1}{N}\sum_{i=1}^{N} MCAR_i(Z,T)$$

Z,T = Days for mean cumulative abnormal daily returns

MCAR(Z,T) = Mean abnormal daily return for company i on days (Z,T)

N = Number of stock split companies in the sample

The t-statistics has (N-1) degrees of freedom and is one-sided

4.3 Valuation effects of stock split execution dates

In an efficient market, traders are unable to earn abnormal profits by trading on the public announcement of a stock split. However, an article by Charest (1978) first suggested that traders could have earned an excess return of approximately 1,5% by purchasing shares at the end of the announcement month of a stock split and holding then for three months. A paper by Woolridge (1983) documented a related anomaly on the ex-dates of securities that predominantly pay small stock dividends. He found that share prices increase, on average, approximately 1% on the ex-dates of these stock dividends. Other evidence includes the paper by Choi & Strong (1983) on when-issued shares[24]. For stock splits, when-issued split shares are sometimes traded between the announcement and the ex-date. These contracts entitle the holder to receive the newly distributed shares when they are issued. Choi & Strong found that the split factor adjusted prices of when-issued shares were about 1% above the price of the unsplit shares. This difference is of the same magnitude as the ex-date returns of stock splits.

The event study of stock split ex-dates is conducted using the post-split period to estimate the market model (1). The 200 days starting 51 days after the ex-date and ending 250 days following the ex-date are used to estimate the market model parameters because it is assumed that by then the systematic risk of the company has stabilized on the new post-split level.

The portfolio error variance is calculated in a similar way to that of the announcement date excess returns, except that the portfolio event window for the variance is the +1 through +50 days following the ex-date because of a possible shift in volatility. The methodology used to examine ex-date abnormal returns is similar to that used for the announcement effects de-

24 These are contracts that entitle the holder to receive the newly distributed shares when they are issued.

scribed in section 4.2. In other words, mean abnormal returns are calculated by the market, mean adjusted and market mean adjusted models and similar t-statistics are used to test for significance levels.

4.4 Volatility increases subsequent to stock split ex-dates

One of the more basic claims of modern finance theory is the economic irrelevance of shares outstanding: the total market value of a firm's equity is independent of the number of shares outstanding. An obvious implication of this irrelevance hypothesis is that the security returns process is also independent of shares outstanding. By focusing on the impact of stock splits on return variances, this paper examines the *irrelevance hypothesis* on empirical level.

In theory, variances preceding and following the split ex-date should on average be no different, yet empirical studies such as Ohlson & Penman (1985) have shown that return volatility is significantly greater following the split ex-date. Further studies on the volatility shift provide several explanations for the volatility increase. The increase could be due to relatively higher spreads (due to tick size effects) causing more bid-ask bouncing. Other explanations include the higher number of trades following the split ex-date and increased price discreteness.

Furthermore, a volatility shift associated with a stock split ex-date would indicate short-term profit opportunities for call option holders if the shift is not incorporated in option prices. On the other hand, from the point of view of the shareholders of the splitting company, increased volatility can be interpreted as a cost in a world where investors seek mean-variance efficient portfolios. This is because increased volatility implies increased risk of the share.

The possible shift in volatility will be examined using two different methods. The first is a straightforward F-test testing for difference of variances (or standard deviations) and the second one a more complex approach using ARCH models.

A possible volatility shift is examined using a standard F-test for difference of standard deviations in the pre- and post-split periods. To start with, daily standard deviations for each stock and the whole sample are calculated over periods of 100 days surrounding the ex-date of the split. These individual daily standard deviations are based on a 100-day moving estimation period[25].

The null hypothesis is that the standard deviation before and after the split ex-date are equal. The alternate hypothesis, on the other hand, is that the post-split standard deviation is higher than the pre-split standard deviation:

25 As a check for robustness the individual standard deviations were calculated using other (shorter and longer) estimation periods but the results showed very small differences.

$H_0 = \overline{\sigma_2} = \overline{\sigma_2}$

$H_1 = \overline{\sigma_2} > \overline{\sigma_2}$

The F-test statistics is defined as:

(8) $$\underline{F} = \overline{\sigma_2} / \overline{\sigma_1}$$

which is distributed with $F(n_2-1, n_1-1)$ degrees of freedom and because of the alternate hypothesis the test is one-sided. The F-test values are then interpreted based on their respective significance levels in order to validate a higher standard deviation following the split ex-date.

To test for possible ARCH effects around the ex-dates of stock splits the following models are tested for both samples:

(9) $$y_t = \gamma_0 + \varepsilon_t$$

(10) $$h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2$$

(11) $$h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j h_{t-i}$$

Where (9) + (10) is the ARCH model and (9) + (11) the GARCH model. Models with different lag structures will be estimated for both data sets in order to find the best fitting ARCH model to describe the situation around the ex-date. If the returns series exhibits ARCH effects the best fitting model will be used for further analysis of a possible volatility shift around the ex-date of stock splits.

Once the best fitting ARCH model is found it is used together with a dummy variable in the variance regressor to identify the character of the volatility shift around the ex-date. Three different dummies will be used as explanatory variables in the variance regressor of the appropriate ARCH model. The first dummy is a step dummy which has a (…0,0,0,1,1,1…) structure describing a permanent shift in volatility. The second dummy is an impulse dummy with a (…0,0,0,1,0,0,0…) structure describing a temporary peak around the ex-date. The third dummy variable is a decreasing impulse dummy with a (…0,0,0,1,0.9,0.8,0.7...) structure describing a temporary but linearly declining volatility shock. The results for each dummy variable are then interpreted based on their significance levels.

5. RESULTS OF THE EMPIRICAL STUDY

5.1 Valuation effects of stock split announcements

The market model parameters, the individual mean returns and the mean market returns were estimated over a 200 day estimation period beginning 250 days prior to the announcement and ending 50 days prior to the announcement. The market model parameters, the intercepts and coefficients from the regressions were then calculated.

The results indicate some problems in measuring betas. Infrequently traded stocks tend to have downward biased betas whereas frequently traded stocks tend to have upward biased betas. This is reflected in the low empirical average beta of 0,49 for the Finnish sample and 0,59 for the Swedish sample. Infrequent trading has been typical for small Nordic stock markets especially during the 1980's. Therefore, estimating betas on daily data for these markets often leads to average empirical betas of less than one[26]. I take my results as being typical but also consider the potential underestimation of betas not to be severe enough to require further adjustments to the beta estimation methods used.

