International transmission of stock market movements
- *a Scandinavian focus* -

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Abstract

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Purpose: Previous research has found an increased transmission of stock movements in Europe, partly caused by the establishment of institutions as the EU and the EMU. The purpose of this paper is to find the possible impact from the EU and the EMU concerning the evolution of international transmission of stock market movements, on four Scandinavian markets, Denmark, Finland, Norway and Sweden.

Method: The research is based on primary data, existing theories and earlier studies regarding international transmission of stock market movements. The examined method is a VAR (Vector autoregressive model) including a 10x1 vector of variables. Furthermore the tests considered are correlation, granger-causality, variance decomposition and impulse response. The investigation period is 1/1-1990 to 31/12-1994 and 1/1-2000 to 31/12-2004, hence before and after the Swedish and Finnish membership of the EU, and the Finnish membership of the EMU.

Conclusions: It is difficult to interpret any larger changes in the interdependence between the Scandinavian stock markets. We only find evidence for an increased correlation and a more efficient response to foreign shocks, which may indicate a higher degree of interdependence among the stock markets during the two periods studied. The Scandinavian stock markets' interdependency with the larger European stock markets has increased significantly and particularly for Finland, which today is a highly integrated European stock market. This result is inconsistent with previous studies.

1 Introduction

1.1 Background

The equity markets of developed economies have become increasingly international and the flow of portfolio investments to other countries has increased rapidly. Key changes include the competition resulting from the globalisation of financial markets and market operations, the advanced technology for world-wide information transmission, processing and diversification among participants, such as banks and investment service providers. (www.euronext.com)

This development in the wake of the global crash of equity markets in mid-1987, contagion from the Mexican tequila crisis in 1995 and the Asian crisis in 1997-1998, have created substantial interest among researchers regarding stock market interdependencies.

Research has been made in order to examine why different equity markets exhibit similar behaviours. Although the degree of interdependencies between different equity markets varies, regional proximity, social and economic similarities and financial integration, rather than irrational contagion have all been pointed out as important factors in order to explain spill over effects between stock exchanges, (Jin, 2003), (Yang, 2003), (Fratzscher, 2002), (Soydemir, 2000), (Booth et al, 1997), (Karolyi, 1995), and (Lin et al, 1994).

It is easy to understand this interest in international capital market integration where the liberalization of capital movements and the securitization of stock markets result in national stock markets that more and more react on new information from international sources. Several emerging and developed regions all over the world have been studied although the vast majority of studies have focused on the most important stock markets including the US in particular.

The European Union and especially EMU serve as an interesting and dramatic development within international finance, as they represent the highest level of regional economic

integration that has ever been reached (Yang et al, 2003). As far as we know there has been limited research regarding the interdependence between equity markets and the impact from the EU and the EMU. The results from empirical research vary depending on the equity markets studied but empirical studies have shown that real integration in Europe has been a pre-condition for a successful monetary union, Frankel and Rose (1997) and that macro-economic factors including elements originated from the EU and EMU can cause an increase in integration among stock markets (Yang et al (2003), (Fratzscher, 2002), (Dickinson, 2000), (Kanas, 1998) and (Leachman and Francis, 1995).

In Europe, Scandinavia is a region that consists of a group of small stock markets. Even though the countries have strong social, economical, historical ties, earlier research (based on empirical findings from Scandinavian stock indices before the adhesion of Sweden and Finland to the European Union) have found that the Scandinavian stock markets are not that integrated and thereby mostly dependent on their own past values, (Pynnönen et al, 1998), (Booth et al, 1997), (Martikainen et al, 1993), (Mathur et al, 1990).

Preceding earlier research of the possible impact from the EU and the EMU concerning the transmission of stock market movements, this study will focus on their implication on four Scandinavian countries, Denmark, Finland, Norway and Sweden, a region with many similarities where today all countries except Norway are members of the EU and where Finland is a member of the EMU. We will therefore, given existing theory and earlier studies on stock market integration, where social, economic and financial integration are pointed out as factors that drive stock market movements address two related questions:

1. In what way has the interdependencies between the four Scandinavian stock markets changed after the Swedish and the Finnish entry in the European Union in 1995, followed by the Finnish entry in the Economic Monetary Union in 1999.

2. In what way has the interdependence between EU stock markets and the four Scandinavian stock markets changed after the Swedish and the Finnish entry in the European Union in 1995, followed by the Finnish entry in the Economic Monetary Union in 1999?

1.2 Target group

This thesis is directed towards business students, mainly with a finance degree, tutors and professors.

1.3 Disposition

Chapter 1 – Introduction

Following earlier research of the possible impact from the EU and the EMU concerning the transmission of stock market movements, this study will focus on their implication on four Scandinavian countries, Denmark, Finland, Norway and Sweden, a region with many similarities where today all countries except Norway are members of the EU and where Finland is a member of the EMU.

Chapter 2 – Methodology

In this section we will describe the econometrical tests, within the framework of the vector autoregressive model (VAR), which determine transmission of stock market movements.

Chapter 3 – Theory

In order to emphasize the role of the EU and the EMU in explaining possible increased interdependency among national stock markets, this chapter will disclose a review of earlier research and what they have mentioned as possible important factors in explaining the integration among national stock markets.

Chapter 4 – Empirical findings and Analysis

In this chapter we will display our empirical findings in regards to the econometric tests we have performed. The content and result of each test is discussed separately. Subsequently the results will be discussed within the context of previous research.

Chapter 5 – Conclusion

In this chapter we will try to expound the empirical results of our study and discuss the factors behind them. We will further suggest future research that is related to our study.

2 Methodology

In this section we will describe the econometrical tests, within the framework of the vector autoregressive model (VAR), which determine transmission of stock market movements. The model has been used in several previous studies, Eun and Shim (1989), Soydemir (2000), Pynnönen (1998), Mathur et al (1990) and Dickinson (2000) hence it is a general accepted model.

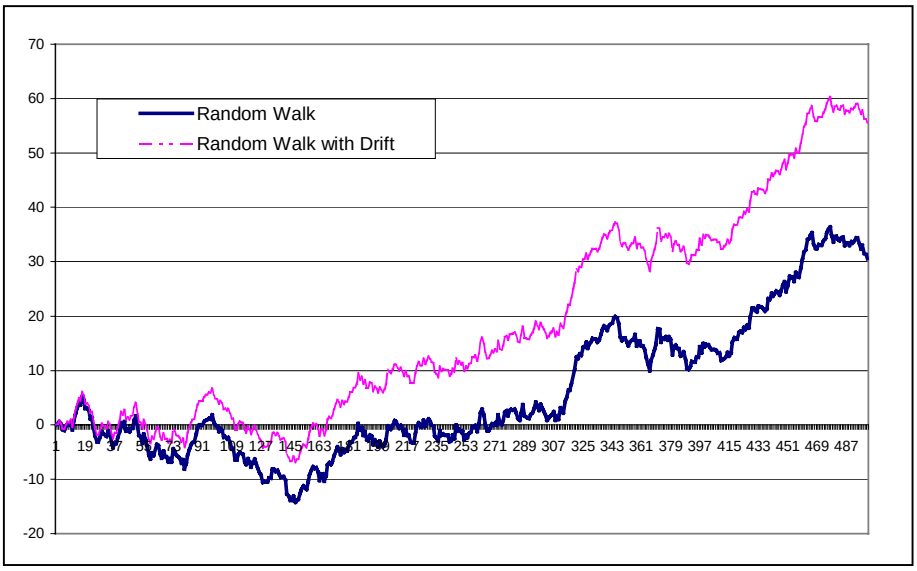
The VAR model was popularised in econometrics by Sims (1980) as a natural generalisation of univariate autoregressive models. A VAR is a system regression model and considered a hybrid between the univariate time series model and the simultaneous equations model, further more it is seen as a good alternative to large-scale simultaneous equations structural models. An important feature of the VAR is its flexibility and the ease of generalisation. Below we will discuss the advantages of using a VAR model compared to simultaneous models. There are some other models that have been used to describe the transmission of stock market movements. An earlier report by Hamao, (1990) includes the pure Autoregressive Conditionally Heteroskedastic model (ARCH), since it is a popular non-linear financial model to forecast volatility. Recent empirical studies have mostly used the Generalised Autoregressive Conditionally Heteroskedastic (GARCH) model to estimate ARCH error terms, i.e. Ln et al, (2001), Ng, (2000), Kim and Roger, (1995), Lin et al, (1994), Karolyi, (1995) and Fratzscher, (2002), since it is more prudent than the ARCH model and avoids overfitting. Others economists have applied the Exponential Generalised Autoregressive Conditionally Heteroskedastic (EGARCH) models, Booth et al, (1997) and Kanas, (1998). Finally one of the most recent studies includes the wavelet analysis, Hahn et al (2004). The previous studies using the VAR methodology, can be separated into two groups; one looking at the short-term relationship using the VAR including Variance Decomposition and Impulse response and the other looking at the long-run relationship using VECM and cointegrating testing, Mash (1998) and Dickinson (2000).

Independently from the models used as tools to investigate the relationship between stock markets, it is a useful prerequisite to obtain stationary data to prevent spurious regressions and to make it possible to perform hypothesis tests. The stationarity is estimated by the AR unit

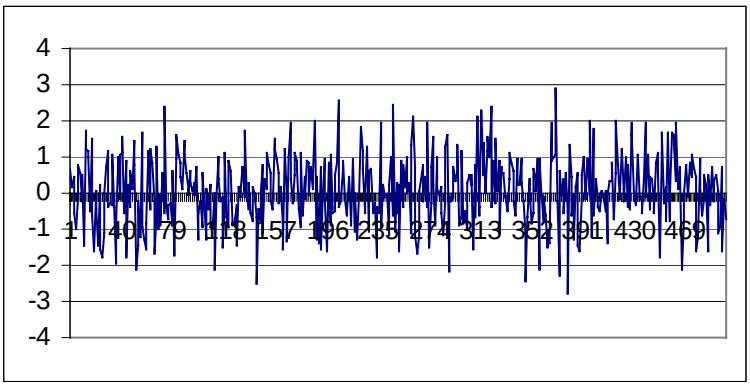
root test estimated by the augmented Dickey -Fuller test (ADF), which report the inverse roots of the characteristic AR polynominal. The estimated VAR is stable if all roots lie within the unit root circle. If we find a non-stationary VAR, results such as impulse response standard errors are not valid. Another test to check for stationarity is the Phillips-Perron (PP) test, which give the same conclusions as augmented Dickey-Fuller. The limitation with both these tests is that its significance of reporting stationarity is low when the root is getting near the non-stationary boundary. If this result occurs, a Kwaitkowski test can be performed where the null hypothesis of stationarity and alternative hypothesis are displayed. (Brooks 2004)

The order of integration and cointegration are very important determinants of the characteristics that sets of time series exhibit. Traditionally, the most common order of integration analysed in economic time series is either zero or one. A series with integration order zero have a finite time-independent variance. Such a series is stationary in the sense that a shock only has temporary effect on future realisations of the series, and the series is expected to cross its mean within a finite period of time. The autocorrelation function of the series is decreasing. A series with integration order one, on the other hand, is non-stationary in the sense that the variance approach infinity with time. A shock or innovation has a permanent impact on future realisations of the series hence; the expected time between crossings of the mean is infinite. Furthermore the autocorrelation function is a stable non-decreasing function of time for all levels of lags. (Pynnönen 1998)

Graph 1 Non-stationary data (www.cambridge.org)



Graph 2 Stationary data (www.cambridge.org)



In order to induce stationarity in non-stationary data a usual response is to take the first differences of each of the first integrated variables and then use these first differences in the accurate model. An example of when inducing the first difference in stochastic non-stationary data is necessary (which is very common phenomenon in stock exchange indices) is the random walk with drift, which is showed below:

$Y_t = \mu + y_{t-1} + u_t$

Letting $\Delta y_t = y_t - y_{t-1}$ giving $Ly_t = y_{t-1}$ so that $(1 - L)y_t = y_t - Ly_t = y_t - y_{t-1}$ if the original formula is taken and y_{t-1} is subtracted from both sides:

$Y_t - y_{t-1} = \mu + u_t$

$(1-L)y_t = \mu + u_t$

$\Delta y_t = \mu + u_t$

By inducing the first difference, we will find a new variable Δyt, which will be stationary generated. (Brooks 2004)

By transforming the data as explained above, potential problems associated with any non-stationary data in the original stock market indices will be alleviated. Notably is that this construction of preventing non-stationarity is only possible when we are studying a short-run relationship, a long-run relationship between stock markets would require a more arduous methodology such as the VECM and cointegrating-testing.

2.1 Why using a VAR?

There are several advantages of using the VAR compared to univariate time series models or simultaneous equations structural models. One of the most important factors is that the system is free of a priori restrictions on the structure of relationships. That is, the researcher does not need to specify which variables are endogenous or exogenous since they are all considered to be endogenous. This is a very important requirement dealing with simultaneous equations structural models. Sims argued that the Hausman-type test (testing for exogenity) is often not employed in practice when it should be, the specification of certain variables as exogenous, required to form identifying restrictions, is likely in many cases to be invalid. Since no restrictions are imposed on the structural relationships between variables, the VAR system can be viewed as a flexible approximation to the reduced form of the correctly specified but unknown model of the actual economic structure. Another important advantage of the VAR is that it is said to perform better forecasts than traditional models like simultaneous equation models. These conventional models are often considered to be misspecified and deliver spurious forecasting, and so it is appealing to use the VAR for the purpose of stylizing empirical regularities among time-series data. The VAR model is free of pre determined restrictions on the structure of relationships. Many studies employ univariate analyses with the consequence that they implicitly ignore the effect of other third-party countries in their conclusions, Soydemir, (2000). Since the VAR model is multivariate in nature it can more easily deal with such above-mentioned problems. (Brooks 2004)

A pedagogical picture of the VAR model considering a simple bivariate VAR, where there are only two variables, y_{1t} and y_{2t}, each of whose current values depend on different combinations of two previous k values of both values, and error terms is showed below. Each variable depends only upon the immediately previous values of y_{1t} and y_{2t} plus an error term, (Brooks 2004)

$$Y_{1t} = \beta_{10} + \beta_{11} y_{1t-1} + a_{11} y_{2t-1} + u_{1t}$$

$$Y_{2t} = \beta_{20} + \beta_{21} y_{2t-1} + a_{21} y_{1t-1} + u_{2t}$$

Instead of having only two variables, y_1 and y_2, the system could also include g variables that is y_1, y_2 , y_3,…., y_g which will often be the case. Another way of expressing the VAR was originally done by Sims, considering the fact that it can include an infinite number of variables:

The standard VAR model developed by Sims (1980) is expressed as:

$$1) \qquad y_t = \beta_0 + \sum_{x=0}^{m} \beta_i \, y_{t-i} + u_t$$

Where, in our study, y_t is a 10 x 1 vector of variables determined by *m* lags of all 10 variables in the system, u_t is a 10 x 1 vector of forecast errors of the best linear prediction of y_t using all of the past y_{t-i} . β_0 is a 10 x 1 vector of constant term coefficients and β_i is the 10 x 10 matrices of coefficients on the *i*th lag of *y*. By construction, the u_t is uncorrelated with all the past y_{t-i}. To better analyse the system's reaction to random shocks or more accurately, trace out the system's moving average representation, we can successively substitute on the right-hand side of Equation (1) and form a moving average representation of the system expressed as follows:

$$2) \qquad y_t = \sum_{i=0}^{x} \theta_i \, u_{t-i}$$

As Soydemir (2000) points out, the dependent variable y_t is a linear combination of current and past one-step-ahead forecast errors. The *a*, *b*th component of θ_i shows the response of the *a*th market in *i* periods after a unit random shock in the *b*th market. The u_{t-i} is serially uncorrelated by construction, although they may be contemporaneously correlated.

In order to capture the distinct responses, it is important to transfer the error terms. A lower triangular matrix V is chosen in order to obtain the orthogonalized innovations z from u = Vz. The *a,b*th component of θ_i V in equation (3) represents the impulse response of the *a*th market in *i* periods to a shock of one standard error in the *b*th market:

3) $$y_t = \sum_{i=0}^{x} \theta_i \, V z_{t-i}$$

The orthogonalization also provides $\sum^{T}i=0$ $C^2ab\ i$, which is the component of forecast error variance in the T+1 step-ahead forecast of y_a that is accounted for innovation in y_b. This decomposition of the forecast error variance gives a measure of how important one variable is in generating fluctuations in its own and other variables. The advantage of using orthogonalized innovation is that it is possible to allocate the variance of each element in y to sources in elements of z, since z is serially and contemporaneously uncorrelated. (Soydemir 2000)

2.1.1 What are the disadvantages?

Despite the advantages of the VAR it also has its critics. Hahn (2004) writes a report regarding transmission of stock market movements using the wavelet analysis. In this report the author claims that both the VAR methodology using forecast errors from the regression model, and the GARCH methodology using the estimated ARCH error terms, are sensitive to model specification when estimating the transmission of stock market movements. In this chapter this shortage of the VAR will later be discussed in the part dealing with variance decomposition and impulse response. Another typical criticised aspect is that the VAR is said to be a-theoretical. In contrast to simultaneous structural systems where valid exclusion restrictions ensure a theoretical based model, little concern is taken with regards to theoretical information about the relationship between the variables, when constructing the VAR model. A consequence is that the VAR is less responsive to theoretical analysis and policy prescriptions. Another outcome of this may be that the model will be spurious by data mining. In order to alleviate the problem and to further interpret the equations, three sets of statistics

are used: block significant tests, variance decomposition and impulse responses. (Brooks 2004)

Studying the transmission of stock market movements can be seen as a joint study of the spill over of prices and the volatility of prices. Ultimately, it is the perceived importance of the information contained in other markets' price movements that influences investors in the market to which the spill over occurs. Some of the information may be revealed in the volatility of stock prices rather than in the price itself. This aspect can be measured by the GARCH model but not by the VAR model. Despite this drawback of the VAR claimed by authors using the GARCH, the results from studies examined by the VAR are considered reliable and respected in the overall discussion of transmission of stock market movements.

