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TRADING VOLUME AND INTERNATIONAL TRADING IN STOCKS - Their Impact on Stock Price Volatility***

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ABSTRACT: This paper sets out to investigate how two important changes in the Finnish stock market have affected the stock price volatility on the Helsinki Stock Exchange. These changes are the enormous increase in the trading volume and the sudden increase in the interest for Finnish stocks shown by foreign investors in the beginning of the eighties. The results indicate that the internationalization of the Finnish stock market is more important in explaining the observed change in stock price volatility during the eighties than is the increase in trading volume.

KEY WORDS: Market microstructure, international stock market integration, restricted and unrestricted shares, Helsinki Stock Exchange.

CONTENTS

1. Introduction

The purpose of this paper is to relate the increase in trading volume and the increase in the foreign interest for Finnish stocks to the change in stock price volatility observed between 1978-80 and 1986-88. Although the increase in trading volume and the increase in the foreign interest for Finnish stocks are to some extent linked to each other, it will be shown that these phenomena are expected to have diverse effects on stock price volatility.

While the annual turnover in 1980 was 1 185 mil. measured in constant 1988 FIM[1], it had increased to 37 452 mil. FIM in 1988. This increase is partly explained by the increase in relative prices for shares. However, if the quantity of shares traded in 1980 is indexed as 100, the volume in 1988 was still 734[2].

One of the explanations for this increase in trading volume is that the interest of international investors for Finnish stocks has increased dramatically during this period. Foreign investments in Finnish stocks on a larger scale began in 1982 and 1983. In the beginning of 1984 the Helsinki Stock Exchange (henceforth: the HeSE) started the separate listing of stocks which were restricted with respect to foreign ownership and those that were unrestricted. In 1988 the law was modified changing the upper limit of foreign ownership in Finnish companies from 20 % of the equity to 40 %, while the upper limit on the voting power was kept at 20 %[3].

In the next section we will review the literature to show why an increase in trading volume should cause volatility to drop while the increase in trading in Finnish stocks by international investors should have the opposite effect. The paper then continues with a description of the data. Next, our two alternative explanations are subjected to empirical tests. A summary concludes the paper.

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[1] The cost of living index has been used to transform the 1980-year FIM to 1988-year FIM.

[2] Deflating the turnover in current FIM with the UNITAS market index.

[3] The only companies excepted from this law were Finnish insurance companies, in which foreign ownership was unrestricted prior to the summer of 1989. In 1989 the law was extended to include Finnish insurance companies as well.

2. Background

Empirical studies[4] on the long-run relationship between trading volume and price volatility on asset markets indicate that an increase in trading volume will be accompanied by a drop in volatility[5]. The main reason to expect a decrease in volatility in response to an increase in volume is the fact that the increase in volume usually is accompanied by an increase in the number of traders. The price effects from idiosyncratic demand shifts tend to cancel out to a larger extent when there is a larger number of independent traders. In practice this will occur because of a higher density of limit orders close to the last trading price. Empirical support for a negative relationship between trading frequency and volatility have been found in cross-country comparisons, e.g. in Cohen, Ness, Okuda and Withcomb (1976), and in comparisons of issues exhibiting differences in trading frequencies on the same exchange, e.g. in Pagano (1985).

As pointed out by Pagano (1985) we would expect an increase in trading volume to affect only the non-systematic volatility. In a CAPM world with a constant risk-free rate (r_f) the return on the i:th stock during period t (r_{it}) will depend on three separate random disturbances, i.e.

$$(1) \quad r_{it} = r_f + \beta_i ((r_{mt} - \bar{r}_m) + (\bar{r}_m - r_f)) + \delta_{it} + \varepsilon_{it}$$

where the first random term is the difference between the realized market return, r_{mt}, and its expected value: $\bar{r}_{mt}$. In the return for the individual stock this disturbance will be dampened or amplified by that stock's beta β_i. The second random term δ_{it} is due to new information which exclusively concerns company i and which is interpreted in the same way by all individuals, and the third random term ε_{it} consists of the aggregate effect of the idiosyncratic demand shifts for all individual investors. The terms δ_{it}, and ε_{it} together constitute the non-systematic part of volatility. An increase in the number of traders will affect the volatility of the return exclusively through ε.

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[4] See Cohen, Maier, Schwartz, and Withcomb (1978) , Garbade and Silber (1979), Tauchen and Pitts (1983), and Pagano (1989a).

[5] As pointed out by Tauchen and Pitts (1983) this phenomenon should be separated from the opposite relationship between price changes and trading volume in the short run which has been observed in a large number of studies. A survey of these studies is given in Karpoff (1987). The short-run relationship builds on a reverse causation, i.e. from price changes to volume.

A larger number of traders will imply that idiosyncratic demand shifts for individual traders will cancel out to a larger extent[6]. However, this is on the condition that the distribution of the size of each trade over each transactor will increase less than the number of traders. An increase in the weight of an individual transactor or a group of transactors may counteract the tendency towards a more efficient elimination of the idiosyncratic risk component.

International investors appeared on the Finnish stock market in the beginning of the eighties. This group consisted of a small number of relatively large investors. Due to the small size of the Finnish stock market, Finnish stocks constitute an unimportant part of the investment opportunity set faced by these investors. Excluding or including Finnish stocks in the portfolio of such an investor will in most cases be a minor adjustment in the investment strategy of the portfolio manager. However, relative to the capitalization of the stocks involved the fluctuations in the demand generated by these investors are much larger than the demand fluctuations generated by domestic investors, who have been compelled to restrict most of their investments to domestic shares[7]. Thus, it seems likely that these investors may have contributed to an increase in volatility by increasing the dispersion of ε in (1).

In summary, there have been at least two counteracting tendencies that may have influenced the stock price volatility on the HeSE during the eighties: The increase in the number of domestic traders, which ought to dampen the price fluctuations, and the inflow of foreign investors, which is likely to have the opposite effect. In the following we will try to assess the importance of these effects on the volatility of Finnish stock prices.