Figure 2 shows the behavior of the mean cumulative abnormal returns (MCARs) around the announcement day for the Finnish sample. Pure stock splits and combined stock splits and stock dividends are included in the sample of 18 stocks.

The significance of the announcement day effect is examined over various intervals. Since the results of the statistical tests are rather similar for all return generating models used, only the results for the market model are reported in Table 1. A statistically significant positive announcement day return of 3,2% (market model) is found for the Finnish sample of 18 stocks. The mean cumulative abnormal return for event days –1 to +1 is 5,1% (market model) and is statistically highly significant regardless of the type of t-statistics used. The mean cumulative abnormal return for event days –5 to +5 is 5,7% (market model) indicating that most of the announcement effect is absorbed during the two days surrounding the announcement. Further evidence of this is revealed by the fact that the mean cumulative abnormal return for event days –10 to +10 is only slightly more, that is 5,8% (market model). Thus, hardly any effect remains after +5 event days of the announcement. The timing of the announcement effect can also be analyzed from Figure 2, which similarly indicates that the positive news are reflected in prices by the end of event day +2.

Figure 2 also gives some indication of continued positive abnormal returns during event days +5 to +20, and of a reverse effect during event days +20 to +30, but looking at the average over event days +5 to +30 there is no distinct drift. Figure 2 also indicates a relatively strong pre-announcement drift between event days –40 to –5. This could be due to informa-

26 See e.g. Berglund et al. (1989) and Martikainen (1991).

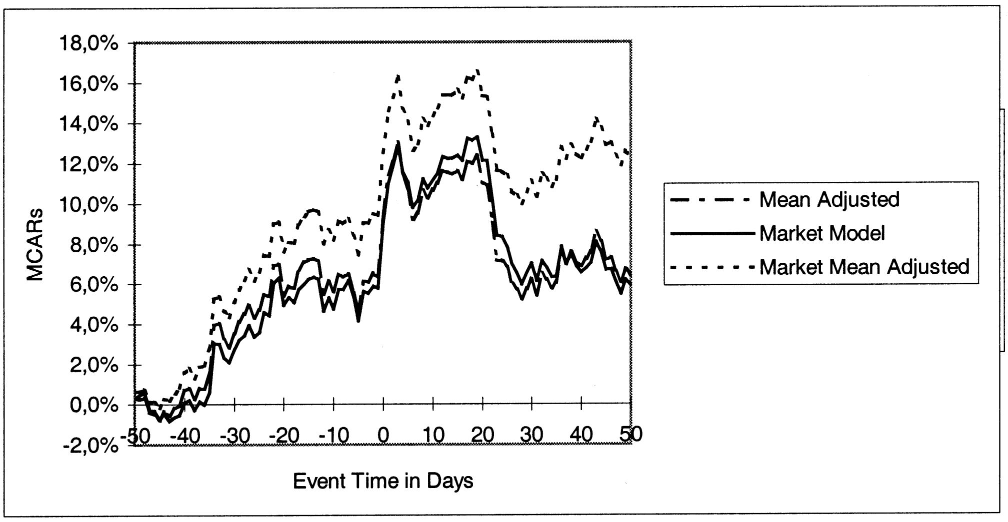

Figure 2: The graph shows the behavior of the Mean Cumulative Abnormal Returns during the event window. MCARs are measured in percents of mean cumulative excess return. MCARs are obtained from the market, mean adjusted and market mean adjusted models indicated in the legend. Sample size is 18.

FIGURE 2. Announcement effect at the Helsinki Stock Exchange

tion leakage about the split or the self-selection bias. However, a detailed study of the pre- and post-announcement drifts is beyond the scope of this paper. In this respect the results are similar to those obtained by FFJR and GMT in which a strong pre-announcement drift was detected but no post-announcement drift.

Thus, the announcement of a stock split (or a combined stock split and stock dividend as in 6 cases in the Finnish sample) is interpreted as a positive signal by the market. This positive reaction occurs mostly during event days –1 to +1. The results indicate that it takes more than one day for the market to incorporate company specific news in the share price – merely reflecting the market specific speed of informational efficiency. This is also partly due to the fact that the sample contains splits from the 1980's when news reached the market more slowly and there was less trading compared with today's markets.

Figure 3 shows the behavior of the mean cumulative abnormal returns for the Swedish sample during the research period 1988–1997. Only one combined stock split and stock dividend is included in the sample – the rest are pure stock splits. The results for the Stockholm Stock Exchange are similar to those obtained for the Finnish markets. There is a clear positive announcement effect of stock splits – the results of the statistical tests for the market model are reported in Table 2. The announcement day abnormal return for the splitting companies is 0,9% (market model) and is significant at the 5% level regardless of the statistical test used.

TABLE 1. Statistical tests of the announcement effect at the Helsinki Stock Exchange

MCAR(Period)	MCAR	t-value time series	t-prob	t-value cross-sectional	t-prob
Market model					
MCAR(0)	0,03187	4,5329	0,0000**	3,54849	0,0004**
MCAR(–1,+1)	0,05129	4,2115	0,0000**	6,5201	0,0000**
MCAR(–5,+5)	0,05725	2,4551	0,0088**	10,4257	0,0000**
MCAR(–10,+10)	0,05852	1,8160	0,0377*	8,8461	0,0000**

Table 1: MCAR (Period) shows the event window over which the Mean Cumulative Abnormal Return is calculated. MCAR is the Mean Cumulative Abnormal Return obtained for the specified event days. The first t-value is based on the time-series standard deviation of the mean daily abnormal returns. The second t-statistics is based on the cross-sectional standard deviation of the stock specific daily abnormal returns. T-prob indicates the significance level of the t-value (one-sided test). *Significant at 5% level, **Significant at 1% level. Sample size is 18.

The mean cumulative abnormal return for event days –1 to +1 is 2,0% (market model) and is significant. The mean cumulative abnormal return for event days –5 to +5 is only slightly larger 2,3% (market model) indicating that most of the announcement effect occurs during the two days surrounding the event day.

In terms of the actual announcement returns on the Swedish markets the results are similar to those obtained for the Finnish sample. However, the announcement effect in Sweden is much smaller compared to that of the Finnish markets. Furthermore, the results are very much in line with previous results obtained for the Stockholm Stock Exchange by Liljeblom[27] (1989) who studied stock splits and other stock distributions during 1977–85. In this respect, there seems to be no change in the announcement effect. A stock split is still interpreted as a positive signal on the Swedish markets and the effect has not changed much in magnitude.

