MARKO S. MAUKONEN

THREE ESSAYS ON THE VOLATILITY OF FINNISH STOCK RETURNS

Helsingfors 2004
Three Essays on the Volatility of Finnish Stock Returns

Key words: volatility forecasting, idiosyncratic volatility, idiosyncratic risk

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FOREWORD

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I wish to note also here that the last essay benefited greatly from the data that was kindly provided by Independence Investments LLC.

I am extraordinarily grateful for having had Eva Liljeblom as my thesis-advisor, John Doukas and Magnus Dahlqvist as the examiners of this thesis, and Kajsa Fagerholm’s assistance at the department. Last, but not least, Clas Wihlborg has accepted to act as the opponent at the public defense of the thesis.

I alone take full responsibility for all errors in the thesis.

Helsinki, May 30, 2004

Marko Maukonen
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PART A
SUMMARY SECTION OF THE DOCTORAL THESIS “THREE ESSAYS ON THE VOLATILITY OF FINNISH STOCK RETURNS”
1. INTRODUCTION

Volatility has been present, in one form or the other, for quite some time. In the spirit of the deduction in Ineichen (2000), one can assert that had equities always existed, equity return volatility would have been present already at the times of Babylon (c. 1700 B.C.). In modern times, which are of interest to us, in line with the Markowitzian mean-variance framework, investors think of assets in terms of risk and return. Volatility (variance of stock returns) is one way of quantifying risk.1

This essay-collection is built around the following thematical questions on the volatility of stock returns:

(i) Do more complex volatility models outperform simple Random Walk models in out-of-sample predictive power? (Essay 1);

(ii) Has stock market volatility on average increased and what is the relation between stock market volatility and macroeconomic growth? (Essay 2);

and

(iii) What determines idiosyncratic volatility? (Essay 3).

There exists currently a voluminous literature on the subject matter in Essay 1. In 2003 Robert Engle received the Nobel Prize in Economics “for methods of analyzing economic time series with time-varying volatility (ARCH)” 2 Laureate Engle’s contributions to the literature on financial economics are outlined as follows: “[…] investors and financial institutions need forward-looking—forecasts—of volatility during the next day, week and year. In an outstanding paper in 1982, Robert Engle formulated a model which allows such evaluations.” 3 Forecasts of volatility are indeed pivotal in many financial applications. For example, volatility forecasting is of utmost importance in option pricing (see, e.g., Green and Figlewski, 1999)—in fact, volatility is the only one of the five input parameters in the Black and Scholes (1973) option
pricing formula that is not directly observable. Volatility forecasts are also needed in the Value-at-Risk (VaR) framework. The VaR is applied by banks and financial institutions and used to estimate the capital requirements for market risk that follow from the Basle II rules (Basle Committee on Banking Supervision, 1996). In Essay 1, several common models of volatility are empirically examined and it is found that the more engineered time-series models, of GARCH and exponentially weighted moving average type, yield better forecasts compared to simple Random Walk type models.

The theme in Essay 2 has also been studied before in the literature. However, the perspective in Essay 2 is new and follows the recent work of Campbell, Lettau, Malkiel and Xu (2001). The focus in prior research has mainly been on the dynamics of market volatility, whereas the focus here is on three decomposed components of the total aggregated volatility for individual firms: (i) a market related volatility; (ii) an industry-specific residual volatility; and (iii) a firm-specific residual (idiosyncratic) volatility. Similar to the seminal findings of Campbell et al. (2001) on US data, we find that idiosyncratic volatility has on average drifted upwards in Finland during 1970–2001. Moreover, idiosyncratic volatility is found to account for most of the total aggregated volatility for our sample of stocks listed on the Helsinki Stock Exchange. This is to our knowledge the first time the Campbell et al. (2001) finding is verified on out-of-sample basis, i.e. with data other than that from the US market. As is commonly known, the three volatility measures are persistent. Finally, it is found that idiosyncratic volatility is related to the overall macroeconomic growth: it moves countercyclically and is able to predict future growth in the Gross Domestic Product.

Research on idiosyncratic volatility is motivated for several reasons. Idiosyncratic volatility is obviously of interest to the investors that have not diversified their portfolio and are perhaps holding only one single stock. It is also related to pricing errors and hence of concern to arbitrageurs. Idiosyncratic volatility is important in scholarly work that relies on an event-study framework. Finally, again in option pricing and other financial applications that use volatility as an input parameter, idiosyncratic volatility is relevant due to its large influence on the total volatility.4
The theme in Essay 3 is—to our understanding—at the front of the state-of-the-art in financial economics. Given that the lion’s share of the total aggregated volatility is engendered by idiosyncratic volatility, it seems motivated to examine the determinants of it. We find that industrial focus, small and young firms, high trading volume, and block ownership (and to some extent large institutional investors) are positively related to idiosyncratic volatility.

On the whole, this essay-collection aims to further our understanding of stock return volatility in three main categories. In the first essay, it is examined how weekly and monthly volatility of a market return index is forecasted best. In the second essay, we look at the dynamics of the total aggregated stock return volatility of individual stocks by decomposing it into a market, industry-and firm-level residual volatility; and observe how these components on the one hand have developed during the last 30 years and on the other how they are related to the macroeconomic growth in Finland. In the third essay, for a cross-section of Finnish stocks, we seek for determinants of the idiosyncratic volatility.