The fact that restricted and unrestricted stocks are listed separately on the HeSE makes it possible to empirically analyze the effects of the foreign trading activity. Looking at expression (1) it is apparent that the first random shock, i.e. the one which comes from the market, ought to be the same for the restricted share and its unrestricted counterpart. Furthermore the second random shock, i.e. the one which comes from commonly known

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[6]According to Cohen, Maier, Schwartz, and Withcomb (1978) this applies mainly to non-specialist markets. On markets with designated market makers idiosyncratic shifts tend to be smoothed out by the specialists.

[7] Prior to 1986 Finnish residents were not allowed to purchase foreign securities. From the beginning of 1986 they were allowed to buy foreign securities for up 10 000 FIM. The upper limit was increased to 50 000 FIM in June 1987 and to 300 000 FIM in August 1988. However, the practical consequences of this liberalization were negligible during our sample period which ends with 1988. Most restrictions for non-financial institutions were lifted in Septmber 1989, and for individuals they will be removed in June 1990.

new information about the firm, should be the same for these shares. Thus, the only difference should be due to discrepancies in ε, the idiosyncratic disturbance.

If it were possible to empirically separate the latter two shocks in (1), our task would be simple. The development in the volatility of restricted shares could be related to the development of the trading volume, while the volatility of restricted stock prices could be compared with the price volatility of their unrestricted counterparts. However, since active traders may induce some of the new information through the trading process itself, we may find spillover effects from the price volatility in unrestricted share prices to restricted share prices. This possibility implies that a more careful analysis is required. Before embarking on that analysis we will take a brief look at the data.

3. The Data

The empirical analysis will be based on a comparison of stock returns generated during two distinct periods on the Helsinki Stock Exchange (henceforth the HeSE), the first being 1978-80, and the second being 1986-88. Table 1 gives a crude comparison of the 2 periods based on the average annual turnover for all stocks during the two periods.

Table 1. Average annual turnover on the Helsinki Stock Exchange during the two sample periods. The adjustment for inflation is based on the cost-of-living index and the conversion to USDs on the average exchange rate during the year.

	in mil. FIM	in mil. 1988-year FIM	in mil. USD
1978-80	528	968	137
1986-88	28222	29199	6392

Even in real terms the increase is of the order of 30. The number of listed companies in 1978-1980 varied from 49 to 50. In the later period the number was rapidly increasing from 51 at the end of 1985 to 69 at the end of 1988[8]. Since this increase is minor compared to the increase in turnover, the turnover for individual stocks was substantially higher in the latter period, as well. This increase in turnover was accompanied by an increase in the number of brokerage firms from 11 at the end of 1980 to 26 at the end of

[8] The number of listed issues on the exchange is substantially larger especially during the latter period due to the fact that the same company may have shares which are restricted vs. unrestricted (since ´84) regarding foreign ownership and shares which differ with respect to voting power, listed separately on the exchange.

1988. At the same time the two largest brokerage firms´ shares of the annual turnover fell from above 50 % to approximately 30 %.

The trading procedure remained the same on the HeSE throughout both periods although considerable strain on the system was occasionally experienced during the latter period. Each day, the trading started with a calling out, an auction in which all stocks were "called" out one by one. The purpose of this calling out was to find the right price interval. Trades were allowed after the calling out exclusively in the so-called bid-ask spread established in the double auction.

The returns on which the analysis in the paper is based are computed as:

$$(2) \quad r_t = \ln\left(\frac{P_t + d_t}{P_{t-1}}\right),$$

where ln is the natural logarithm, P_t is the average of the lowest and highest trading price on day t, adjusted for splits, stock dividends and rights issues, and d_t the dividend at day t, taken to be 0 if the stock does not happen to go ex-dividend on that day. Days in which no trading in the stock has occurred are omitted. Thus the number of observations may differ from one stock to another. However, to be included in the sample the stock had to be listed during the whole three-year period, and furthermore it had to be subject to trade during more than 80 % of all trading days in that period. Thus, we were left with 28 stocks in the first, low-turnover period and 56 stocks in the high-turnover period. Table 2 summarizes the information on the trading frequency in our two samples.

Table 2. Characteristics of the low-volume (1978-80) and the high-volume (1986-88) samples[9] used in this study. The total number of trading days on the HeSE was 714 in the former period and 748 in the latter[10]. The third column reports the average over the sample for the number of days with at least one transaction recorded for the stock. The last column reports the same number as a percentage of the total number of trading days on the exchange in the sample period.

Period	# of stocks in sample	Average # of days trading	Average rel.tr.freq.
1978-80	28	668.0	93.6%
1986-88	56	705.2	94.3%

Next, we turn to the characteristics of the data which are relevant for the analysis of the influence of foreign investors on the stock price volatility on the HeSE. Table 3 reports some basic figures on the importance of unrestricted stocks on the HeSE during 1986-88. The table reveals that there was a substantial increase in the relative importance of the trade in unrestricted shares from 85 to 86, the first year included in our sample.

Table 3. Unrestricted shares on the HeSE in 1985-88.

Year	'85	'86	'87	'88
# listed firms at year-end	50	52	52	69
with unrestricted shares	20	24	28	30
per total # listed firms	40.0%	46.2%	53.8%	43.5%
Share of total turnover in stocks	13.9%	23.2%	22.9%	29.5%
Share of total book value of stocks	6.8%	12.9%	13.8%	15.1%

Furthermore, Table 3 shows that the turnover in unrestricted shares accounted for a significant portion of the total turnover in shares on the Helsinki Stock Exchange during the whole 1986-88 period. Consequently it seems likely that the trading in unrestricted shares may have contributed to the stock price volatility on the HeSE during that period.

[9] The actual number of firms in the sample is smaller than the number of stocks since there are firms that have several stocks listed on the exchange. Leaving only one stock per firm - the most frequently traded one - would have reduced the 78-80 sample to 23 stocks, with an average relative trading frequency of 94.1 %, and the 86-88 sample to 38 stocks, with an average relative trading frequency of 94.3 %.