Another critical part of the VAR modelling is to decide the lag length, which partly determines the outcome of the modelling. One approach to select the appropriate lag length would be to use information criteria. Information criteria embody two factors; a term which is a function of the Residual Sum of Square (RSS) and one term considering the penalty for the loss of degrees of freedom from adding an extra parameter. When adding a lag or new variable to an equation it will have two effects on the information criteria, the RSS will fall and the value of the penalty term will increase. The object is to choose the number of parameters minimising the information criteria. The three most popular information criteria are Akaike (AIC), Schwarz's Beysian (SBIC) and the Hannan-Quinn (HQIC). SBIC is strongly consistent but inefficient and AIC is not consistent but generally more efficient. Which means that the SBIC will asymptotically deliver the correct model, while AIC will deliver on average too large a model, even with an infinite amount of data. Formulas for the three most popular information criteria are given below:

$$\text{AIC} = \ln(\hat{\sigma}^2) + 2k/T$$

$$\text{SBIC} = \ln(\hat{\sigma}^2) + k\ln(T)/T$$

$$\text{HQIC} = \ln(\hat{\sigma}^2) + (2k/T)\ln(\ln(T))$$

Where $\hat{\sigma}^2$ is the residual variance (also equivalent to the residual sum of squares divided by the number of degrees of freedom T-k). K=e+i+1 is the total number of parameters estimated and T is the sample size. The information criterion are actually minimised subject to $e < \bar{e}$, $i < \bar{i}$,

that is an upper limit is specified on the number of moving average (i) and/or autoregressive (e) terms that will be considered. (Brooks 2004).

Obviously the lag length supported by all three criterions is preferable, but since AIC is considered the most accurate in previous papers studying the transmission of stock market movements we will prioritise the AIC when deciding the lag length. The univariate criteria could be applied separately to each equation, but it is usually deemed preferably to require the same lag length for each equation. Since different lag length for each equation is seen as a restriction which is one of the main arguments for using the VAR, which it is non-restricted and lets the data speaks for itself. (Brooks 2004)

2.2 Granger Causality

Vector autoregression has proven to be a useful tool for analysis of short-term spill over effects. With the aid of VAR models one can easily test granger-causality as well as other kinds of linear feedback in a manner suggested by Geweke (1982). It is likely that, when a VAR includes many lags of variables, it will be difficult to see which sets of variables have significant effect on each dependent variable and which do not. This will be sorted out by using a granger-causality test. Assuming that all the variables in the VAR are stationary, the joint hypotheses can easily be tested. The granger-causality test is used in order to see if there exits unidirectional causality from y_1 to y_2. If both sets of lags were significant, it would be said that there was "bi-directional causality". If there is causality between y_1 to y_2, but not vice versa, it would be said that variable y_1 is strongly exogenous (in the equation for y_2). If neither set of lags is statistically significant in the equation for the other variable, y_1 and y_2 are independent. We construct a granger-causality test in order to use the information of which of the variables in the model that have statistically significant impact on the future values of each of the other variables in the model. This information will give us the possibility to create a VAR model consisting of only exogenous variables which could be desirable in a theoretical point of view, although it is clearly not in the true spirit of VAR modelling where any sort of restriction should be avoided. (Brooks 2004)

2.3 Variance decomposition

After the granger-causality tests are done, a variance decomposition of the VAR equation will offer a slightly different method in examining its content. The variance decomposition gives the proportion of the movements in the dependent variables that are due to their own shocks, versus shocks to other variables. There has been some criticism concerning the VAR equations that was originally developed by Sims in 1980. Runkle (1987) argues that the statistical significance of both variance decomposition and impulse response functions for unrestricted VARs are questionable. Prior studies have not provided confidence intervals for variance decomposition and impulse response functions, Eun and Shim, (1989) and Jeon and von Furstenberg, (1990). Thus Monte Carlo integration techniques with two standard error bands are implemented for both variance decomposition and impulse response functions.

When the variance decomposition is performed, the ordering of the variables is highly important since impulse responses refer to a unit shock to the errors of one VAR equation alone, ceteris paribus. Given the financial theory this is not realistic since the error terms are likely to be correlated across the equations in some way. The ordering of the variables is not important if they were completely independent from one another. If the variables are correlated then it is important to use financial theory as a way to establish a variable order. The more correlated the variables are, the more important is the ordering. Critics of the VAR have pointed out the difficulties of accurately interpreting both the impulse response and the variance decomposition, Runkle, (1987) and Yang et al (2003), however, are using an alternative technique to avoid the ordering dilemma using generalised variance decomposition which was originally developed by Koop, Pesaran and Potter (1996). This approach is invariant to the ordering of the variables when conducting the VAR, in different from the Cholskey factorisation which is normally used. A generalised VAR analysis has, according to Yang et al (2003), been argued to give a more realistic description of stock market linkages, Dekker, Sen and Young, (2001). Although one shortcoming of the generalised variance decomposition is that unlike the Choleskey factorisation, for any given variables does not necessarily add up to 100%. Since in this study we are working with a ten vector VAR, which will make the possible amount of orderings nearly infinite, it would be more appropriate using the generalised VAR, Jorgensen et al (2002). However the generalised variance decomposition is only applicable in some software like Microfit 4.0. In this study we are

using the Eviews software which does not give us the possibility to work with pre-programmed generalised variance decomposition, hence the result will be variant to the ordering chosen. This will be discussed in the empirical chapter below.

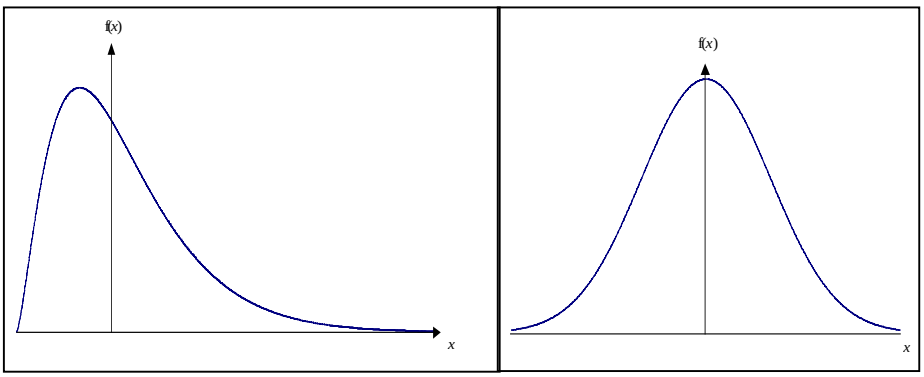
2.4 Impulse Response

After the variance decomposition is performed, the report will focus on impulse responses. Impulse response traces out the responsiveness of the dependent variables in the VAR to shocks to each of the variables. For each variable in each equation separately, a unit shock is applied to the error, and the effects upon the VAR system over time are noted. Given that the system is stable, the shock should gradually die away. As discussed in the variance decomposition part, Yang et al (2003) are in favour of using the generalised impulse response, instead of the cholesky ordering used in most previous studies, to prevent the ordering dilemma. Unlike the generalised variance decomposition, the Eviews software makes it possible to work with the generalised impulse response, which is more applicable in this study considering the large amount of possible orders. Hence we get a result independent of the ordering. This will further be discussed in the empirical chapter below.

2.5 Skewness and Kurtosis

In order to estimate the data using OLS, normality is one of the required assumptions. However for sample size that is sufficiently large, violation of the normality assumption is virtually inconsequential. Appealing to the central limit theorem, the test statistics will asymptotically follow the appropriate distributions even in the absence of error normality. The Jarque-Berra test, which is one of the most common assessments testing for normality, is part of this study as a tool for describing the data, not as a concern of violation of the normality assumption. Two standardised moments of the normality distribution are known as skewness and kurtosis. Skewness measures the extent of which a distribution is not symmetric about its mean value and will give us a notion if there is evidence of more frequent negative or positive shocks. Kurtosis measures how fat the tails of the distribution are, and show if large/small shocks are more common than statistically expected. (Brooks 2004)

Graph 3 Skewed versus normal distribution (www.cambridge.org)



2.6 Description of the data

The data used in this study consist of the daily stock index closing price of four Scandinavian stock markets, five larger stock markets in the EU and the US stock market, obtained through the Ecowin software. This study has not excluded dual listed companies from the indices, which may affect the interdependence between the markets. All the data used is denominated in domestic currency to catch the effect of exchange rate changes and uncertainty. Taking in consideration the banking holidays on each market, the previous day closing price is plotted in the data set. Limited by the availability of historical prices from each index, using the Ecowin database, and an interest in receiving the largest possible samples, we chose two periods, 1/1-90 to 31/12-94 and 1/1-00 to 31/12-04, in total 2614 observations per market. The closing prices have been transformed into rate of return to obtain stationarity. We have considered the daily data of return with absolute value greater than three standard deviations as outliers, which imply that slightly 1% of the observations have been discarded. It would be relevant and appropriate to use a EU index in this study considering our purpose. But since Sweden, Denmark and Finland are included in such an index the consequence would be multicollinearity which would decrease the validity of the study. Another option would be to create an EU index excluding these markets. But this is not possible using the Ecowin data base since it does not include data during the relevant period for the study from all the EU stock markets. Our solution using five major stock markets of the EU as a benchmark can be considered as a limitation but the result will still be relevant to our purpose. The chosen EU

stock markets are the British, German, French, Spanish and the Dutch[1]. The Italian market is one of the larger markets in the EU but since it is not possible, using the Ecowin database, to obtain the data from the MIB30 or total MIB during the two periods 1990-1994 and 2000-2004, Italy has been excluded from the sample. Choosing to use the larger EU area markets as a benchmark, it is not possible to investigate the relationship between the Scandinavian markets and other small markets in the EU area which could be of interest.

Specifically the chosen indices are the following; US (US) S&P 500, UK (UK) FTSE100, Germany (GER) DAX30, France (FRA) CAC 40, Spain (SPA) IBEX35, Netherlands (NET) AEX, Sweden (SWE) OMXS30, Norway (NOR) OSEAX, Denmark (DEN) OMXC20 and Finland (FIN) OMXH25. These stock markets are comprehensive since they include future trading (except the Norwegian). The data of the OBX20 index in Norway would have been a more accurate index to use but there is no available data from this index during the two periods. As a second choice we have chosen to use the OSEAX total index which is a larger index on the Oslo stock exchange. This overall selection of indices is supported by previous studies, which facilitate a comparison. The inclusion of the US is important since it facilitates a deeper understanding of the impact of the EU and the EMU on the Scandinavian stock markets. By examining how the stock market integration between the larger EU markets and the Scandinavian stock markets compared to the US integration with the Scandinavia stock markets has changed after the Swedish and Finnish entry in EU and the Finnish entry in the EMU. It is also important to include the US since previous studies have suggested the US to be the most exogenous and influential stock market in the world, hence we will capture the possible indirect effect of the US stock market.

[1] The size of a stock market may be estimated by its turn over or by the market capitalization of the included companies. Both these ratios are supporting our choice of markets. (http://fese.org/statistics/market_indices/)

3 Theory

In order to emphasize the role of the EU and the EMU in explaining possible increased interdependency among national stock markets, this chapter will at first describe the markets chosen to study and thereafter in general terms discuss the conceptions of financial integration and market efficiency. We will also disclose a review of earlier research and what they have mentioned as possible important factors in explaining the integration among national stock markets.

3.1 The Scandinavian region at a glance

In order for the reader to get a deeper understanding of the four Scandinavian countries and its stock markets we provide a section that highlights their similarities. The resemblances have been the reasons why earlier studies on interdependence between stock markets have been made within the area.

The region consists of a group of small stock markets with strong social, historical and cultural ties. They have related languages and are also similar in terms of a high level of living standard including education, democracy, income and public health (http://hdr.undp.org/). The politics within the countries are similar where common issues are presented and discussed within the EU and before the Nordic Council and the Nordic Council of Ministers which serves as the focal point for the regional governmental co-operation and unification.

The four Scandinavian countries are all very open economies and major trading partners with each other and they have similar high import and export intensities (www.scb.se, www.statistikbanken.dk, www.ssb.no, www.tulli.fi). The US and the EU are all major trading partners although small differences exist. The UK is one of the most important trading partners for Norway explained by their interest in the oil resources of the North Sea and Russia is an important trading partner for Finland due to their historical and economical ties. (Pynnönen et al, 1998),

The industrial structure of the different countries is fairly similar including diversified industries with technologically advanced productions (http://stat.wto.org). Differences exist including Denmark with an important agricultural sector (www.danmark.dk) and Norway with its shipping industry and as one of the world's largest oil exporters where major competitive advantages within branches of different sub-sector of the oil sector have been developed (Asplund et al, 2001).

Through Nordic co-operation and through the EU membership, the four countries have undergone financial deregulations and ironed out differences between national tax systems by certain common rules on indirect taxation, value added tax and excise duties. Finland as a member of the EMU has followed a set of criteria in order to meet the requirements for the EMU. These criteria included economic and financial discipline including the limitation of public borrowing, minimising the inflation, cutting interest rates, reducing budget deficits and stabilising the currency's exchange rate. (www.europa.eu.int)

Sweden and Denmark have chosen not to participate in the EMU, but through the EU the free movement of capital in the single market is valid together with the coordination of the economic policy. Norway has chosen not to participate in the EMU and the EU, by consequence the country is not as harmonised as the three other EU member states, although Norway participates in a large number of EU programmes covering most EU policy areas, including enterprise, environment, education and research programmes through the European Economic Area (EEA).(http://europa.eu.int)

All the four countries are affected by the Investment Services Directive (ISD) from 1996 which was laid out by the EU. The directive integrates the capital markets, by ensuring the cross-border mobility of the financial intermediaries on the market (http://europa.eu.int). The securities markets are still subject to high regulatory activity through both legislation and self-regulation. In order to develop a common competitive internal market for financial services, the EU adopted the Financial Services Action Plan in 1999 (OMX Annual Report, 2004).

The Scandinavian equity markets are similar with almost similar opening hours thus simultaneous trading in their stock markets. The Copenhagen, Helsinki, and Stockholm stock exchange are part of the OMX and in 2006, a joint Nordic stock exchange list will be

established, which will make it possible to increase liquidity by benchmarking Scandinavian companies within the same sector (Johnson, 2005). All the equity markets including the Oslo stock exchange are equipped with automated trading mechanisms with an availability of almost identically constructed market indices. All the four stock exchanges are part of the NOREX Alliance and share the same system for equity trading (SAXESS) with harmonised rules and requirements with respect to trading and membership (www.norex.com). In recent years, the Scandinavian stock markets have been marked by a sharp increase in activity and rapid internationalisation where the foreign investors have a Nordic outlook in their investment approach, and they see the Scandinavian countries as a combined equity market (Johanson, 2005). The internationalisation of investor activity and increase in foreign ownership has improved stock market liquidity. Today foreign investors constitute important owners of listed Scandinavian shares (www.norex.com).

3.2 Review of theories

3.2.1 Financial integration

Financial integration expresses the links between national and global financial markets. Three forms of integration can be distinguished: total, indirect and direct financial integration. The financial integration can also vary in strength from perfect integration to segmentation. Total financial integration, as analyzed comparing different markets' interest rates, means that expected real interest rates are the same on the markets included in the sample. If the total financial integration is not perfect this may be caused by imperfect direct and/or indirect financial integration. The direct financial integration is also expressed as a capital market integration which is expressed as deviations from "the law of one price"[2] for financial securities such as bonds and stocks. If the perfect direct financial integration is upheld, an equity investor can expect the same risk-adjusted return on its investments on different markets. A national stock market is considered segmented if the required rate of return on securities in the market differs from the required rate of return on securities of comparable securities that are traded on other national stock markets. Indirect financial integration or spill

[2] "The law of one price" means that an identical product is sold at the same price on to different markets if there are no restrictions on the transportation costs of moving the product between the two markets.

over from one stock market to another stock market occurs when the return on an investment in one country is indirectly linked to the return on investments in other countries. In other words the influence is put forth indirectly through other markets. If there is a segmentation of goods market and foreign exchange market, the capital markets are indirectly disintegrated. (Oxelheim, 1996)

When the total financial integration is established between two markets, it means that they encompass perfectly goods and foreign exchange markets and highly coordinated economic policies so that the relative political risk premium is zero. If we would have a perfect total integration on a global scale, the world would consist of one financial market, created by perfectly linked financial markets under stringent "purchasing power parity"[3]. (Oxelheim, 1996)

3.2.2 Efficient markets

According to financial theory, a stock market is believed to be efficient if security prices in that market reveal all available relevant information and adjust quickly to any new important information. This implies that the transaction costs are low, that there are many participants in the market and that these participants have enough financial strength to drive security prices. One important point is that an efficient national stock market can correctly price all shares traded on that market on the basis of information available to the investors that participate in that market. On the other hand, if the stock market is segmented as argued by Oxelheim (1996), foreign investors would not participate, by consequence the shares in the segmented stock market would be priced on the basis of domestic rather than international principles. (Eitman et al, 2000)

Segmented stock markets could be a result of information asymmetry caused by national and foreign investors being uninformed by each other's equity securities. Regulation prohibiting national investors from holding foreign securities can result in a disinterest in following developments in foreign securities markets, or to factor such information into their own pricing of national securities. As a result, the national securities would be priced correctly as on an efficient market, but incorrectly relative to one another, considering foreign and

national information. Another cited characteristic that can cause stock market segmentation is taxation where there is a preference of holding bonds rather than stocks thus reducing the liquidity in the stock market. Other reasons are financial, foreign exchange and political risks which could reduce the liquidity in the national stock market due to the absence of foreign investors. (Eitman et al, 2000)

In line with the efficient market theory, in order for a firm to be properly priced it is important that there are many participants in the market. Thus, the size of the stock market is crucial in order to maximise liquidity. Based on figures from 1998, London, NYSE and Nasdaq are considered the most liquid and prestigious stock exchanges. Germany, France and Spain have fairly liquid stock markets. The stock markets of Amsterdam and Stockholm are less liquid where their domestic firms sometimes have trouble raising new equity capital. (Eitman et al, 2000)

3.3 Review of prior empirical findings

Several studies have been made concerning the interdependence among national equity markets. However the papers differ considering the choice of method, the geographical areas and to the extent of economic and industrial development among the stock markets studied. The degree of interdependence varies between stock markets and several economists have been trying to explain why.