A general limitation to all three essays is that only the Finnish stock market is considered. The three essays are related, yet independent. Therefore, as the essays examine different aspects of stock return variance, also the method used to estimate the stock return variance differs from essay to essay. For instance, the GARCH model—which is a good model to predict volatility according to Essay 1—is not used in Essays 2 and 3 because their research question involves idiosyncratic volatilities, i.e. the volatility defined as the volatility of the residuals from an asset pricing model. Moreover, the measure of idiosyncratic volatility in Essay 2 differs from that in Essay 3 because the aim in the former is to examine time-series properties of aggregated volatility of the Finnish stock market; while the aim in the latter is to find firm-specific covariates to idiosyncratic volatility, and hence aggregated estimates are futile.

The purpose of this summary section of the doctoral thesis is to present “[…] the research problem, goal, method and results [of the thesis]. In the summary section the research results and contribution are also reported in detail. In addition, the relevance of
the included essays for the whole is reported”. The remainder of this summary section is organised so that a summary of the three essays is provided separately in three subsequent sections.
2. SUMMARY OF ESSAY 1 “ON THE PREDICTIVE ABILITY OF
SEVERAL COMMON MODELS OF VOLATILITY: AN
EMPIRICAL TEST ON THE FOX INDEX"

“The lesson from Lord Rayleigh’s solution [to the problem of the Random Walk] is that in open
country the most probable place to find a drunken man who is at all capable of keeping on his
feet is somewhere near his starting point!” (Pearson, 1905b, p. 342)

To apply the solution to the problem of the Random Walk (Pearson, 1905a and b, and
Rayleigh, 1905) on stock return volatility may not be appropriate. It has been known for
a considerable time that volatility is time dependent. More specifically, related to the
subject matter in this paper, it has been maintained that large (small) price changes are
often followed by large (small) changes of either positive or negative sign. To come to
terms with this phenomenon let us look at what a casual examination of the ten largest
daily positive and negative returns of the Finnish Options Index (FOX) in Table 1
below reveals.

Table 1. Ten Highest Positive and Negative Daily Returns for the FOX Index
from May, 1988 to March 1999

<table>
<thead>
<tr>
<th>Rank</th>
<th>Return</th>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.71%</td>
<td>1998-10-12</td>
<td>Nokia rebounds from the 1998-10-08 value loss.</td>
</tr>
<tr>
<td>2</td>
<td>6.78%</td>
<td>1991-11-18</td>
<td>Devaluation of the Finnish markka boosted up the export sector.</td>
</tr>
<tr>
<td>3</td>
<td>6.30%</td>
<td>1991-01-22</td>
<td>Forestry stocks rallied up mainly due to KOP's large acquisitions of Yhtyneet Papperitehtaat.</td>
</tr>
<tr>
<td>4</td>
<td>6.29%</td>
<td>1997-10-29</td>
<td>Nokia recovering from the fall on 1997-10-28.</td>
</tr>
<tr>
<td>5</td>
<td>5.62%</td>
<td>1992-09-08</td>
<td>Devaluation of the Finnish markka.</td>
</tr>
<tr>
<td>6</td>
<td>5.45%</td>
<td>1992-11-03</td>
<td>Private investors speculating on Banking and Insurance stocks.</td>
</tr>
<tr>
<td>7</td>
<td>4.78%</td>
<td>1998-01-15</td>
<td>The market anticipated Nokia’s forthcoming semi-annual report.</td>
</tr>
<tr>
<td>8</td>
<td>4.74%</td>
<td>1998-09-08</td>
<td>U.S. Federal Reserves signalled of a plausible rate-cut.</td>
</tr>
<tr>
<td>10</td>
<td>4.33%</td>
<td>1993-01-05</td>
<td>All stocks “dashing upwards” (Nousurynnäkkö, in Finnish) despite the frantic state of affairs in the banking sector.</td>
</tr>
</tbody>
</table>
Table 1—continued

<table>
<thead>
<tr>
<th>Panel B: Negative returns</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-8.27% 1997-10-28</td>
</tr>
<tr>
<td>2</td>
<td>-7.82% 1998-10-08</td>
</tr>
<tr>
<td>3</td>
<td>-6.47% 1998-08-11</td>
</tr>
<tr>
<td>4</td>
<td>-6.28% 1998-09-10</td>
</tr>
<tr>
<td>5</td>
<td>-5.50% 1995-12-15</td>
</tr>
<tr>
<td>6</td>
<td>-5.39% 1999-01-13</td>
</tr>
<tr>
<td>7</td>
<td>-5.26% 1997-10-27</td>
</tr>
<tr>
<td>9</td>
<td>-4.98% 1998-08-27</td>
</tr>
<tr>
<td>10</td>
<td>-4.88% 1998-08-25</td>
</tr>
</tbody>
</table>

This table is amended from Maukonen (1999) and the FOX index data to which it pertains is described more in detail in Maukonen (2002). The return in the second column is the first difference of the logarithm of the FOX index price level. The event explanation to the price movement in the fourth column is from *Kauppalehti* (daily Finnish newspaper) and the causality of these explanations is thus only indicative, i.e., it does not conform to usual scientific rigour.