[10] The surprisingly large difference between the number of trading days between the periods is explained by the fact that the exchange was closed on Mondays during the summer in the previous period.

An additional problem created by our data is related to the crash in October 1987. The stock market volatility on the HeSE, as on other exchanges around the world, reached a record-level during that week[11]. In the following we attempt to assess the impact of the October crash by reporting the results excluding the week that started on October 19th along with the results for the 1986-88 period as a whole. Still, the "nervousness" created by the October crash probably had some effect on the volatility after the crash week as well.

As in Pagano (1985) we will try to eliminate changes in the volatility which are due to changes in the market using a modified market model:

$$(3) \quad r_{it} = \alpha_i + \frac{\beta_i (r^*_{mt} + \rho_{-1} r^*_{mt-1} + \rho_{-1} r^*_{mt+1})}{(1 + 2\rho_{-1})} + \nu_{it},$$

where:
α_i = the market model constant, β_i = the OLS beta coefficient for stock i, ρ_{-1} = the first order serial correlation coefficient for the market return, ν_{it} = the idiosyncratic return component of stock i, r^*_{mt} = the market return in excess of its long-run mean. The modification to the standard market model is in essence the Scholes-Williams (1977) correction for non-synchronous trading.

The fact that returns on individual stocks on the HeSE [12] are subject to significant first order serial correlation will also affect the calculated daily volatility. As shown by Cohen Hawawini, Maier, Schwartz and Withcomb (1983) positive serial correlation implies that the computed standard deviation will be a downward biased estimate of the true variance. They prove that an unbiased estimate of the true variance is provided by:

$$(4) \quad s^2_{adj.} = s^2(1+2\sum_{i=1}^{n} \rho_{-i}),$$

where s^2 is the sample variance, ρ_{-i} is the serial correlation coefficient of order i, and n is the number of relevant coefficients. Based on our results on the autocorrelation structure reported in Berglund and Liljeblom (1990), as well as on the results on beta estimation reported in Berglund, Liljeblom, and Löflund (1989), we decided to keep n as low as 2.

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[11] See APPENDIX 2.

[12] See e.g. Berglund, Wahlroos and Örnmark (1983).

4. The Impact of the Increase in Trading Volume

On the basis of the decomposition of the stochastic part of asset returns given in expression (2) it was hypothesized that an increase in trading volume would cause a drop in price volatility due to a more efficient diversification of idiosyncratic demand shifts induced by a larger number of traders. Since the trading volume during 1986-88 was far larger than the trading volume in 1978-80 the hypothesis to be tested is:

(5) $H_1: \bar{\sigma}_{86\text{-}88} < \bar{\sigma}_{78\text{-}80}$, $H_0: \bar{\sigma}_{86\text{-}88} = \bar{\sigma}_{78\text{-}80}$,

where, $\bar{\sigma}$ is the average standard deviation of returns (Δ log(price)), and the subscript refers to the time period.

The stock price volatilities, as measured in three different ways, during the two periods are compared in Table 4.

Table 4. Average means and standard deviations multiplied by 1000 and corresponding cross-sectional dispersions (standard deviations of averages) for log-price differences during the two periods[13]. The residual standard deviation denotes the deviation of v_i in expression (3). The CHMSW adj. standard deviation is computed separately for each stock using formula (4).

		# of stocks	Mean	St.dev.	Res.st.dev.	CHMSW. adj.
1978-80	Average	28	0.80	11.07	9.32	14.68
	st.dev.		0.08	0.61	0.54	0.75
1986-88	Average	56	1.40	20.70	17.11	21.33
	st.dev.		0.12	0.73	0.70	0.69
1986-88 Excl. crash week	Average	56	1.56	19.61	17.02	21.24
	st.dev.		0.12	0.74	0.70	0.69

[13] The corresponding basic figures for the one stock/company sample are:

		# of stocks	Mean	St.dev.	CHMSW. adj.
1978-80	Average	23	0.78	10.71	14.13
	st.dev.		0.09	0.69	0.83
1986-88	Average	38	1.52	19.61	20.49
	st.dev.		0.16	0.84	0.77

The table reveals that the null hypothesis in (5) clearly cannot be rejected in favour of the proposed alternative hypothesis. Instead of a decrease we seem to observe a significant increase in volatility when we move from the 1978-80 to the 1986-88 period. This is the case even if we leave the crash-week out or adjust for market fluctuations using expression (3). The CHMSW-adjustment according to expression (4) brings the standard deviations the most closely in line. Whereas the standard deviation on an average is approximately 45 % lower in the other cases the difference is reduced to somewhat above 30 % when the CHMSW (1983) - adjustment is used. This fact indicates that the serial correlation in returns was significantly stronger during the previous period[14].

As a further interesting detail we may note that only the unadjusted volatility seems to be affected by the omission of the crash week. The two adjustments will mitigate the difference for separate reasons. In the case of market adjusted returns the reason is found in an exceptionally high correlation between returns for individual stocks during the crash week. Removing the effect of the market removes the excess volatility for individual stocks. On the other hand, the fact that the omission of the crash week has a scant effect on the CHMSW-adjusted standard deviations is explained by a drastic change from positive to negative serial correlation in returns during the crash week. When the crash week is omitted the drop in volatility is counterbalanced by an increase in average serial correlation, an increase which makes the CHMSW correction more powerful[15].

Since measured standard deviations are strongly affected by outliers, we used a non-parametric method to check for the robustness of the results. For this purpose the Wilcoxon-Mann-Whitney test was used to compare the standard deviations in the two samples.

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[14] This is confirmed in Berglund and Liljeblom (1990).

[15] See Berglund and Liljeblom (1990).

Table 5. The results of a Wilcoxon-Mann-Whitney test for the equality of volatility in the two samples.