As mentioned earlier, a possible explanation for the positive announcement effect found on both markets could be provided by simultaneous announcements of other company specific news. News such as earnings proxies or dividend announcements are typically announced simultaneously with the stock split on the Nordic stock markets. As mentioned earlier in the paper, due to difficulties in obtaining data for all such company specific news for the sample companies, I chose *not* to control for these other news. Therefore, it is possible to pose some doubt on my results in this respect.

However, there are at least two facts that support my conclusions. Firstly, the Swedish sample is quite large (60) and it is very likely that not all of the split companies have declared

27 Liljeblom (1989) found abnormal returns of 0,3% during event day 0 and 1,9% during event days –1 to +1 for a sample of 20 pure stock splits on the Stockholm Stock Exchange during 1977–85. (Liljeblom 1989, 12–13)

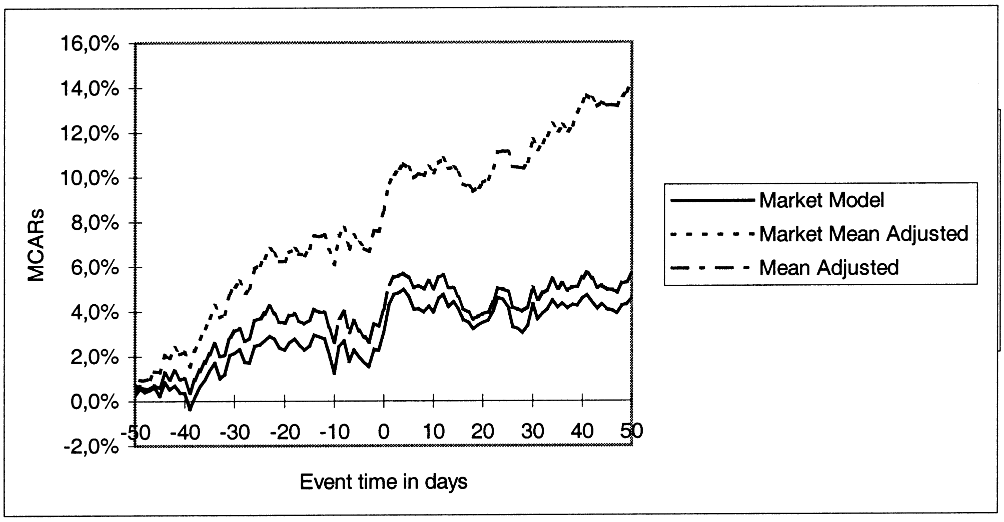

Figure 3: The graph shows the behavior of the Mean Cumulative Abnormal Returns during the event window. MCARs are measured in percents of cumulative excess return. MCARs are obtained from the market, mean adjusted and market mean adjusted models indicated in the legend. Sample size is 54.

FIGURE 3. Announcement effect at the Stockholm Stock Exchange

other company specific news simultaneously with the split. Secondly, annual results and cash dividends are typically announced during February / March and announcement proxies typically about a month after the calendar quarter both in Sweden and Finland whereas the stock split announcements in the sample occur throughout the calendar year.

Furthermore, the fact that the announcement effect and post-announcement behavior have remained similar on both markets before and after the Nordic recession – that is before 1991 and after 1994 – was verified for both samples. These results are not presented since they do not provide any additional insights of the announcement effect on these markets.

Another interesting issue that requires further analysis is whether the *stock split factor* explains the magnitude of observed abnormal returns. The analysis revealed that the differences in the announcement effect are relatively small, but that there are larger differences in the pre- and post-announcement drifts of the MCARs. This was especially true for the Finnish sample, for which the post-announcement performance of the lowest split factor group (100%–200%) seemed to be negative, whereas the highest split factor group (900%–) demonstrated superior pre- and post-announcement drifts. The middle group of (200%–500%) split factor shows moderate behavior in the sense that the pre- and post-announcement drift is not as strong.

The differences for various split factor groups were not as distinct in the Swedish sample. In the Swedish sample the stocks in the 300% and 400% split factor groups have a larger an-

TABLE 2. Statistical tests of the announcement effect at the Stockholm Stock Exchange

MCAR(Period)	MCAR	t-value time series	t-prob	t-value cross-sectional	t-prob
Market model					
MCAR(0)	0.00856	1.9281	0.0298*	2.2190	0.0153*
MCAR(–1,+1)	0.01997	2.5968	0.0061**	4.1888	0.0000**
MCAR(–5,+5)	0.02378	1.6144	0.0564	6.5893	0.0000**
MCAR(–10,+10)	0.01863	0.9154	0.1822	4.5663	0.0000**

Table 2: MCAR (Period) shows the event window over which the Mean Cumulative Abnormal Return is calculated. MCAR is the Mean Cumulative Abnormal Return obtained for the specified event days. The first t-value is based on the time-series standard deviation of the mean daily abnormal returns. The second t-statistics is based on the cross-sectional standard deviation of the stock specific daily abnormal returns. T-prob indicates the significance level of the t-value (one-sided test). *Significant at 5% level, **Significant at 1% level. Sample size is 54.

nouncement effect and superior MCAR drifts both pre- and post-announcement. On the other hand, the lowest split factor group (100%) performs slightly worse during the research period whereas the highest split factor group has performed relatively well (although not better than the 300% and 400% groups). Therefore, the differences in performance of the split factor groups seem not behave linearly as with the Finnish sample.

Due to the fact that on both markets the split factor subgroups are quite small any conclusions should be treated with caution. In my opinion, the size of these subgroups is too small to conduct extensive statistical tests on the difference of the means of the groups. The second reason for not conducting such tests is that Liljeblom (1989) has already performed similar tests on her larger sample including both splits and stock dividends for the Stockholm Stock Exchange. Even though her sample was much larger (156), most of the differences between split factor groups were not large enough to produce significantly different group means[28] (Liljeblom 1989, 17).

Furthermore, normally the desired split factor is chosen based on the desired trading range: in this respect the split factor is merely an indicator of the pre-announcement performance or drift of the stock. Therefore, a larger split factor indicates that the stock has performed better but it should not necessarily be interpreted as an *additional* positive signal from the management. A detailed study of the stock split factors and the announcement effect is beyond the scope of this paper – in my opinion it is better to wait for more observations of stock splits before conducting further research on these two markets.

28 Significant differences were observed only between the smallest split factor group (<30%) and the groups from the third smallest group (>200%) upwards (Liljeblom 1989, 17).