Table 1 suggests that volatility clusters. Days with high returns are often followed by days with high returns of equal or opposite sign: the large negative return October 8, 1998 (October 27 and 28, 1997) is followed by a large positive return October 12, 1998 (October 29, 1997); and the large positive return November 3, 1992 is followed by a large return of equal sign the following day. Many high returns have concentrated in August and September 1998. Casual empiricism aside, FOX index daily returns, and to some extent also weekly and monthly returns, are autocorrelated, and weekly and monthly volatility estimates are very persistent (Maukonen, 2002, Table 1, p. 815). Therefore, a model that forecasts volatility should clearly somehow be able to incorporate this behaviour of stock returns.

Following up on the critique by, for instance, Merton (1980) on the traditional econometric models, Engle (1982) introduced the Autoregressive Conditional Heteroskedasticity model (ARCH). The beauty of the ARCH model is in the fact that it does not rest on the assumption of constant variance but allows the conditional variance to evolve over time trying to identify the presence of sequential time periods of relative
unstablleness and stability. Later, Bollerslev (1986) generalised the ARCH (GARCH) to have a more flexible lag structure, now trying to capture high-frequency effects as well as the long term structure in volatility. A model with a similar aim is the Exponentially Weighted Moving Average model (EWMA), which is used for instance in the Riskmetrics™ methodology. The question still remains: How do the more complicated models perform empirically in comparison to the simpler (Random Walk) models? Moreover, in many financial applications the focus is on future volatility, hence the models should be able to predict, not only on in-sample but also on out-of-sample basis.

The aim of Essay 1 is to examine the comparative out-of-sample forecasting performance of several common models of volatility. In this respect the prior papers in the extant literature that this paper is closest to in its nature include Akgiray (1989), Dimson and Marsh (1990), Tse (1991), Brailsford and Faff (1996), and Walsh and Tsou (1998); while it should be pointed out that the literature on volatility forecasting using one or one group of models is far greater.

This essay has independent value also besides the fact that it examines volatility forecasting on the Finnish market. In the prior literature, the more complex (GARCH and EWMA) models have not always dominated the simpler (Random Walk) models. The additional evidence this paper is intended to provide, and the extension to the literature, focuses on three main points and the combination of them in the empirical test:

(i) the correct estimation of realised index return volatility,

(ii) forecast estimation, i.e. computation associated with the creation of the prediction, and

(iii) forecast evaluation, i.e. testing the accuracy of the forecasts.
The first of these is quite straightforward. Never the less, if not taken into consideration, incorrect estimation of realised volatility will lead to spurious conclusions in the test. Andersen and Bollerslev (1998) find that the forecasting ability of the GARCH model increases when the sampling frequency of the returns used to estimate realised volatility is increased. Using high-frequency return data is not unproblematic due to serial correlation in the returns. For the sake of brevity, results of the analysis are presented in the paper for only one estimation method. We used however three proxies of realised volatility; finding that although the weekly and monthly variances composed of positively autocorrelated daily returns are downward-biased (see also Perry, 1982) they yield better results in the evaluation of predictive accuracy than a proxy based on squared low frequency (weekly and monthly) price innovations. The conclusions based on the high frequency proxy are furthermore uniform to the analysis carried through using high frequency estimates corrected for the \textit{ex post} known degree of serial dependency as in Cohen, Hawawini, Maier, Schwartz and Whitcomb (1983).

The second issue, forecast estimation, is mainly a concern for the more advanced models; and particularly for the GARCH fitted to low frequency return data. One could fit the GARCH model to daily data and scale it thereafter—i.e. multiply the conditional variance with a constant—to obtain lower frequency forecasts. The features of multiple-step forecasting with the GARCH model have not been fully explored (see, e.g., Andersen and Bollerslev, 1998). The problem is that the scaling will most likely lead to spurious volatility forecasts due to non-i.i.d. returns. Thus, in order to generate one-week-and one-month-ahead forecasts we use a large set of weekly and monthly return data observations, respectively.

The third issue, forecast evaluation, is perhaps the most interesting in light of the previous literature—the widely used error statistics have yielded inconclusive results among themselves.\(^\text{13}\) To take this into account, a rather plenty set of alternative error statistics is used in the paper. In addition, we use as a primary source of ranking a basic OLS regression-based efficiency test, as for instance in Pagan and Schwert (1990), Canina and Figlewski (1993), and West and Chou (1995). In this test the estimate of true volatility for period-t is regressed on the prediction for period-t, by one of the
models at a time, \( \sigma_t^2 = \beta_0 + \beta_1 \sigma_{t-1}^2 + u_t \). To assess forecast efficiency the coefficient of determination, R-squared, can be relied on. The model with the highest R-squared is the best predictor. However, in as much as the R-squared does not account for biases, the necessary joint condition of \((\beta_0, \beta_1) = (0,1)\) is required. As a secondary source of ranking we examine several of the previously used symmetric and asymmetric error statistics. We find the error statistics to be as a whole not as reliable as the above regression-based methodology, which is supported by the controversy existing in prior literature regarding the former methodology.