Volatility	incl.crash	excl.crash	market adj. returns	CHMSWadj.
U:	59	107	116	232
E(U)	784	784	784	784
Std(U)	105.39	105.39	105.39	105.39
Z[16]-val. for dev.	-6.87	-6.42	-6.33	-5.23

All four Z statistics are considerably higher in absolute value than critical values at any conventional significance levels. The results in Table 5 in general point in the same direction as those in Table 4. There is definitely no support for the hypothesis that the increase in trading volume would have produced a drop in volatility, on the contrary we observe a significant increase in volatility when moving from the low-turnover to the high turnover period. Still, there are some factors that seem to exaggerate the increase in volatility. Our results indicate that the change in the autocorrelation pattern between the periods is the most important of these factors.

Referring to Table 4 we note that the average return as well was considerably higher during the 1986-88 than during the 1978-80 period. To the extent that the higher volatility observed for individual stocks also is present in the market return[17], the higher return may perhaps be interpreted as a higher risk premium due to the higher volatility. Another tentative explanation in which the causality is reversed is that the higher average return during the latter period gave less scope for the short selling restriction to dampen the fluctuations than during the previous period.

The considerably higher return in the 1986-88 than in the 1978-80 period coincides with a difference in economic activity in Finland. This fact may affect the observed difference in volatility between the two periods. Using data for the U.S. Schwert (1989) found a significant relationship between the phase of the business cycle and the volatility of stock prices. According to Schwert´s results the volatility tends to be higher in recessions than

[16] Follows the standardized normal distribution under the null-hypothesis of equivalence between the samples.

[17] In other words, to the extent that the increased volatility is explained by an increase in the market risk rather than an increase in the unique risk of the firm.

in expansions! This is, according to Schwert (1989), explained by the fact that the average leverage of firms tend to be higher during recessions.

The 1978-80 period in Finland marked the end of a recession, while the 1986-88 period was a period with a high level of economic activity. The average leverage during the first period was consequently higher than during the latter period. Thus, rather than being an explanation for our observed difference in volatility, Schwert´s (1989) results point in the same direction as our original hypothesis. That leaves us with the internationalization of the Finnish stock market as the main candidate in our search for an explanation for the increase in volatility.

5. The Impact on Stock Price Volatility of the Increase in the Interest for Finnish Stocks by Foreign Investors

As shown by Hietala (1989) we would expect that the price of an unrestricted share is higher than the price of its restricted counterpart. The reason for this is twofold. Firstly, since foreigners cannot indiscriminately buy Finnish shares they will be able to bid up the price only on unrestricted shares. Secondly, since Finnish investors have been restricted from buying foreign shares, they have been forced to hold less than perfectly diversified portfolios. Thus, Finnish stocks will contribute more to the risk of the Finnish market portfolio than to the risk of the well diversified international investor´s portfolio. Consequently foreign investors will be prepared to pay more for Finnish stocks than a Finnish investor, and unrestricted shares will be at least as expensive as corresponding restricted ones. Because of this price difference, rational Finnish investors should keep only restricted shares in their portfolios.

This takes us to the expected volatility for unrestricted versus restricted shares. On the basis of Pagano´s (1985) decomposition of the stock return in expression (2) above it was argued that unrestricted shares may in fact be subject to a larger price volatility than restricted shares. The reason is that since the number of foreign investors who are actively trading in Finnish shares is relatively small idiosyncratic demand shifts for any one of these investors will affect the price more than idiosyncratic demand shifts in the case of a restricted share.

Furthermore, since traders may not be able to perfectly distinguish between information induced price changes, and price changes induced by random demand shifts, price

changes in the unrestricted share may cause additional price changes in the corresponding restricted share as well.

In this paper our main interest is to analyse whether the increase in volatility observed in Table 4 may be attributable to the trading by foreigners in Finnish shares. Our first hypothesis will be the following:

(6) $H_1 : \overline{\sigma}_{ur} > \overline{\sigma}_r$, $H_0 : \overline{\sigma}_{ur} = \overline{\sigma}_r$,

where, $\overline{\sigma}$ is the average standard deviation, ur, denotes unrestricted, and r, restricted shares. According to the hypotheses in (6) we would expect the standard deviation of returns on unrestricted stocks to be higher than the standard deviation of returns for restricted stocks.

A somewhat different hypothesis can be tested utilizing the 1978-80 period, when all shares on the HeSE, in effect, were restricted. The evidence in favour of a volatility increasing impact from foreign trading would be strengthened if the average price volatility for restricted shares during the 1986-88 period would be smaller than or at least not significantly larger than the average volatility during the 1978-80 period. Consequently, the following hypothesis is of interest, especially if the null hypothesis in (6) can be rejected:

(7) H_1: $\overline{\sigma}_{r,86\text{-}88} > \overline{\sigma}_{r,78\text{-}80}$, H_0: $\overline{\sigma}_{r,86\text{-}88} = \overline{\sigma}_{r,78\text{-}80}$.

The null hypothesis in this case is the opposite of that in (5). While the null-hypothesis in (5) was based on equality between unrestricted and restricted shares in the 1986-88 period, the null hypothesis in (6) is based on equality between restricted shares in 1986-88 and all shares in our sample in 1978-80.

Taking (6) and (7) together, the most straightforward results would be: either no rejection of H_0 in (6) and rejection of H_0 in (7), or rejection of H_0 in (6) and no rejection of H_0 in (7). The first set of results, i.e. no significant difference between restricted and unrestricted shares in the 1986-88 period, and a significant difference between restricted shares in the 1986-88 period and the 1978-80 period, would indicate that foreign trading on the HeSE provides at most a weak explanation for observed stock price volatility. The second set of results, i.e. a significant difference between restricted and unrestricted shares in 1986-88, and no difference between the restricted shares in 1986-88 and the shares in 1978-80 (all restricted), on the other hand, would indicate that a considerable part of the increase in stock price volatility on the HeSE is due to foreign trading. Finally,

if the null hypothesis can be rejected in (6) as well as in (7), i.e. if the price volatility for restricted shares during the 1986-88 period - while smaller than the price volatility for unrestricted shares - still turns out to be higher than during the 1978-80 period, we cannot exclude the possibility that foreign trading may constitute the major explanation for the increase in volatility. In fact, it may even seem plausible that some of the increased stock price volatility in companies with unrestricted shares may have affected the price volatility for other companies as well.