The existence of and the factors behind interdependence among stock markets has attracted significant attention, especially at the back of the October 1987 crash, which caused correlated stock price movements all over the world. Monday October 19, 1987 known as the Black Monday is the most famous day and on that day, the Dow Jones Industrial Average fell 22.6%, the largest one-day decline in recorded stock market history. This one-day decline was not confined to the United States, but was mirrored all over the world. By the end of October, stock markets in Australia had fallen 41.8%, Canada 22.5%, Hong Kong 45.8%, and the United Kingdom 26.4%. Several explanations, about the underlying reasons to the US crash,

[3] The purchasing price party implies that the price of a basket of goods would be the same in each market.

have been offered by researchers such as computer program trading, illiquidity, overvaluation and market psychology.

Regarding spill over effects from one stock market to another it has been suggested a range of factors including economic fundamentals such as trade links, macroeconomic factors including interest rates and currencies, deregulations and the improvement and harmonisation of trading platforms which have led markets becoming more interdependent.

Another reason for stock market correlation that has been discussed is market contagion, that stock prices in one market are affected by the changes in another market beyond what can be explained by connections through economic fundamentals. According to Lin (1994) many traders in Tokyo recall that the day after the Black Monday in the US, they sold Japanese stocks on information about the market crash in New York, probably without assessing what fundamental links there were between US price declines and Japanese stocks. Under such a scenario, speculative trading and noise trading may appear on the international arena, where price movements driven by fads and a herd instinct may be transmitted across boarders. This reasoning is further supported in the papers of Black (1986) and De Long et al (1990). The economists Becker, Finnerty and Friedman (1995) present the following hypothesis:

> […] a systematic tendency on the part of foreign traders to overreact to the movements of the U.S. market (henceforth, the overreaction hypothesis). According to this view, international participants ignore fundamental international economic information and simply focus on price movements in other countries, particularly the U.S. Thus, the integration among international equity markets is a manifestation of pricing mistakes that are transmitted from one market to another by systematic overreaction on the part of international traders.

According to Roll (1992), one of the most cited economists within this area of research, there are three separate factors explaining the lack of intercorrelation among equity markets. He finds empirical evidence that:

> (1) The equity index behaviour is partly attributable simply to the technical procedures of index construction. Some market indexes have a small number of stocks (less than 30) while others have large numbers. Some national markets are industrially concentrated while others are very diversified. This diversification element explains a part of the observed intermarket differences in price index behaviour. (2) Nations vary in their industrial composition and have industries that are inherently more or less volatile.

We can think of the index from a country as an analogous to a managed portfolio with particular industry sectors. Even a large portfolio can be influenced by disproportionate investments in certain industries. (3) Exchange rates play a significant role. With returns expressed in a nation's own (local) currency, part of a stock index' return volatility is induced by monetary phenomena such as changes in anticipated and actual local inflation rates.

The following chapter in this report will display different qualities that researchers have pointed out as important factors of spill over effects across national stock markets.

3.3.1 Trade links and geographic proximity

One of the most cited arguments behind spill over effects is that transmission patterns between any two countries are much more predictable for countries that have strong and well-established trade ties. The economist, Marcel Fratzscher (2002) argues that real convergence between two countries can have a significant effect on financial market integration, as described by Oxeleim (1996), since asset returns reflect to some extent the business cycle and the interdependency through trade.

Eun and Shim (1989) wrote a paper based on the theorem of internationally efficient stock markets which in contrast to the behavioural finance state, that stock prices reflect all known information and therefore are accurate in the sense that they reflect the collective beliefs of all investors about future prospects. They used a nine-market VAR system to locate all the main channels of interactions among national stock markets, and trace out the dynamic responses of one market to innovations in another. The markets covered were western European markets together with the US, Canada, Hong Kong, Australia and Japan, during the period 1980-1985. They found empirical evidence that innovations in the US stock markets were strongly and rapidly transmitted around the world. They continue saying that this transmission may reflect the US dominant position on the world economy. The Swiss stock market was the most interactive stock market where innovations in every other stock market are fed into the Swiss market. According to Eun and Shim, the high interactive nature of the Swiss stock exchange is reflected by its high degree of interaction with the world economy in general.

US has been found to be the dominant equity market in several studies (Hamao, 1990) (Roll, 1992) (Lin et al, 1994) (Kim and Rogers, 1995) (Karolyi, 1995) (Aaltonen, 1999) (Ng, 2000) (Soydemir, 2000) (Hahn et al, 2004). Previous studies have found significant spill over effect from the US to other markets that are economically linked with the US, including papers by Hamao (1990), Lin et al (1994) and Karolyi (1995). They found that countries that are economically integrated with the US such as the UK, Japan and Canada react to US stock market innovations. Impulses from Canadian or Japanese stock markets had little or any effect on US markets (Hamao 1990, Karolyi 1995), while on the other hand, Lin et al. (1994) had shown significant interdependencies between Tokyo and New York markets. This empirical finding is in line with the public information hypothesis by Becker et al (1995) stating:

> […] (Referred to henceforth as the public information hypothesis), which is consistent with efficient markets theory, is that the heightened awareness of U.S. equity market performance by international participants is attributable to the dominance of the U.S. in the world marketplace. Because the U.S. is the dominant producer of goods and services in the world economy, the U.S. is also the most important producer of information. In addition, U.S. traders will possess a more provincial view and ignore information from other countries. Thus, common reactions to U.S. news will result in an international correlation structure in which the U.S. leads the world.

In order to extend the knowledge of spill over effects, there are studies discussing how the level of economic development affects the degree of the interdependencies. This was made by including emerging markets and developed markets in the studies. Given differences in trade flows and the stock prices as reflectors of economic fundamentals one would expect developed stock markets to influence other stock markets more heavily than stock markets of emerging countries, (Roll, 1992) (Kim and Rogers, 1995) (Ng, 2000) (Soydemir, 2000) (Ln et al, 2001) (Jin, 2003) and (Hahn et al, 2004).

All studies showed a transmission of movements from the developed markets to the emerging markets studied, but the reverse effect lack significance. The economist, Soydemir found empirical evidence, from the period 1989-1994 using a four-variable VAR model, that Brazil responded stronger to chocks originating from Argentina than from a chock originating from Mexico. Mexico on the other hand responded stronger from chocks from the US market than Brazil did. The explanation given was that Brazil had stronger trading ties with Argentina. Argentina and Brazil had strong trade links and the trade links of these two countries with Mexico were roughly around one tenth of the Argentina - Brazil trade. Also, the volume of

exports and imports of Argentina and Brazil with the USA was much smaller than that of Mexico's. Mexico on the other hand was more linked with the US economy through the NAFTA-agreement. Mexico had the highest trade links with the US among the Latin American countries.

According to Kim and Rogers (1995) there was an increased spill over effect from the developed countries after the liberalisation of the Korean stock market in 1992, where foreigners were allowed to directly own shares in Korean quoted companies. They also drew the conclusion from their results that the Tokyo market influenced the stock return volatility on the Korean market in higher degree than from the influence of the New York market. Explanation can be, according to Kim and Rogers, the geographic proximity and closer economic ties between Korea and Japan. In opposite Ng (2000) found that the US stock market spill over effect on the Pacific-Basin[4] markets is more significant then the Japanese spill over effect, despite their geographical proximity to Japan.

While many researchers have found empirical evidence of interdependencies between stock markets in countries that are economically integrated, Booth, Martikainen and Tse (1996) investigated the spill over relation, using an EGARCH-model during the period 1988-1994, among Scandinavian markets, a region with a history of strong economic cooperation. Surprisingly they found small or no evidence of significant price and volatility spill over which is consistent with other findings in the same region (Mathur et al, 1990) (Pynnönen et al, 1998).

3.3.2 Macroeconomic factors and deregulations

In an early study by Gultekin, Gultekin and Penati (1989) the effects of governmental policies on the interdependencies among national stock markets were studied. By using multi factor asset pricing models on daily stock returns during the period 1977-1984 on the US and the Japanese stock markets they found that the Japanese Foreign Trade Control Law imposed in 1980, which removed most of the restrictions of capital movements, was highly instrumental in making the two stock markets more integrated. Other empirical findings support the view that governmental regulations are the source of market segmentation, (Eitman et al 2000)

(Bekaert and Harvey, 1997) (Hietala, 1989) (Ng, 2000). Bekaert and Harvey (1997) argued that the liberalization policies often increase the correlation of the local and the world equity market. In a report by Angela Ng (2000) she examined the spill over effects from Japan and the US to six Pacific-basin equity markets using ARCH-family models on weekly equity indexes during the period 1975-1996. Particular interest was put on the capital market liberalization efforts, exchange rate changes, number of depository receipts listing, country fund premium and sizes of trade that were implemented and their impact on spill over effects. The empirical result supported the hypothesis that the US and the Japanese stock markets would influence the Pacific-basin stock markets at a higher degree after the regulatory changes.

The geographical proximity, partnerships in trade, cultural similarity and the increased economic integration between China, Taiwan and Hong Kong led the researcher Jin (2003) to study the daily, weekly, monthly and yearly correlation between the stock markets during the period 1997-2001. The three countries are all major trading partners where Hong Kong and Taiwan were, in 1998, the most important sources of direct investments in China. Jin found that the correlation of the returns from the Taiwan and the Hong Kong stock exchanges were comparable with the degree of economic integration between the two countries. The Shanghai stock market, on the other hand, didn't provide any similar correlation between the Taiwanese or the Hong Kong stock markets despite their geographic proximity, increased trade links and cultural similarity.

Jin argued that the reason why the correlations between the returns of the markets indexes are not comparable to the economic integration was the policy control of the Shanghai stock market. In China, according to Jin, 50% of the significant movement of the Shanghai market was caused by changes in trading rules and changes in policies concerning the stock market.

Several studies have been made on the Nordic countries and its stock market interdependencies (Knif et al, 1998) (Mathur et al, 1990) (Booth et al, 1997 and 1999). The Scandinavian countries have been a subject of several studies since they have a history of high economic interdependencies among themselves and therefore they should have stock markets that are fully integrated. A full integration, supported by Oxelheim (1996), implies

[4] Pacific-basin countries include: Hong Kong, Korea, Malaysia, Singapore, Taiwan and Thailand

simultaneous adjustment to new information so that there are no opportunities for abnormal returns linked with lagged information processing. Earlier studies have shown that this is not the case although there is a weak but statistically significant relationship between Scandinavian stock market return.

Mathur et al (1990) used a VAR-model on the Nordic countries and the US on a monthly basis during the period 1974-1985. The conclusion from the empirical results was that the markets were less than fully integrated and that the US market only affected the Danish stock market. The Swedish market seemed to be leading the other markets while shocks from Denmark or Finland didn't spill over to other Scandinavian markets. According to the authors, during that period the Nordic countries had regulations on capital markets with restrictions on foreign ownership of shares listed at the Nordic stock markets where Norway for example didn't permit foreign ownership in certain sensitive industries such as paper and mining.

Using VAR-models on a very long time span on monthly data from 1920 to 1994, Knif and Pynnönen (1998) showed that long term and the short term relationships between the Swedish and the Finnish equity markets increased after the first oil crisis in 1972 and particularly after the Swedish and Finnish deregulation of the capital markets started out in the mid-1980s. The sub-period 1986-1994 were the period with instantaneous causality between the series became considerably larger.

In a paper by Booth and Martikainen (1999) they give a rationale why the interdependency among the Scandinavian markets can be expected to increase in the future. According to the authors and also supported by Oxelhein (1996), factors that may increase the spill over effects are the harmonisations of accounting laws and EU directive on investment services together with elimination of currency risks through the EMU. Other factors are the considerable increase of foreign ownership followed by the foreign ownership restrictions. This is supported by the empirical findings of Kim and Rogers (1995) who studied the South Korean stock market. The economists found increased spill over effects from the major foreign stock markets after the declaration that the South Korean stock exchange would undertake a significant liberalization, by allowing foreigners to directly own shares in South Korean companies.

Studies within the European Union and the Economic Monetary Union (EMU) have been conducted in order to examine possible stock market linkages with regional macroeconomic integration, (Yang et al, 2003), (Fratzscher, 2002), (Dickinson, 2000) and (Kanas, 1998). The European Union and especially EMU serves as an interesting and dramatic development within international finance, as it represents the highest level of regional economic integration that has ever been reached, (Yang et al, 2003). Furthermore, empirical result by Frankel and Rose (1997) showed that an EMU entry provide a substantial drive for trade expansion and correlated business cycles.

During the period 1984 to 1993, Kanas (1998) examined the volatility spill over across three of the largest stock markets in Europe (i.e. London, Frankfurt and Paris) using a univariate EGARCH-model. With regards to the October 1987 stock market crash, the data was divided in two parts, pre-crash until September 1987 and post-crash from November 1987. The conclusion after a comparison of the results showed that spill over from one stock market to another occurred with a higher number and a higher intensity during the post-crash period which is a sign of increased stock market interdependencies. According to Kanas, the reason for increased spill over effects after 1987 was partly explained by the increased deregulation and abolition of controls within these markets which in turn facilitated the free flow of capital. In 1988, the European Community adopted a directive on the liberalization of capital movements within the Community which gradually abolished exchange, interest and credit controls (Bongini, 2003). This conclusion is also supported by Roll (1989) who argues that market deregulation increase stock market interdependence.

Dickinson (2000) ran a VECM on the US, France, Germany and the UK stock markets during the period 1980-1995. The preliminary but indicative results stated that macroeconomic fundamentals such as output, inflation and interest rates were variables that increased long run capital market integration. Short run responses on the other hand was explained as international transmission of noise and in conclusion there didn’t appear to be a major increase in the degree of integration of stock markets in Europe despite the potential for much closer real integration.

Marcel Fratzscher (2002) at the European Central Bank in Frankfurt, Germany conducted an extensive study of the integration of the European stock markets during the period 1986-2000. The focus was on the role of EMU and its implications on the stock markets by conducting a

trivariate GARCH model with time-varying coefficients. The empirical results were based on 16 OECD countries where some were part of the Euro area, some of which had not adopted the Euro yet and some (including the US) of which were not member of the EU. The affects from the EMU in explaining equity market integration were measured by three important pillars, exchange rate stability, real convergence, and monetary policy convergence such as interest rates and inflation rates. The empirical findings show that the stock markets in Europe were highly integrated, although a striking finding was that the stock market integration was much lower during the ERM crisis of 1992-1993. Something that contradicts prior findings of increased financial interdependence during the Latin America and Asian currency crisis (Kim and Haque, 1997). The results lead to the conclusion that an increase of exchange rate uncertainty leads to a decrease of stock market interdependencies.

Other findings were that the EMU have raised the degree of financial integration among European stock markets. The spill over effects were highly asymmetric where on average a negative shock have a 25% larger effect than positive innovations, and large shocks have about 10% bigger impact than small ones, asymmetric spill over effects are something which is consistent with several other studies (Booth, 1997) (Kanas, 1998) (Soydemir, 2000).

When Fratzscher compared the results from the period 1986-1992 with 1993-2000, the US is the dominant stock market during the first period while the Euro area market has become increasingly important for the European stock markets and the dominant force for all the Euro area countries during the period 1993-2000. By dividing the data set into sub groups the researcher could show that the financial integration had increased within the Euro area market since the announcement of its members in 1998. Interesting finding was also the fact that not only the financial integration with Euro area countries and the US has become stronger over time but also, during the 1990s, the importance of own past shocks have become significantly smaller, something that was a sign of increased financial integration and efficient stock markets. If the stock markets returns strongly depend on their own past values it is explained to be due to the presence of a time-varying risk premium or some form of stock market inefficiency (Fama, 1991).

Given the disadvantages of looking at a longer time horizon or even sub periods with regards to the general picture of the overall integration, the researcher, used a 12 month rolling estimation technique. The results showed that countries that initially were considered to be

unlikely candidates, such as Italy, to join the Euro had an increase in financial integration at a later stage, when it was more likely that it was to join the EMU, than countries that were more certain candidates such as Spain and the Netherlands.

Fratzscher also studied which components of the EMU that contributed to the increased degree of shocks that was transmitted across financial markets. It was found that the reductions of exchange rates as well as the monetary convergence of interest rates and inflation rates were the most important factors behind the increased financial integration of all the European stock markets, and in particular the Euro area markets. The reduction of exchange rate uncertainty in particular played an important role as a driving force behind the swift increase in integration since 1996, leading up to the implementation of the Euro in 1999. Since the existence of exchange rate uncertainty leads to hedging costs, more volatile exchange rates will lead the investors to require increased national risk premiums. As a consequence exchange rate uncertainty along with transaction costs and government restrictions on market transactions can function as devices for market segmentation as described by Eitman et al (2000).

While Fretzscher (2002) found increasing stock market interdependency within the Euro area, Yang, Min and Li (2003) found that there were differences between large and small EMU countries concerning the financial integration among stock markets. The researchers used VAR-models during the period 1996-2001 on ten EMU countries, the UK and the US. The period was further divided in two sub-periods, 1996-1998 and 1999-2001, that is before and after the EMU. Attention was paid on how the establishment of the EMU including a common currency together with a single monetary policy has affected stock market integration. Regarding short run interdependencies the researchers found clear evidence that the large EMU markets Germany, France, Italy and the Netherlands, are more integrated with each other after the EMU. Surprisingly the smaller EMU countries, Austria, Belgium and Ireland, became more isolated in the latter period. According to the researcher this could be due to too small a market size and illiquidity of its stock markets. The US market and its relationship with the EMU stock markets didn't show a clear pattern. Germany and France responded more to a US shock in the later period compared to the pre-EMU period, while Italy and the Netherlands responded less to a US shock during the last period. During both periods the US stock market appeared to be the most exogenous market and it didn't react differently to the creation of the EMU. Moreover they found that the UK, after the establishment of EMU,

seemed to be less integrated with the other EMU stock markets, something that indirectly support the hypothesis that macroeconomic factors partly drive stock market integration.

3.3.3 Stock exchanges

Economic integration and macroeconomic factors such as deregulations, lower transactions costs including harmonisations of exchange rates and interest rates have been, through empirical studies, pointed out as driving forces behind interdependency among stock markets. A cited factor among economists has also been the size and structure of the stock markets and its equity indexes in explaining spill over effects, something which is also pointed out by Roll (1992).

Fratzscher (2002) studies the financial integration within the Euro area and its integration with non-Euro area stock markets. While the European markets increased its financial integration with other European markets when the exchange rate uncertainty was diminished, the US influence on the European countries where not sensitive to the US dollar exchange rate volatility. According to this research the important role of the US stock market on the European markets is not explained by exchange rate volatility, other factors such as its large and dominant market size seem to be a more suitable explanation.