5.2 Valuation effects of stock split ex-dates

On efficient markets the execution of a stock split should not cause any abnormal behavior. On the day of the split, the par value of the stock is changed and the new equilibrium price calculated accordingly. The market has become aware of the split much earlier and all information effects should have been fully reflected in the share price. However, as presented earlier, abnormal returns have been observed during stock split ex-dates on several markets. The ex-date effect has been explained by e.g. measurement related issues such as widening spreads around the ex-date. Blume & Stambaugh (1983) have shown that the bid-ask spread causes an upward bias in rates of return and Conrad & Conroy (1994) find evidence that closing prices on the ex-date occur more frequently at the ask.

The occurrence of a possible ex-date effect on the Helsinki and Stockholm Stock Exchanges was studied using exactly the same methodology as for the announcement day effect. However, there was one significant difference. The market model parameters, the individual mean returns and the market mean returns were calculated over a 200 day post-execution time interval, starting 50 days after the ex-date and ending 250 after the ex-date. In this way the possible non-stationarities in betas (i.e. higher post-split betas) are taken into consideration and the same applies to the calculation of the mean returns for individual stocks. Non-stationarities in betas are clearly detected. The average post-split beta for the Finnish sample is 0,79 (compared to 0,49 pre-split) and 0,84 for the Swedish sample (compared to 0,59 pre-split).

Figure 4 shows a graphical illustration of the ex-date effect for the Finnish sample and the results of the statistical tests for the market model are reported in Table 3. When both t-statistics are taken into consideration no statistically significant abnormal returns are found for the Finnish sample even though the graph gives a different impression. There is a negative ex-date effect of –0,7% during event day 0, –1,2% during event days –1 to +1 and –3,8% during event days –5 to +5 but none of these is statistically significant (all from the market model). However, the cross-sectional t-statistics is significant for both event days –5 to +5 and –10 to +10, but the time-series t-statistics remains insignificant. This effect can also be identified from Figure 4 in which there is a clear drop in MCARs during event days –5 and –4. However, this effect is reversed during respective post-split event days.

Therefore, no significant ex-date effect is found for the Finnish sample. The Finnish market seems to be efficient and rational in the sense that stock splits on average cause no ex-date effect. No further analysis of the ex-date effect on the Finnish sample was conducted.

Figure 5 shows a graphical illustration of the ex-date effect for the Swedish sample and the results of the statistical tests for the market model are reported in Table 4. Contrary to the results for the Finnish markets a statistically significant positive ex-date effect is detected for the Swedish markets regardless of the model used. A positive ex-date effect of 0,9% (market

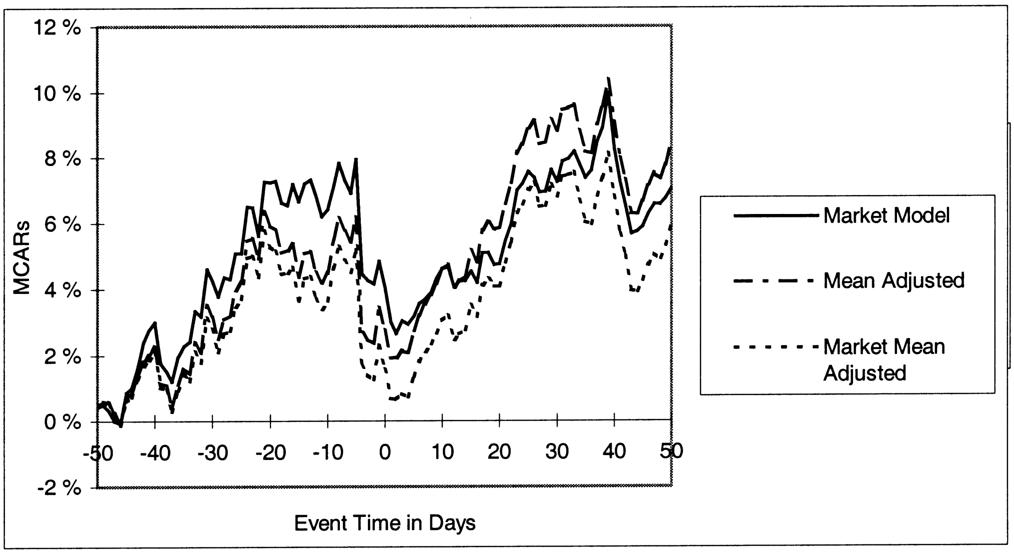

Figure 4: The graph shows the behavior of the Mean Cumulative Abnormal Returns during the event window. MCARs are measured in percents of cumulative excess return. MCARs are obtained from the market, mean adjusted and market mean adjusted models indicated in the legend. Sample size is 18.

FIGURE 4. Execution-day effect at the Helsinki Stock Exchange

TABLE 3. Statistical tests of the ex-date effect at the Helsinki Stock Exchange

MCAR(Period)	MCAR	t-value time series	t-prob	t-value cross-sectional	t-prob
Market model					
MCAR(0)	**–0,00805**	**–1,01915**	**0,1565**	**–0,6694**	**0,2530**
MCAR(–1,+1)	**–0,01159**	**–0,84653**	**0,2006**	**–1,5472**	**0,0638**
MCAR(–5,+5)	**–0,0375**	**–1,4307**	**0,0794**	**–4,5291**	**0,0000****
MCAR(–10,+10)	**–0,01596**	**–0,4407**	**0,3306**	**–2,3545**	**0,0111***

Table 3: MCAR (Period) shows the event window over which the Mean Cumulative Abnormal Return is calculated. MCAR is the Mean Cumulative Abnormal Return obtained for the specified event days. The first t-value is based on the time-series standard deviation of the mean daily abnormal returns. The second t-statistics is based on the cross-sectional standard deviation of the stock specific daily abnormal returns. T-prob indicates the significance level of the t-value (one-sided test). *Significant at 5% level, **Significant at 1% level. Sample size is 18.

model) is found for event day 0. However, this abnormal return is statistically significant only at the 10% confidence level if the worse t-statistics is taken as benchmark. For event days –1 to +1 a highly statistically significant positive abnormal return of 1,7% (market model) is found. The abnormal return for event days –5 to +5 is 1,3% (market model) indicating that all of the