Due to the potential spillover effect in volatility from unrestricted to closely related restricted shares there are some subtleties involved in the specification of which stocks to include in the group of restricted stocks. Restricted stocks in firms with no unrestricted stocks listed on the HeSE will unambiguously belong to the group of restricted stocks. However, since the number of companies with no listed unrestricted shares on the HeSE was quite small in the 1986-88 period we decided to include restricted stocks in firms for which the trading in the unrestricted stock is of minor importance, as well. The importance of the trading in the unrestricted share was determined using two alternative criteria. The first alternative focussed on the price difference and the other criterion focussed on the observed trading frequency.

The logic behind the first criterion is the one found in Hietala (1989), i.e. that shares in a Finnish company will be more valuable to a foreign investor since they will produce larger diversification benefits in a foreign investor´s portfolio than in a typical Finnish investor´s portfolio. The price difference between the unrestricted share and the corresponding restricted one will be a direct measure of the discrepancy between the interest in the company between foreign and domestic investors. A small difference indicates scant interest on behalf of foreign investors. Thus the first criterion was to include restricted stocks in companies which had an unrestricted series listed on the exchange in cases where the average price difference, between the unrestricted stock and its restricted counterpart, did not exceed 10 %. The results using this definition are reported in Table 6.

Table 6. Average means and standard deviations multiplied by 1000 and corresponding cross-sectional dispersions (standard deviations of averages) for log-price differences for different samples. The residual standard deviation denotes the deviation of v_i in expression (3). The CHMSW adj. standard deviation is computed separately for each stock using formula (4). Restricted stocks are defined to be stocks in companies with no listed unrestricted shares, or in companies where the price difference between restricted and unrestricted < 10 %. Panel B reports F-distributed test-statistics for a comparison of volatilities for restricted and unrestricted shares, hypothesis (6), restricted shares in 1986-88 with shares in 1978-80, hypothesis (7).

Sample	# stocks		Mean	St.dev.	Res. st.dev.	CHMSW. adj.
Panel A						
1978-80	28	Average	0.80	11.07	9.32	14.68
		st.dev.	0.08	0.61	0.54	0.75
1986-88	30	Average	1.45	19.10	16.16	19.52
restricted		st.dev.	0.18	0.80	0.85	0.69
1986-88	13	Average	1.14	25.03	20.34	25.61
unrestricted		st.dev.	0.22	1.24	1.23	1.39
1986-88	30	Average	1.56	19.61	16.10	21.24
restricted, excl. crash week		st.dev.	0.12	0.74	0.85	0.69
1986-88	13	Average	1.38	23.60	20.19	25.32
unrestricted, excl. crash week		st.dev.	0.21	1.38	1.23	1.40
Panel B						
Hypothesis (6)	**m+n**					
incl. crash	43	T^2		16.30	7.57	19.31
excl. crash	43	T^2		7.61	7.23	8.61
Hypothesis (7)						
incl.crash	58	T^2		62.16	45.04	22.70
excl. crash	58	T^2		78.19	44.17	41.69

Comparing the third row in Table 6, Panel A with the second row, or the fifth row with the fourth row, it seems that the null hypothesis in (6) can be rejected in each of the cases. More formally this is seen in Panel B in which the T^2-statistic for a comparison of the average volatilities are reported. Under the null hypothesis the T^2 has the F-distribution with (1,m+n-2) degrees of freedom. The critical value on a one percent significance level, (1,40) degrees of freedom, is 7.31, and for (1,60) it is 7.08. We conclude that it is unlikely that the difference in observed volatility between unrestricted stocks and restricted ones, would have been produced by chance.

By comparing the second and the fourth with the first row in Panel A, or by looking at the last two rows in Panel B, we note that even more decisively, we may reject the null hypothesis in (7). In summary, we conclude that stock price volatility for restricted shares has been lower than the stock price volatility for unrestricted shares during the 1986-88 period, while even restricted shares have been subject to a higher volatility during the 1986-88 than during the 1978-80 period.

As an interesting detail, we note that the exclusion of the crash week does not affect the volatility for the restricted shares except for the CHMSW adjusted volatilities. In this case the effect of omitting the crash week is to increase the estimated volatility. The reason for this increase is that the omission of the crash week will increase the estimated positive serial correlation and this will make the CHMSW-adjustment more important than when the crash week is included.

The second criterion for selecting the group of restricted stocks is based on the trading frequency in the unrestricted stock. Accordingly, restricted stocks in companies in which the unrestricted was subject to trade in less than half of the number of trading days during 1986-88 were regarded as genuine restricted stocks. The results obtained with this criterion are reported in Table 7.

Table 7. Average means and standard deviations multiplied by 1000 and corresponding cross-sectional dispersions (standard deviations of averages) for log-price differences for different samples. The residual standard deviation denotes the deviation of v_i in expression (3). The CHMSW adj. standard deviation is computed separately for each stock using formula (4). Restricted stocks are defined to be stocks in companies with no listed unrestricted shares or companies in which the trading in unrestricted occurred in less than 50 % of days when the exchange was open.Panel B reports F-distributed test-statistics for a comparison of volatilities for restricted and unrestricted shares , i.e. hypothesis (6), and restricted shares in 1986-88 with shares in 1978-80, i.e. hypothesis (7).

