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Volume of Trading and Stock Volatility in the Swedish Market

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Abstract

Recent studies have shown that increased liquidity is perhaps not always strictly beneficial and that high trading volumes can produce trading noise causing increased volatility above that based on fundamentals. This study investigates whether this applies to the Swedish stock market by analyzing dual-class stocks that have the same cash flow rights but different control rights and different trading volumes. The experiment investigates the effect of volume on observed stock volatility while naturally controlling for the flow of fundamental information. The results indicate that shares with higher trading volume have lower volatility compared to shares with low trading volume. There is no evidence of high trading volumes causing increased volatility and it could be argued that increased liquidity is still beneficial in the Swedish stock market as it is likely to lead to lower volatility and prices closer to their fundamental values. However, more research is needed as this study is rather restrictive and is not generalizable over all shares traded in the market.

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1. Introduction

The purpose of this paper is to investigate the effect of trading volume on observed volatility in the Swedish stock market and whether stock trading produces its own volatility above that based on fundamentals. From 1990 to 2008 there was a considerable increase in the volume turnover rate[1] in the Swedish stock market, increasing from less than 0,2 in yearly turnover in 1990 to 2,4 in 2008, before dropping substantially to 0,8 and 0,7 in 2009 and 2010, respectively (see Figure A1 in Appendix).[2]

Similar trend has been observed in the U.S. stock market where traded volume increased tremendously from the late 70's (turnover rate around 0,25) to 2008 (turnover rate almost 4) and dropped in 2009 (Dichev, Huang and Zhou 2011). Such substantial increase (and decrease in latest years) is likely to truly transform the marketplace as a market in which stocks change hands once every five years is likely to be very different from a market where stocks change hands two or three times per year. The difference is likely to lead to different outcomes in fundamental issues like stock valuation, equity risk and market efficiency (Dichev et al 2011). Trading in financial markets has changed due to new processing and communication technologies and higher turnover has been associated with more frequent trades and lower transaction costs (Angel, Harris and Spatt 2010 and Chordia, Roll and Subrahmanyam 2011). This study investigates some of these changes in relation to the effect of high volumes of trading on stock volatility.

There exists great amount of literature on the relation between liquidity and stock prices where the general findings indicate that higher liquidity is correlated with lower transaction costs and makes creating and adjusting investment positions easier (for example Brennan, Chordia and Subrahmanyam 1998 and Jones 2002). Higher liquidity also seems to be rewarded by investors

[1] Calculated as the annual value of traded volume divided by the market capitalzation.

[2] Source: World Federation of Exchanges. Note that the source provides volume and market capitalization data for OMX Stockholm from 1990 to 2003 and for OMX Nordic from 2004 to 2010. The turnover rate for OMX Nordic is used as an approximation for turnover rate in the Swedish market from 2004, assuming a high correlation.

as it leads to higher prices and by reducing estimation noise it also leads to prices closer to fundamental values (Amihud and Mendelson 1991 and Liu 2006). However, the measure of liquidity varies between researchers. Amihud and Mendelson (1986) and Fang, Noe and Tice (2009) use the relative effective bid-ask spread as a measure of liquidity, which Fang et al (2009) consider to be the best proxy for stock liquidity. Others, for example Brennan et al (1998) and Datar, Naik and Radcliffe (1998), propose volume of trading and the turnover rate, respectively, as a more appropriate measure of liquidity. Among others, Brennan and Subrahmanyam (1995) and Glosten and Harris (1988) have shown that volume of trading is a major determinant of stock market liquidity and several studies (for example Stoll 1978) have found that volume of trading is the most important determinant of the bid-ask spread. Even though there exists substantial amount of empirical research on the effect of liquidity and trading volume on the level of stock prices, there has been less focus on the effect of trading on the stock volatility, especially when controlling for fundamental information.

According to the empirical evidence presented above, there is a strong argument that higher liquidity and volume of trading should lead to better price discovery and thereby to prices closer to their fundamental values. Therefore, more trading should reduce the estimation noise and the volatility of returns. However, other evidence suggests that increased volume of trading does in fact induce higher stock volatility. The argument is that high trading produces trading noise that can lash prices away from fundamentals. Campbell, Grossman and Wang (1993) show how noise traders can lead prices away from fundamentals, pushing them in temporary swings and reversals. Therefore, there seems to be two opposing forces and in practice there is a poor idea of which effect dominates. The relation between volume of trading and stock volatility might even be non-linear, changing sign depending on the dominating force at different levels of trading.

Dichev et al (2011) investigate the effect of high volumes of trading on observed stock volatility in the U.S. stock market. According to existing research the variables volume and volatility are simultaneously driven by their flow of fundamental information (Karpoff 1987) and unexpected or new information will cause changes in both stock prices and trading volume (Schwert 1989). This presents the most significant problem in the investigation, that is that both volume of trading and the stock volatility are endogenously driven by information flow. Dichev et al (2011) address this problem by identifying three natural experiments where the setting controls for fundamental information flow and firm characteristics and by analyzing the aggregate time-series and the cross-section of trading volume and volatility, while controlling for information flow and other determinants of volatility. They find a reliable and economically substantial positive relation between volume of trading and stock volatility in the U.S. stock market. The objective of this study is to determine whether the same applies to the Swedish stock market.

To investigate the effect of trading volume on stock volatility in the Swedish market one of Dichev's et al (2011) natural experiments will be applied. The setting naturally controls for information flow and firm characteristics, while there is a significant exogenous variation in traded volume. The natural experiment involves examining dual-class stocks traded on the Stockholm Stock Exchange. The advantage of this method is that it provides almost a perfect natural control for the flow of fundamental information. This is because the two stock classes have identical cash flow claims but different control rights and often substantially different volumes of trading. In addition, to extend the investigation two sub-samples are investigated as well as the time-series of Swedish stocks for a period of 20 years, from 1992 to end of year 2011. The advantage of the time-series extension is that it is more realistic and adapts better to the natural properties of the stock market. The disadvantage, however, is that the natural control for fundamental information is lost.

The paper proceeds as follows. In the second chapter there is a discussion about theory, existing literature and the theoretical background of the subject. The third chapter describes the research methodology applied and the results are presented in chapter four. In chapter five the results are discussed and finally, in the sixth chapter, the results are summarized and concluding remarks presented.

2. Theory and background

The volume of stock trading in the U.S. market has increased considerably during the last 50 years where the annualized value-weighted turnover has increased from less than 10 percent in 1960 to more than 300 percent in 2009 (Dichev et al 2011). This substantial increase and at the same time transformation of the marketplace can be important for the rest of the world as well, as Dichev et al (2011) believe that the U.S. experience in volume of trading is ahead of the curve and it seems that the rest of the world is moving in the same direction. Trading in financial markets has changed substantially over the last 25 years with the growth of new information processing and communication technologies (Angel et al 2010). Chordia et al (2011) explore this sharp uptrend in trading activity and investigate the associated changes in market efficiency. They find that higher turnover has been connected to more frequent smaller trades and their evidence indicate that the gradual decrease in trading costs have influenced the turnover trend. In the Swedish stock market there was also a substantial increase in volume turnover between 1990 and 2008 from 20 percent to 240 percent but a very steep drop in 2009, down to 80 percent and further down to 70 percent in 2010.[3] These material changes in volume turnover are likely to have transformed the marketplace and can lead to different outcomes in fundamental issues like stock valuation and market efficiency (Dichev et al 2011).

2.1 Liquidity and asset prices

There exists great amount of literature on the relation between liquidity and asset prices. In earlier papers the most common measure of liquidity is the bid-ask spread and researchers find numerous benefits related to increased liquidity.[4] Amihud and Mendelson (1986) find that a stock's expected return is an increasing and concave function of the bid-ask spread and Jones (2002) finds that high spreads predict high stock returns. More recently, many researchers have proposed a different measure of liquidity. Brennan et al (1998) find that trading volume is acting as a proxy for the liquidity in the market and that traded volume is strongly negatively related to stock returns. Glosten and Harris (1988)

[3] Source: World Federation of Exchanges.

[4] Note that increased liqudity means lower bid-ask spread, and vice versa.

and Brennan and Subrahmanyam (1995) also show that the trading volume is a major determinant of market liquidity. Datar et al (1998) use the turnover rate as a proxy for liquidity and find that this measure of liquidity plays a significant role in explaining cross-sectional variation in stock returns, even after controlling for other determinants of stock returns like the firm size, book-to-market ratio and the firm's beta. Liu (2006) proposes a new liquidity measure that he calls the standardized turnover and captures multiple dimensions of liquidity such as the trading speed, trading quantity and the cost of trading. According to his results, the standardized turnover is highly correlated with both the bid-ask spread and the volume of trading. Finally, Jones (2002) investigates both the bid-ask spread and the turnover and their effect on stock returns. He finds that high spreads predict high stock returns and that high turnover predicts low stock returns.

According to the literature discussed above the bid-ask spread is positively related to stock returns while the volume of trading is negatively related to stock returns. A number of studies document the reliable relation between volume of trading and transaction costs (bid-ask spreads, brokerage fees and execution costs), where the two variables reinforce each other and a change in either one can lead to changes in the other (for example Branch and Freed 1977 and Copeland and Galai 1983). Higher liquidity, defined as either higher volume of trading, lower transaction costs or both, and everything else equal, leads to lower cost of capital and higher prices (for example Amihud and Mendelson 1991, Brennan et al 1998 and Liu 2006).

From the existing liquidity literature the overall impression is that higher liquidity is a universally good thing. Investors benefit from higher liquidity as it allows them to build and adjust investment positions in an easier, faster and cheaper way, and it leads to lower cost of capital and higher asset prices. Market makers also benefit from higher liquidity as it generally makes their job easier and less risky. Therefore, and as increased volume of trading and decreased transaction costs reinforce each other, it seems that all parties involved always prefer higher liquidity. However, the evidence on the relation between volume of trading and volatility of stock returns has not yet been discussed and assuming that high levels of traded volume can increase volatility above that of fundamentals, higher liquidity might not always be a pure positive phenomenon.

2.2 Liquidity and stock volatility

Compared to the amount of research on the relation between liquidity and the level of asset prices the evidence on the relation between volume of trading and stock volatility is rather limited, especially controlling for fundamentals. From the evidence presented above there is a straightforward argument that increased volume of trading reduces the estimation risk in asset pricing and thereby leads to reduced volatility of stock returns. Empirically, there is in fact some evidence that suggest that more trading does indeed reduce volatility. Elyasiani, Hauser and Lauterbach (2000) show for example that traded volume increases and stock price precision improves (that is volatility decreases) when U.S. stocks move from Nasdaq to NYSE. These evidence, however, appear to be occasional and difficult to generalize. Other studies suggest exactly the opposite, which is that increased volume of trading does induce higher stock volatility.

The basic idea behind the suggestion of more trading inducing higher stock volatility is that trading does produce trading noise and movements in trading can lash prices away from their fundamental values. Number of studies discusses how stock volatility appears to be above that explained by fundamentals. Schiller (1981) finds that measures of stock volatility appear to be far too high given the variability of underlying fundamentals. Extending this argument leads to the hypothesis that more trading produces volatility. In line with this, Cutler, Poterba and Summers (1989) conclude that it is unlikely that stock volatility is fully explained by news about future cash flows and discount rates and DeLong, Shleifer, Summers and Waldmann (1990) argue that noise traders that follow positive feedback strategies can increase volatility above that explained by fundamentals even in the presence of rational speculators. Consistent with the view that trading produces its own volatility are the findings that asset prices are much more volatile during trading hours than during non-trading hours (French and Roll 1986). Finally, Black (1986) argues that more noise trading will increase liquidity in the market but at the same time introduce noise into the prices and thus more trading and higher volatility are correlated.