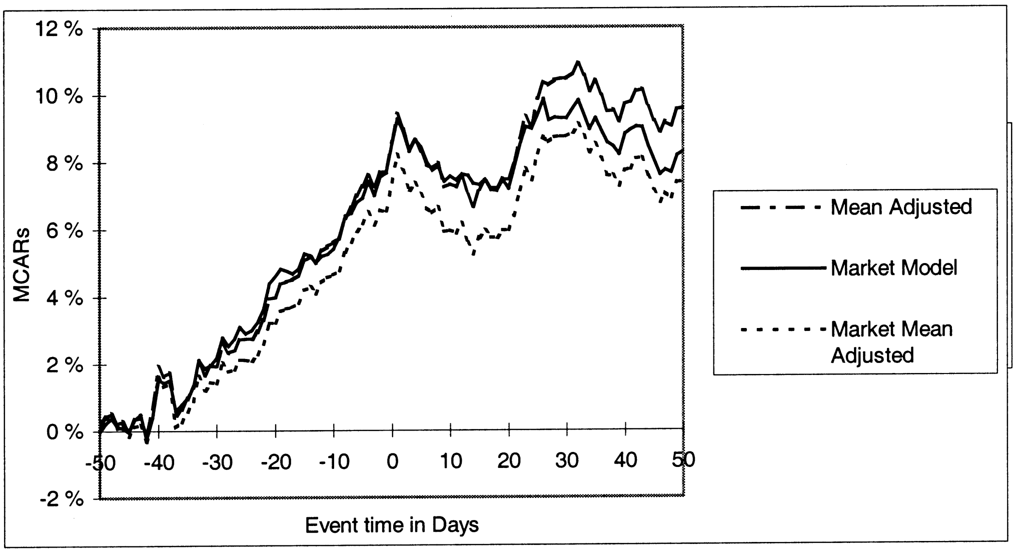

Figure 5: The graph shows the behavior of the Mean Cumulative Abnormal Returns during the event window. MCARs are measured in percents of cumulative excess return. MCARs are obtained from the market, mean adjusted and market mean adjusted models indicated in the legend. Sample size is 60.

FIGURE 5. Execution-day effect at the Stockholm Stock Exchange

ex-date effect occurs during the two days surrounding the execution day. Surprisingly similar results for the ex-date effect are obtained from all models which gives further support for the conclusions.

To my knowledge there is no other study, which would have examined abnormal returns around the ex-dates of stock splits at the Helsinki or Stockholm Stock Exchanges[29]. The positive ex-date effect found for the Stockholm Stock Exchange can be interpreted as an indication of market inefficiency. My study does not analyze possible explanations for the ex-date effect but earlier papers on the ex-date effect provide various measurement related explanations. These include e.g. widening spreads around the ex-date.

Concerning my sample, simultaneous announcements of other company specific news provide no explanation either, since the news of the split have occurred on average 98 days prior to the ex-date on the Swedish markets. The Swedish sample is also larger than the Finnish one (60 compared to 18) and the ex-date effect is not caused by outliers (i.e. extremely strong individual ex-date effects). A possible explanation could be the occurrence of simulta-

29 However, a positive ex-date effect has been identified at a number of other stock exchanges. See e.g. Charest (1978), GMT (1984) or Choi & Strong (1983).

TABLE 4. Statistical tests of the ex-date effect at the Stockholm Stock Exchange

MCAR(Period)	MCAR	t-value time series	t-prob	t-value cross-sectional	t-prob
Market model					
MCAR(0)	**0.00890**	**2.4698**	**0.0085****	**1.404**	**0.0830**
MCAR(−1,+1)	**0.01736**	**2.7792**	**0.0038****	**3.679**	**0.0002****
MCAR(−5,+5)	**0.01664**	**1.3916**	**0.0851**	**4.375**	**0.0000****
MCAR(−10,+10)	**0.02307**	**1.3958**	**0.0845**	**6.934**	**0.0000****

Table 4: MCAR (Period) shows the event window over which the Mean Cumulative Abnormal Return is calculated. MCAR is the Mean Cumulative Abnormal Return obtained for the specified event days. The first t-value is based on the time-series standard deviation of the mean daily abnormal returns. The second t-statistics is based on the cross-sectional standard deviation of the stock specific daily abnormal returns. T-prob indicates the significance level of the t-value (one-sided test). *Significant at 5% level, **Significant at 1% level. Sample size is 60.

neous ex-dates of cash dividends, but this does not seem to be a good explanation since cash dividends in Sweden are paid during April / May and stock split ex-dates in the sample have occurred throughout the course of the calendar year. Also, the splits have always been approved by the shareholders meeting before execution, so the confirmation that the split would *not* be cancelled, is not a plausible explanation either.

Using daily stock returns in event studies raises several problems regarding the time-series properties of excess returns. In order to validate the use of the statistical tests used to detect abnormal performance, tests of normality of the mean abnormal returns series for all models were examined. The empirical results indicate that the mean abnormal returns series are not completely normally distributed but that the deviations are not severe. The skewness of almost all distributions is negative indicating that the samples are skewed to the left, i.e. more observations on the left side of the mean. Secondly, the distributions of the mean abnormal returns exhibit low kurtosis indicating that the distributions are fat-tailed. The Jarque-Bera test was conducted to test for normality. In the Finnish sample, normality can be rejected only for the announcement day abnormal returns using the market model. However, in the Swedish sample normality is rejected at the 5% level for all series except for the market mean adjusted returns (announcement date). This is slightly surprising since the Swedish sample is larger than the Finnish one. On the other hand, similar findings have been obtained e.g. in Liljeblom's (1989) study of stock splits at the Stockholm Stock Exchange. Since normality is rejected for the Swedish sample, the results obtained for the Swedish sample using the time-series t-statistics must be interpreted with caution. This is due to the fact that the tests may not be well specified. However, my results for the Swedish sample indicate such strong significance levels, that slight non-normality of the abnormal return distributions should not affect the conclusions.

Further tests were conducted to detect possible first-order serial correlation and non-stationarity of the abnormal returns time series. The Durbin-Watson statistics was used to test for first-order serial correlation. The results clearly indicate that no first-order serial correlation is present since the test values are very close to 2 in all cases. The Augmented Dickey-Fuller test was used to test for stationarity of the abnormal returns. The unit root could not be rejected for any of the samples at any conventional confidence levels. Thus, the abnormal returns series seem to be stationary and variance estimates are therefore well specified.