Sample	# stocks		Mean	St.dev.	Res. st.dev.	CHMSW. adj.
Panel A						
1978-80	28	Average	0.80	11.07	9.32	14.68
		st.dev.	0.08	0.61	0.54	0.75
1986-88 restricted	25	Average	1.51	19.86	17.10	20.58
		st.dev.	0.21	1.11	1.09	0.91
1986-88 unrestricted	13	Average	1.14	25.03	20.34	25.61
		st.dev.	0.22	1.24	1.23	1.39
1986-88 restricted, excl. crash week	30	Average	1.64	19.18	17.02	20.47
		st.dev.	0.21	1.08	1.08	0.93
1986-88 unrestricted, excl. crash week	13	Average	1.38	23.60	20.19	25.32
		st.dev.	0.21	1.38	1.23	1.40
Panel B						
Hypothesis (6)	**m+n**					
incl. crash	38	T^2		8.38	3.44	9.74
excl. crash	38	T^2		6.01	3.30	8.82
Hypothesis (7)						
incl.crash	53	T^2		50.86	43.91	25.37
excl. crash	53	T^2		45.02	43.30	24.05

First of all, we may note that the number of restricted shares has dropped from 30 to 25 when the criterion has been changed. However, the main results remain basically the same. In Panel B the T^2 value for the comparison of the average volatility between restricted and unrestricted shares in line with hypothesis (6), is no longer significant. Overall it seems safe to conclude that the price volatility for unrestricted shares was higher than for the restricted ones during the 1986-88 period while even the restricted shares exhibited a considerably higher price volatility during the 1986-88 period than the corresponding average in the 1978-80 period.

As a final check hypotheses (6) and (7) were subjected to nonparametric tests. The results are reported in Table 8. Since the difference between the results reported in Table 6 and Table 7 turned out to be quite small the test was performed exclusively using the criterion based on the price difference between the unrestricted share and its restricted counterpart to define the group of restricted shares.

Table 8. The results of a Wilcoxon-Mann-Whitney test for the equality of volatility between restricted and unrestricted stocks in 1986-88 (upper panel), and between restricted stocks in 1986-88 and 1978-80 (lower panel). Restricted stocks are defined to be stocks in companies with no listed unrestricted shares, or in companies where the price difference between restricted and unrestricted < 10 %.

Comparison of 30 restricted stocks in 1986-88 with 13 unrestricted

Volatility	incl.crash	excl.crash	market adjusted returns	CHMSW adj.
U:	67	149	100	63
E(U)	195	195	195	195
Std(U)	37.82	37.82	37.82	37.82
Z	-3.37	-1.20	-2.50	-3.48

Comparison of 30 restricted stocks in 1986-88 with 28 stocks in 1978-80

Volatility	incl.crash	excl.crash	market adjusted returns	CHMSW adj.
U:	43	72	76	164
E(U)	420	420	420	420
Std(U)	64.27	64.27	64.27	64.27
Z	-5.86	-5.41	-5.35	-3.98

The results in Table 8 support the results reported in Table 6 and Table 7. The only case in which the null hypothesis cannot be rejected is in the comparison between unrestricted and restricted shares on the basis of unadjusted volatilities when the crash week is omitted. Generally, it seems that the null hypothesis may be rejected for (5) as well as for (6)[18].

A serious problem in the previous tests is that there may be some important variables not directly related to the hypotheses that we are testing which may cause a difference between our samples. Thus, e.g. the firms in the group of restricted firms may in general be smaller than the firms in our group of unrestricted shares. Larger Finnish firms are

[18] The difference between the two comparisons in the level of Z-values is partly due to the fact that the number of unrestricted stocks (13) is considerably smaller than the number of stocks in the 78-80 sample (28).

likely to have more extensive international operations, and to be subject to a larger foreign interest than smaller Finnish firms. Fortunately, our data allows for a partial solution to this problem since there are some firms that have both unrestricted and restricted shares listed and actively traded on the HeSE. The number of these separate series of shares was 9 during the 1986-88 period.

If a higher volatility in the unrestricted stock is likely to spill over to the unrestricted counterpart, we would expect the null hypothesis in (5) to be more difficult to reject when the unrestricted and the restricted shares are from the same firm than when they are from different firms. On the other hand, if the difference between the unrestricted and the restricted share is approximately the same when stocks in the same firm are compared as when the stocks are from different firms we may conclude that the volatility spillover is relatively unimportant. The results obtained when comparing the price volatility for unrestricted shares with the price volatility of identical restricted shares are reported in Table 9.

Table 9. Average means and standard deviations multiplied by 1000 and corresponding cross-sectional dispersions (standard deviations of averages), Panel A, for log-price differences for unrestricted and restricted, in other respects identical, shares. The residual standard deviation denotes the deviation of v_i in expression (3). The CHMSW adj. standard deviation is computed separately for each stock using formula (4). Panel B reports F-distributed test-statistics for a comparison of volatilities for restricted and unrestricted shares, i.e. hypothesis (6).

Sample	# stocks		Mean	St.dev.	Res. st.dev.	CHMSW. adj.
Panel A						
1986-88 restricted	9	Average	1.31	18.97	14.73	20.26
		st.dev.	0.21	1.44	1.18	1.51
1986-88 unrestricted	9	Average	1.31	26.03	20.86	25.45
		st.dev.	0.20	1.63	1.62	2.02
1986-88 restricted, excl. crash week	9	Average	1.46	17.87	14.72	20.33
		st.dev.	0.20	1.36	1.18	1.50
1986-88 unrestricted, excl. crash week	9	Average	1.53	24.53	20.74	25.20
		st.dev.	0.18	1.80	1.60	2.02
Panel B						
Hypothesis (6)	m+n					
incl. crash	18	T^2		9.44	8.30	3.76
excl. crash	18	T^2		7.74	8.14	3.32

Surprisingly, the results in Table 9, Panel A are very close to those reported in Panel A of Table 6 or Table 7. The T^2 values in Panel B should be compared to the critical values of the F-distribution with (1,16) degrees of freedom. For a 1% significance level the critical value is 8.53 while it drops to 4.49 when moving up to 5% significance level. Less significant results are expected a priori as a consequence of the smaller number of observations. The least significant results are observed for the CHMSW adjusted volatilities. The reason is that the returns on the restricted shares are more significantly serially correlated than the returns on the unrestricted ones. This is consistent with the hypothesis that unrestricted shares are subject to more pronounced idiosyncratic demand shifts.