2.3 Recent findings

Like mentioned before, the literature on volume and volatility is not as extensive as on volume and the level of asset prices. Nevertheless, it seems that researchers are focusing to a greater extent on this relation in recent years. There are quite many papers issued in recent years, investigating the volume and volatility relation, although often within a particular setting or for a specific market. Zhang (2010) finds a positive correlation between high frequency trading and stock price volatility, after controlling for firm fundamental volatility and other exogenous determinants of volatility. The relation between volume and volatility is driven mainly by the number of trades in the Chinese stock market (Song, Tan and Wu 2005), the expected component of volume significantly explains variation in volatility on the Istanbul stock exchange (Kiymaz and Girard 2009) and day trading (when investors buy and sell the same stock on the same day) by individual investors in the Finnish market is positively related to stock volatility, even when general trading activity is controlled for (Kyröläinen 2008). Furthermore, Foucalt, Sraer and Thesmar (2011) show that retail trading has a positive effect on stock volatility by investigating a reform in the French stock market. The reform triggers a drop in retail trading by raising the relative cost of speculative trading for retail investors, which results in a substantial drop in return volatility. Sabbaghi (2011) investigates the asymmetric volatility and trading volume relationship by conducting an EGARCH analysis on the G5 countries and the results suggest that trading volume is an important variable in explaining conditional stock volatility. Le and Zurbruegg (2010) study the role of trading volume in volatility forecasting and find that the introduction of trading volume into various ARCH models improves volatility forecasts. Return volatility is higher in periods with public news while trading volume is higher in periods with no news according to Darrat, Zhong and Cheng (2007). They also find that in periods without public news, volume Granger-causes volatility without feedback. Finally, Ejara and

Ghosh (2004) investigate the impact of ADR listing[5] on the trading volume and stock volatility in the domestic market and find that the ADR listing results in increase in both trading volume and price volatility. The studies mentioned above are rather specific and not easily generalizable and the literature that studies the relation between trading volume and stock volatility in a global context is still relatively limited.

2.4 Volume of trading and stock volatility

Volume and volatility are variables that are simultaneously driven by the flow of fundamental information (Karpoff 1987 and Schwert 1989). In some of the studies discussed above researchers have tried to control for the flow of fundamental information while in others the endogenous co-movement of volume and volatility has been investigated. This paper focuses on the effect of traded volume while controlling for fundamental information. This is in line with Dichev's et al research paper (2011) where they investigate the relation by using a number of settings, including natural experiments (exchange switches, S&P 500 changes and dual-class shares), the aggregate time-series and the cross-section of U.S stocks. Dichev et al (2011) find a reliable and substantial positive relation between volume of trading and stock volatility and conclude that stock trading produces its own volatility above and beyond that based on fundamentals.

As a result of conflicting results in existing literature on the effect of increased trading volume it seems like a plausible hypothesis that the relation between trading and volatility is non-linear and might even change sign depending on the level of trading. It could be argued that at low levels of trading an increase in traded volume reduces estimation noise and thereby causes a decrease in volatility while high levels of trading could indicate speculative overheating, increased level of noise trading and thereby more volatility. This indicates that the benefits of increased liquidity are the highest at relatively low levels of trading and there might be very real costs of going beyond some point of traded volume. Perhaps there exists an optimal level of trading where the benefits of

[5] The issuance of American Depositary Receipts (ADR) by foreign (non-American) firms. The ADRs are traded on U.S. exchanges while the underlying shares trade in the domestic markets.

liquidity are realized but the costs of increased volatility are limited. While these topics are open for further research this paper focuses on investigating the relationship between volume of trading and stock volatility in the Swedish stock market, controlling for fundamental information.

3. Methodology

The method in this study is based on one of the methods presented by Dichev et al (2011) and involves looking at dual-class stocks and investigating the difference in volume and volatility between the pair of shares. This provides a comparison of essentially the same underlying security but in different trading environments. Therefore, investigating the difference between traded volume and volatility of the two classes of shares traded for a firm potentially provides enough exogenous variation in trading intensity, while holding fundamentals constant. As the two shares hold exactly the same cash flow rights while they have different control rights and often a substantially different trading volume, this experiment is considered to provide an almost perfect control for fundamental information. The experiment is considered to be a natural experiment as it naturally controls for flow of fundamental information and since the goal of this study is to examine the effects of volume on stock volatility while holding fundamental information constant, the advantage of the dual-class setting is that it provides a natural and efficient control for potential other variables influencing volatility. The most important variables to control for are those related to information flow while other influential variables could for example include the firm size, profitability, nature of business and corporate governance. The dual-class experiment naturally controls for all these variables.

3.1 The sample

The sample is obtained by searching for shares that have the same company name but different share name, traded on the Stockholm Stock Exchange at the end of year 2011. It is required that the pair issues have an overlap of at least three years of trading. The original sample has 29 firms and 58 shares and daily data was collected for the shares' price, volume of trading and number of shares outstanding, over a period of 20 years. An overview table of the original sample is presented in Table A1 in Appendix. The table includes the pair shares, their control rights, cash flow rights and number of firm-month observations available. In addition, it indicates which firms were excluded from the final sample and for what reason. Four firms were excluded from the sample, thereof, one as a result of having different cash flow rights between the pair of shares. The other three firms that were excluded had more than one fourth of their monthly observations as a zero trade and/or zero volatility. As an observation of zero volume and/or zero volatility is considered to have no informational value in this particular study the three firms were excluded from the final sample. The final sample therefore consists of 24 firms and 48 shares. The number of firm-month observations available is 4.988 but after excluding single observations with zero volume and/or zero volatility the number of observations used in the research is 4.899. Excluded observations therefore amount to 89, or 1,8 percent of the final sample.

Descriptive statistics of the final sample can be found in Table A2. Firstly, the market value of equity, as of end of year 2011, is presented for each share. These amounts are also presented graphically in Figure A2. It can be seen that the firms in the sample are of a reasonable size with a mean (median) market value of equity of 57,2 (33,6) billion SEK. In Table A2 the average yearly return, turnover and volatility is also presented, as well as the percentage difference between the higher and lower average yearly turnover for each firm. By looking through these numbers it can be seen that there is in fact a substantial variation in turnover between pair shares with the median difference being 444,7 percent, which means that the average turnover for the higher traded share exceeds the lower one by a median of almost 445 percent. Finally, the correlation in daily returns between the pair shares is presented. It can be seen that the correlation is positive for all firms while the strength varies between them. For most of the firms there is a high correlation and the mean (median) correlation over all firms is 65,6 (77,2) percent. This high correlation confirms that the pair shares are largely moved by the same underlying fundamental information while the correlation is still sufficiently different from perfect to allow for possible different return volatility effects.

Before discussing the main test of the study some more descriptive statistics are presented graphically in Figure A3. In the figure there are 24 graphs, one for each firm. The graphs present the yearly turnover and volatility for the pair shares for a period of 20 years, from 1992 through 2011 (shorter period if the shares started trading later than 1992). The graphs are helpful to visually investigate the difference between the pair shares and whether there seems to be a relationship between volume of trading and volatility. The graphs confirm what was observed in the sample statistics table before (see Table A2) that in most cases there is a substantial difference in traded volume between the two shares. Also, it can be seen that volatility between pair shares is highly correlated, in some cases almost perfectly correlated while in others there are substantial deviations. By going through the graphs it can be seen that in most cases the less traded share seems to have higher volatility than the higher traded share, which is opposite to what was expected. The graphs will be referred to and discussed further later in the paper.

3.2 Method

To carry out the main test of the study monthly volume and volatility is calculated from the daily data collected. Monthly volume is defined as the total number of shares traded during a month divided by the average number of shares outstanding during the same month. Monthly volatility is the standard deviation of daily returns over a month, scaled to monthly volatility by using the square-root-of-time rule. Next, the test variables are created and named DIF_Volume and DIF_Volatility. The DIF_Volume variable is defined as the difference in volume between the higher volume issue and the lower volume issue, divided by the lower volume. The DIF_Volatility variable is defined as the difference in volatility between the higher volume issue and the lower volume issue, divided by the volatility of the low volume issue. The test variables are calculated for all 4.899 pair-month observations. By calculating the median of the two variables it can be seen that there is indeed a large difference in volume between the two share classes with a median of 1.154 percent. However, the median of the DIF_Volatility variable is a negative 4,3 percent, indicating that shares with higher turnover have lower volatility of returns, which is again the opposite of what was expected. By working with medians the problem related to outliers is avoided.

Brief descriptive statistics for the test variables can be found in Table 1 below. The table presents the mean and median as well as the 10th, 25th, 75th and 90th percentiles. From the statistics it can be seen that both variables are non-normally distributed with large differences between means and medians. As a result of this non-normality the tests used in this study rely on measures of central tendency and non-parametric tests.

Table 1 – Descriptive statistics

The table presents the mean and median (50th percentile) values of the two test variables, DIF_Volume and DIF_Volatility, as well as the 10th, 25th, 75th and 90th percentiles.

	Mean	10%	25%	50%	75%	90%
DIF_Volume	7640.9%	56.3%	220.0%	1153.7%	5232.7%	16659.7%
DIF_Volatility	-1.7%	-34.5%	-16.6%	-4.3%	6.0%	20.6%

The next step is to take the test variables, DIF_Volume and DIF_Volatility, and rank the firm-month share pairs into quintiles on the DIF_Volume variable. This is carried out in two different ways, firstly by ranking all observations directly, independent of the firm, and secondly by ranking into within-firm quintiles. In the following chapters of this paper the two methods are discussed as "all observations ranked directly" and "ranked by firm". The medians of each quintile for both test variables are then presented while the formal test, using the Wilcoxon Sum Rank Test, is on the difference between the DIF_Volatility medians of the extreme quintiles. In addition, the Spearman's correlation is calculated, directly from all observations when the variables are ranked directly and separately for each firm when ranked by firm.

3.3 Extension

To extend the investigation the aggregate time-series of Swedish stocks are examined for a period of 20 years, from 1992 to end of year 2011. This extended investigation is more realistic than the dual-class stock method and adapts better to the natural properties of the stock market. However, the disadvantage is that the natural control for flow of fundamental information is lost.

To carry out the time-series analysis daily data on price, volume and shares outstanding is collected for all stocks traded on the Stockholm Stock Exchange at the end of year 2011. This provides a total of 277 shares and data is collected over a period of 20 years or back to 1992. For the available data, annualized average turnover and volatility are calculated and plotted. Average turnover is defined as the one-year average of daily total number of shares traded divided by the total number of shares outstanding. Multiplying with the number of trading days in a year then annualizes the average turnover. The average volatility is the value-weighted average of stock volatility, measured as the sum of stock volatility for each stock multiplied with its corresponding weight. Multiplying with the square root of the number of trading days in a year annualizes the average volatility. In addition to plotting the time-series of volume and volatility, the Spearman's correlation is calculated for the series.

Additional extension is to divide the sample into two sub-periods. As a result of the substantial drop in turnover between 2008 and 2009 (see Figure A1 in Appendix) it was considered appropriate to investigate the years 1992 through 2008 separately, 2009 through 2011 separately, compare the results with each other and the original sample from 1992 to 2011.

4. Results

The main results are presented in Table 2 below. The table presents the medians for each quintile, both when all observations are ranked directly and when ranked by firm. It also presents the difference between the two extreme quintiles (Q5-Q1), the Wilcoxon z-score related to the Q5-Q1 difference, the Spearman's correlation when observations are ranked directly and whether the statistics are significant or not.

Table 2 – Dual-class investigation results for the total sample

The table presents the median values of each quintile for both of the test variables, DIF_Volume and DIF_Volatility, when observations have been ranked on DIF_Volume. The two columns on the left apply when all observations have been ranked directly and the two columns on the right apply when observations have been ranked into within-firm quintiles. Below the quintiles, the differences between the extreme quintiles are presented, as well as their Wilcoxon z-statistic and finally the Spearman's correlation. A star mark for Wilcoxon z-statistic and Spearman's correlation indicates significance at the 1% level.

	Sample period 1992-2011			
	Observations ranked directly		Ranked by firm	
	DIF_Volume	***DIF_Volatility***	***DIF_Volume***	***DIF_Volatility***
Q1	57%	-1.15%	200%	-3.44%
Q2	340%	-2.78%	762%	-5.62%
Q3	1179%	-4.92%	1474%	-4.45%
Q4	3982%	-5.86%	2684%	-4.53%
Q5	17420%	-10.32%	6366%	-3.17%
Q5-Q1 Diff.	17363%	-9.18%	6166%	0.27%
Wilcoxon z	38.33*	9.27*	29.19*	0.88
Spearman's correlation	-0.1552*		Close to zero	

** Indicates significance at the 1% level*

Firstly, it should be pointed out that the difference in volatility variable (DIF_Volatility) is negative for all quintiles in both methods. This indicates that according to the results the relationship between volume and volatility is negative while the strength of this negative relationship varies. The results are very different depending on whether observations are ranked directly or by firm. When all observations are ranked directly there is much more variation in volume between quintiles and there is a monotonic decrease in volatility, meaning that with higher volume there is less volatility. The difference between the extreme quintiles for volatility is relatively high at negative 9,18 percent and highly significant according to the Wilcoxon z-statistic. The Spearman's correlation confirms this result with a highly significant negative relation of 0,16. However, when observations are ranked into within-firm quintiles the result is very different. Firstly, there is much less variation in volume between quintiles, which is understandable as this percentage difference in volume between pair shares can vary greatly between firms. Also, there is no longer a monotonic decrease in the volatility and the strength of the negative relation seems to fluctuate randomly over quintiles. The difference between the extreme quintiles is close to zero and far from being significant. It is not possible to perform the Spearman's correlation test directly on the whole sample when observations are ranked by firm but instead the correlation for each firm is calculated separately. Even though the results are not a part of a formal test and the results are not presented they give a mean and a median of the Spearman's correlation over all firms close to zero and only three firms have a significant correlation (at the 1 percent level) between volume and volatility. The reason for the different results between the two methods is mainly the fact that a few firms can easily dominate a quintile when the observations are not ranked into within-firm quintiles and therefore the second method, to rank by firm, is considered theoretically more correct. This will be discussed in more detail in the following chapter.