5.3 Volatility increases subsequent to stock split ex-dates

The shift in volatility during the ex-date of stock splits which has been documented in several earlier international studies was tested using the F-test and ARCH models as described in section 4.3. To begin with, a graphical illustration of the volatility behavior around the ex-dates of stock splits is shown in Figure 6 for the Finnish sample and in Figure 7 for the Swedish sample. Looking at the graphs it is obvious that a volatility shift has occurred even on the aggregate level of the whole sample on both markets. This shift in volatility seems to be permanent at least during the event window. The shift is in the magnitude of approximately 0,5% of daily volatility for the Finnish sample and 0,3% for the Swedish sample. Furthermore, the

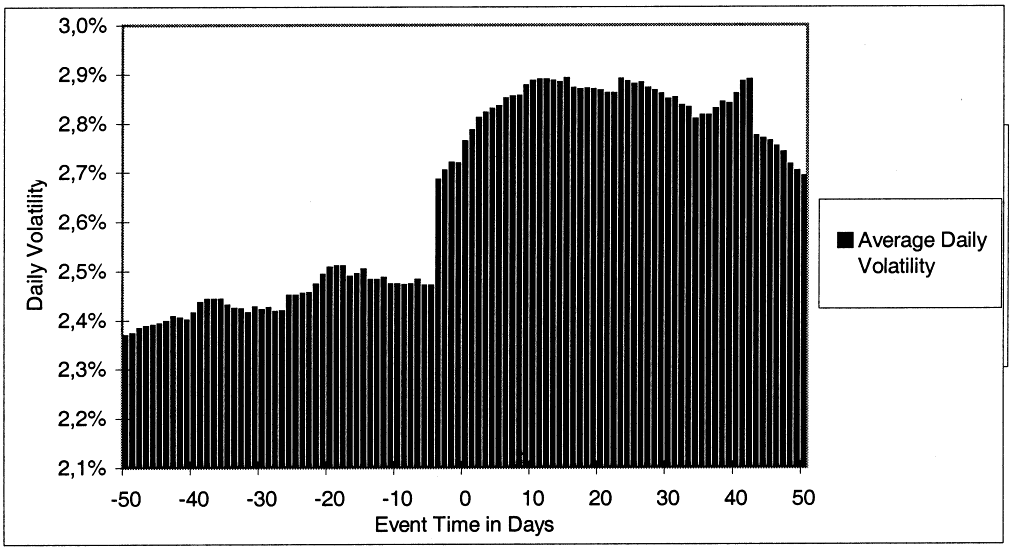

Figure 6: The figure shows the average daily volatility (equally weighted) of the splitting stocks at the Helsinki Stock Exchange. Volatility is measured over a 100 day rolling estimation period based on returns from t-99 days to t days.

FIGURE 6. Volatility shift following stock splits at the Helsinki Stock Exchange

Table 5. F-test results measuring volatility shift around the ex-date at the Helsinki Stock Exchange

Company	Volatility Pre ex-date	Volatility after ex-date	F-test	F-prob
Sampo A	0.0142	0.0219	1.5430**	0.0012
Asko A	0.0162	0.0152	0.9386	0.6723
MetsäSerlaB	0.0185	0.0212	1.1459	0.1688
Valmet A	0.0205	0.0171	0.8324	0.9017
WSOY B	0.0219	0.0235	1.0690	0.3191
Benefon	0.0260	0.0304	1.1690	0.1358
Nokia A	0.0187	0.0270	1.4444**	0.0049
Raisio	0.0204	0.0206	1.0080	0.4777
Tamfelt Etu	0.0169	0.0332	1.9631**	0.0000
Finnlines	0.0242	0.0186	0.7682	0.9682
Instru	0.0202	0.0319	1.5801**	0.0007
TT-tieto	0.0192	0.0256	1.3316*	0.0220
Effoa/silja	0.0500	0.0394	0.7890	0.9523
Lassila&T	0.0327	0.0280	0.8586	0.8584
Kajaani	0.0274	0.0231	0.8442	0.8834
Fiskars	0.0131	0.0255	1.9461**	0.0000
Turkistuottajat	0.0325	0.0317	0.9734	0.5753
YIT	0.0161	0.0332	2.0615**	0.0000
Sample Average	0.0227	0.0261	1.1495	0.1633

Table 6: The table shows the results of the F-tests for the Finnish sample of 18 stocks. The individual daily volatility pre- and post-split is indicated in columns 2 and 3: these are measured over a period of 100 days in event time. The F-test statistics is distributed with F(n-1,n-1) degrees of freedom. *Significant at the 5% level, **significant at the 1% level (both one-sided tests).

volatility increase seems to be a sudden shift on the Finnish markets and slightly more gradual on the Swedish markets. Obviously, the shift is larger for the Finnish markets.

The results of the F-tests are presented in Table 5 for the Finnish sample and in Table 6 for the Swedish sample. In the Finnish sample, 11 of the 18 stocks (61%) exhibit increased post-split volatility when the post-split standard deviation is compared with the pre-split standard deviation (the F-statistics) but only seven of these are statistically significant at the 5% level. The null hypothesis of equal standard deviations pre- and post-split cannot be rejected for the whole sample (only at the 16% level).

In the Swedish sample 46 of the 60 stocks (77%) in the sample exhibit increased volatility following the split. However, only 35 of these are statistically significant at the 5% level. Similarly, the null hypothesis of equal standard deviations prior to and after the split cannot be rejected for the whole sample at conventional confidence levels (only at the 12% level). One interesting point to note in the Swedish sample is that the increase in volatility has been much more distinct during the early years of the research period, that is during 1988–1993, but has

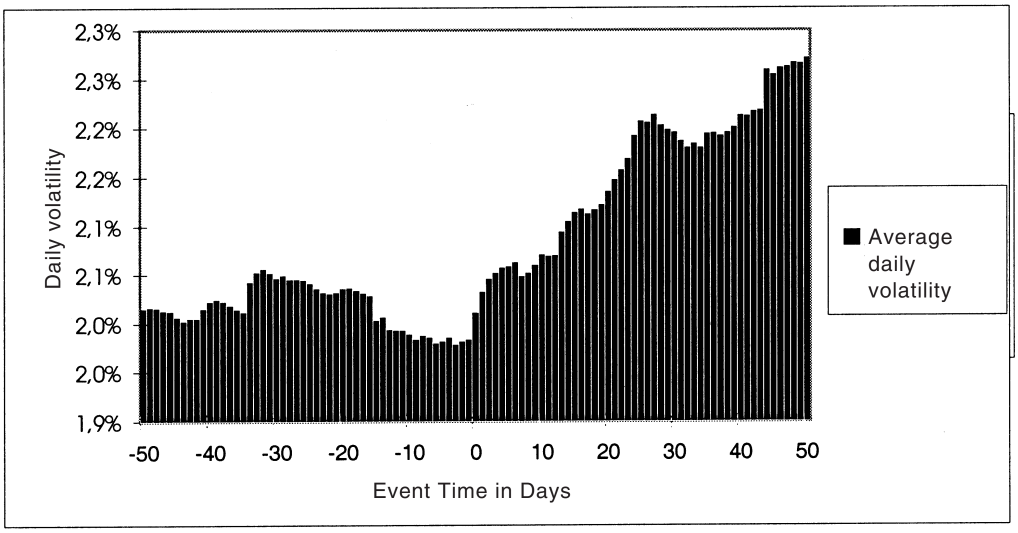

Figure 7: The figure shows the average daily volatility (equally weighted) of the splitting stocks at the Stockholm Stock Exchange. Volatility is measured over a 100 day rolling estimation period based on returns from t-99 days to t days.