In comparing the results in Table 9 with those reported in Table 6 we note that with respect to volatility the restricted shares on an average are much closer to restricted shares in other firms, i.e. to firms that lack actively traded unrestricted shares, than to otherwise identical unrestricted shares in the same company. This indicates that the idiosyncratic demand shifts in the unrestricted share seems to have no spillover effects on the price of its restricted counterpart.

7. Conclusions

The purpose of this paper was to analyse how the increase in trading volume, and the increase in the foreign interest for Finnish stocks have contributed to the change in stock price volatility that has been observed on the HeSE between 1978-80 and 1986-88. Using a decomposition of stock returns in different stochastic components proposed by Pagano (1985) it was shown that we would expect the increase in trading volume to dampen the volatility while we would expect the increased foreign interest to have the opposite effect.

The empirical analysis was carried out as a comparison of the standard deviation of daily returns of listed stocks on the HeSE in 1986-88, a period of high turnover and active trading in unrestricted shares, and in 1978-80, a period with low turnover and no trading in unrestricted shares. To make our sample less heterogeneous over the different periods all stocks that were traded during less than 80 % of all trading days on the HeSE were omitted. This left us with 28 stocks for the first period and 56 for the latter period.

Contrary to our expectations it turned out that stock prices were more volatile during the latter period than during the first. This was the case even after making proper adjustments for changes in return serial correlation, as well as after omitting the crash week in 1987 from the comparison. An increased dispersion was also observed for market model residuals.

The observed increase in volatility in the latter period turned out be at least partly explained by foreign trading in Finnish shares. The price volatility of restricted shares in listed companies that lacked actively traded, unrestricted shares was clearly lower than the price volatility of unrestricted shares. Furthermore, a sample of restricted shares that had, otherwise identical, actively traded, unrestricted shares listed on the HeSE, turned out to have significantly less volatile prices than their unrestricted counterparts. In fact this group of restricted shares exhibited almost the same average price volatility as the group of restricted shares of companies that lacked actively traded listed unrestricted shares. Thus, it seems that there was no spillover effect from the higher volatility in unrestricted shares to the prices of restricted shares in the same company.

The increase in foreign trading in Finnish stocks could have been pointed out as the major culprit for the increase in volatility between 1978-80 and 1986-88, if only the price volatility in restricted shares in 1986-88 would have been lower, or at most the same, as the price volatility in the 1978-80 period, when foreign interest in Finnish shares was practically nil. However, this was not the case. Even restricted shares turned to be significantly more volatile in the 1986-88 period. Since the volatility spillover from unrestricted shares to restricted shares in the same company was so small it seems that the increased volatility in restricted shares in companies that lack actively traded unrestricted shares can hardly be explained by spillover from the price volatility in unrestricted shares in other companies. This leaves us to look for other explanations to the general increase in stock price volatility on the HeSE during the beginning of the eighties[19].

---

[19] Possible candidates are an increase in the number of significant noise traders due to the general increase in interest for stock market speculation in Finland, and the effect of short sales restrictions which will be less effective when stock prices have gone up than when there has been a downward pressure on prices.

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APPENDIX 1: Skewness and Kurtosis of Return Distributions.

Table A1 reports the excess kurtosis and skewness for the two periods which are compared. A more detailed analysis of these characteristics are found in Berglund and Liljeblom (1990). The skewness and the excess kurtosis measures are computed as follows:

$$\text{(A1)} \quad \text{skewness} = \frac{\sum (r_i - \bar{r})^3}{\sqrt{(n-1)^3}\ \sigma_r^3}, \text{ and}$$

$$\text{(A2)} \quad \text{excess kurtosis} = \frac{\sum (r_i - \bar{r})^4}{(n-1)^2\ \sigma_r^4} - 3,$$

where r_i is the change in the log of the price, $\bar{r}$ is the average r_i, σ_r is the standard deviation of r, and n is the number of observations.

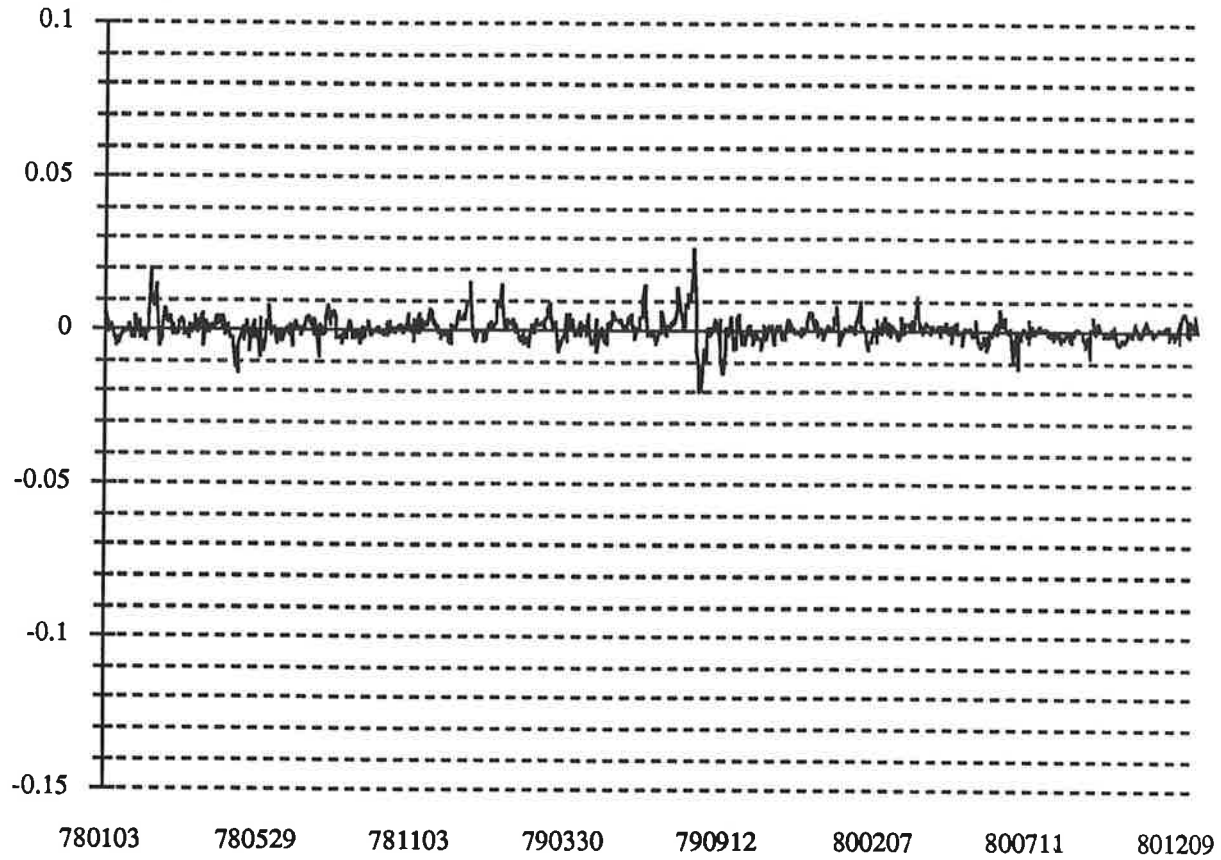
		Skewness		**Excess kurtosis**	
		unadj. returns	market adj. ret.	unadj. returns	market adj. ret.
1978-80	Average	1.968	1.781	45.42	38.25
	st.dev.	0.740	0.668	13.38	11.94
1986-88	Average	-0.385	0.260	16.23	11.72
incl. crash	st.dev.	0.168	0.159	2.20	1.78
1986-88	Average	0.138	0.271	10.31	11.74
excl. crash	st.dev.	0.132	0.160	1.35	1.78