All in all, the results of Essay 1 suggest that it is not prudent to apply the solution to the problem of the Random Walk to volatility forecasting. We find empirical evidence that the forecasts from Random Walk model are dominated by the forecasts from the GARCH and EWMA models.

To the extent that volatility is predictable, the conclusion of Essay 1 is that index return variance is best predicted with the more developed GARCH and EWMA models. It should be noted, none the less, as a caveat that this paper is limited to the statistical significance of the volatility predictions; which, as usual, need not imply economic significance. An interesting question outside the scope of Essay 1 would be to study the economic consequences of relying on alternative volatility predictions. The evaluation of forecast accuracy would ideally be based on the loss function of the model user (Bollerslev et al., 1994)—it might, however, prove impossible to obtain the true economic loss function. One practical, and an alternative to the experimental environment in Essay 1, is to use volatility forecasts to price options and evaluate the profitability of alternative trading strategies as in Berglund et al. (1990). Berglund et al. (1990) in fact find that the GARCH model yields better forecasts than the alternative volatility models they examined and that a trading strategy based on the predictions of the GARCH model “produced significant positive profits” (op.cit., p.18). In general, to consider all permutations of evaluations of a set of alternative volatility and options models, and different hedging techniques is a vast task (see Green and Figlewski, 1999).
3. SUMMARY OF ESSAY 2 “IDIOSYNCRATIC VOLATILITY ON A SMALL EUROPEAN STOCK MARKET”

Prior literature on asset price volatility has mainly concentrated on the variance of market index returns. From this part of the literature it is now known, among other things, that market volatility has not trended upwards in recent times, especially when a long observation period is used. Schwert (1989), with over one hundred years (1857–1987) of market return data from the US market, does not find that market volatility has increased (see also Schwert, 1990b). The results on Finnish data mainly support this conclusion (see, e.g., Liljeblom and Stenius, 1993, 1997). None the less, investment-practitioners, media and regulators have maintained that stock price volatility in general has increased (Jones and Wilson, 1989 and Schwert, 1990a). It has been argued that such perception to some extent is only an illusion in the minds of the investors and created by the high levels of stock indexes (Schwert, 1990a).

In Essay 2 we revisit the question: Has stock return volatility on average increased? This is done in the spirit of, and following, the recent study by Campbell, Lettau, Malkiel and Xu (2001). The innovation in the Campbell et al. (2001) paper is that the total aggregated volatility of stocks is decomposed into three components: (i) a market related risk; (ii) an industry-specific residual risk; and (iii) a firm-specific residual, or idiosyncratic, risk.

In the previous literature, Campbell et al. (2001), working with US data for the years 1962–1997, confirm the Schwert (1989) finding that there is not a positive trend in market volatility, while they on the other hand find that there is a positive trend in the idiosyncratic volatility component. That is, Campbell et al. (2001) find that the individual US firms have on an average become more risky. Moreover, they find that the bulk of the total aggregated volatility is comprised of idiosyncratic volatility. Hence, these two results taken together do in fact conform very well to the perception that stock return volatility by and large has increased.
The Campbell et al. (2001) results have however yet not been verified on out-of-sample data, i.e. on a data set that is different from the one on which the empirical finding seminally was documented—which is the gap in the literature that this paper is intended to fill. Xu and Makiel (2003) have found in-sample support for an increasing idiosyncratic volatility by examining the US data between 1952 and 1998. In contrast, Hamao, Mei and Xu (2003) find recently on Japanese data that the aggregated idiosyncratic volatility has decreased during 1986–1999 while the market volatility seems to have increased during 1975–1999. Hence the results from the Japanese market are also at odds with respect to the relation between idiosyncratic volatility and business cycles. That is, idiosyncratic volatility in Japan has decreased during the severe Japanese economic and banking crises, while Campbell et al. (2001) find that idiosyncratic volatility and macroeconomic growth are negatively associated.15

In Essay 2, the Campbell et al. (2001) methodology of decomposing the aggregated volatility to a market, industry-and firm-level component is applied to data on stock returns from the Finnish market.16 We test and find that there is an upward sloping trend in the monthly idiosyncratic volatility (firm-level) estimates for the sample of firms listed on the Helsinki Stock Exchange during 1970 and 2001. Mean and variance decompositions show that the market volatility accounts for a very small fraction of the total aggregated volatility and that most of the mean and variance is due to firm-and industry-level sources; and in addition, for the aggregated variance, due to the covariance between firm-and industry-level volatility. Therefore, it can be concluded that stock market risk in general has increased also in Finland. This is, without a doubt, a result that has value to the Finnish audience. Similar to the US finding, the tests do not detect a positive trend for the market volatility for 1970–2001, although it seems that the Finnish market volatility drifts downward (upward) during the first (second) part of the sample 1970–1985 (1986–2001). Examination of dependencies in time domain show, as expected, that the volatility measures are very persistent.