McAndrews (2002) cites several reasons why a consolidation among stock markets (i.e. a larger stock exchange) has its advantages. The two most important advantages are operational economies of scale and trading economies of scale. The operational economies of scale can be attained though shared trading platforms which could lower fixed costs and reduce resource & development costs for the stock markets. Investment banks and stock brokers benefit from shared trading platforms which could reduce their costs for maintaining connections with several trading platforms. Trading economies of scale would lead to heightened market liquidity and reduced market fragmentation. The shared trading platform could reduce the cost of cross-border transactions, attracting new international investors which could lead to higher trading volumes. High trading volumes are an important factor for a stock exchange as it leads to increased liquidity as described by Eitman et al (2000) and lower cost of capital for the listed firms. According to McAndrews, liquidity is the ability to buy and sell an asset rapidly

at a price comparable to the price of the prior transaction, assuming no new information has arrived.

Masih et al (1998) wrote a paper concerning the long run and short run linkages of Australian and the four Asian NIC stock markets, Taiwan, South Korea, Singapore and Hong Kong using a VECM technique together with VAR-models. During the period 1982-1994, the results suggested a leading role of the Hong Kong market in driving fluctuations in the Australian and the other NIC stock markets. Taiwan and Singapore appeared to be the most endogenous markets as they were vulnerable to shocks from the more established markets Australia and Hong Kong. The greatest percentage of own variance being explained by its own shocks, without itself being described by any other equity market to any significant degree, was in the case of the Hong Kong market. The Hong Kong stock market appeared to be the most exogenous market in the region. According to the researchers the Hong Kong stock market dominance was partly explained by its relative higher liquidity that is due to higher market capitalization and trading volumes.

Kanas (1998), as mentioned earlier, could report increased and more intense spill over between the London, Paris and Frankfurt stock markets during the post-crash period of 1987. Supported by prior research (Roll, 1989), Kanas explained the increase in spill over from the markets by increased capital market deregulations started in the late 1980s. The other explanation was the introduction of new automated trading systems in Paris, Frankfurt and London in the late 1980s and early 1990s from their so-called ‘old-fashioned’ open outcry trading system. These new trading systems with continuous electronic auctions including automatic order matching, in which traders communicate only via computer screens, without revealing their names were developed separately, although most of the trading systems had the same basic architecture (McAndrews 2002). Kanas (1998) also found empirical evidence that during the post-crash period, London stock market was the most influential among the three markets in terms of volatility spill over, which can be attributed to the fact that London stock exchange was further strengthened during the later period as the leading market in terms of capitalisation and trading volumes which in turn was a result from the introduction of the Stock Exchange Automated Quotations (SEAQ) system as well as the settlement system TAURUS. According to Kanas (1998), SEAQ caused a considerable volume of large scale trades to move from Paris and other European markets to the London stock exchange.

In Yang, Min and Li's study (2003) on the European stock market integration before and after the EMU it was found that the smaller EMU countries, Austria, Belgium and Ireland, became more isolated in the latter period. According to the researcher this could be due to too small a market size and illiquidity of its stock markets, which leads to higher transaction costs and increased risks which in turn become an obstacle for active participation of international investors. This empirical finding was in line with previous studies made on the Scandinavian markets. Mathur et al (1990) studied the interdependencies among the Nordic countries and the US. Using a VAR-model on the Nordic countries and the US on a monthly basis during the period 1974-1985, they found empirical result that the markets were less than fully integrated and that the US market only affected the Danish stock market. The Swedish market seemed to be leading the other markets while shocks from Denmark or Finland didn't spill over to other Scandinavian markets. Restrictions on foreign ownership were cited reasons for the lack of integration. Another cited reason was that the Nordic stock markets are relatively small with few listed stocks which are thinly traded which in turn reduce the liquidity of the shares. Mathur et al (1990) gave support to their argument by referring to Jennergren and Korsvold who argued that stock prices in small markets are less likely to follow a random walk and by consequence they are more likely to be less efficient (Mathur, 1990). Mathur et al continue saying that:

> […] the size and trading structure of these markets implies that information may not be readily available, thus making it more costly for investors to acquire information.

In the research by Booth, Martikainen and Tse (1997) they study the interaction of the Scandinavian stock market from the period 1988 to 1994 by using an extended multivariate EGARCH model. At the back of a discussion of creating a joint Scandinavian stock market and the fact that their economies are integrated, the results from the empirical study showed that spill over exist but they are few in numbers. The stock markets returns strongly depended on their own past values (i.e. linear dependencies) which were explained by the presence of a time-varying risk premia or some form of stock market inefficiency (Fama, 1991). Another explanation given was the result of infrequent trading of the listed stocks.

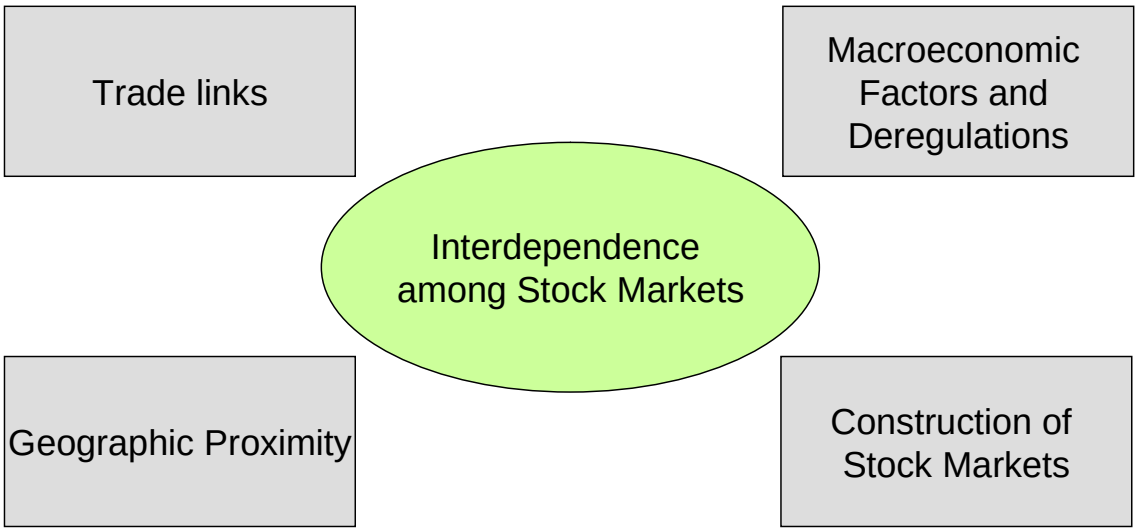
Martikainen et al (1993) have studied the Finnish stock market integration with the Swedish and the US stock market. The empirical findings were similar to the findings of Mathur et al (1990) stating that the Finnish stock market was not integrated with other stock markets. A

cited explanation was the thin trading in the Finnish stocks which made the transaction of foreign investors more difficult. Finnish shares were at the time divided into restricted and non-restricted shares, combined with the relatively poor knowledge of Finnish firms together with a complicated accounting system leads to complex and difficult investment analysis. This was further supported by the reasoning of McAndrews (2002) who state that obstacles for foreign investors to trade in a stock exchange are due to regulatory differences and accounting diversity, since the investors must familiarise themselves with the regulatory and accounting regime in each market. Other obstacles are the home-country bias with increased information costs from cultural and linguistic differences together with the geographic distance between home and foreign markets. According to Lewis (1999), the home country bias is the preference for holding shares in its own country despite the advantages of international portfolio diversification and increased liquidity of their investments.

3.4 Our hypothesis

Prior studies have showed that not only economic integration between two countries is a prerequisite in order to achieve interdependence between the stock markets. Several other factors, many which can be originated from the EU and the EMU, as showed by Fratzscher (2002) and Frankle and Rose (1997), have been pointed out, including macroeconomic factors and the construction of stock exchanges.

Below figure 1 show the factors that have been mentioned to influence interdependency between stock markets:



Our hypothesis supported by earlier research is that our empirical findings will show an (1) increased integration between the Scandinavian stock markets. We also believe that Norway is the least integrated stock market within Scandinavia in the latter period 2000-2004 due to it's non-membership of the European Union and the EMU.

Furthermore we believe, supported by earlier findings, that (2) the interdependence between Finland and Sweden has increased the most and that they together with Denmark are the most integrated stock markets with continental EU markets.

4 Empirical findings and analysis

In this chapter we will display our empirical findings arranged in regards to the econometric tests we have performed. The content and result of each test is discussed separately. Subsequently the results will be discussed within the context of previous research.

4.1.1 Summary statistics

Tables 1 and 2 report the summary statistics for the daily return during the two sample periods. During the period 1990-1994 all the markets have a low rate of return. We also find that the DEN, FRA, GER and NET markets are negatively skewed while the US, FIN, NOR, SPA, UK and SWE markets are positively skewed, Negative skewness indicates that negative shocks are more frequent than positive once. All the markets in the sample display a leptokurtic distribution (>3) which means fatter tails and more peaked at the mean than a normal distribution**,** indicating that large shocks are more common than statistically expected. None of the markets fulfil the Jarque-Bera criteria for normal distribution.

Table 1 Summary statistics 1990-1994

	DENMARK	FINLAND	FRANCE	GERMANY	NETHERLANDS	NORWAY	SPAIN	SWEDEN	UK	US
Mean	-0.0001	0.0000	-0.0001	0.0002	0.0004	0.0002	0.0000	0.0002	0.0003	0.0003
Median	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000
Maximum	0.0254	0.0377	0.0329	0.0329	0.0254	0.0314	0.0333	0.0358	0.0230	0.0221
Minimum	-0.0251	-0.0365	-0.0344	-0.0348	-0.0249	-0.0361	-0.0327	-0.0372	-0.0232	-0.0198
Std. Dev.	0.0076	0.0117	0.0100	0.0096	0.0073	0.0099	0.0095	0.0106	0.0075	0.0067
Skewness	-0.1336	0.1300	-0.0801	-0.0382	-0.1447	0.0774	0.0047	0.0649	0.0457	0.0629
Kurtosis	4.0265	3.6311	3.2635	3.7752	3.7222	3.4206	3.5298	3.4707	2.9561	3.5719
Jarque-Bera	56.7285	23.4901	4.7957	30.5878	30.5179	10.1282	14.1560	12.0184	0.5179	17.2877
Probability	0.0000	0.0000	0.0909	0.0000	0.0000	0.0063	0.0008	0.0025	0.7719	0.0002
Sum	-0.1271	0.0146	-0.0686	0.2296	0.4469	0.2697	0.0345	0.2565	0.3185	0.3690
Sum Sq. Dev.	0.0707	0.1647	0.1218	0.1113	0.0651	0.1175	0.1098	0.1360	0.0672	0.0542
Observations	1210	1210	1210	1210	1210	1210	1210	1210	1210	1210

Table 2 reporting summary statistics of the period 2000-2004 and shows a similar pattern as the previous period. FIN, FRA, GER, NOR, SPA, UK and US are now displaying negative

skewness in diversity to the previous period. The rate of return, standard deviation and size of the kurtosis are similar to the period 1990-1994. Also during this period, none of the markets fulfil the bell-shaped characteristics of a normal distributed data, hence not fulfilling the Jarque-Bera criteria for normal distribution.

Table 2 Summary statistics 2000-2004

	DENMARK	FINLAND	FRANCE	GERMANY	NETHERLANDS	NORWAY	SPAIN	SWEDEN	UK	US
Mean	0.0003	-0.0003	-0.0002	-0.0003	-0.0004	0.0005	-0.0002	-0.0004	-0.0001	-0.0003
Median	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0002	0.0000	0.0000	0.0000
Maximum	0.0344	0.0498	0.0435	0.0521	0.0504	0.0311	0.0405	0.0489	0.0375	0.0354
Minimum	-0.0352	-0.0501	-0.0457	-0.0536	-0.0488	-0.0322	-0.0415	-0.0512	-0.0480	-0.0344
Std. Dev.	0.0108	0.0142	0.0136	0.0158	0.0142	0.0097	0.0129	0.0154	0.0108	0.0109
Skewness	0.0622	-0.0588	-0.0081	-0.0620	0.0693	-0.2190	-0.0815	0.0303	-0.0817	-0.0373
Kurtosis	3.6843	4.0309	3.6754	3.6678	4.4817	3.4989	3.5482	3.4667	4.2167	3.3552
Jarque-Bera	24.8136	55.2238	23.4086	23.6646	113.5869	22.6104	16.7811	11.3599	77.2932	6.7579
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0034	0.0000	0.0341
Sum	0.3678	-0.3808	-0.2896	-0.4141	-0.5421	0.6643	-0.2061	-0.5465	-0.1568	-0.4026
Sum Sq. Dev.	0.1425	0.2475	0.2277	0.3053	0.2496	0.1166	0.2055	0.2900	0.1446	0.1448
Observations	1231	1231	1231	1231	1231	1231	1231	1231	1231	1231

4.1.2 Deciding the lag length and Dickey-Fuller test

After inducing the first difference, the data display a high degree of stationarity according to the augmented Dickey-Fuller test. Considering the high significance there is no need questioning the stationarity which would have been the case if the results were close to insignificance (that is close to the 5% p-value line). As a consequence we do not further test the data with Phillip-Perron or Kwaitkowski tests.

The lag length of the VAR used is one lag in the first period 1990-1994 and two lags of the second period 2000-2004. The information criteria where unanimous for the first period while in the second period HQ and SBIC suggest one lag while AIC suggests two lags. Since overall no criterion is definitely superior to the others but AIC is the most common criteria used by previous studies, the lag length is determined to two. Over all the small amount of lags in both periods is a sign of efficiency and fast response from the stock markets included in the sample. The tables showing the information criteria are displayed in the appendix.

4.2 Presentation of results

4.2.1 Cross correlation

The cross correlation between the examined ten national stock markets' daily returns are reported in table 3. The test is made to point out how related the markets are, in other words the degree of linear relation between the stock markets. Since we are using daily data the contemporaneous correlation of the returns reflect the degree to which the other markets in the sample share new information producing an abnormal return in one market within one calendar day. Overlooking the correlation matrix 1990-1994, we find a rather low correlation between the Scandinavian markets compared to those between the larger European markets, ranging from the highest SVE-NOR 0,39 to the lowest DEN-FIN 0,19. Sweden (average = Ø = 0,30) is in average the most correlated market to the other Scandinavian markets followed by Norway (Ø 0,29), Denmark (Ø 0,25) and Finland (Ø 0,22).

The Scandinavian markets' correlation to the larger European markets is more dispersed ranging from the highest SWE-NED (0,44) to the lowest UK-FIN (0,12). On average Sweden (Ø 0,49) is the most correlated market with the continental European markets and the UK followed by NOR (Ø 0,41), DEN (Ø 0,31) and Finland (Ø 0,19). Regarding the Scandinavian markets correlation with the US during the period 1990-1994 we find smaller degrees with an average of 0,06 with SWE (0,09) as the highest and Denmark (0,03) as the lowest.

Table 3 Correlation matrix 1990-1994

	DENMARK	FINLAND	FRANCE	GERMANY	NETHERLANDS	NORWAY	SPAIN	SWEDEN	UK	US
DENMARK	1.00	0.19	0.22	0.31	0.27	0.28	0.22	0.26	0.22	0.03
FINLAND	0.19	1.00	0.14	0.18	0.16	0.22	0.16	0.25	0.12	0.05
FRANCE	0.22	0.14	1.00	0.52	0.65	0.32	0.51	0.38	0.59	0.21
GERMANY	0.31	0.18	0.52	1.00	0.60	0.35	0.40	0.39	0.38	0.16
NETHERLANDS	0.27	0.16	0.65	0.60	1.00	0.38	0.50	0.44	0.62	0.19
NORWAY	0.28	0.22	0.32	0.35	0.38	1.00	0.29	0.39	0.30	0.09
SPAIN	0.22	0.16	0.51	0.40	0.50	0.29	1.00	0.40	0.47	0.16
SWEDEN	0.26	0.25	0.38	0.39	0.44	0.39	0.40	1.00	0.33	0.09
UK	0.22	0.12	0.59	0.38	0.62	0.30	0.47	0.33	1.00	0.28
US	0.03	0.05	0.21	0.16	0.19	0.09	0.16	0.09	0.28	1.00

Table 4 shows the correlation between the markets during the period 2000-2004. The correlation in general has increased significantly, both concerning the regional correlation in Scandinavia but also the Scandinavian markets correlation to the EU and the US. The regional

Scandinavian correlation is now ranging from SWE-FIN (0,67) to DEN-FIN (0,44). With an average of SWE (Ø 0,54) followed by Finland (Ø 0,53), DEN (Ø 0,46) and NOR (Ø 0,46).

The Scandinavian markets correlation to the larger European markets is now ranging from SWE-GER 0,70 as the highest to UK-DEN 0,42 as the lowest with the following average numbers SWE 0,84, FIN 0,72 , NOR 0,61 and DEN 0,60. The correlation with US is ranging from SWE 0,41 to DEN 0,24 with an average of 0,30. The overall highest correlation can be found between the continental European stock markets in the sample.

Table 4 Correlation matrix 2000-2004

	DENMARK	FINLAND	FRANCE	GERMANY	NETHERLANDS	NORWAY	SPAIN	SWEDEN	UK	US
DENMARK	1.00	0.44	0.51	0.46	0.51	0.43	0.48	0.50	0.43	0.24
FINLAND	0.44	1.00	0.64	0.58	0.57	0.47	0.59	0.67	0.51	0.32
FRANCE	0.51	0.64	1.00	0.85	0.87	0.52	0.82	0.72	0.77	0.49
GERMANY	0.46	0.58	0.85	1.00	0.81	0.47	0.75	0.70	0.71	0.57
NETHERLANDS	0.51	0.57	0.87	0.81	1.00	0.51	0.76	0.66	0.74	0.46
NORWAY	0.43	0.47	0.52	0.47	0.51	1.00	0.49	0.46	0.46	0.24
SPAIN	0.48	0.59	0.82	0.75	0.76	0.49	1.00	0.66	0.67	0.43
SWEDEN	0.50	0.67	0.72	0.70	0.66	0.46	0.66	1.00	0.63	0.41
UK	0.43	0.51	0.77	0.71	0.74	0.46	0.67	0.63	1.00	0.46
US	0.24	0.32	0.49	0.57	0.46	0.24	0.43	0.41	0.46	1.00

To further point out the evolvement of the correlation, the growth rates are displayed (in percentage) in table 5 and 6 below. The tables show that Finland is the market that has changed the most regarding the correlation while Norway is getting behindhand.