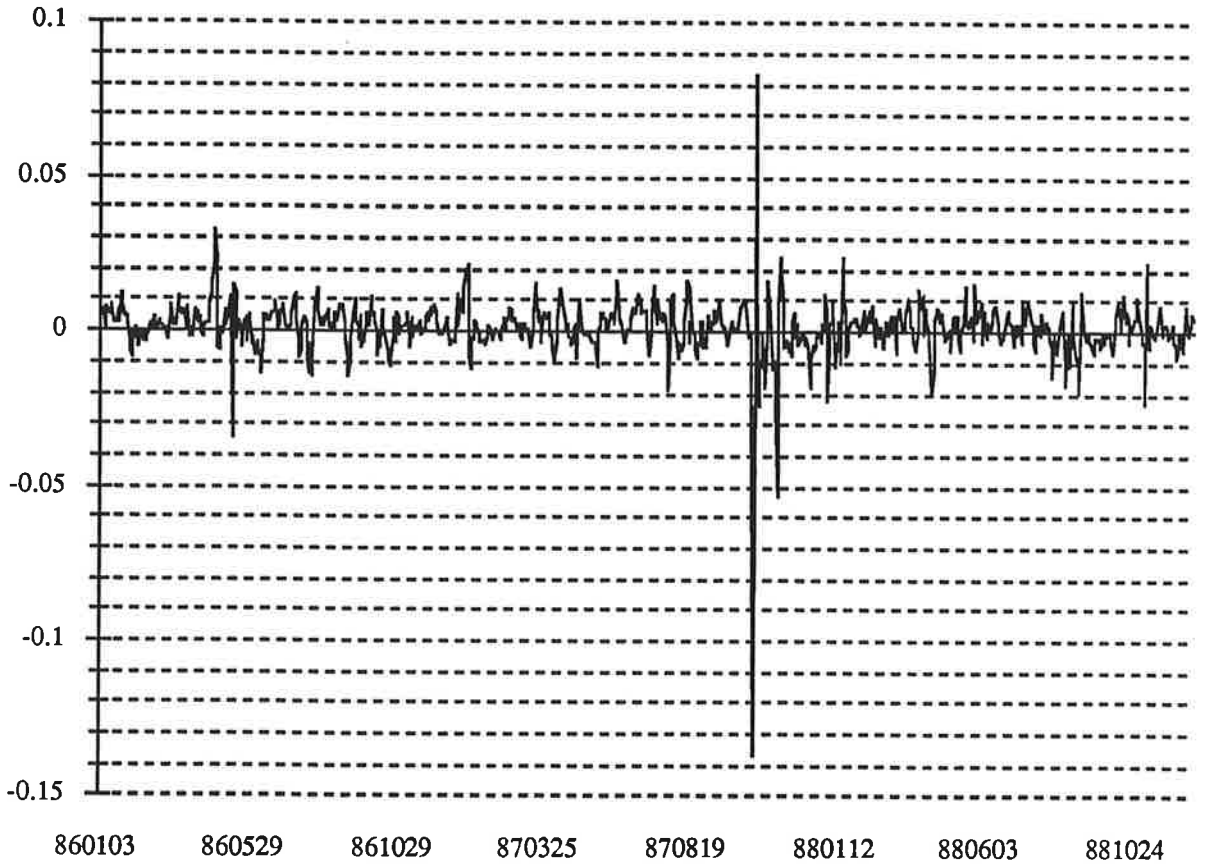
Table A1. Average skewness and excess kurtosis and corresponding cross-sectional dispersions (standard deviations) for the averages computed on log-price differences during the two periods using formulas (5) and (6)[20]. The market adjusted return is defined as n_i in expression (3).

[20]The corresponding figures for the unadjusted returns in the one stock/company sample were:

		Skewness	**Excess kurtosis**
		unadj. returns	unadj. returns
1978-80	Average	1.968	45.42
	st.dev.	0.740	13.38
1986-88	Average	-0.385	16.23
incl. crash	st.dev.	0.168	2.20

APPENDIX 2: Differences of the logarithm of a value-weighted all shares index during the two periods.





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