In this essay we furthermore construct quarterly volatility estimates of the three components to match the data that is available for the Gross Domestic Product (GDP). It is then established that all volatility measures to some extent, and especially
idiosyncratic volatility, move countercyclically (i.e., volatility is high at ‘bad-times’ phenomenon). In this respect, the results lend support to the Schwert (1989) and Campbell et al. (2001) findings on US data and are thus in contrast to the conclusions drawn from Japanese data in the recent work by Hamao et al. (2003). For our data set, there is a notable increase in the idiosyncratic volatility during the severe Finnish banking and economic crises in the 1990s. It is furthermore found that idiosyncratic volatility predicts future growth in the GDP. In general however, but perhaps not surprisingly, the relation to GDP is weaker for the data from the Finnish economy when compared to the respective finding on US data in Campbell et al. (2001).

The portfolio implications from the results in this paper are interesting. As discussed e.g. in Campbell et al. (2001) an increasing idiosyncratic risk will, ceteris paribus, have many consequences. An increase in the aggregated idiosyncratic volatility, while the aggregated market volatility remains unchanged implies that the correlation between individual stocks has decreased. Furthermore, a positive trend and inertia in the idiosyncratic and market volatility, respectively, implies that the explanatory power (R-squared) of the market model has decreased. Similarly, as idiosyncratic volatility increases, it will become increasingly important to diversify across a number of stocks to reduce the variance of a portfolio. However, while we found that idiosyncratic volatility has trended upward for the sample of Finnish stocks (1970–2001) we found also that market volatility has risen in the latter part of the sample (1986–2001), hence the portfolio implications of our results differ to some extent from those in Campbell et al. (2001). That is, it is reasonable to assume that correlations among stocks, and the explanatory power of the market model, have not declined in the same extent as in Campbell et al. (2001). It would seem that the correlation structure in the US market is different from that in Finland. The portfolio implications from the dynamics between idiosyncratic risk and the total market risk are a topic for our further and on-going research.
4. SUMMARY OF ESSAY 3 “EXPLAINING IDIOSYNRACRIC VOLATILITY: AN EMPIRICAL ANALYSIS ON A CROSS-SECTION OF FINNISH FIRMS”

To date there has been very little research done on explaining the behaviour of idiosyncratic risk. In Essay 3 we extend the current literature on stock return volatility by examining a set of plausible explanatory variables of idiosyncratic volatility, which have hitherto for the most part been unexamined or unexamined in a multivariate setting.

4.1 What could explain idiosyncratic volatility?

The managers of a firm may diversify the firm across several (independent) business segments. By choosing not to “put all the eggs in one basket” they can diversify the risk of the return of their firm’s equity. In line with an argument that managers should leave the diversification activities to the investors, Comment and Jarrell (1995) find that there is a trend towards greater corporate focus for US firms 1974–1989, i.e., towards firms that are less diversified across business segments. Denis, Denis and Yost (2002) later confirm this finding for US data between the years 1984 and 1997. We are the first in Finland to construct standard measures for industrial diversification following Berger and Ofek (1995) and Comment and Jarrell (1995), and find that there are some signs of a trend towards increasing corporate focus also for the sample of Finnish firms during 1994 and 2001. We hypothesise that a greater corporate diversification (focus) is associated negatively (positively) with idiosyncratic volatility, i.e. the return of a firm with a portfolio of activities should have a smaller residual variance when compared to a firm with fewer or just one activity in its portfolio. A firm may also, in addition to industrial diversification, diversify its activities across several (independent) national markets. We construct a measure for global diversification that is similar to Denis et al. (2001) in the previous literature and find some evidence that the Finnish firms—which for our sample, to begin with, are globally very diversified—have become increasingly diversified in this respect towards the end of our sample in 2001.
The hypothesis regarding our main research question is again that global diversification (focus) is negatively (positively) associated with idiosyncratic volatility.

It is proposed in the literature that institutional investors, much like certain animals, have a tendency to herd [see Hirshleifer and Teoh (2003) for a literature review on this topic]. By simultaneously buying or selling and engaging in positive-feedback trading, the argument is that institutional investors destabilise the market, and their presence is thus associated positively with volatility. While Lakonishok, Shleifer and Vishny (1992), for instance, find little support for the herding argument, there are others (recently, e.g., Dennis and Strickland, 2002) that conclude the opposite. Empirically for US data between 1980 and 1996, Gompers and Metrick (2001) find that the degree to which firms’ shares are owned by large institutional investors is positively correlated with the volatility of the firm. Specifically related to the research question in our paper, Xu and Malkiel (2003) conclude that institutional investors create idiosyncratic volatility—they find empirically for the cross-section of US data 1989–1996 that there is a positive association between the residual variance from the CAPM and the degree of institutional ownership, and that institutional ownership Granger–causes idiosyncratic volatility. In theory, any large stock holder (block owner) might destabilise the market and contribute to volatility with its trades that are plausibly large. We construct on the one hand a variable for large institutional owners (in effect, the sum of equity held by institutional investors owning 5% or more of the firm’s equity) and on the other a variable that does not necessitate that all of the institutional investors are block owners (in effect, the sum of equity held by institutional investors owning 1% or more of the firm’s equity). Finally, we construct a variable for all block owners (the sum of equity held all investors owning 5% or more of the firm’s equity). Such variable construction is similar to, e.g., McConnell and Servaes (1990) in the previous literature. The set-up is made more apparent in Figure 1 below.
Figure 1. Ownership Structure Schematically Outlined

(the scale is indicative)

<table>
<thead>
<tr>
<th>Institutional investors</th>
<th>Small investors</th>
<th>Block owners</th>
</tr>
</thead>
</table>

1% 5%
Fraction of equity owned by an investor $i$

The variables are: (i) the mass of equity owned by institutional investors that are block owners; (ii) the mass of equity owned by small and large institutional investors; and (iii) the mass of equity owned by all block owners. The inference from these three variables should enable us to examine the hypothesis of whether there is a positive association between institutional investors (block owners) and idiosyncratic volatility (idiosyncratic volatility).