Table 5 Correlation growth between the Scandinavian stock markets

CORRELATION GROWTH BETWEEN THE PERIODS 1990-1994 TO 2000-2004 (%)			
	Denmark	Finland	Norway
Finland	131		
Norway	54	120	
Sweden	90	166	19

Table 6 Correlation growth between Scandinavian and the European stock markets

CORRELATION GROWTH BETWEEN THE PERIODS 1990-1994 TO 2000-2004 (%)				
	Denmark	Finland	Norway	Sweden
Germany	48	224	33	79
UK	93	341	54	90
France	129	354	65	90
Spain	116	224	67	63
Netherlands	92	258	35	51

This pattern of contemporaneous correlations may reflect the degree of economic integration between countries. This is so because the more integrated two economies are, the more strongly the stock market movements in one country would be correlated to those in another country. The strong evolvement of the Finnish correlation seems to attest to this factor. However, correlation per see does not alone indicate whether there are any links between any pair of markets. The out put of the correlation may also be caused by the index construction and the amount of companies included in the indices which is pointed out by Roll (1992). To investigate the existence of spill over effects and global shock reactions among the markets, granger causality, impulse response and variance decomposition are displayed.

4.2.2 Granger Causality

To get a deeper understanding of the direction of the correlation we perform granger-causality tests which report the direction and the significance of the correlation between the markets in the sample. There is an indistinctive pattern regarding the granger-causality test. Table 7 displays the significant results of the granger-causality tests during 1990-1994. As can be seen there is a “larger markets granger-causing smaller markets” pattern. In Scandinavia Finland is granger-caused by all the other markets in the region, Denmark and Norway have a bi-directional relation while Sweden is granger-causing all the other markets in Scandinavia. The US market is significantly strongly granger-causing all the other markets in the sample which is probably the most distinct pattern. Furthermore the larger markets in Europe generally significantly influence the smaller markets in Scandinavia, particularly Finland and Denmark but no distinct pattern can be found

Table 7 Granger-causality test 1990-1994

Pairwise Granger Causality Tests
Sample: 1/01/1990 12/30/1994

Null Hypothesis:	Obs	F-Statistic	Probability	
Scandinavian granger-causality				
SWEDEN does not Granger Cause FINLAND	1238	39.0639	5.6E-10	
NORWAY does not Granger Cause FINLAND	1237	17.5029	3.1E-05	
SWEDEN does not Granger Cause DENMARK	1238	17.0992	3.8E-05	
NORWAY does not Granger Cause DENMARK	1234	20.3698	7.0E-06	
DENMARK does not Granger Cause NORWAY	1234	4.28867	0.03858	w
DENMARK does not Granger Cause FINLAND	1235	4.15698	0.04168	w
SWEDEN does not Granger Cause NORWAY	1245	4.17265	0.04129	w
Continental Europe and the UK granger-causality to Scandinavia				
UK does not Granger Cause NORWAY	1249	5.25979	0.02199	w
SPAIN does not Granger Cause SWEDEN	1254	4.33267	0.03759	w
SWEDEN does not Granger Cause GERMANY	1244	17.6464	2.9E-05	
FRANCE does not Granger Cause SWEDEN	1256	8.57836	0.00346	w
NETHERLANDS does not Granger Cause FINLAND	1249	25.0387	6.4E-07	
UK does not Granger Cause FINLAND	1252	34.2536	6.2E-09	
UK does not Granger Cause DENMARK	1250	26.7840	2.6E-07	
FRANCE does not Granger Cause FINLAND	1250	41.9614	1.3E-10	
GERMANY does not Granger Cause FINLAND	1240	7.17679	0.00748	
SPAIN does not Granger Cause DENMARK	1248	10.9723	0.00095	
NETHERLANDS does not Granger Cause DENMARK	1247	34.1114	6.6E-09	
DENMARK does not Granger Cause NETHERLANDS	1247	6.61918	0.01020	w
FRANCE does not Granger Cause DENMARK	1251	24.8880	6.9E-07	
DENMARK does not Granger Cause FRANCE	1251	3.88073	0.04906	w
SPAIN does not Granger Cause FINLAND	1246	30.7626	3.6E-08	
GERMANY does not Granger Cause DENMARK	1242	10.0245	0.00158	w
UK does not Granger Cause SWEDEN				
Continental Europe and the UK granger-causality				
FRANCE does not Granger Cause GERMANY	1259	40.2556	3.1E-10	
NETHERLANDS does not Granger Cause GERMANY	1256	17.4521	3.2E-05	
SPAIN does not Granger Cause GERMANY	1251	11.2853	0.00080	
UK does not Granger Cause GERMANY	1254	34.6166	5.1E-09	
UK does not Granger Cause NETHERLANDS	1261	3.94630	0.04719	w
FRANCE does not Granger Cause UK	1265	7.28005	0.00707	
US granger-causality				
US does not Granger Cause DENMARK	1237	53.6453	4.3E-13	
US does not Granger Cause FINLAND	1242	27.7111	1.7E-07	
US does not Granger Cause SWEDEN	1243	105.447	8.5E-24	
US does not Granger Cause NORWAY	1238	89.0417	1.9E-20	
US does not Granger Cause UK	1252	78.4182	2.8E-18	
US does not Granger Cause SPAIN	1252	54.3813	3.0E-13	
US does not Granger Cause NETHERLANDS	1249	127.232	3.6E-28	
US does not Granger Cause GERMANY	1244	103.880	1.8E-23	
US does not Granger Cause FRANCE	1254	52.5817	7.2E-13	

w= close to the 5% significant line indicating barely significance

The granger-causality tests on the data from the period 2000-2004 show a rather similar pattern to the data from 1990-1994. The larger the size of a stock market the larger is the granger-cause. In Scandinavia Sweden is granger-causing Finland and have bi-directional causality to Norway. The US is still significantly granger-causing all the other markets. In Europe the most distinctive pattern is that Germany is granger-causing all the markets in Scandinavia.

Table 8 Granger-causality 2000-2004

Pairwise Granger Causality Tests
Sample: 1/03/2000 12/31/2004

Null Hypothesis:	Obs	F-Statistic	Probability	
Scandinavian granger-causality				
SWEDEN does not Granger Cause FINLAND	1225	6.59337	0.00142	
SWEDEN does not Granger Cause NORWAY	1243	5.50728	0.00416	
NORWAY does not Granger Cause SWEDEN	1243	3.67378	0.02566	w
FINLAND does not Granger Cause NORWAY	1222	3.02683	0.04883	w
Continental Europe and the UK granger-causality to Scandinavia				
GERMANY does not Granger Cause SWEDEN	1239	11.5402	1.1E-05	
GERMANY does not Granger Cause NORWAY	1230	15.3222	2.7E-07	
FRANCE does not Granger Cause NORWAY	1232	4.96456	0.00712	
UK does not Granger Cause NORWAY	1248	4.03226	0.01797	w
SPAIN does not Granger Cause NORWAY	1242	5.07640	0.00637	
UK does not Granger Cause FINLAND	1229	7.11960	0.00084	
GERMANY does not Granger Cause DENMARK	1234	10.8666	2.1E-05	
DENMARK does not Granger Cause GERMANY	1234	3.69709	0.02507	w
UK does not Granger Cause DENMARK	1252	4.63071	0.00992	
DENMARK does not Granger Cause UK	1252	3.24761	0.03920	w
GERMANY does not Granger Cause FINLAND	1204	16.8179	6.3E-08	
Continental Europe and the UK granger-causality				
GERMANY does not Granger Cause FRANCE	1239	16.4337	9.0E-08	
GERMANY does not Granger Cause SPAIN	1239	4.53968	0.01086	w
GERMANY does not Granger Cause NETHERLANDS	1233	21.2602	8.4E-10	
GERMANY does not Granger Cause UK	1243	9.36120	9.2E-05	
UK does not Granger Cause FRANCE	1251	3.22555	0.04007	w
US granger-causality				
US does not Granger Cause UK	1237	65.2168	1.2E-27	
US does not Granger Cause SPAIN	1233	42.5718	1.3E-18	
US does not Granger Cause NETHERLANDS	1217	86.1161	1.1E-35	
US does not Granger Cause GERMANY	1216	26.0700	8.2E-12	
US does not Granger Cause FRANCE	1222	74.7691	2.4E-31	
US does not Granger Cause FINLAND	1204	104.447	1.5E-42	
US does not Granger Cause NORWAY	1224	64.7299	1.9E-27	
US does not Granger Cause SWEDEN	1242	72.4080	1.8E-30	
US does not Granger Cause DENMARK	1229	53.0157	8.3E-23	

w= close to the 5% significant line indicating barely significance

The significance of granger-causality may be related to three factors. Either the relevant markets are dependent on the same factors, but one of them are “leading” the other, meaning that the first market is considering the second market’s reaction before investors on the first market react to the new information. The consequence of this behaviour is granger-causality (correlation with a lag). This phenomenon can be found looking at the German market’s causality of the Scandinavian markets, since the German economy is the most influential in Europe. The other factor of granger-causality may be that the markets are sensitive to the same sort of information but that the lack of liquidity, on normally a smaller market, makes it inefficient adjusting to new information. This will be displayed as a one-day lag correlation, i.e. granger causality relation to other markets. The third factor is due to that the stock markets are operating in different time zones. Since the US is operating in a time zone proceeding the western European time, the correlation within one day between Europe and the US will appear with a one-day lag and by consequence it will be seen as a granger-causality relation between the regions. In this study we have found that larger economies are in higher degree granger-causing smaller markets. The German and the US markets are for example significantly granger-causing all the Scandinavian markets during the period 2000-2004. Hence the highly significant granger-cause from the US to Scandinavia can be explained by the time zone factor and the “leading” market factor, while the German granger-causality relationship to Scandinavia may be explained by the “leading market” factor alone. The over all highly US granger-causality of all the other markets in the sample are concordant with several previous papers studying different geographic areas, which is evidence for that the US market is no doubt the most influential “leading” market in the world regardless of the time zone factor. On the other hand, if no significant granger-causality is displayed while high degree of correlation is found, this may indicate that the markets are highly interdependent and that the information is transmitted efficient and during one day (if the test is made on daily data). If no granger-causality can be found while a low degree of correlation exists this may indicate that the markets are independent of each other. The former explanation rather than the latter may be the cause of our granger-causality pattern.

4.2.3 Variance Decomposition

The variance decomposition gives us the proportion of the movements in the dependent variables that are due to their "own" shocks, versus shocks to the other variables. A shock to i.e. the US market will of course directly affect that variable, but will also be transmitted to all the other markets in the sample. Table 9 provides the decomposition of day-10 ahead forecasts of the stock markets. As can be seen in the table there is no market exogenous enough to fully explain its own variance. The table can be seen as a summary, which can be useful identifying the main influence among the ten markets. As discussed in chapter 2, an assumption of the particular order of the markets in order to compute the variance decomposition is necessary. The more correlated the residuals are from an estimated equation, the more the variable ordering will be important. Since most of the markets in this study are highly correlated during this period 1990-1994, the ordering of the variables will be crucial for the output of the results. In this study the ordering of the markets is made regarding their weight of the total world annual GDP. Earlier studies suggest that the degree of exogenity of a market depends on its economic influence on other markets, (Eun & Shim 1989), we believe that the GDP factor is a good way of ranking the degree of economic influence. The US is ranked as number one, since it is the country with the largest weight of the total world annual GDP followed by GER, UK, FRA, SPA, NET, SWE, NOR, DEN and FIN. We have also estimated the variance decomposition on the orders of stock market size and the reverse GDP (with Finland as number one and the US as the last) to get a picture of the importance of the order chosen. Unfortunately the results are divergent due to the sensitivity of the tests. However, since we are comparing two periods using the same ordering, the different results of the variance decomposition during the two periods will still be interesting to analyse.

Despite the results sensitivity of the chosen order, there is a clear pattern in the variance decomposition. The Scandinavian markets' variances are to a very low degree explained by shocks on the other markets within the Scandinavian region. According to our tests the Swedish market may affect the other Scandinavian markets but the significance is low and dependent of the chosen order**,** as a consequence we can not draw any conclusions from the test. This is displayed in appendix 2.

However, the sensitivity of foreign shocks has increased significantly during the two periods independently of the ordering. It is, by far, the larger markets in Europe and the US that are explaining the variance of the Scandinavian markets. The table below displays the degree of which European versus US shocks can explain the variance of the Scandinavian markets, and the growth of dependence of the markets to foreign shocks. The degree of how own shocks may explain the variance is also displayed. Further information of the results of the variance decomposition can be found in the appendix. The ordering is based on the GDP ranking but is consistent with the order based on stock market size. As can be seen the Finnish market has increased its dependence of foreign markets the most, followed by the Danish. The Norwegian market has not evolved in the same significant way. The Swedish market is however in absolute numbers the market that is most dependent of foreign shocks. In total the European stock markets explain a higher degree of the variance on the Scandinavian markets compared to the US however. The European shocks originate from five different markets while the US is one single market. The importance of both European and US markets can nevertheless undoubtedly be pointed out.

Table 9 consensus of the variance decomposition, including equally weighted markets, among the Scandinavian stock markets (100=max)

		BY INNOVATIONS IN								
	DAYS	EUROPEAN MARKETS			US MARKET			HOME MARKET		
		1990-1994	*Growth %*	2000-2004	1990-1994	*Growth %*	2000-2004	1990-1994	*Growth %*	2000-2004
Sweden	10	20	*84*	37	9	*182*	25	71	*-48*	37
Norway	10	12	*90*	23	7	*106*	15	76	*-20*	61
Denmark	10	12	*97*	23	4	*201*	12	81	*-26*	60
Finland	10	6	*383*	29	3	*804*	23	84	*-54*	39

4.2.4 Impulse response

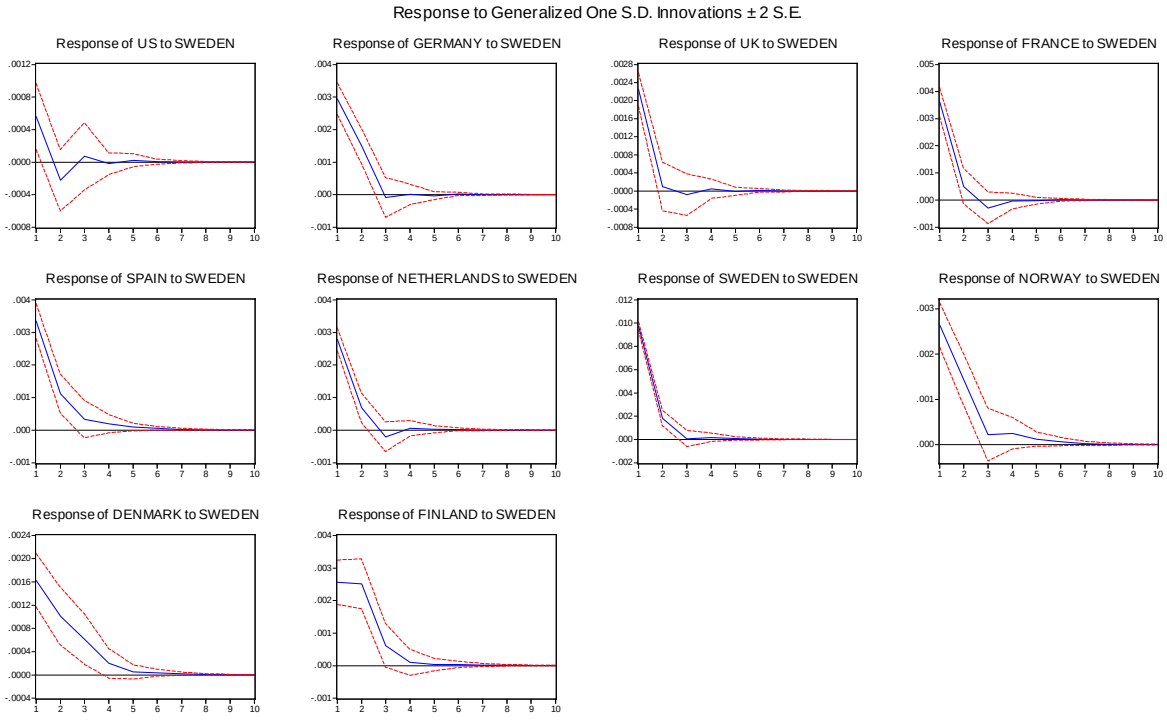
To examine the pattern of how the ten markets individually respond to a shock in a specific market we use the impulse response test. Below, blocks 1-6 display plotted graphs providing generalised impulse responses of the ten markets to shocks from a specific market during the two periods. The pattern of the graphs will give the sign of the response of foreign shocks as well as how fast they are transmitted through the market system. When approximating the

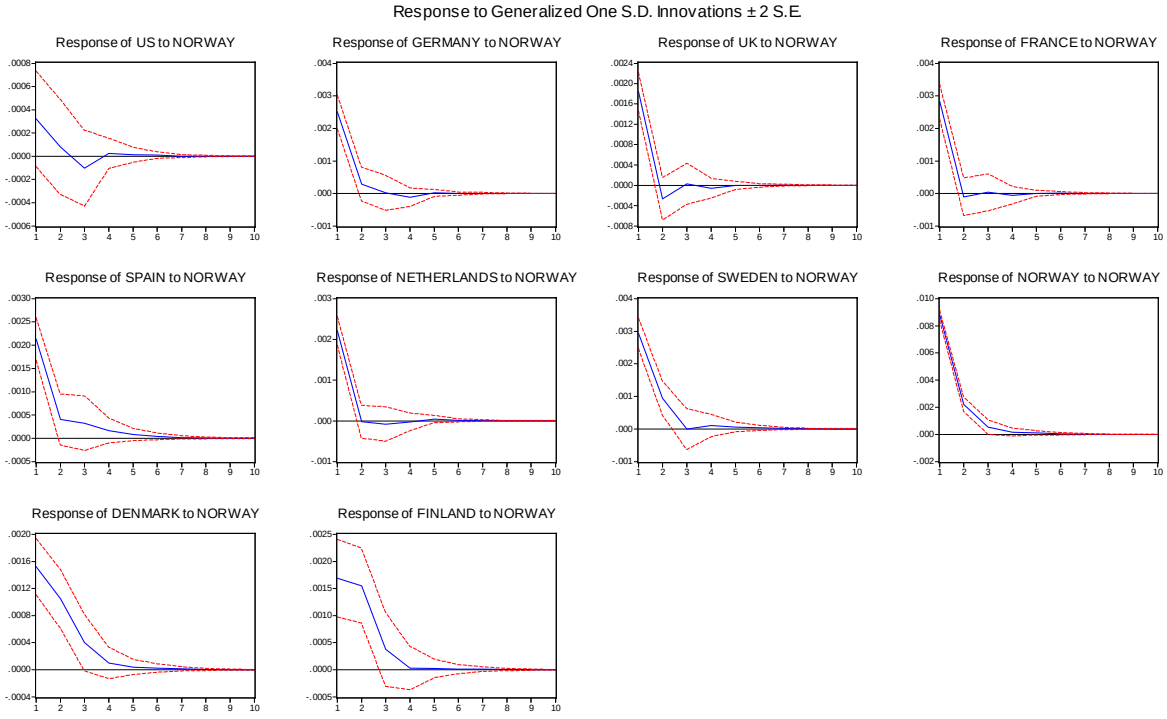
impulse responses of our estimated VAR, we have used generalised impulses that are not dependent on the VAR ordering. When studying the graphs we get the degree of the transmitted responses from a shock in the vertical line and the days of response in the horizontal line. If the graph crosses the horizontal line it means that there has been a reverse reaction. The Monte Carlo significance bands will give the degree of significance in the graphs.