The results from the two sub-samples, on the one hand from 1992 through 2008 and on the other hand from 2008 through 2011, are presented in Table 3 below. The table presents the same statistics as before, the quintiles, the difference between the extreme quintiles, Wilcoxon z-statistic and the Spearman's correlation

Table 3 – Dual-class investigation results for the two sub-samples

The table presents the median values of each quintile for both the test variables, DIF_Volume and DIF_Volatility, when observations have been ranked on DIF_Volume. The two columns on the left apply when all observations have been ranked directly and the two columns to the right apply when observations have been ranked into within-firm quintiles. Below the quintiles, the differences between the extreme quintiles are presented, as well as their Wilcoxon z-statistic and finally the Spearman's correlation. A star mark for Wilcoxon z-statistic and Spearman's correlation indicates significance at the 1% level. The first part of the table refers to the sub-sample period from 1992 to 2008 and the second part of the table refers to the sub-sample period from 2009 to 2011.

Sub-sample period 1992-2008

	Observations ranked directly		Ranked by firm	
	DIF_Volume	***DIF_Volatility***	***DIF_Volume***	***DIF_Volatility***
Q1	52%	-1.59%	182%	-3.77%
Q2	312%	-2.53%	640%	-5.27%
Q3	1052%	-5.56%	1353%	-4.45%
Q4	3629%	-4.78%	2363%	-4.57%
Q5	16605%	-10.17%	6386%	-3.72%
Q5-Q1 Diff.	16553%	-8.58%	6204%	0.05%
Wilcoxon z	34.72*	7.45*	26.45*	1.04
Spearman's correlation	-0.1338*		Close to zero	

** Indicates significance at the 1% level*

Sub-sample period 2009-2011

	Observations ranked directly		Ranked by firm	
	DIF_Volume	***DIF_Volatility***	***DIF_Volume***	***DIF_Volatility***
Q1	79%	0.01%	503%	-4.73%
Q2	502%	-3.01%	1248%	-4.84%
Q3	1625%	-4.84%	1868%	-3.89%
Q4	5139%	-8.12%	2530%	-5.02%
Q5	16536%	-15.55%	3679%	-3.33%
Q5-Q1 Diff.	16457%	-15.56%	3175%	1.41%
Wilcoxon z	16.55*	6.46*	8.83*	1.02
Spearman's correlation	-0.2482*		Close to zero	

** Indicates significance at the 1% level*

The results from the sub-periods do not differ significantly from the total sample results; the direction of the relationship is the same, significant when observations are ranked directly and insignificant when ranked by firm. However, the strength of the negative relationship between volume and volatility is not as strong in the period from 1992 to 2008 and stronger in the period from 2009 to 2011, compared to the total sample. This can be seen from the extreme quintiles differences that are negative 8,6 percent in sub-sample 1992-2008 and negative 15,6 percent in sub-sample 2009-2011, compared to a negative 9,2 percent in sample 1992-2011. When ranked by firm the magnitude of the negative difference in volatility varies between quintiles, in a similar manner as before. The difference between the extreme quintiles is close to zero for sub-sample 1992-2008 while it is a little more negative, or negative 1,4 percent, for sub-sample 2009-2011, although insignificant for all samples. The Spearman's correlation when all observations are ranked directly confirms the results from the extreme quintiles differences as the correlation is not as strong for sub-sample 1992-2008 and stronger for sub-sample 2009-2011, compared to the total sample 1992-2011. More precisely, the negative correlation increases from 13,4 percent, to 15,5 percent and then to 24,8 percent for sub-sample 1992-2008, total sample 1992-2011 and sub-sample 2009-2011, respectively.

It is considered theoretically more correct to rank observations into within-firm quintiles and when looking only at the results from that method there is not a significant relationship between traded volume and stock volatility. The fact that the median DIF_Volatility in each quintile is negative indicates that higher traded stocks have lower volatility although the formal tests in this study find no reliable relationship between the two variables. The results from the time-series analysis extension are to some degree consistent with this, as there does not seem to be a significant relation between volume and volatility. The plot of the time-series of the volume and volatility can be found in Figure A4 in Appendix. In addition, the Spearman's correlation, actually having a different sign from the previously discussed results, is less then one percent and far from being significant. Besides from the discussion above not much attention is given to the time-series analysis mainly because of two important limitations. Firstly, the time-series analysis does not control for flow of fundamental information, or any other variables influencing volume and volatility. Secondly, data is collected only for firms traded on the Stockholm Stock Exchange as of end of year 2011 and therefore the data does not represent all stocks traded on the market in the years before.

5. Discussion

Like mentioned above previous literature suggests that benefits of trading in financial markets is perhaps not a one-way street. There is a strong theoretical argument that increased liquidity, in a form of increased volume of trading, leads to a better price discovery, prices closer to their fundamental values and therefore lower volatility in stock returns. In contrast, there is evidence that suggest that increased volume of trading produces trading noise and leads to higher volatility, above that based on the stock's fundamentals. Dichev et al (2011) used a similar dual-class method, among other methods, to investigate the effect of volume on volatility in the U.S. stock market and found a reliable significant positive relationship. According to the result presented in the previous chapter the positive relationship between volume and volatility does not exist in the Swedish stock market and the results in fact suggest an opposite relation.

As there exist evidence of a negative as well as a positive relationship between volume of trading and volatility the results are not all that surprising. Even though research has shown a positive relation in the U.S. stock market it has to be taken into account that the Swedish stock market is in fact very different from the American one. The U.S. stock market is the most developed and by far the largest stock market in the world. The market capitalization of the two largest U.S. stock exchanges, NYSE and NASDAQ, is 18,6 times the market capitalization of the total Nordic Exchange and the value of share trading is over 37 times that of the trading in the Nordic Exchange.[6] Therefore, it could be argued that the U.S. market is in a different state, highly liquid where the benefits of liquidity have been fully utilized and increased volume of trading can therefore produce trading noise and lead to increased volatility. In contrast, the Swedish stock market is not as liquid as the U.S. market and the results from this study indicate that there is still a substantial amount of benefits involved in increased liquidity and volume of trading.

[6] Source: World Federation of Exchanges.

It is important to understand the difference between the two methods used in this study, to rank all observations directly and to rank into within-firm quintiles, in order to analyze why the methods give different results and to interpret the results correctly. In both methods the DIF_Volume and DIF_Volatility observations are divided into quintiles by ranking them on the DIF_Volume variable. However, each quintile does not include all of the same observations in the two different methods. When ranked by firm, each firm is investigated separately, the firm's observations ranked on DIF_Volume and divided into five quintiles. Therefore, the firm has equally many observations in each quintile and each quintile has equally many observations coming from a particular firm. However, the magnitude of the DIF_Volume variable can differ greatly between firms, with a median value from less than one for ATLAS and SSAB and up to a median value of 194 and 214 for HOLMEN and ELECTROLUX, respectively. Therefore, when ranking into within-firm quintiles, there is much more dispersion in the DIF_Volume observations in each quintile. In contrast, when all observations are ranked directly, there is a perfect rank and a monotonic increase of the DIF_Volume variable. Interestingly, the medians of the DIF_Volatility variable show a monotonic decrease, indicating that volatility decreases with increased volume and that the negative relationship grows stronger with higher volume. The difference between the extreme quintiles for DIF_Volatility is significant according to Wilcoxon z-statistic and there is a negative significant Spearman's correlation that confirms the results. However, there is a structural problem with ranking all observations directly and the problem will be discussed in the following paragraph. Note that despite the dispersion in DIF_Volume observations within quintiles, when ranked by firm, the medians of each quintile still show a monotonic increase and the difference between the extreme quintiles is significant according to the Wilcoxon z-statistic. The same cannot be said about the volatility as there is no observable relationship and neither the extreme quintiles difference nor the Spearman's correlation is significant.

The structural problem that arises when all observations are ranked directly is that a small number of firms can, and in this case do, dominate a particular quintile. To further explain this, the three firms that have the highest median in DIF_Volume are investigated. The firms are MODERN TIMES, HOLMEN and ELECTROLUX, with medians of DIF_Volume 185, 194 and 214, respectively. By looking at the volume-volatility graphs in Figure A3 it can be seen that there is a very low (sometimes close to zero) trade with the firms' A-shares. The very low turnover in the A-shares, while a substantially high trade in the B-shares, results in very high DIF_Volume values for the three firms. When all observations are ranked directly, most of the three firms' observations will land in the highest or higher quintiles and as a result these firms will dominate the higher quintiles. Looking again at the volume-volatility graphs for the three firms that dominate the higher quintiles, it can be seen that for all of them the volatility of the low traded share is considerably higher than for the high traded share. Theoretically, it is reasonable to see higher volatility for the lower traded share, as the turnover is very low and therefore there is a worse price discovery and irregular trades causing more fluctuations in the price. This higher volatility in the low traded shares of the high DIF_Volume firms explains why the results show this high negative difference in volatility in the higher quintiles, when all observations are ranked directly. At the other end, the firms that have a considerable amount of trading in both of their shares can also be explored further. The three firms that have the most similar trade in their shares, and the lowest median in DIF_Volume, are SSAB, ATLAS and SVENSKA HANDELSBANKEN. By looking at the volume-volatility graphs for the three firms, in Figure A3, it can be seen that there is a considerable amount of trading in both shares. In these cases the volatility lines for the pair of shares are much closer to each other and for example in SSAB's case they fluctuate almost perfectly together. For ATLAS and SVENSKA HANDELSBANKEN it can be seen that the lower traded share often has higher volatility although the magnitude of the dispersion is much smaller than for the firms with high percentage difference in volume. This is consistent with the results of a negative difference in volatility, although with a much smaller magnitude, in the lower quintiles. To iterate, the few firms' dominance in particular quintiles does cause a structural problem and therefore it is considered theoretically more correct to rank the observations into within-firm quintiles.

When observations are ranked into within-firm quintiles the relationship between volume and volatility is not statistically significant. The difference between the extreme quintiles for the volatility is positive but very small and with a Wilcoxon z-statistic of only 0,9 it is not significant. By looking at the Spearman's correlation for each firm it is observed that only three firms have a significant relationship (at the 1 percent level) between volume and volatility, two of them are positive and one negative, and the median of the Spearman's correlation over all firms is close to zero (0,027). The statistical tests therefore indicate that there is no relation between the variables. However, the median of DIF_Volatility, which represents the percentage difference between the volatility of a high traded share and a low traded share, is negative for all quintiles, varying from negative 3,17 percent to negative 5,62 percent. Even though the magnitude of the negative difference is not increasing with higher volume the negative sign in all quintiles indicates that between pair shares, the share with higher volume has lower volatility. To further explore this it is helpful to once again investigate the volume-volatility graphs for all the firms in Figure A3. By looking through the graphs it can be seen that for 16 out of 24 firms the volatility of the lower traded share is higher (at least most of the time) compared to the volatility of the higher traded share. As for the rest of the firms, 7 firms are indecisive, that is the volatility of the high and low traded shares is roughly the same or it varies over time which volatility is higher, and for only one firm there is an indication of a lower volatility for the lower traded share. This is consistent with the results of a negative median of the difference in volatility in all quintiles. Even though the statistical tests do not reveal a significant relationship between volume and volatility an analysis of the results shows that for the dual-class shares in the sample the lower traded share tends to have higher volatility.