New information, information revealed in trading, and herding may cause trading volume and volatility [see, e.g., Karpoff (1987) for a review attempt on this subject]. In general, it seems to be an empirical fact that there is a positive relation between volatility and trading volume [on aggregate level see, e.g., Schwert (1989) and for individual stocks see, e.g., Epps and Epps (1976)]. We inspect whether there is a positive association between trading volume and idiosyncratic volatility.

Executives now in an increasing amount receive stock options as a part of their compensation. It is well known that option value increases with volatility. Then one could argue that executives with this type of pay are more prone to make riskier investments (see, e.g., Cohen, Hall and Viceira, 2000). We test the hypothesis that executive stock options programmes are positively associated with idiosyncratic volatility.
Campbell et al. (2001) argue that firms are entering the stock market in a phase in which the long-term prospects of the firm are still surrounded by great uncertainty. In their recent research Fama and French (2004) reason along similar lines, namely that during the last two decades US firms have started to list their stocks when they are still relatively small, unprofitable, and exhibiting high growth. Specifically related to the research question in *Essay 3*, Pástor and Veronesi (2003) develop a theoretical model that, among other things, implies higher idiosyncratic volatility for young firms; the rationale is that younger firms usually have an uncertain foreseeable profitability. In their sample consisting of US firms, Pástor and Veronesi (2003) find empirically that idiosyncratic volatility estimates from a one-factor model indeed are on average higher for young firms (cf. Wei and Zhang, 2004).\(^{21}\) We also test the hypothesis that idiosyncratic volatility is negatively associated with firm age.

Campbell et al. (2001) furthermore suggest that leverage would be positively associated with idiosyncratic volatility, which is empirically tested in *Essay 3*.\(^{22}\)

### 4.2 How is idiosyncratic volatility measured in this paper?

We construct idiosyncratic volatility estimates using two alternative asset pricing models. Systematic risk is modelled with on the one hand the Sharpe–Lintner–Black CAPM and on the other the Fama and French (1993, 1996) three factor model. Idiosyncratic volatility is the variance of the residual from these models. We fit these models to both domestic (CAPM) and international (Fama and French three-factor model) benchmark data. The international benchmarks appear furthermore in two variants so as to check the sensitiveness of the results with respect to different perceptions of market integration. Thus, all the variations taken together, we make sure that our results are not driven by one particular—and perhaps incomplete—model for asset prices, or by bad proxies for the risk factors. As stressed earlier, in this paper we do not use the Campbell et al. (2001) approach of indirectly measuring the idiosyncratic volatility through aggregation, because later in the cross-sectional analysis we need idiosyncratic volatilities for the individual firms, which are related to firm-specific explanatory variables.
4.3 How do we test and what do we find?

For firm-year observations reaching from 1994 to 2001 we run pooled cross-sectional regressions in which the logarithm of idiosyncratic volatility is explained with firm size, firm age, industrial focus, global diversification, block ownership, government ownership, trading volume, leverage, and an executive option dummy. In addition to the OLS regressions we estimate Fixed Effects regressions with year and industry effects. We perform sensitivity checks by using the rank of the idiosyncratic volatility instead of a logarithmic transformation to make the raw data more homogeneous, and show that the results are robust with respect to this variation. In order to check the sensitivity of the results with respect to a possible identification problem in the multivariate regression and in order to minimise the possibility of a small sample fallacy, we run bivariate regressions for an extended data set.23

We find, according to our hypotheses, that idiosyncratic volatility is positively associated with industrial focus, block ownership (and large institutional investors, albeit this relation is statistically insignificant), and trading volume. Similarly, idiosyncratic volatility is negatively associated with firm age, and government ownership. The results on global diversification, leverage and executive stock options are statistically insignificant or inconclusive.

4.4 How does this paper contribute?

This paper is among the first studies to examine a fairly broad set of plausible determinants of idiosyncratic risk in a multivariate setting, and it thus contributes to the international literature. We confirm the positive corporate diversification–idiosyncratic volatility relation documented in Comment and Jarrell (1995), and additionally show that this finding is not restricted to the CAPM. We extend the literature also by examining whether there is a negative relation between global diversification and idiosyncratic risk, but find that the evidence on this is weak. We find evidence of a positive volume–idiosyncratic volatility relation, parallel to a positive aggregated

The results on the ownership–idiosyncratic volatility relations are interesting. We find, parallel to Xu and Malkiel (2003), a positive relation between large institutional owners and idiosyncratic volatility. The empirical evidence on a positive block ownership–idiosyncratic volatility relation is however stronger, and in fact it is statistically significant whereas the former relation is not. Finally, there is not a positive association between small&large institutional owners and idiosyncratic volatility. This leads us to conclude that block ownership rather than institutional investors in isolation is behind the positive association to idiosyncratic volatility.