FIGURE 7. Volatility shift following stock splits at the Stockholm Stock Exchange

since become much smaller[30]. This could be interpreted as an indication of increased market efficiency of the Swedish markets. The same cannot be said of the Finnish sample where similar volatility increases are detected throughout the research period. Therefore, the results of the F-tests indicate that, on average, there has been a volatility shift around the ex-date of stock splits but that the null hypothesis of equal variances cannot be rejected at conventional confidence levels using the F-test.

A more sophisticated model to describe the behavior of the variance of stock returns is the ARCH model described in section 4.3. The ARCH models also provide a more efficient econometric approach to examining volatility changes around the ex-date. The daily stock return data for individual stocks and for the sample average returns around the split ex-dates for both Finnish and Swedish data were examined for possible ARCH effects.

These estimations were conducted utilizing the maximum likelihood (ML) estimation method. To maximize the likelihood function, the program uses an iterative procedure based upon the method of Marquardt. The t-statistics of ARCH and GARCH terms were interpreted on the basis of their significance levels. For the Finnish data set the simplest ARCH(1) model provid-

30 A similar result was obtained in the master's thesis of Olsson & Söderblom (1996) for the Stockholm Stock Exchange: they found that 32 of 49 stocks in their sample demonstrated volatility increases during ex-dates of stock splits at the 5% confidence level.

TABLE 6. F-test results measuring volatility shift around the ex-date of stock splits at the Stockholm Stock Exchange

Company	Volatility Pre ex-date	Volatility After ex-date	F-test	F-prob
Eldon B	0.0187	0.0248	1.3302*	0.0224
Cloetta	0.0228	0.0269	1.1782	0.1241
Astra B	0.0144	0.0212	1.4755**	0.0032
Prifast	0.0164	0.0205	1.2528	0.0564
H & M	0.0190	0.0224	1.1816	0.1200
Ratos	0.0124	0.0164	1.3253*	0.0238
ABB A	0.0099	0.0177	1.7960**	0.0000
Segerström & Svensson	0.0240	0.0266	1.1056	0.2398
IBS	0.0352	0.0313	0.8883	0.7979
Biophausia	0.0273	0.0306	1.1194	0.2135
Securitas B	0.0152	0.0197	1.2969*	0.0337
MoDo B	0.0185	0.0152	0.8225	0.9155
Westergyllen	0.0190	0.0221	1.1641	0.1423
Cyncrona/OEM	0.0230	0.0241	1.0509	0.3634
Ericsson b	0.0150	0.0234	1.5562**	0.0010
Stora A	0.0126	0.0188	1.4892**	0.0026
SSAB A	0.0135	0.0171	1.2670*	0.0479
Haldex	0.0149	0.0217	1.4604**	0.0039
Nokia	0.0210	0.0288	1.3714*	0.0132
OM gruppen	0.0147	0.0161	1.0950	0.2614
Salenstjarnan	0.0239	0.0260	1.0908	0.2701
Doro telefoni	0.0202	0.0251	1.2462	0.0607
Volvo B	0.0181	0.0141	0.7812	0.9588
Wm data nordic	0.0196	0.0221	1.1288	0.1967
Aga	0.0120	0.0186	1.5434**	0.0012
Oem International	0.0227	0.0240	1.0552	0.3526
Gambro	0.0130	0.0171	1.3182*	0.0260
Atlas Copco A	0.0139	0.0158	1.1347	0.1867
Nolato	0.0210	0.0179	0.8538	0.8672
Forsheda	0.0215	0.0169	0.7880	0.9532
VLT B	0.0291	0.0257	0.8827	0.8102
Linjebuss	0.0212	0.0188	0.8867	0.8015
Jp Bank	0.0280	0.0264	0.9405	0.6672
Midway	0.0398	0.0286	0.7185	0.9899
Hagströmer	0.0166	0.0234	1.4059**	0.0083
Realia	0.1624	0.1131	0.6961	0.9945
Sandvik B	0.0185	0.0159	0.8606	0.8548
Astra B	0.0158	0.0185	1.1691	0.1357
H & M	0.0157	0.0238	1.5135**	0.0018
Graningeverken	0.0098	0.0153	1.5665**	0.0008
Midway B	0.0165	0.0502	3.0371**	0.0000
Freia Marabou	0.0122	0.0163	1.3371*	0.0205
Karolin Invest	0.0146	0.0284	1.9367**	0.0000
Ericsson B	0.0166	0.0264	1.5907**	0.0006
Scancem A	0.0131	0.0186	1.4259**	0.0063
SCA B	0.0107	0.0175	1.6297**	0.0003

Continued

TABLE 6. Continued

Company	Volatility Pre ex-date	Volatility After ex-date	F-test	F-prob
Kinnevik B	0.0204	0.0172	0.8443	0.8833
Gnosjö	0.0096	0.0147	1.5352**	0.0013
Gullspangs kraft B	0.0117	0.0235	2.0130**	0.0000
JM Bygg	0.0130	0.0216	1.6649**	0.0002
Alfa Laval	0.0138	0.0188	1.3642*	0.0145
Betongindustri	0.0140	0.0180	1.2868*	0.0380
Sydkraft	0.0118	0.0426	3.6054**	0.0000
Sydsvenska Dagbladet	0.0174	0.0241	1.3840*	0.0112
Hufvudstaden	0.0104	0.0210	2.0230**	0.0000
Gotland	0.0230	0.0218	0.9503	0.6404
Regnbågen	0.0118	0.0147	1.2485	0.0591
Korsnäs	0.0163	0.0224	1.3731*	0.0129
Geveko	0.0122	0.0220	1.7923**	0.0000
Swepart	0.0139	0.0177	1.2737*	0.0444
SKF B	0.0148	0.0202	1.3655*	0.0143
Programator	0.0357	0.0231	0.6470	0.9989
Pharos	0.0260	0.0204	0.7824	0.9578
Indevo	0.0163	0.0228	1.4018**	0.0088
Opus	0.0169	0.0471	2.7777**	0.0000
Sample Average	0.0201	0.0237	1.1823	0.1192

Table 8: The table shows the results of the F-tests for the Swedish sample of 60 stocks. The individual daily volatility pre- and post-split is indicated in columns 2 and 3: these are measured over a period of 100 days. The F-test statistics is distributed with F(n–1,n–1) degrees of freedom. *Significant at the 5% level, **significant at the 1% level (both one-sided tests).

ed the best fit and for the Swedish data the GARCH(1,1) model when tested both on the total sample average returns and individual stock returns around the ex-date. Models with different lag structures and combinations of the ARCH and GARCH terms were examined and selected based on the likelihood ratio tests, but more complex models did not add any explanatory power. This is a rather typical finding in ARCH analysis of stock returns: typically a surprisingly small number of parameters is sufficient to model the variance dynamics of even long sample periods[31] (Bollerslev et al. 1992, 22). The intuitive interpretation of the findings would be that the Finnish and Swedish stock returns data seem to exhibit rather ″short″ memory or persistence of return variance.