As presented above, the results for the two sub-samples are not significantly different from the main results. When all observations are ranked directly there is a clear and significantly strong negative relation between the volume and volatility. For the period from 2009 to 2011 there is a similar dispersion in the DIF_Volume variable while there is an even greater dispersion in DIF_Volatility, compared to the total sample. The median DIF_Volatility over all quintiles decreases from zero percent in the first quintile to a negative 15,6 percent in the last quintile, resulting in an extreme quintiles difference of negative 15,6 percent and still highly significant according to the Wilcoxon z-statistic. These results are interesting as they indicate that within the first quintile, where there is not much difference in volume of trading between the pair shares, the two shares have approximately the same level of volatility as the median of the difference in volatility is close to zero. The difference in volatility then decreases monotonically between quintiles and reaches a negative 15,6 percent for pair shares with the most difference in volume. The Spearman's correlation for this particular sub-sample is also considerably stronger than for sub-period 1992-2008 and for the total sample period. The results for the sub-period 1992-2008 are much closer to the results for the total sample, understandably as the sub-sample spans 17 out of 20 years of the total sample. The fact that there seems to be a stronger negative relation for the years 2009 to 2011, and as there was a big drop in turnover in years 2009 and 2010 (according to the World Federation of Exchanges), there is weak evidence of a greater dispersion in volatility in times of lower trading. When looking at the sub-samples when observations are ranked into within-firm quintiles the results are not significantly different from the total sample where the extreme quintiles differences are not significant. The variation in DIF_Volatility between quintiles is similar to the total sample although the negative difference in the first quintile for sub-sample 2009-2011 is quite higher compared to the other samples, resulting in a positive extreme quintiles difference of 1,4 percent. The difference is however not significant and not considered to be of any relevance to the main results.

The results in this study are not generalizable for the Swedish market and further research is needed before any conclusions can be made about the relationship between volume of trading and stock volatility. A good place to start would be to apply different methods, for example another natural experiment where trading volume and volatility in narrow windows around stock additions and deletions from a market index would be examined, or a robust cross-sectional analysis of Swedish stocks controlling for variations in volatility related to fundamentals like size, age, leverage, book to market ratio and deviation in earnings.

6. Conclusion

This study investigates the relation between volume of trading and stock volatility in the Swedish stock market and whether high volumes create volatility above that based on fundamentals. The method used involves examining dual-class shares traded on the Stockholm Stock Exchange as of end of year 2011 and data is collected over a period of 20 years, from 1992 to end of year 2011. The dual-class method naturally controls for the flow of fundamental information, which is important as both volume and volatility are endogenously driven by information flow. As the pairs of shares in the sample hold exactly the same cash flow rights but different control rights and often have substantially different volumes of trade there is a natural control for fundamentals while a significant variation in volume. The main results indicate that between the pair shares in the sample the higher traded share has lower volatility. Also, when all observations are ranked directly, there is a significant negative relationship between volume and volatility, where greater difference in volume leads to greater negative difference in volatility. However, the method where all observations are ranked directly is structurally flawed and therefore the observations are also ranked into within-firm quintiles. The results show no statistically significant relationship between volume and volatility although there is evidence of higher traded shares having lower volatility, between the pair shares in the sample. The results of this study indicate that shares with low levels of trading have higher volatility and it seems that there are still positive effects from increased liquidity to be utilized in the Swedish stock market.

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Appendix

Table A1 – Original sample

The table is an overview table of the original sample, presenting the name of the shares, control rights, cash flow rights and number of firm-month observations available. The star marked firms have been excluded from the sample for reasons given below.

Firm	*Share*	*Control rights*	*Cash-flow rights*	*Number of firm-month observations*
ACAP INVEST*	B A	Low High	Equal	112
ATLAS	A B	High Low	Equal	240
ELECTROLUX	A B	High Low	Equal	240
ERICSSON	A B	High Low	Equal	240
HOLMEN	A B	High Low	Equal	240
HUFVUDSTADEN*	A C	Low High	Equal	162
HUSQVARNA	A B	High Low	Equal	66
INDL.& FINL.SYS.	A B	High Low	Equal	162
INDUSTRIVARDEN	A C	High Low	Equal	240
INVESTOR	A B	High Low	Equal	240
KINNEVIK	A B	High Low	Equal	185
MIDSONA	A B	High Low	Equal	150
MIDWAY HOLDINGS	A B	High Low	Equal	240
MODERN TIMES GP.MTG	A B	High Low	Equal	171
NCC	A B	High Low	Equal	240
ORTIVUS*	A B	High Low	Equal	180
RATOS	A B	High Low	Equal	240
SCA	A B	High Low	Equal	240
SCANIA	A B	High Low	Equal	188
SEB	A C	High Low	Equal	240
SKF	A B	High Low	Equal	240
SSAB	A B	High Low	Equal	240
STORA ENSO	A R	High Low	Equal	156
SVENSKA HANDBKN.	A B	High Low	Equal	240
SWECO*	A B	High Low	Equal	159
SWEDBANK**	A Preference	Equal Equal	Lower Higher	36
TELE2	A B	High Low	Equal	187
TRANSCOM WWD.SDB	A B	High None	Equal	123
VOLVO	A B	High Low	Equal	240

* Firm excluded from final sample as more than 25% of observations include zero trade and/or zero volatility.

** Firm excluded from final sample as the different share issues hold different cash flow rights.

Table A2 – Descriptive statistics for the final sample

The table presents descriptive statistics for firms included in the final sample. The market value of equity is calculated as the number of shares outstanding times the closing price on the last day of trading in 2011. Yearly return is calculated for each year as the log difference of the closing price in year t and the closing price in year t-1. Yearly turnover is the total number of shares traded over a year divided by the average number of shares outstanding over the same year. The percentage difference between high and low turnover is the higher average yearly turnover minus the lower turnover divided by the lower turnover. Yearly volatility is calculated as the standard deviation of daily returns scaled to yearly volatility by multiplying with the square root of the number of trading days in a year.

Firm	Share	MVE (SEK '000) EY 2011	Average yearly return	Average yearly turnover	% difference between high and low turnover	Average yearly volatility	Correlation in daily returns
ATLAS	A	124,230,312	16.1%	7.81	16.0%	34.1%	96.3%
	B	51,040,645	15.5%	6.74		35.5%	
ELECTROLUX	A	1,059,477	7.2%	0.04	9181.4%	45.3%	22.4%
	B	32,987,668	8.6%	4.12		36.3%	
ERICSSON	A	18,205,130	7.5%	0.08	2463.3%	44.8%	87.8%
	B	212,016,218	9.1%	1.93		45.3%	
HOLMEN	A	4,499,715	0.9%	0.04	3167.3%	40.2%	28.9%
	B	12,283,694	4.5%	1.25		33.2%	
HUSQVARNA	A	4,098,704	-10.6%	0.34	357.9%	41.4%	87.7%
	B	14,170,660	-7.7%	1.57		38.5%	
INDL.& FINL.SYS.	A	116,875	-11.7%	0.02	1070.6%	77.1%	26.9%
	B	2,165,240	-5.1%	0.21		53.2%	
INDUSTRIVARDEN	A	23,402,477	7.3%	0.89	70.6%	31.1%	82.2%
	C	9,666,536	7.4%	1.52		31.4%	
INVESTOR	A	38,400,331	8.3%	0.46	351.2%	29.9%	90.4%
	B	58,484,146	8.1%	2.07		29.4%	
KINNEVIK	A	6,491,911	14.9%	0.63	285.3%	39.7%	50.5%
	B	30,644,264	12.2%	2.43		37.0%	
MIDSONA	A	5,928	-4.0%	0.11	79.6%	64.1%	16.6%
	B	297,455	-5.3%	0.19		50.5%	

Table continued on next page

Firm	Share	MVE (SEK '000) EY 2011	Average yearly return	Average yearly turnover	% difference between high and low turnover	Average yearly volatility	Correlation in daily returns
MIDWAY HOLDINGS	A	168,780	-1.8%	0.24	472.2%	60.8%	9.5%
	B	286,028	5.8%	1.40		38.2%	
MODERN TIMES	A	1,910,675	11.9%	0.02	7466.3%	51.3%	48.7%
	B	20,024,906	12.1%	1.40		44.1%	
NCC	A	3,782,781	8.4%	0.08	1183.9%	43.3%	67.7%
	B	9,353,542	6.7%	1.04		40.4%	
RATOS	A	7,024,871	14.5%	0.29	1410.1%	43.3%	25.4%
	B	19,339,948	14.8%	4.39		32.6%	
SCA	A	9,745,931	5.6%	0.15	1349.0%	30.8%	74.2%
	B	62,069,040	6.3%	2.17		27.6%	
SCANIA	A	39,380,000	5.5%	0.80	408.3%	32.8%	93.2%
	B	40,800,000	5.7%	4.06		32.0%	
SEB	A	86,996,022	5.6%	2.28	125.9%	43.3%	84.2%
	C	941,967	5.4%	1.01		44.1%	
SKF	A	6,236,195	8.2%	0.93	620.1%	36.3%	86.1%
	B	60,045,586	10.0%	6.67		33.9%	
SSAB	A	14,602,458	9.4%	2.96	16.3%	36.5%	93.1%
	B	4,391,323	8.7%	3.44		36.8%	
STORA ENSO	A	3,396,716	-3.2%	0.06	3277.9%	36.0%	80.3%
	R	4,505,938	-4.2%	1.89		35.5%	
SVENSKA HANDBKN.	A	110,828,472	10.5%	1.18	37.2%	32.9%	89.7%
	B	2,078,575	10.4%	0.86		33.8%	
TELE2	A	3,127,510	11.0%	0.14	2104.0%	41.1%	70.8%
	B	56,739,322	10.2%	3.17		38.1%	
TRANSCOM	A	279,744	-22.1%	0.51	245.2%	54.6%	68.7%
	B	298,392	-21.4%	1.78		52.5%	
VOLVO	A	50,392,445	10.1%	1.57	417.1%	34.5%	93.9%
	B	110,308,777	10.2%	8.09		33.7%	
Mean		57,221,805	4.9%	1.77	1507.4%	40.4%	65.6%
Median		33,558,079	7.4%	1.11	444.7%	37.5%	77.2%

Figure A1 – Volume turnover in Sweden/Nordics from 1990 to 2010

The graph presents the value-weighted stock trading, calculated as the annual value of traded volume divided by market capitalization, for the Stockholm Stock Exchange from year 1990 to 2003 and for OMX Nordic from 2004 to 2010. The turnover rate for the OMX Nordic is therefore used as an approximation for the turnover rate in Sweden, assuming a high correlation. The data source is the World Federation of Exchanges.

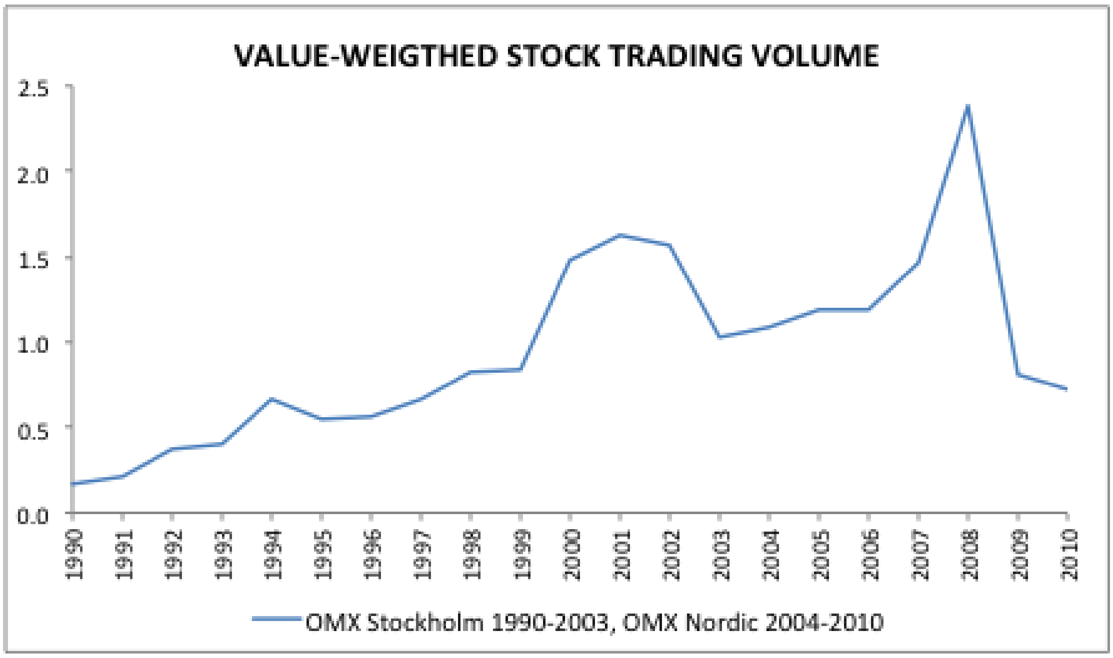


Figure A2 – Market value of equity

The graph presents the market value of equity as of end of year 2011. The market value of equity is calculated as defined in Table A2. The graph shows how the market value of equity is split between the pair of shares for each firm as well as the total value of the firm.