In line with the theoretical and empirical results in Pástor and Veronesi (2003), we find that idiosyncratic volatility decreases with firm age—the extension here once again is that our results hold for idiosyncratic volatility estimates obtained from both the CAPM as well as the Fama and French three factor model.

4.5 Are there any economic implications of the results in this paper?

Figure 2. Bridging Story
It is argued in the previous literature that idiosyncratic volatility is priced (relation A in Figure 2). Goyal and Santa-Clara (2003) find that aggregated idiosyncratic volatility explains US market return, i.e., there is a positive relation between average idiosyncratic volatility and the market return.\textsuperscript{24} Similarly, Malkiel and Xu (2002) find that idiosyncratic volatility is a significant factor in explaining the cross-section of expected returns in the US. Furthermore, it is by now a stylised fact that small firms have a return premium (relation B in Figure 2). The seminal paper for this being Banz (1981), and thence confirmed by many, e.g., Fama and French (1992). What we find in Essay 3 is, among other things, that industrial focus, and block ownership (firm age) is positively (negatively) associated with idiosyncratic volatility [relation 1 in Figure 2]. Interestingly, we also show that size just happens to be a very good proxy for these variables: industrial focus, and block ownership (firm age) is negatively (positively) correlated with size [relation 2 in Figure 2].\textsuperscript{25} Now, assuming that idiosyncratic volatility should be priced, it is of course convenient to note that the size premium goes together with many of the factors that are associated with idiosyncratic volatility: small firms that due to their nature have high idiosyncratic risk, have also higher returns, on average.
REFERENCES


Basle Committee on Banking Supervision, 1996, *Amendment to the capital accord to incorporate market risks*, Basle.


Dennis, Patrick and Deon Strickland, 2002, Who blinks in volatile markets, individuals

Denis, David, Diane Denis and Keven Yost, 2002, Global diversification, industrial

Dimson, Elroy and Paul Marsh, 1990, Volatility forecasting without data-snooping,
*Journal of Banking and Finance, 14*, 399–421.

Engle, Robert, 1982, Autoregressive conditional heteroscedasticity with estimates of the

Epps, Thomas and Mary Epps, 1976, The stochastic dependence of security price
changes and transaction volumes: implications for the mixture-of-distributions

Fama, Eugene and Kenneth French, 1993, Common risk factors in the returns on stocks

Fama, Eugene and Kenneth French, 1996, Multifactor explanations of asset pricing

Fama, Eugene and Kenneth French, 2004, New lists: fundamentals and survival rates,

Gompers, Paul and Andrew Metrick, 2001, Institutional investors and equity prices,

Goyal, Amit and Pedro Santa-Clara, 2003, Idiosyncratic risk matters! *Journal of
Finance, 58*, 975–1008.

Green, Clifton and Stephen Figlewski, 1999, Market risk and model risk for a financial
Hamao, Yasushi, Jianping Mei and Yexiao Xu, 2003, Idiosyncratic risk and the creative

Hamilton, James and Gang Lin, 1996, Stock market volatility and the business cycle,

Hirshleifer, David and Siew Teoh, 2003, Herd behaviour and cascading in capital

Ineichen, Alexander, 2000, Twentieth Century Volatility: A review of stock market

Jones, Charles and Jack Wilson, 1989, Is stock price volatility increasing? Financial

Karpoff, Jonathan, 1987, The relation between price changes and trading volume: a

Kearney, Colm and Valerio Potì, 2003, Idiosyncratic risk, market risk and correlation
dynamics in European equity markets. Working paper, Trinity College Dublin.

Lakonishok, Josef, Andrei Shleifer and Robert Vishny, 1992, The impact of institutional

Liljeblom, Eva and Marianne Stenius, 1993, Macroeconomic volatility and stock market
volatility; empirical evidence on Finnish data. Working paper, Swedish School
of Economics and Business Administration.

Liljeblom, Eva and Marianne Stenius, 1997, Macroeconomic volatility and stock market

Malkiel, Burton and Yexiao Xu, 2002, Idiosyncratic risk and security returns. Working
paper, University of Texas at Dallas.


NOTES

1 Another statistic often used to measure dispersion of stock return is the standard deviation (see, e.g., Schwert, 1990). Financial applications, such as the Black and Scholes (1976) option pricing model for instance, often use standard deviation. In practice, the transformation from variance to standard deviation (standard error) is quite straightforward. In scholarly work that examine the properties of volatility in general, researchers very often operate with variance [see, e.g. Akgiray (1989), Andersen and Bollerslev (1998), Bollerslev (1986), Campbell et al. (2001), just to name a few of the papers cited later], while there are also those who report variances converted to standard errors, (e.g. Schwert, 1989). Our choice of using variance as the operative definition for volatility is consistent with the previous literature on the three topics of the essays.