Since all the markets in the sample are highly developed and that they are open during similar hours (except the US) it is not unexpected to find a fast response and that the effect of a shock on another market works through the system in an efficient manner. But as looking at the variance decomposition, there are some markets which disperse from the others.

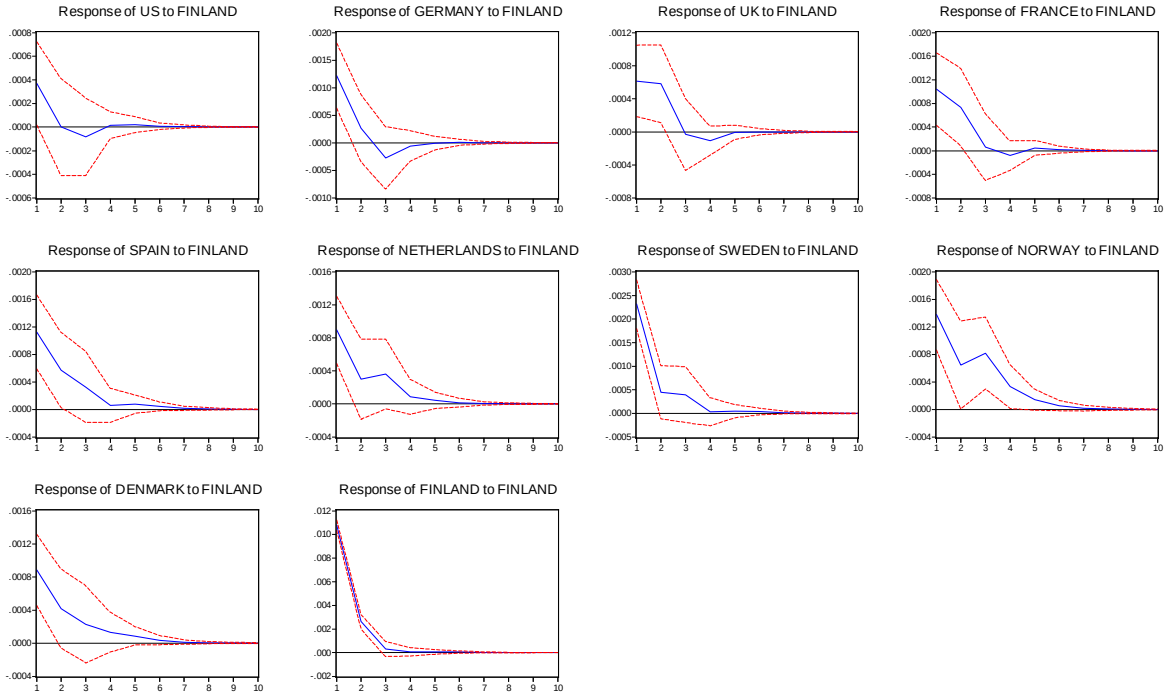
Block 1 and 2 show the results of the response from shocks in the Scandinavian markets during the two periods. The Swedish and Norwegian responses to the Scandinavian shocks are rather efficient and the shocks have worked through the systems within one day during both of the periods. The Danish responses to Scandinavian shocks are in a more significantly way efficient during the period of 2000-2004 compared to the previous period of 1990-1994. Most of the response is on day one and the shocks have worked through on the second day. The most interesting result is the Finnish response to Scandinavian shocks which during the first period is indistinct with broad significance bands and lagged until the third day. This has changed during the second period into an efficient response where the shocks have worked through the Finnish market system on the second day.

Block 1 Impulse response from Scandinavian stock markets 1990-1994

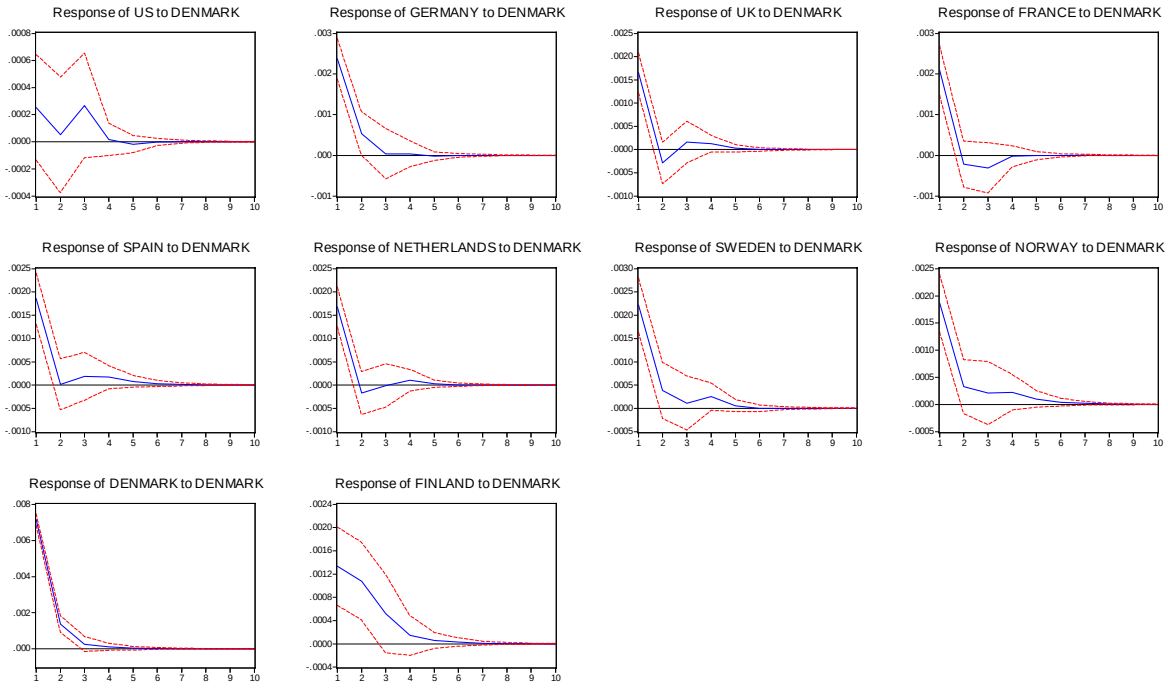




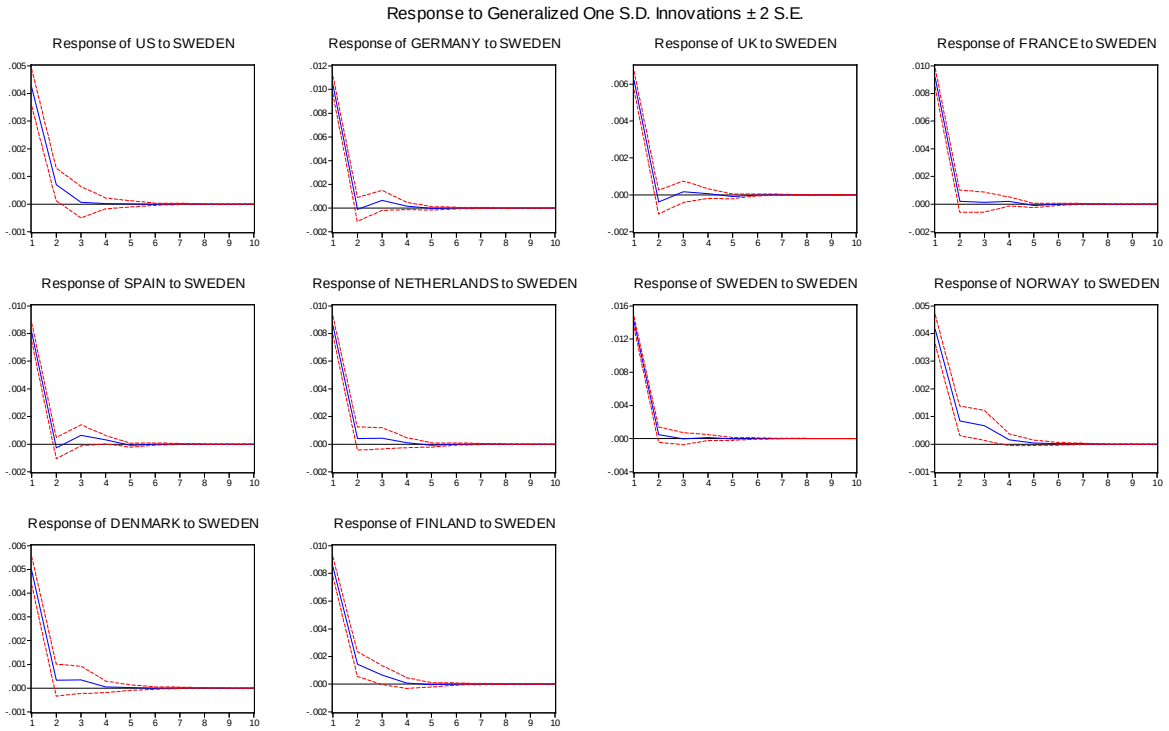
Response to Generalized One S.D. Innovations ± 2 S.E.

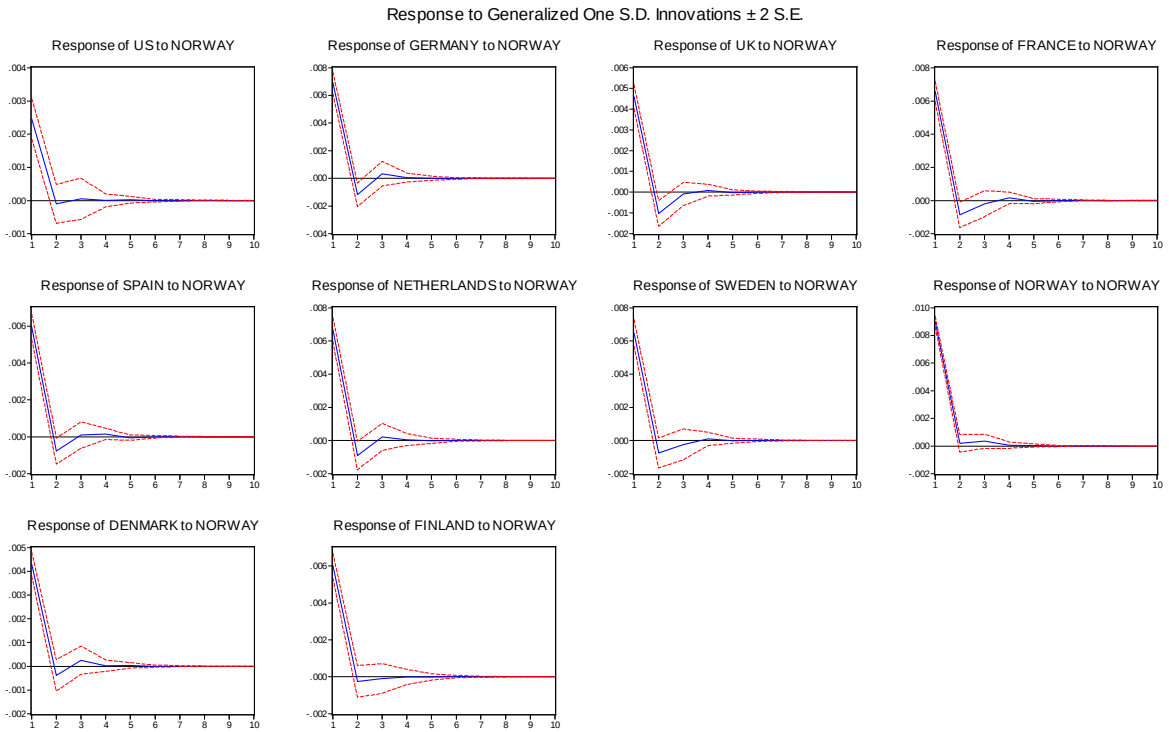


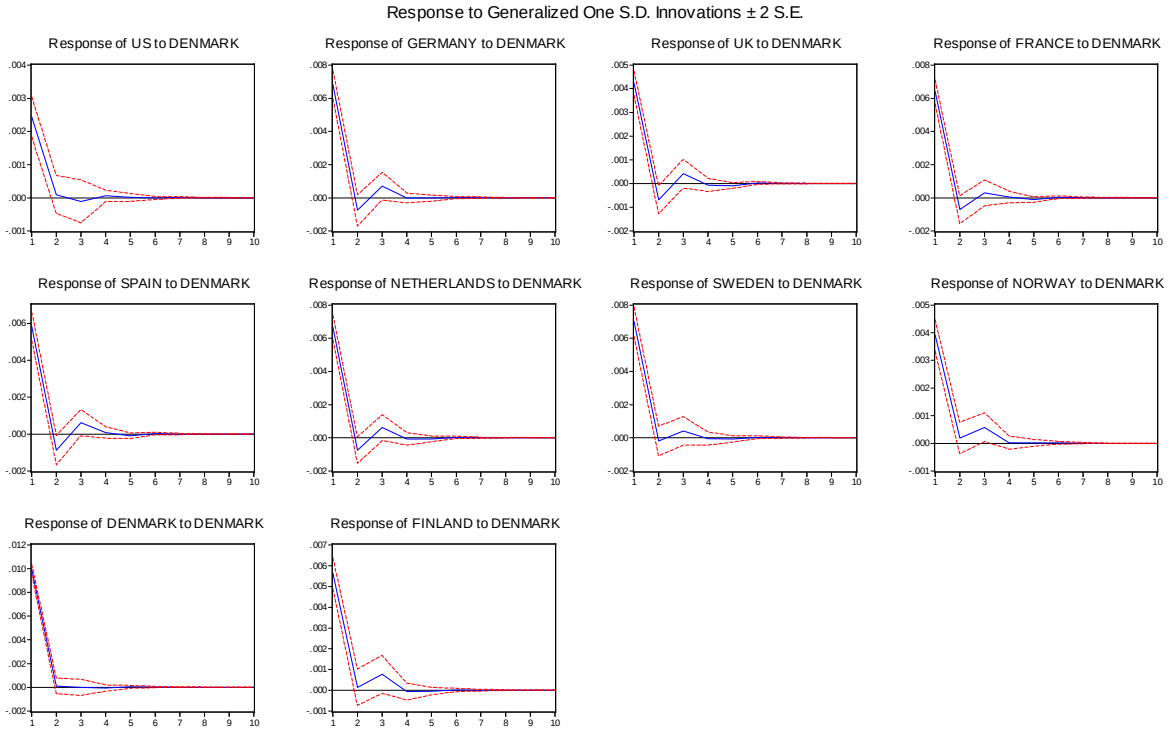
Response to Generalized One S.D. Innovations ± 2 S.E.