The next step in the analysis was to incorporate a dummy variable into the ARCH(1) model for the Finnish sample and into the GARCH(1,1) model for the Swedish sample as explanatory variable in the variance equation[32]. All of the three dummies described in section 4.3. were

31 For instance, French et al. (1987) analyzed daily S&P stock index data for 1928–1984 for a total of 15,369 observations and required only four parameters in the conditional variance equation.
32 Also, a constant term was included in the variance equation.

examined. These were the step, impulse and decreasing impulse dummies. As expected the results indicated that the most significant dummy was the step dummy, which has a (0,0,0,1,1,1,1) structure describing a permanent shift in volatility occurring during the ex-date of the split.

However, when the dummy variable is introduced as an explanatory variable the significance levels of the ARCH terms will change. Therefore, the results for the dummy variable must be interpreted with caution and simultaneous attention must be paid both to the confidence levels of the ARCH term and the dummy. Results for the Finnish sample indicated that the ARCH(1) term remained significant in 8 of 18 stocks (44%) while the step dummy remained significant in 13 of 18 stocks (72%), both at 5% confidence level. In the Swedish sample both the ARCH(1) and the GARCH(1) terms were required to be significant: this occurred in 27 of 65 stocks[33] (42%). The step dummy was significant in 26 out of 65 cases (40%), both at 5% confidence level. The average returns for both samples were also examined: if the ARCH(1) and GARCH(1) terms are accepted at 10% confidence level, the step dummy is accepted for the Finnish sample but rejected for the Swedish sample.

In general the results using ARCH-models are similar to those obtained using the F-test. A volatility shift has occurred in approximately half of the splitting stocks on both markets. On the Swedish markets the volatility shift has been more distinct during the 1980's and the early years of 1990's and seems to have decreased in magnitude during recent years. In my opinion it is impossible to draw any conclusions about the behavior of the volatility shift over time on the Finnish markets: the sample is too small and there seems to be no obvious indication of an increase / decrease in the volatility effect of stock splits.

Financial theory provides several explanations for the volatility shift but these are not explicitly researched in my study. These explanations include e.g. relatively higher spreads, higher number of trades following the ex-date and increased price discreteness. The execution of a stock split provides no new information to the market and the increase in volatility seems therefore "arbitrary": it is also inconsistent with the concept of efficient markets. The issue of market efficiency can also be raised with respect to pricing of options, regardless of the efficiency of underlying stock price behavior. The value of a stock option is increasing in the stock's anticipated return variance; option prices should therefore increase at the declaration of the stock split provided that the split date takes place prior to the option's expiration date. On the other hand, the price of an option expiring prior to the split date should be unaffected by the declaration. The fact that the ex-date seems to exhibit both positive abnormal returns and a volatility shift should provide call-option holders a profit opportunity. In any case, the increased

33 These results are also similar to those obtained by Olsson & Söderblom (1996): they found ARCH-processes for 35 stock returns of splitting stocks at the Stockholm Stock Exchange.

volatility of stock returns following stock splits, which was found on both markets, is a cost to the shareholders of the splitting company since risk (variance) is increased. It also reduces the effect of the stock split as a positive signal from the management.

6. SUMMARY

This paper examines the effects of stock split announcements and executions at the Helsinki and Stockholm Stock Exchanges during 1985–1997. The Finnish sample includes 19 companies and the Swedish 90 companies that have undertaken a stock split during the research period.

The empirical part of the paper examines abnormal returns around the announcement and execution dates of stock splits separately on both markets. Furthermore, possible shifts in volatility are examined. The study uses standard event-study methodology. Abnormal returns are calculated as residuals from the market, mean adjusted and market mean adjusted models. The volatility shift is studied using an F-test. Further tests are conducted to investigate if the return series exhibits ARCH-processes. A dummy variable is added to the ARCH models to investigate a possible volatility shift.

The results obtained in the empirical study support prior international evidence that a stock split is not a ”non-event” as finance theory would lead us to believe. Statistically significant abnormal returns are detected for the announcement of stock splits on both markets. The announcement effect seems not to have changed over time when the 1980's are compared with the 1990's on both markets. Further analysis revealed some differences in the announcement returns when sorted by split factor. The announcement of a stock split is thus interpreted as a positive signal from the management and the effect seems to have persisted over time. The results for the Stockholm Stock Exchange are similar to those obtained by Liljeblom (1989) for an earlier research period (1977–1985) and indicate that the announcement effect has not changed much over the years on the Swedish markets. However, the Finnish results that showed a large announcement effect are pioneering since there is no previous research on the stock split announcement effect for the Finnish markets.

The tests of abnormal returns around the ex-dates of stock splits indicate that an ex-date effect exists at the Stockholm Stock Exchange but not at the Helsinki Stock Exchange. The existence of an ex-date effect on the Swedish markets and the non-existence of it on the Finnish markets are both pioneering results, which have not been studied earlier.

The empirical results for the volatility shift indicate that post-split volatility is higher in about 50% of the stocks on both markets. The F-test could not reject the null hypothesis of equal variances pre- and post-split on aggregate level but succeeded in the rejection on about half of individual stocks. The tests for ARCH-processes revealed that the Finnish event window returns around the ex-date followed an ARCH(1) process and the Swedish a GARCH(1,1) process. The tests of the character of the volatility shift indicated that a step dummy variable describing a permanent shift in volatility provided most significant results. The results were similar to those obtained using the F-test. The shift in volatility seems to have been much stronger in the Swedish markets prior to 1993 but has disappeared since. On the other hand, on the Finnish markets, the effect is still present. The results for the volatility shift confirmed earlier research on the Swedish markets and are pioneering results for the Finnish markets. ■

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