4 The discussion in this paragraph draws on the earlier work of Campbell et al. (2001).

5 The order in which the essays appear in this collection follows certain logic. Essay 1 is placed first because it deals with the volatility of market index returns and is
thus more general than the two latter essays. Essays 2 and 3 concentrate on idiosyncratic stock return volatility and they follow an inherent order amongst themselves. Essay 2 describes aggregated idiosyncratic volatility for the Finnish market as a whole and in particular examines its long-run time-series properties; whereas Essay 3 examines firm-specific, cross-sectional determinants of idiosyncratic volatility and in a sense builds on the results in Essay 2.


7 Mandelbrot (1963) is often credited to be among the first to discuss this phenomenon.

8 FOX index is a Finnish capitalisation weighted, albeit weight restricted, stock price index. FOX data is utilised and described more in detail later in Maukonen (2002), which is the first paper in this essay-collection.

9 Similar findings on Finnish data have been documented before, see, for instance Puttonen (1993) and Berglund and Liljeblom (1988).

10 The ARCH and GARCH literature is by now vast, for literature surveys see Palm (1996), Bera and Higgins (1993), and Bollerslev, Engle and Kroner (1992).

11 Out-of-sample in this context refers of course to a one-step-ahead prediction. In effect, we explore one-week-and one-month-ahead predictions.

12 In an attempt to review the literature on volatility forecasting, Poon and Granger (2003) have recently listed over 90 papers on this topic. Some two-thirds of the papers in Poon and Granger (2003) include at least two different models. The papers quoted in their review include, in addition to forecasting the volatility of stock index returns with various models, also the respective of e.g. exchange rates,
individual stocks, and volatilities derived from option data using the Black–Scholes and other models. In our paper we did not consider implied standard deviations from option contracts due to market thinness.

13 Interestingly, most studies in the prior literature that examine the comparative predictive ability of several common models of volatility rely on only error statistics [Akgiray (1989), Dimson and Marsh (1990), Tse (1991), Brailsford and Faff (1996), and Walsh and Tsou (1998)].

14 The rationale is that there is a confusion between on the one hand a large decrease in absolute terms (i.e., a large drop in terms of points for a stock price index) and on the other the relative change (i.e., percentage change) that is implied by the respective decrease.

15 See also Officer (1973), Schwert (1989), Hamilton and Lin (1996) for a negative stock market volatility–macroeconomic growth relation.

16 For a small economy such as Finland, it would be an interesting extension to the scope of Essay 2 to dichotomise the volatility further into a world market component and a local factor. Unfortunately, the indirect methodology in Campbell et al. (2001), which has its clear advantages, does not allow such decomposition. The link between Finnish stock market volatility and world factors has been studied already by others (see, e.g., Antell, 2000).

17 An interesting extension to Essay 2 would be to examine the relationship between the volatility components and the volatility of macroeconomic growth. The availability of GDP data does, however, pose a serious restriction on efforts along these lines.

18 The R-squared for the market model regression is the regression sum of squares (SSR) divided by the total sum of squares (SST); or equivalently, since
$SST = SSR + SSE, \quad R^2 = 1 - \frac{SSE}{SST}$, where SSE is the error sum of squares, i.e., the idiosyncratic volatility component.

Recently, Kearney and Potì (2003) in fact conclude that correlations among 42 large European stocks in the $Eurostoxx50^{TM}$ index have declined less compared to the US evidence in Campbell et al. (2001).

It is also worthwhile to study the sources of an increasing idiosyncratic volatility. While Essay 3 sets out to examine the cross-sectional determinants of idiosyncratic volatility, there is an interesting forthcoming paper by Wei and Zhang (2004) that examines the sources of increasing idiosyncratic volatility in a time-series setting. Wei and Zhang (2004) conclude that a decreasing (increasing) firm profitability (volatility of firm profitability) explains the increase in the volatility for a typical US stock in 1976–2000.

Parallel to the argument made in Pástor and Veronesi (2003) regarding a positive relation between volatility of firm profitability and idiosyncratic risk, Wei and Zhang, (2004) argue that return-on-equity (ROE, their proxy for profitability, which is defined as earnings divided by book value of equity) and the variance of ROE explains the increase in the volatility for a typical US stock in 1976–2000, while ROE and the volatility of ROE have during that time decreased and increased, respectively. Although it seems that the main research question in Wei and Zhang, (2004) is to explain the increasing trend in idiosyncratic volatility documented seminally in Campbell et al. (2001), they examine also cross-sectional regressions in which return volatility is regressed on proxies for profitability, firm age, size, and leverage. The results from the cross-sectional part in Wei and Zhang (2004) suggest that ROE and the variance of ROE—more than firm age that is advocated by Pástor and Veronesi (2003) as the “[….] favorite proxy for uncertainty about profitability.” (op.cit. p.1776)—are determinants of return volatility.
While the aim of this paper is to find exogenous determinants of idiosyncratic volatility, we do not include lagged variables of the idiosyncratic volatility itself in the cross-sectional regressions.

We considered also the possibility to estimate the cross-sectional regressions on a year-by-year basis, but deemed this not to be a feasible option due to already limited data.


Note that this is based on bivariate correlations between the explanatory variables (Table 5, in Essay 3).