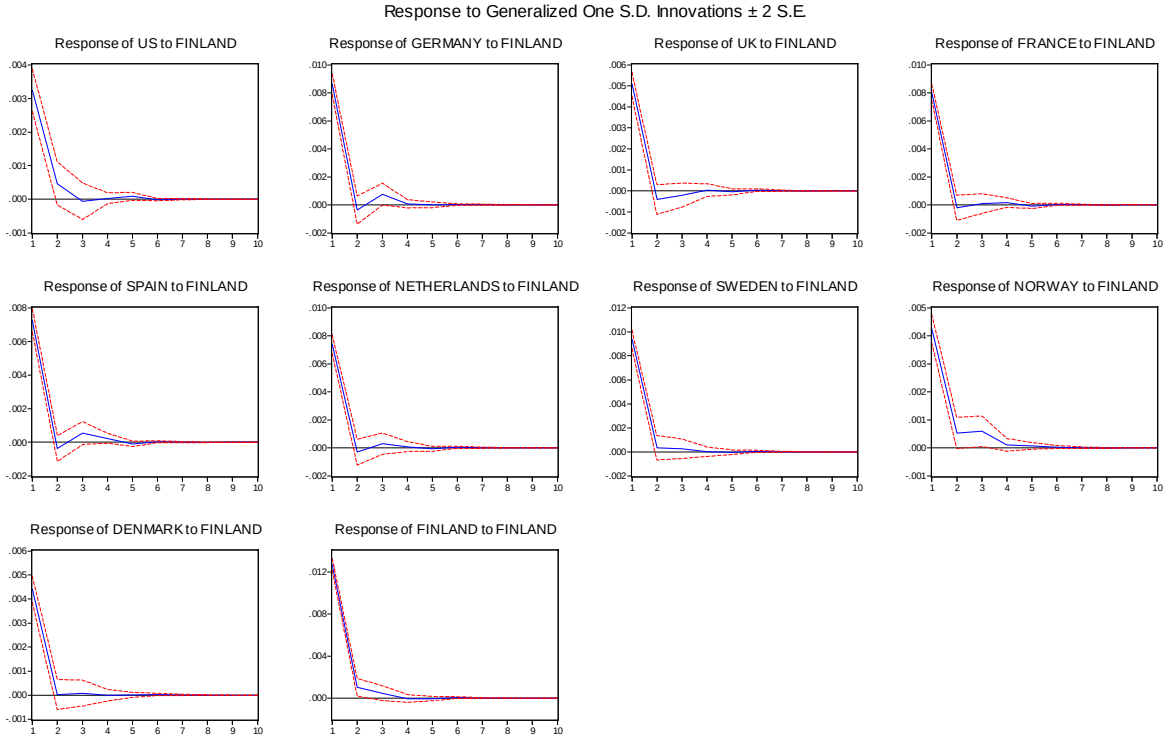


Block 2 Impulse response from Scandinavian stock markets 2000-2004





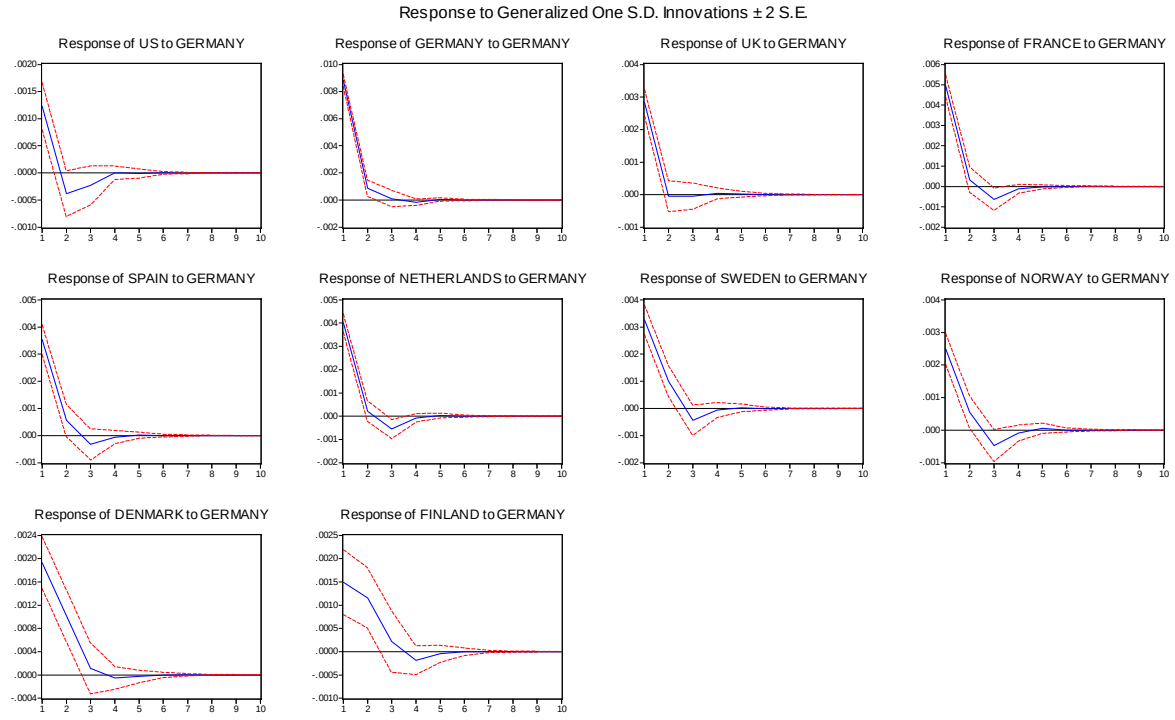


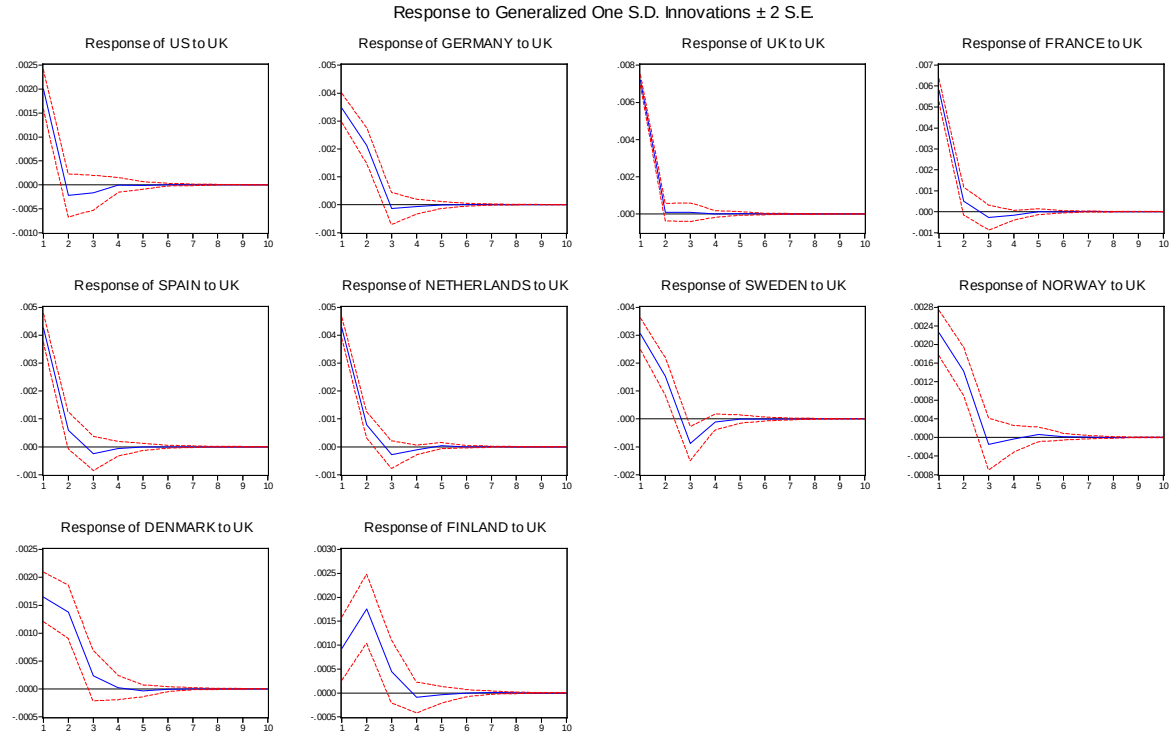


Block 3 and 4 give us the Scandinavian response to European shocks. As discussed in the previous part the Swedish and the Norwegian response to European shocks are efficient during both of the periods although the response is slightly more lagged during the first period. The Danish response has evolved in the same manner to a higher degree of efficiency

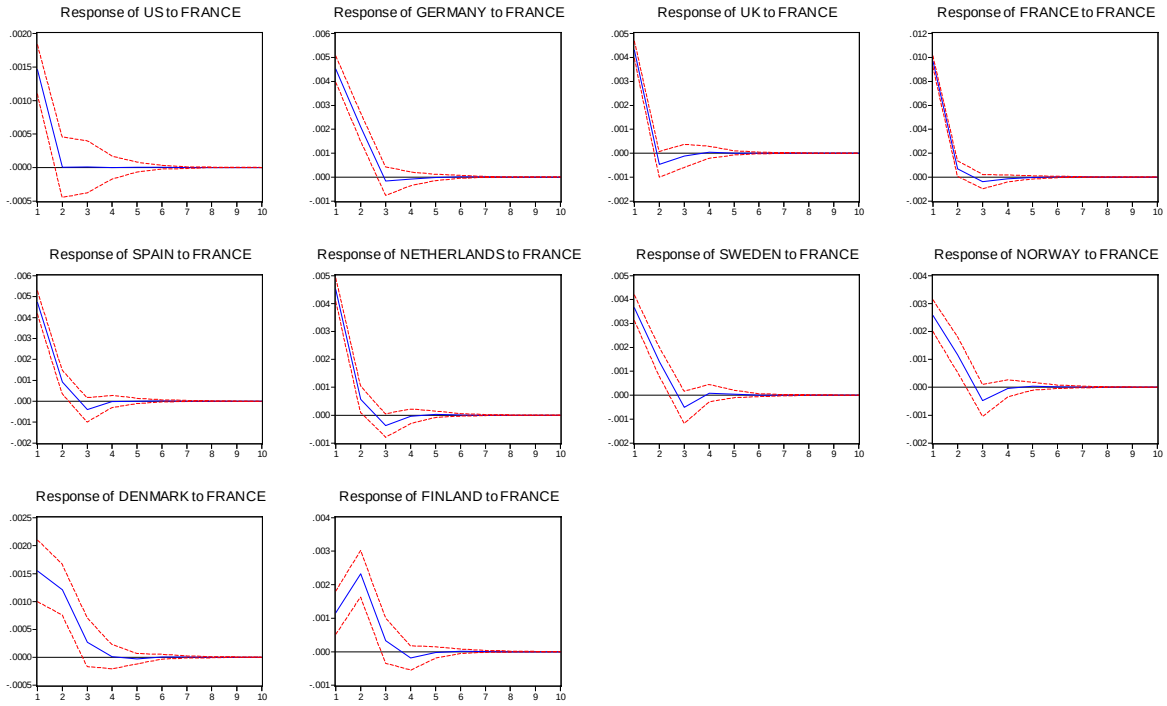
and only a one day lagged response. The Finnish market has gone through a remarkable evolution and the way it reacts to European shocks has improved into a much more efficient market. Within one to two days the Finnish market has responded to European shocks. Overall the way the Scandinavian markets react in the second period to European shocks are concordant to how the larger European markets respond to the same shocks, which is highly efficient. This is evidence for that the Scandinavian markets and above all the Finnish market have improved their degree of efficiency in the latter period.

Block 3 Impulse response from EU stock markets 1990-1994

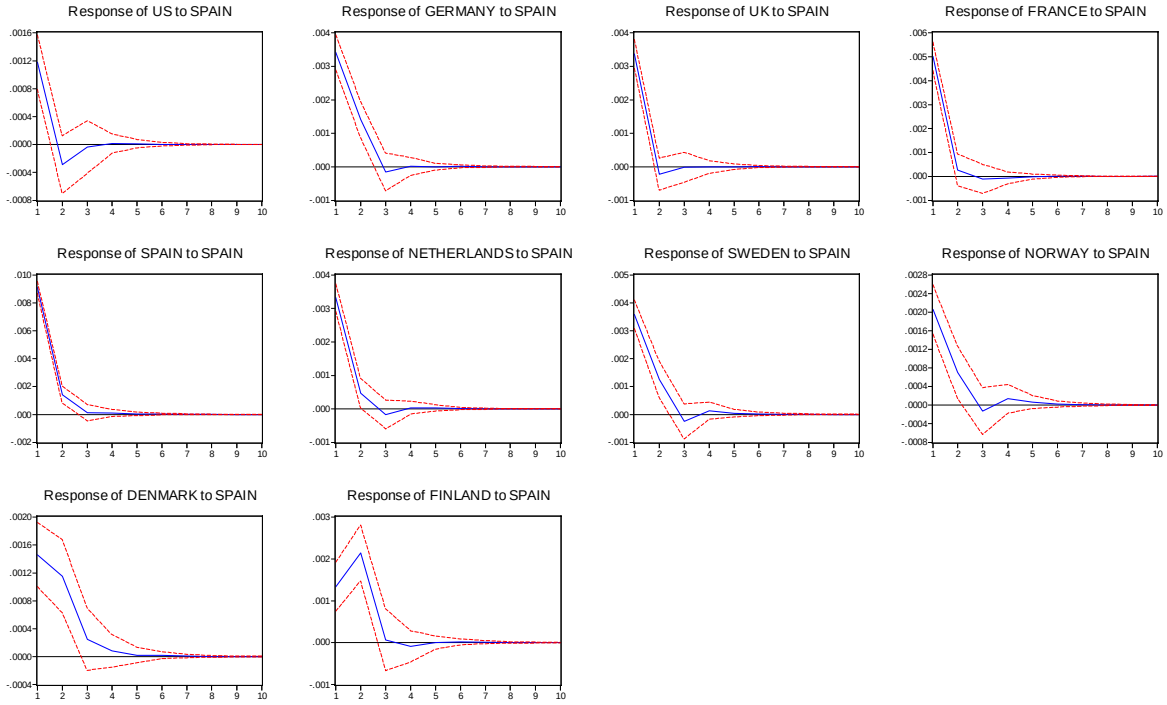


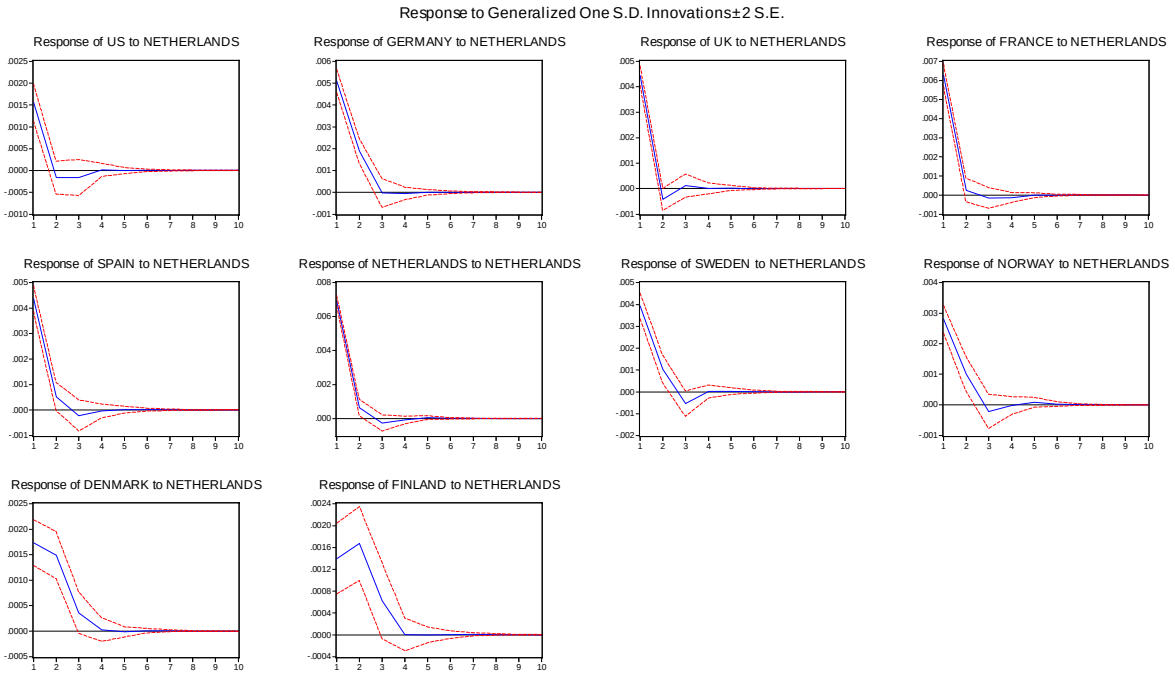


Response to Generalized One S.D. Innovations ± 2 S.E.

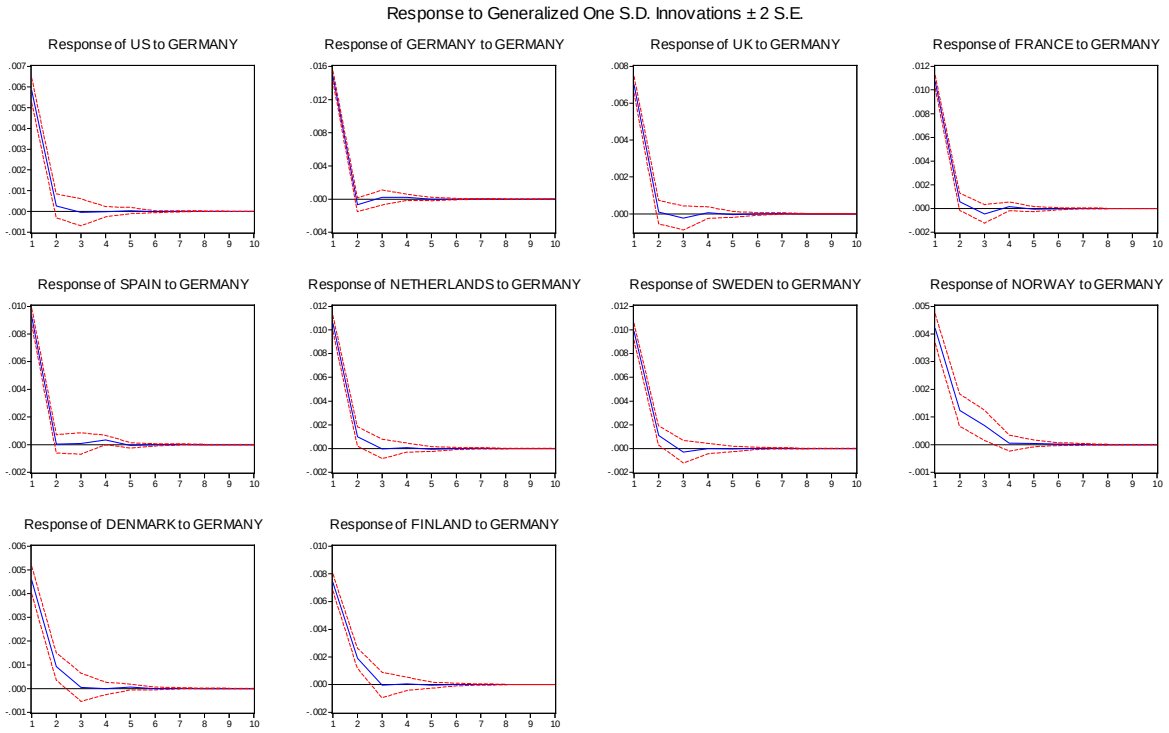


Response to Generalized One S.D. Innovations ± 2 S.E.