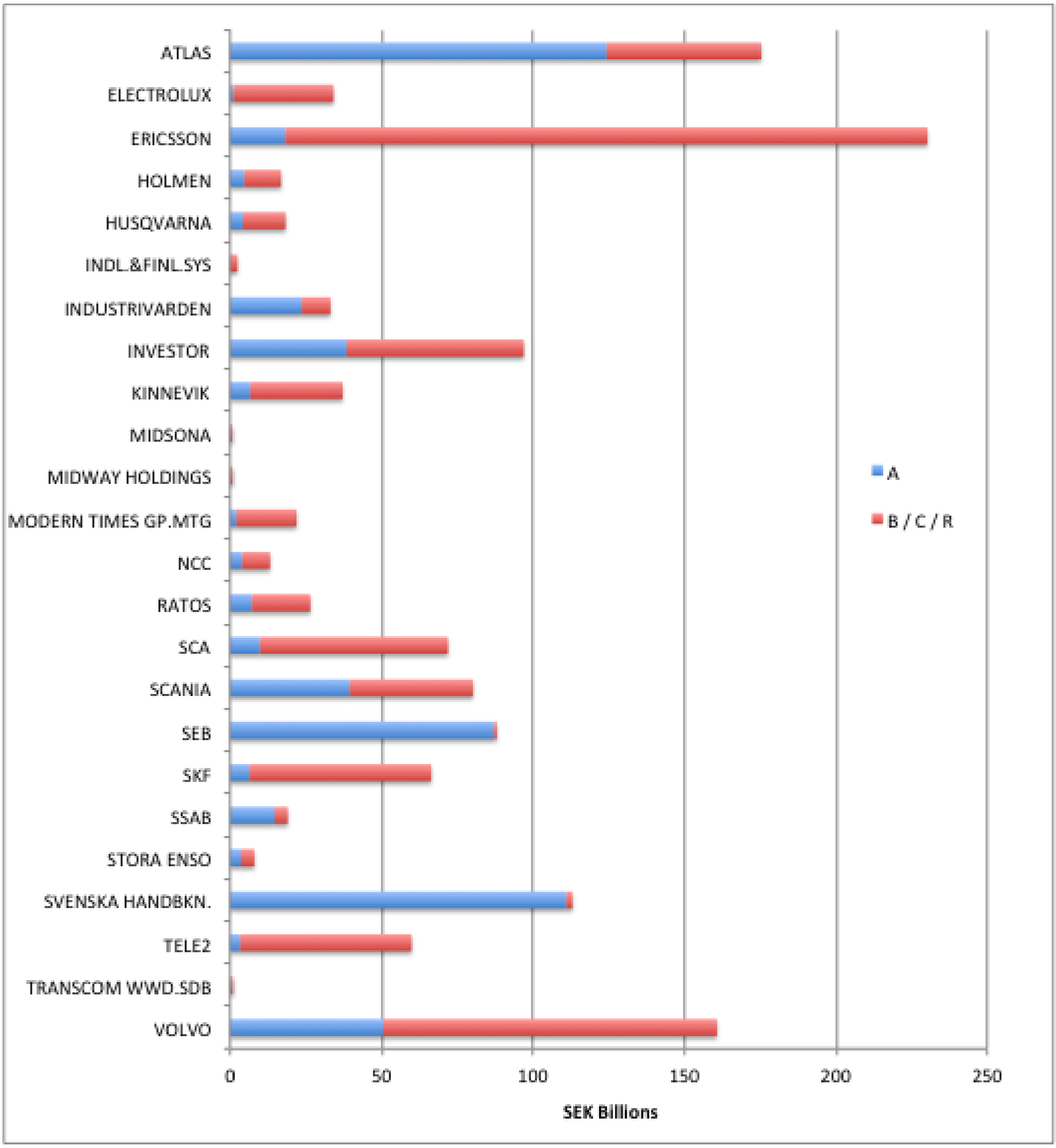
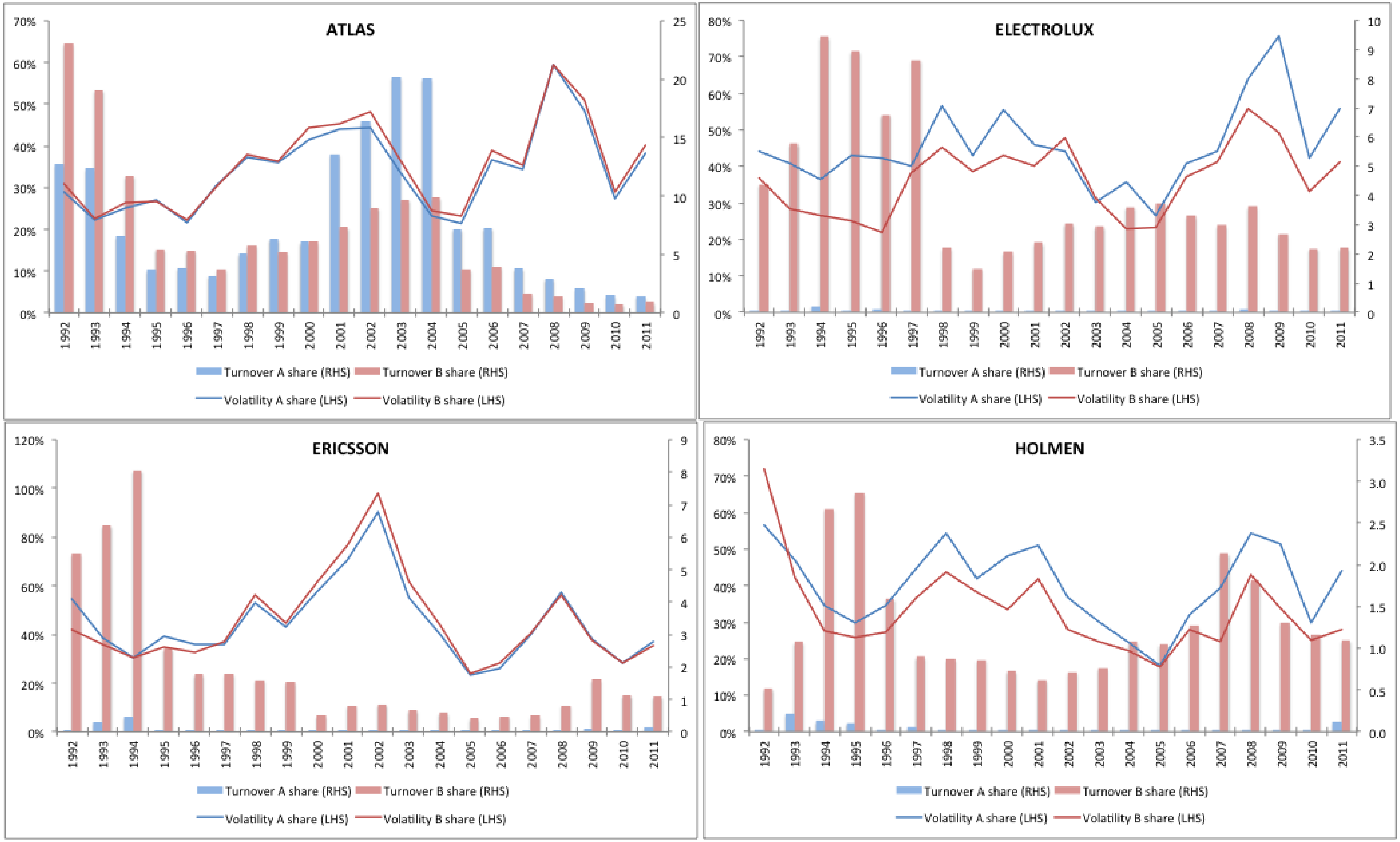
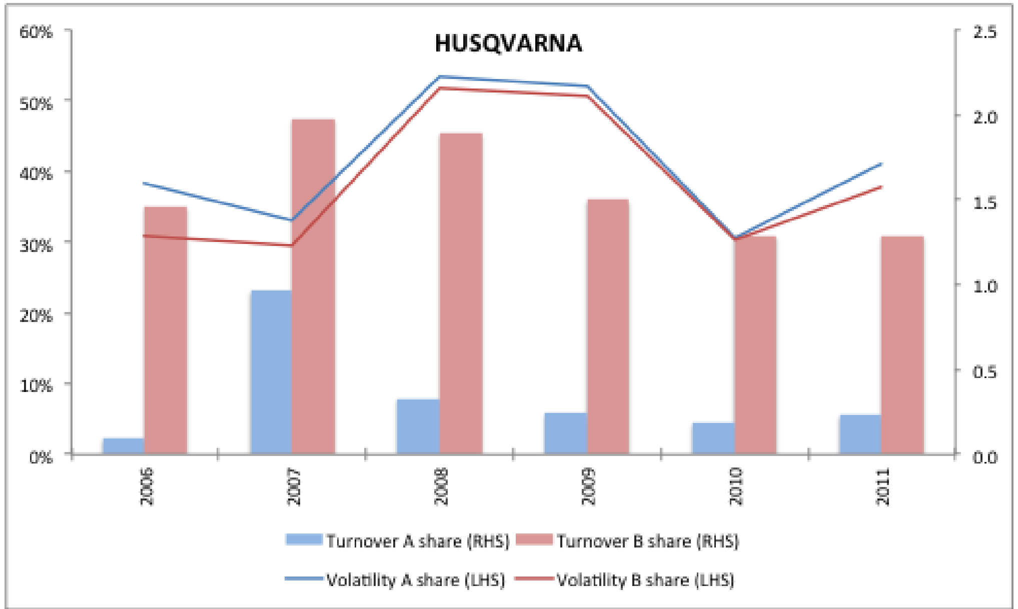


Figure A3 – Volume and volatility for each firm

This figure contains 24 graphs, each presenting the yearly volume and volatility over a period of 20 years (or less if the firm started trading later than 1992), one for each firm in the sample. The yearly volume and volatility are calculated as defined in Table A2.




HUSQVARNA
60%
50%
40%
30%
20%
10%
0%
2.5
2.0
1.5
1.0
0.5
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2006
2007
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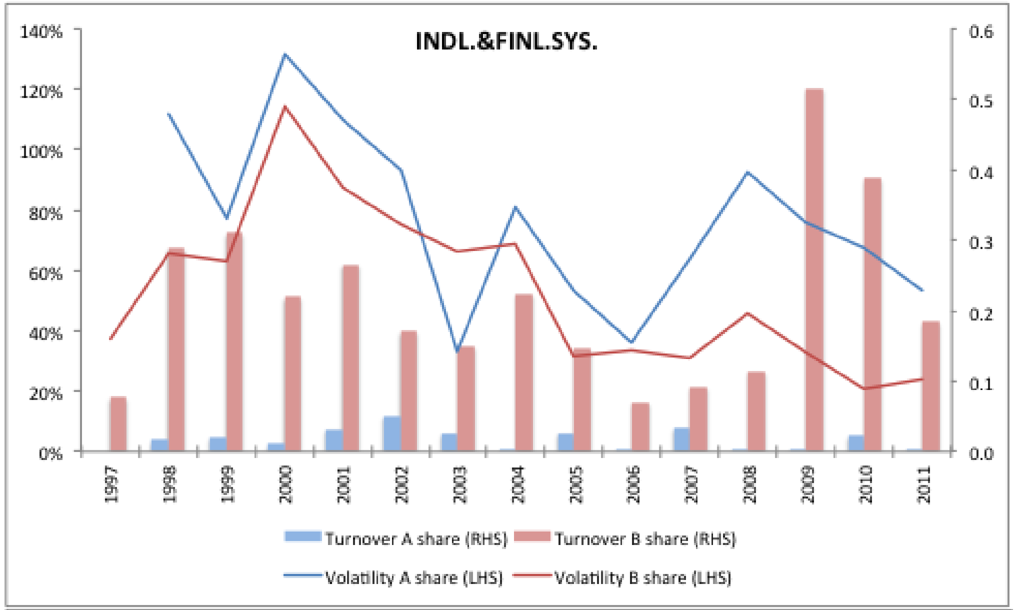
2009
2010
2011
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)


INDL.&FINL.SYS.
140%
120%
100%
80%
60%
40%
20%
0%
0.6
0.5
0.4
0.3
0.2
0.1
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1997
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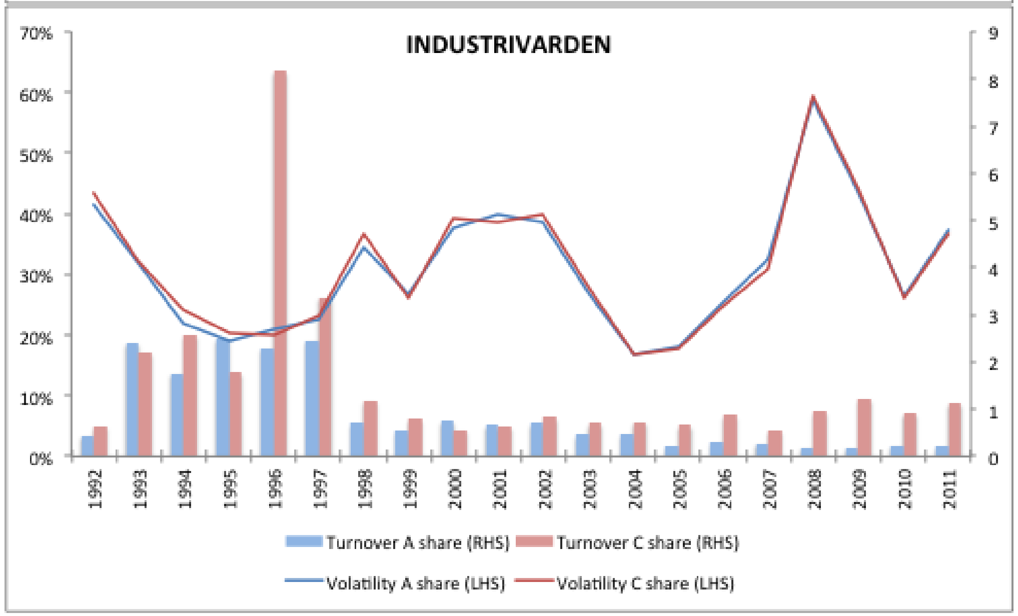
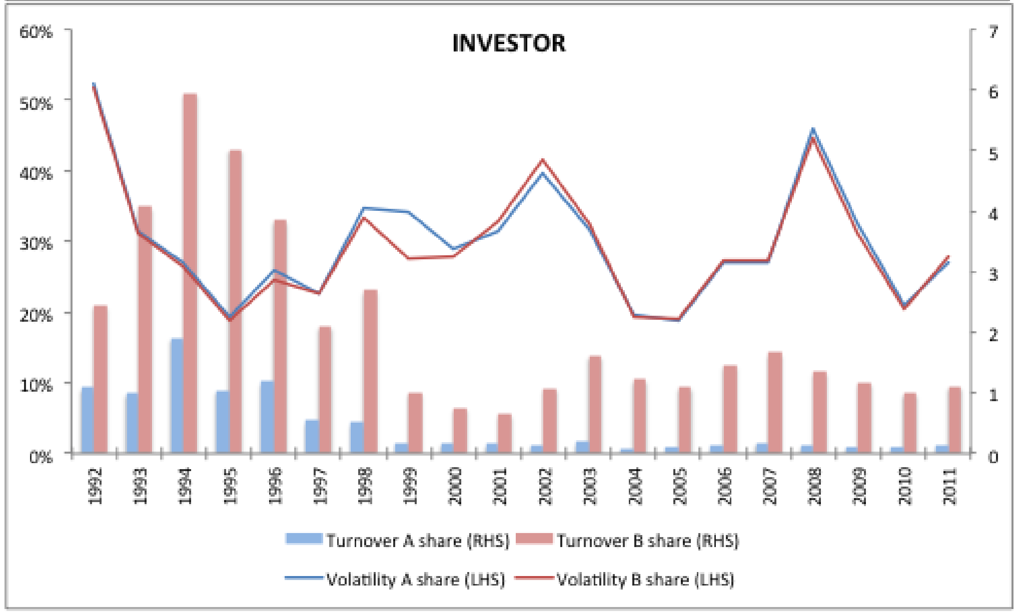
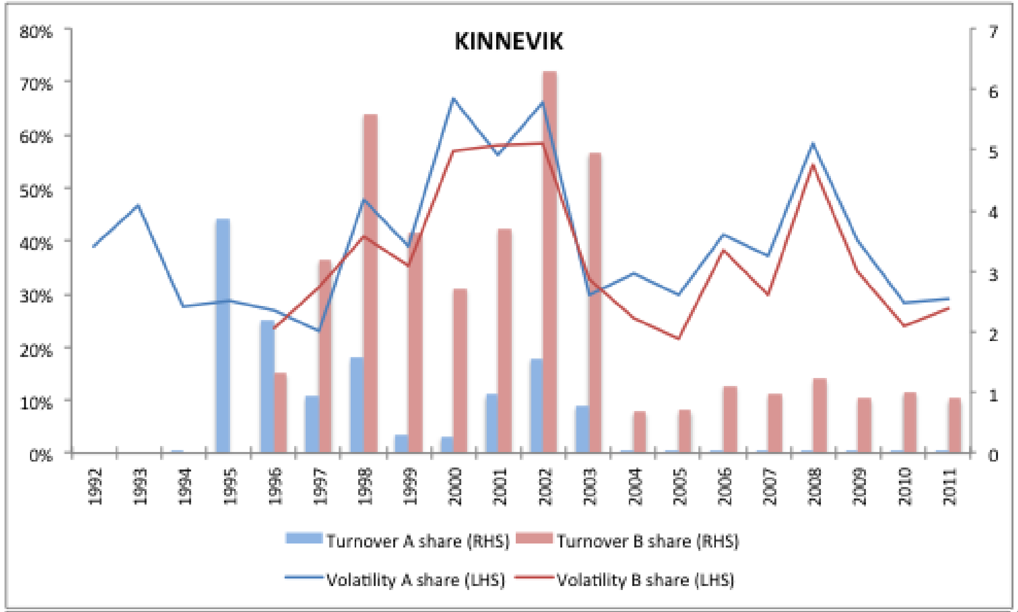
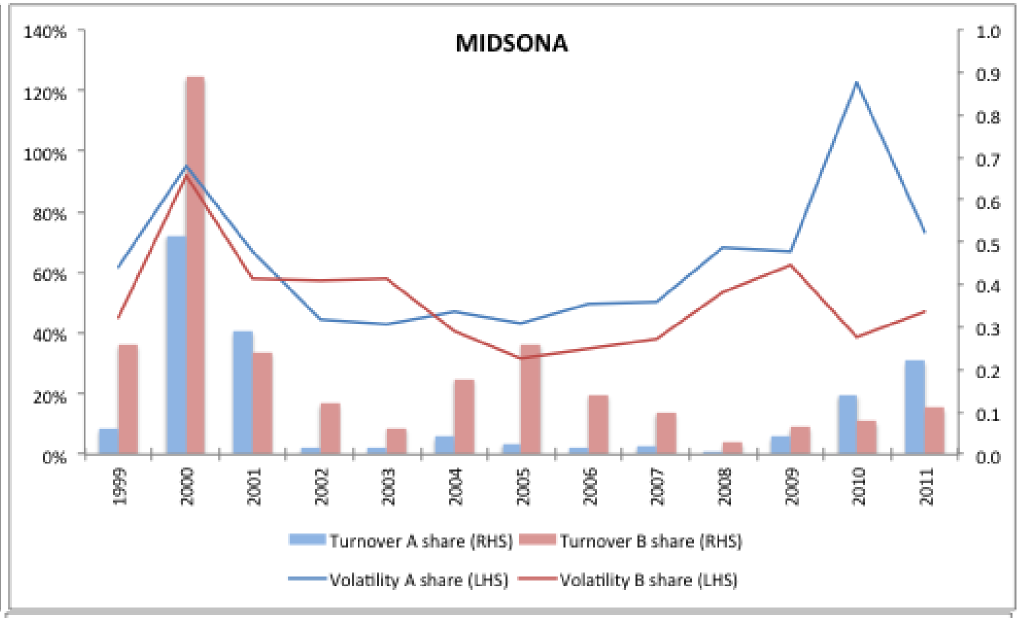
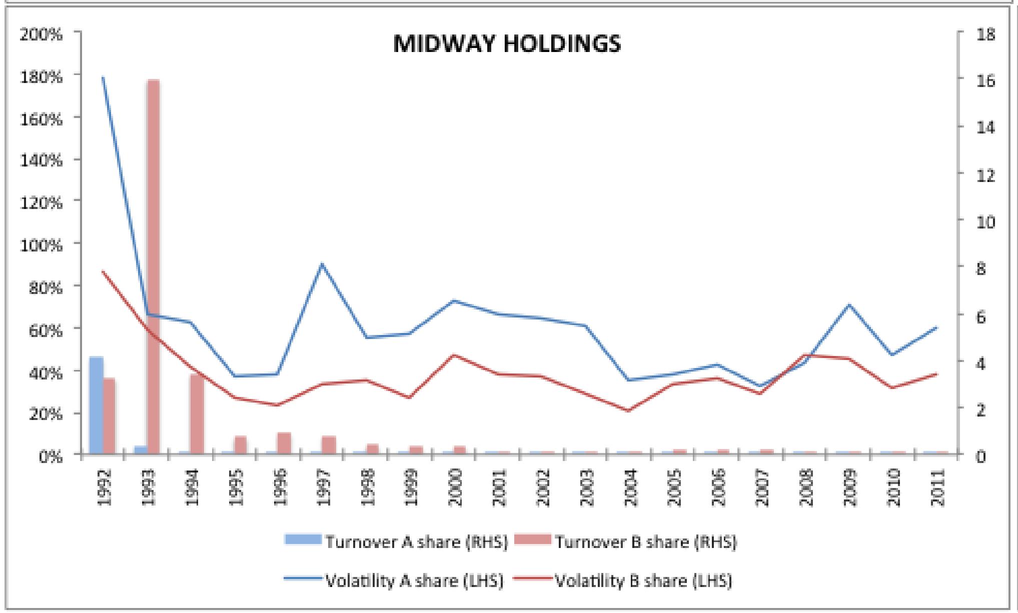
2010
2011
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)

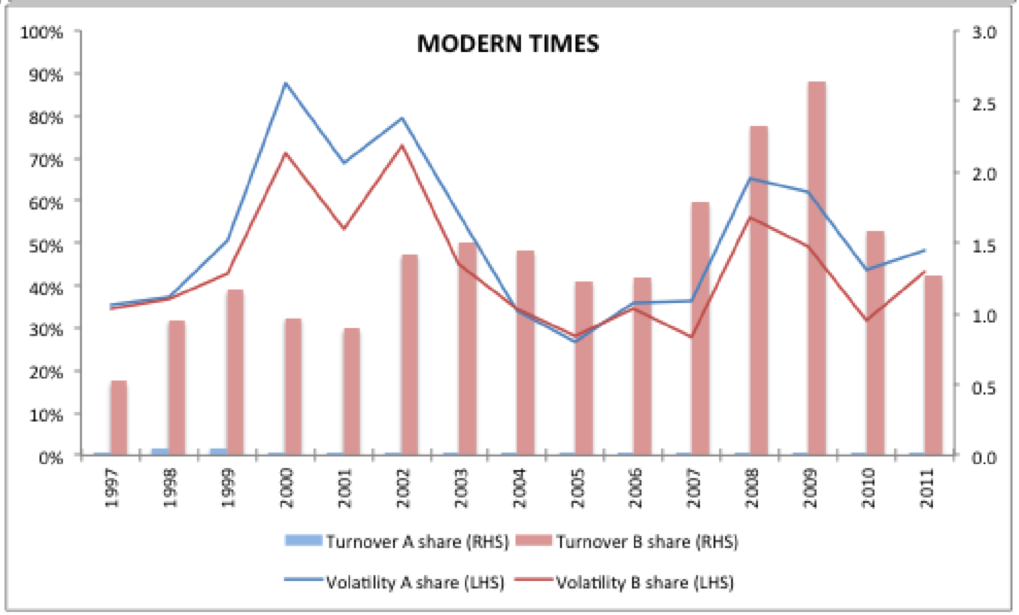

INDUSTRIVARDEN
70%
60%
50%
40%
30%
20%
10%
0%
9
8
7
6
5
4
3
2
1
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Turnover A share (RHS)
Turnover C share (RHS)
Volatility A share (LHS)
Volatility C share (LHS)

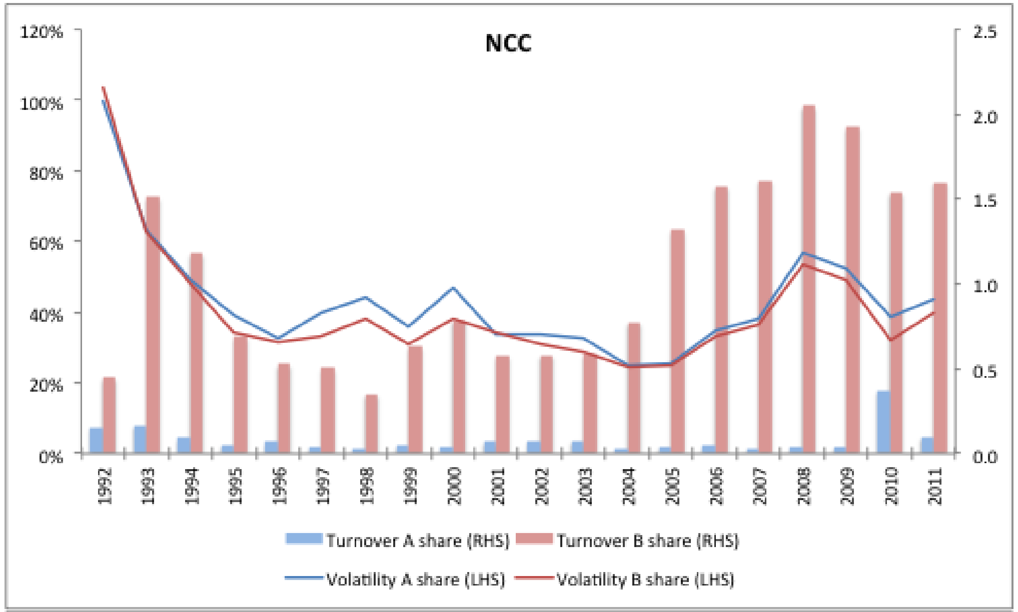

INVESTOR
60%
50%
40%
30%
20%
10%
0%
7
6
5
4
3
2
1
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)

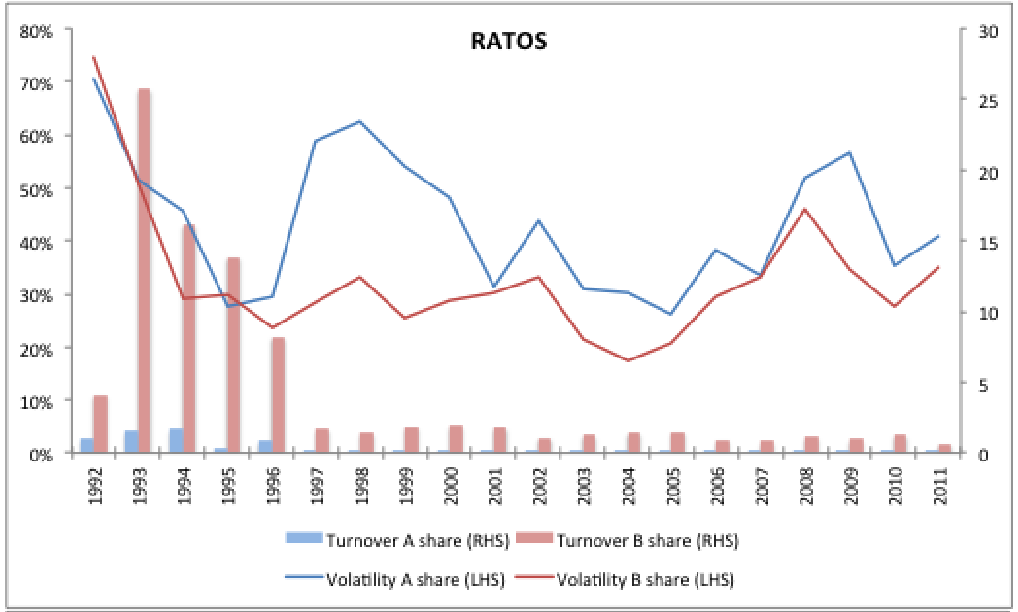

KINNEVIK
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)

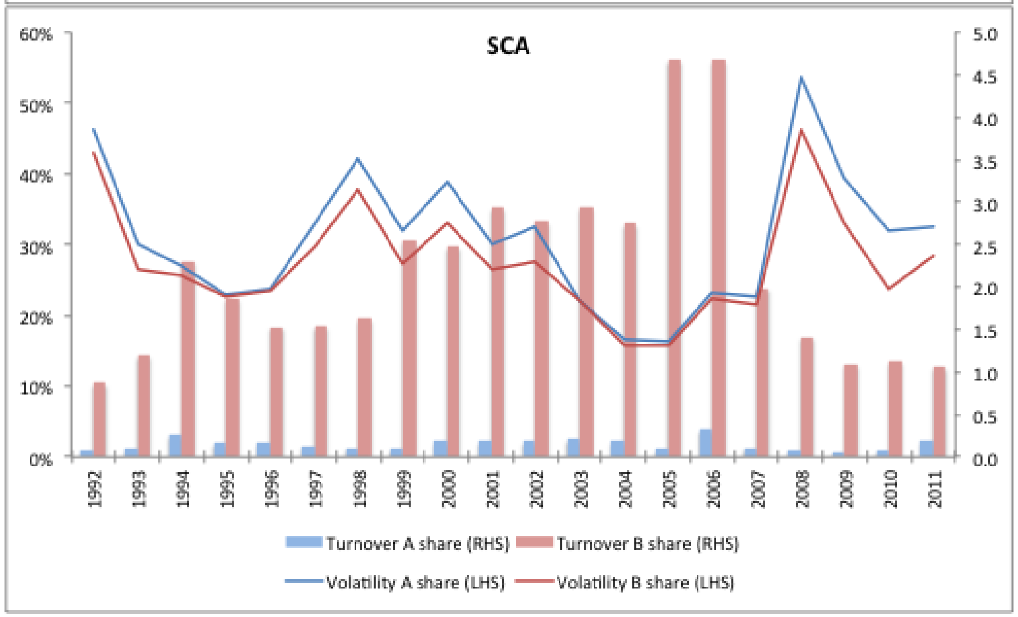

MIDSONA
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)

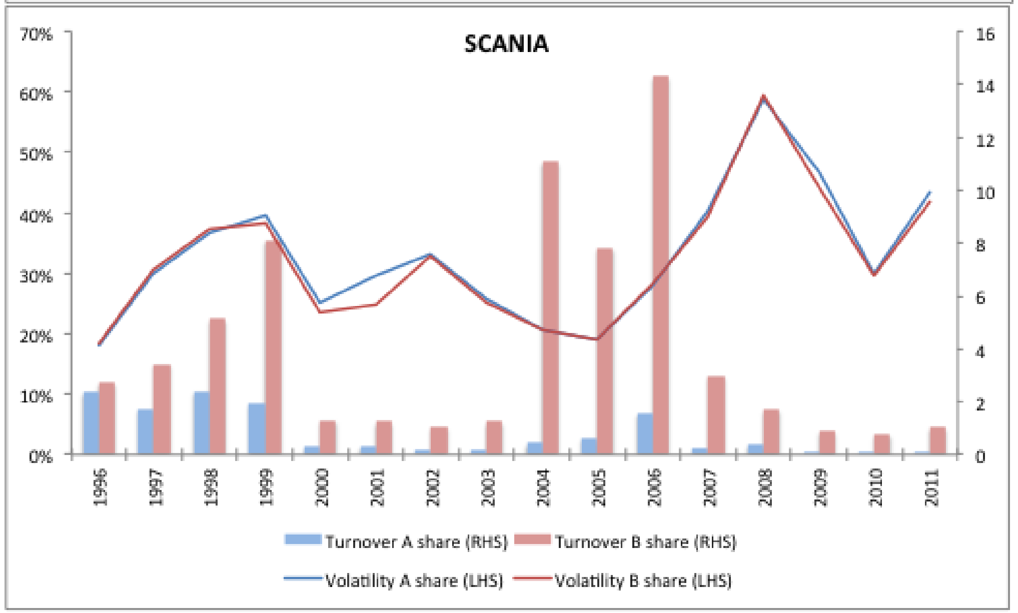

MIDWAY HOLDINGS
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)

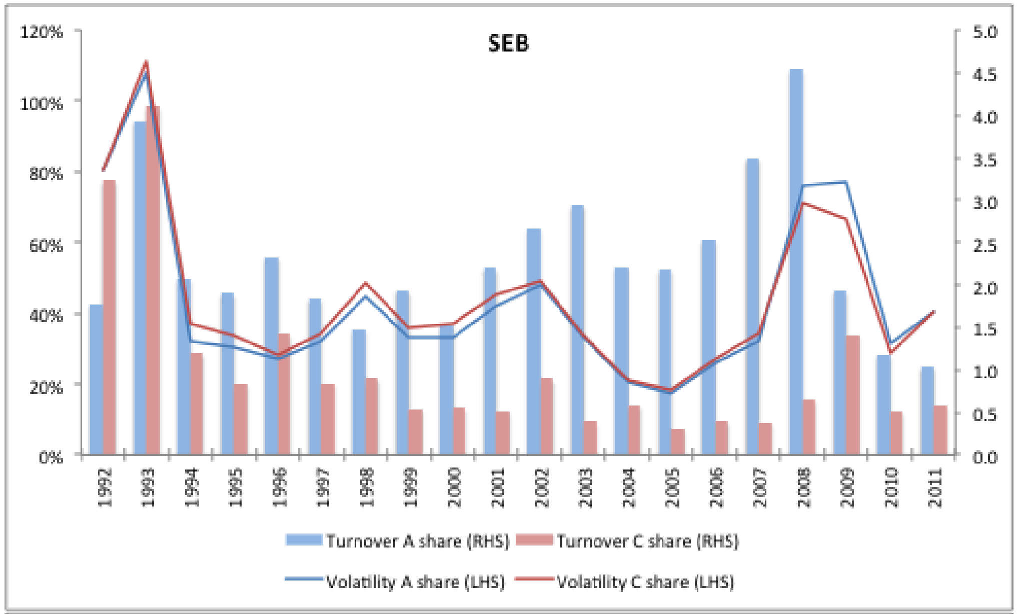

MODERN TIMES
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)

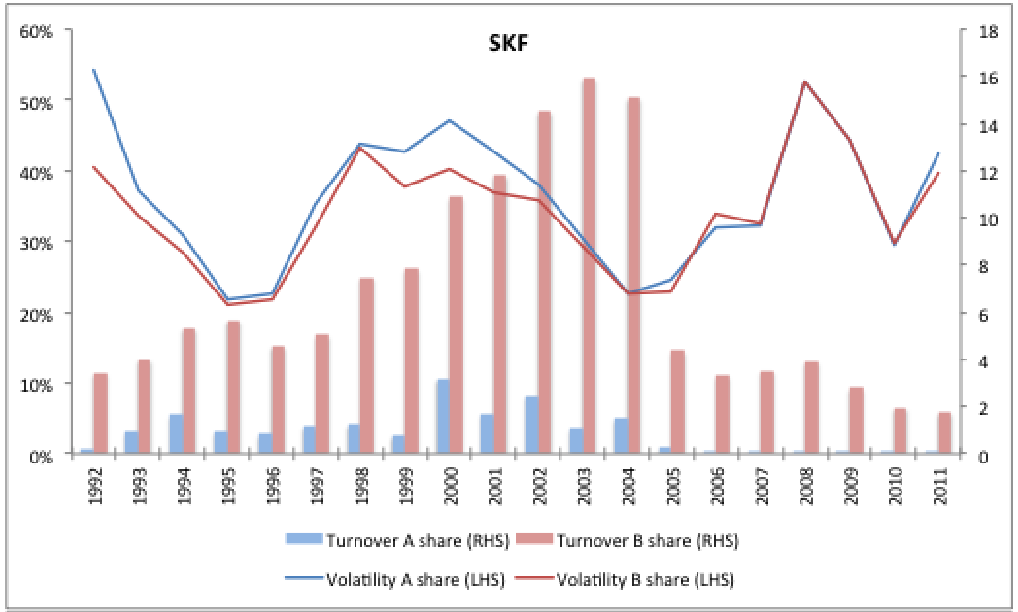

NCC
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)

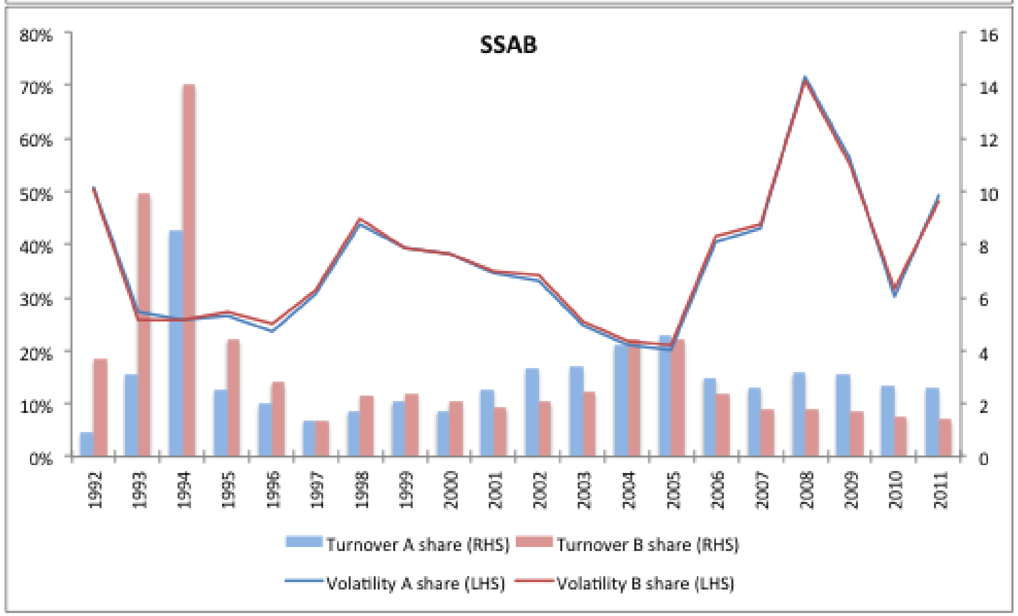

RATOS
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)

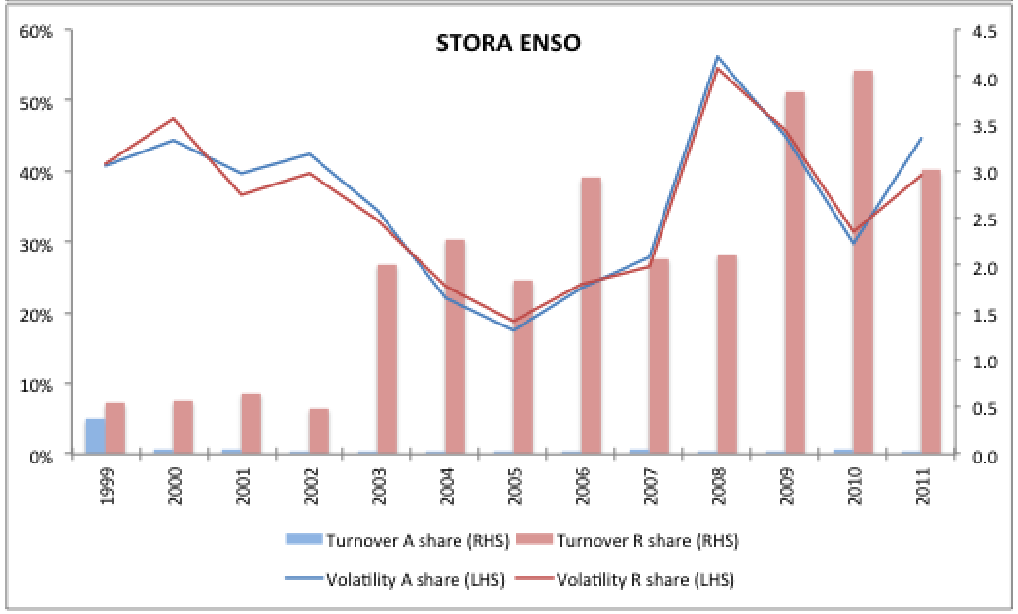

SCA
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)

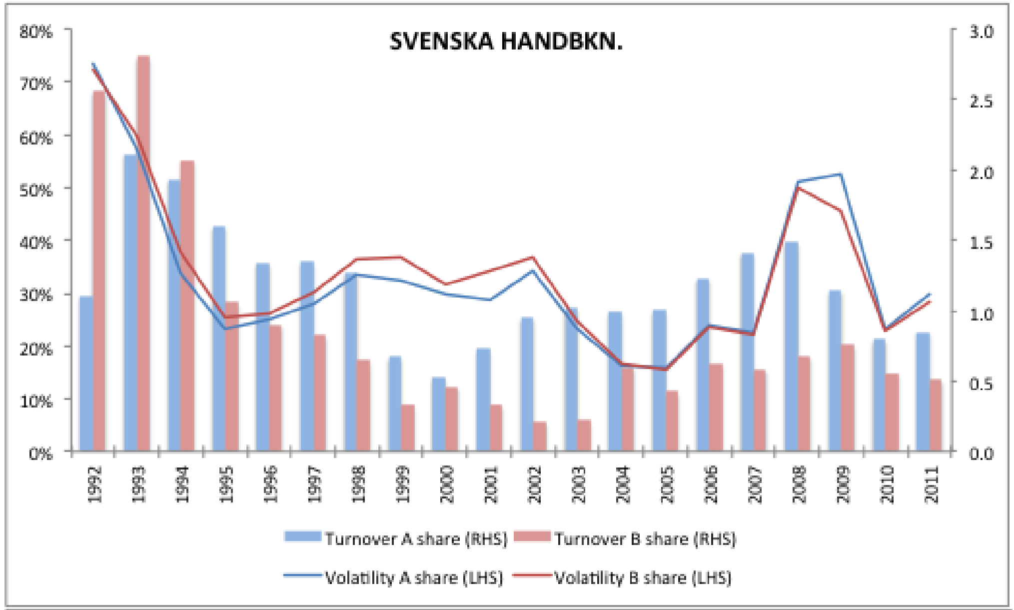

SCANIA
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)

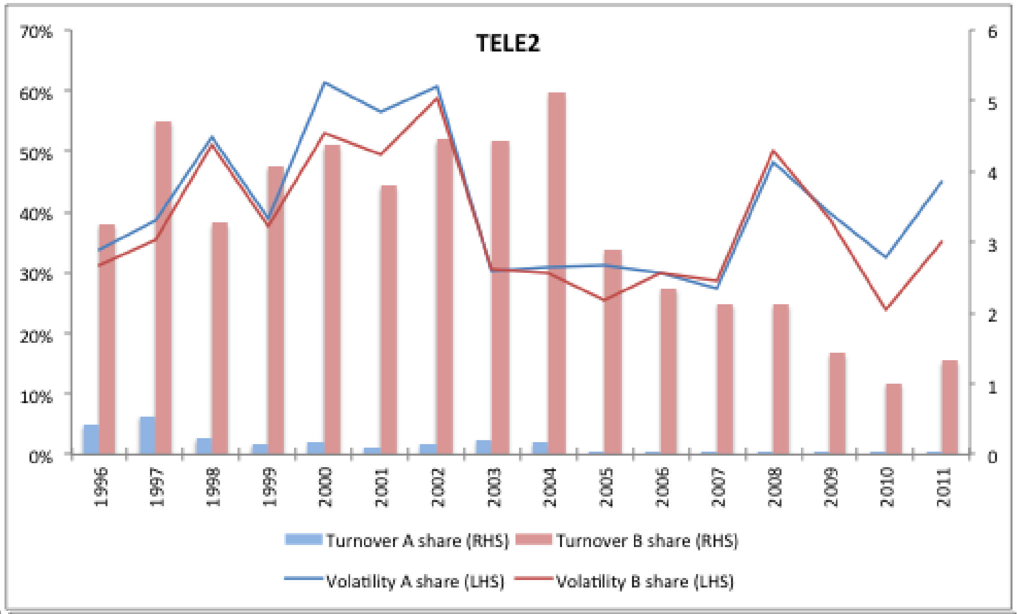

SEB
120%
100%
80%
60%
40%
20%
0%
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Turnover A share (RHS)
Turnover C share (RHS)
Volatility A share (LHS)
Volatility C share (LHS)

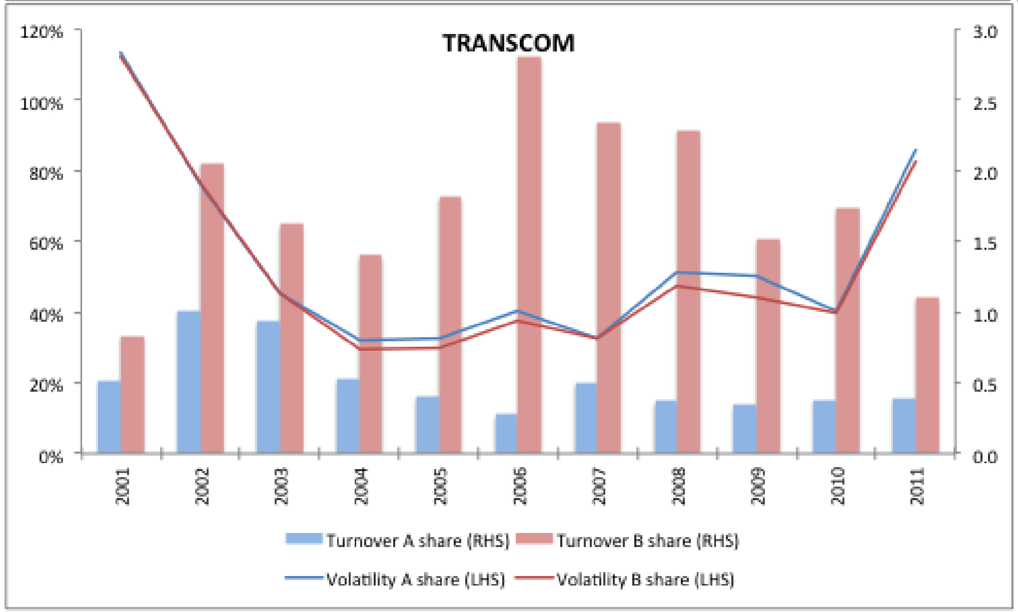

SKF
60%
50%
40%
30%
20%
10%
0%
18
16
14
12
10
8
6
4
2
0
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)


SSAB
80%
70%
60%
50%
40%
30%
20%
10%
0%
16
14
12
10
8
6
4
2
0
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)


STORA ENSO
60%
50%
40%
30%
20%
10%
0%
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Turnover A share (RHS)
Turnover R share (RHS)
Volatility A share (LHS)
Volatility R share (LHS)


SVENSKA HANDBKN.
80%
70%
60%
50%
40%
30%
20%
10%
0%
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)


TELE2
70%
60%
50%
40%
30%
20%
10%
0%
6
5
4
3
2
1
0
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)


TRANSCOM
120%
100%
80%
60%
40%
20%
0%
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)

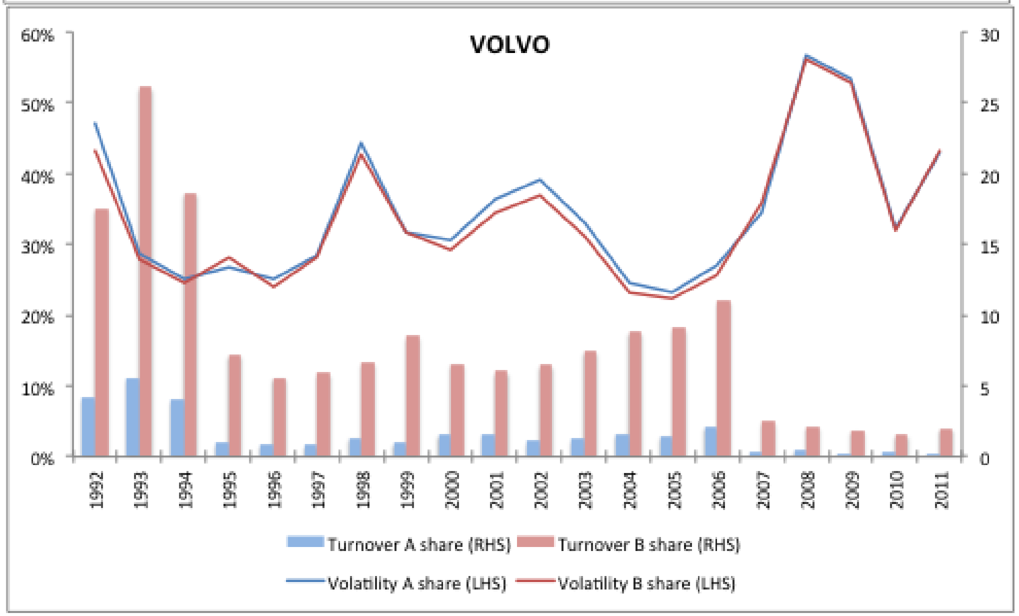

VOLVO
60%
50%
40%
30%
20%
10%
0%
30
25
20
15
10
5
0
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Turnover A share (RHS)
Turnover B share (RHS)
Volatility A share (LHS)
Volatility B share (LHS)

Figure A4 – Time series of aggregated volume and volatility

The graph plots the time-series of annualized average turnover and volatility for the 277 shares traded on the Stockholm Stock Exchange as of end of year 2011. Average turnover is defined as the one-year average of total number of shares traded in a day divided by the total number of shares outstanding. Multiplying with the number of trading days in a year annualizes the average turnover. Average volatility is the value-weighted average of stock volatility, measured as the sum of stock volatility for each stock multiplied with its corresponding weight. Multiplying with the square root of number of trading days in a year annualizes the average volatility.