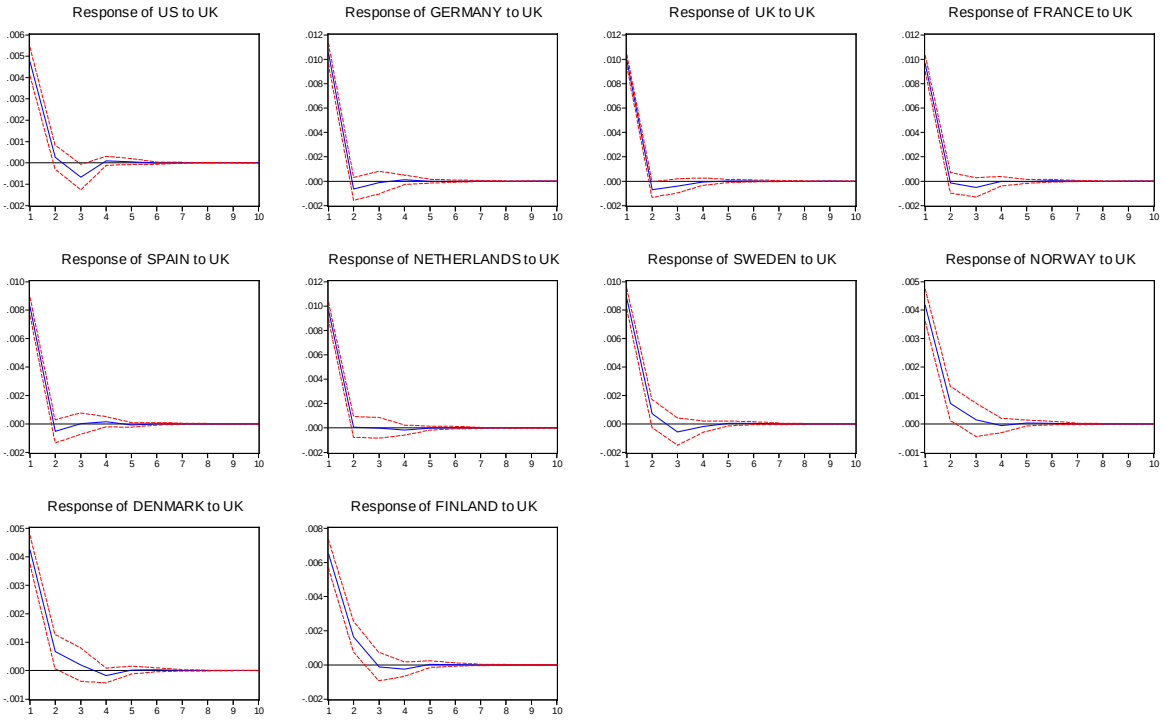




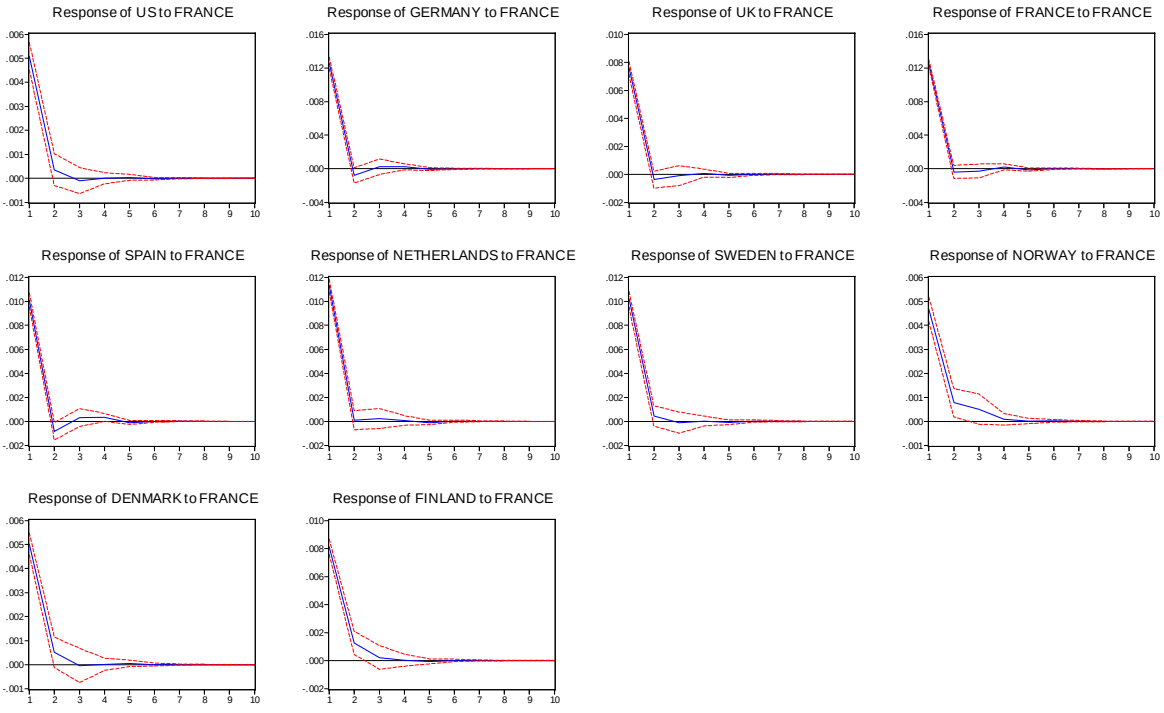
Block 4 Impulse response from EU stock markets 2000-2004

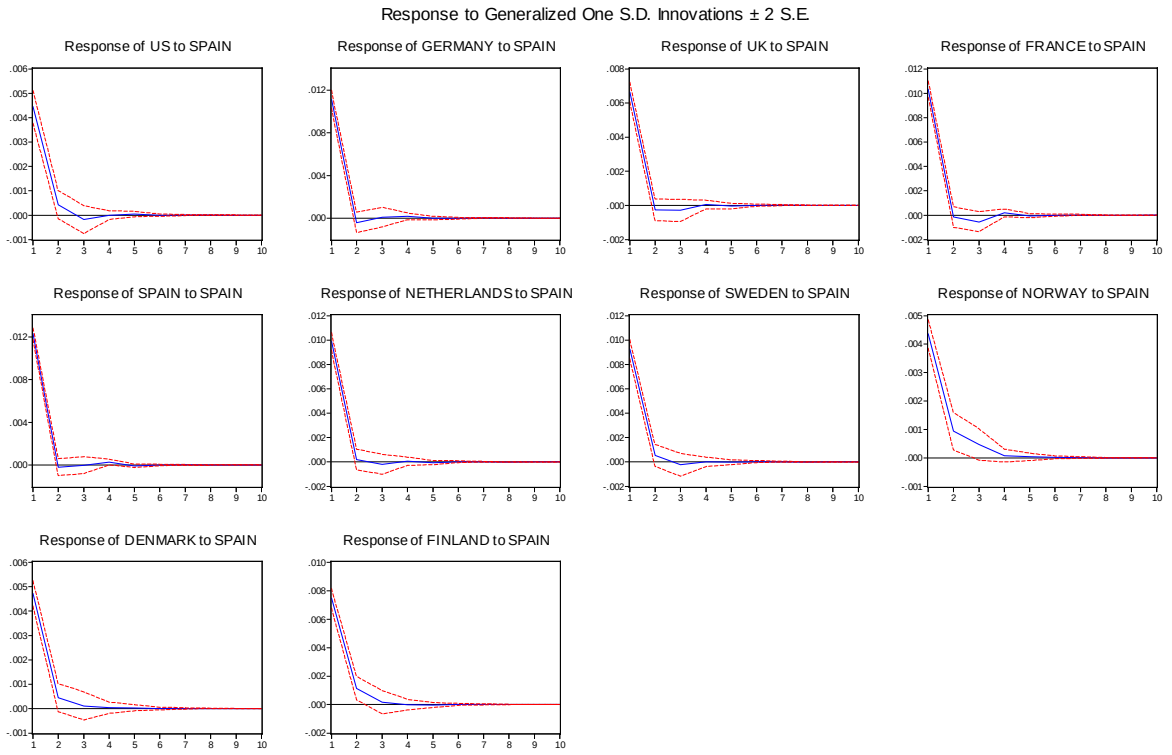


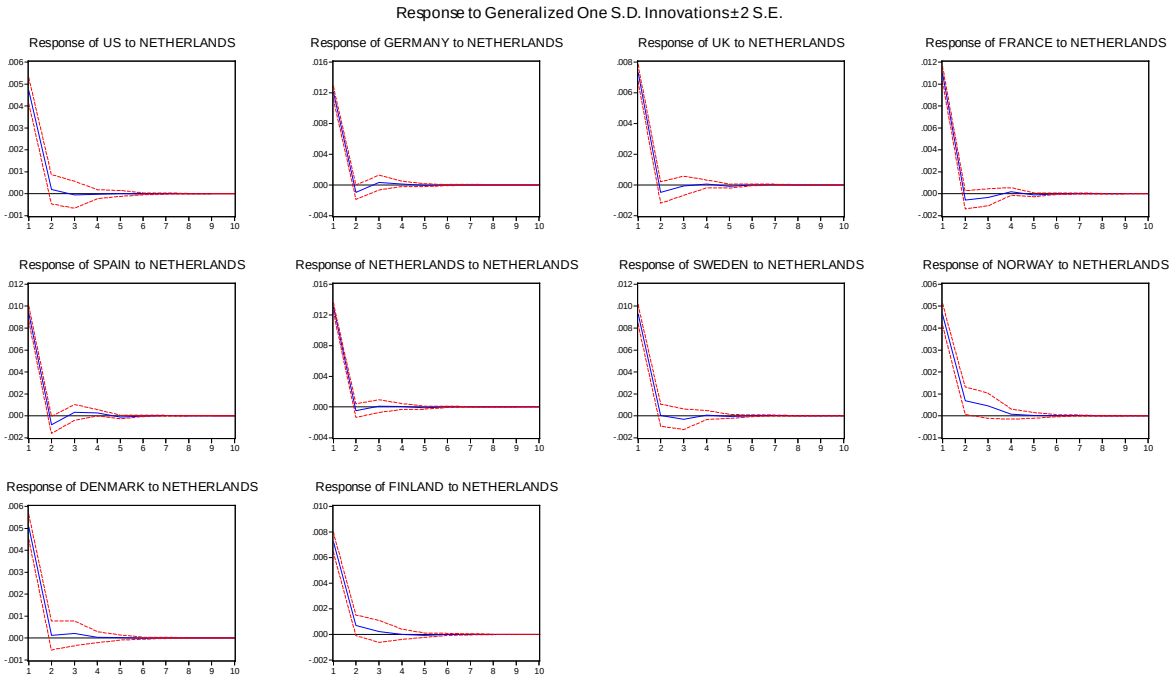
Response to Generalized One S.D. Innovations ± 2 S.E.



Response to Generalized One S.D. Innovations ± 2 S.E.



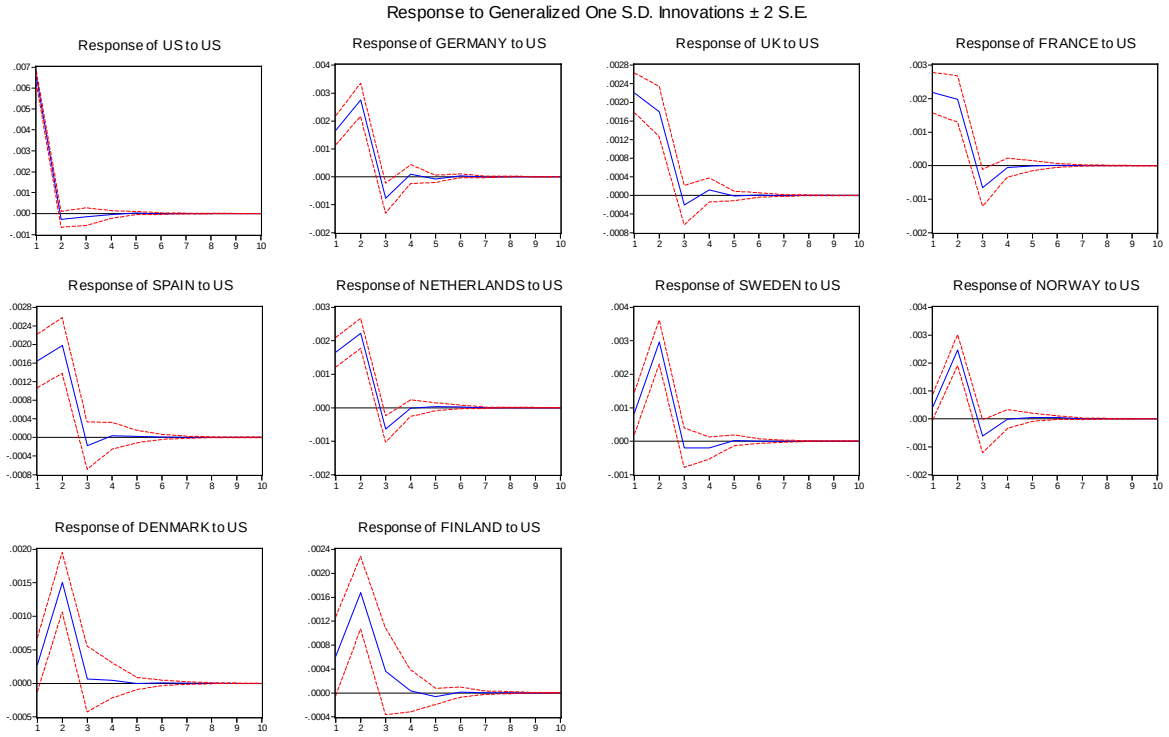




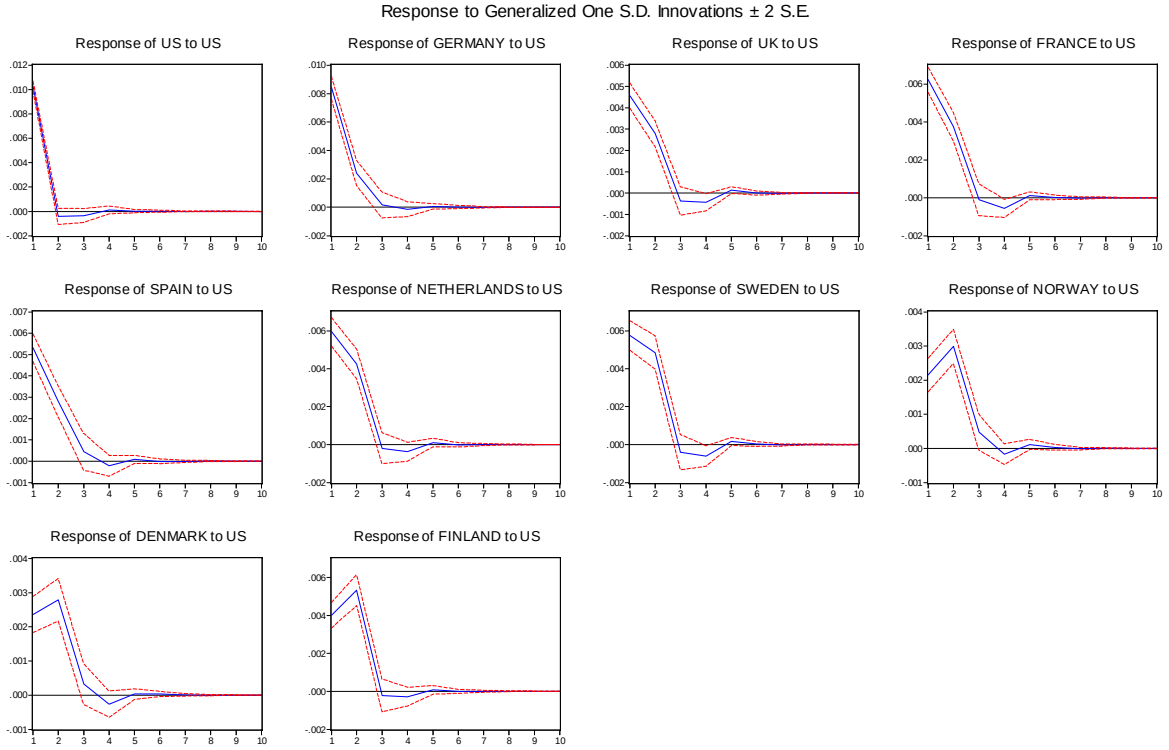
How the ten markets are responding to a shock on the US market during the two periods can be seen in block 5 and 6. During the first period 1990-1994 the Scandinavian markets response to US shocks are peaked on the first day and the shocks have worked through the system within 2-3 days. In the second period the Scandinavian responses are much more efficient as can be seen on the slope of the curves, although still within 2-3 days. Particularly

the Swedish response is coherent with how the larger markets in Europe respond to US shocks. The confidence bands are tight which indicate high degree of certainty.

Block 5 Impulse response from US stock market 1990-1994



Block 6 Impulse response from US stock market 2000-2004



4.3 Our results in relation to previous studies

Our results from the correlation and impulse response concerning the Scandinavian stock market interdependence indicate that the integration has increased among the markets. The variance decomposition and the granger-causality give results that are hard to interpret since these tests are indistinct or show a small amount of significance. This lack of degree of significant results are concordant to previous studies by Pynnönen (1996), Booth et al (1996), Mathur et al (1990), Aaltonen et al (1999), Booth (1999) and Martikainen et al(1993). Although previous researchers have been arguing in favour of Scandinavia as a highly interesting region concerning this topic, since it fulfil the factors which are said to create interdependency, it seems as the Scandinavian regional interdependence is consistently low even after the Swedish and Finnish membership of the EU and the Finnish membership of the EMU.

Our results of the Scandinavian interdependence with the larger European markets and the US are much more significant and distinctive. The Scandinavian markets are highly interdependent with the US and the larger European markets after the Swedish and the Finnish membership of the EU. Particularly Finland has increased its sensitivity to foreign shocks both from Europe and from the US. This is supported by all our tests. Sweden is in absolute numbers the Scandinavian market which is most influenced by foreign shocks followed by Finland, Denmark and Norway. During our two periods Norway is the market which has evolved the least. The Finnish evolution and dependence of foreign shocks is inconsistent with Martikainen (1990) saying that the Finnish market is independent of foreign markets as the US. Furthermore, our results are concordant with several previous studies saying that the US is one of the most influential and important stock markets in the world argued by Eun and Shim (1989), Hamao (1990), Roll (1992), Lin et al (1994), Kim et al (1995), Karolyi (1995), Ng (2000), Soydemir (2000) and Hahn et al (2004). We also find support to the stock markets' high degree of efficiency, as displayed in the impulse response tests, which is argued by Ln el (2001), Jin (2003) and Hahn et al (2004) to exist between developed markets. Our results stating that the interdependency has increased between the Scandinavian markets and the larger European markets after the Swedish and Finnish membership of the EU is consistent with previous studies by Fratzcher (2002), Yang et al

(2003), Dickinson (2000) and Kanas (1998) who argue for the importance of institutions such as EU and the EMU to increase the macro economic integration which will lead to a higher degree of interdependency among stock markets. Particularly the Finnish evolution support their research since Finland is the only Scandinavian market which has joined the EMU, and also the market which has had the strongest evolution according to our results.

The lower degree of interdependence found in the first period is consistent with Fratzscher (2002) who argue for a decline of the interdependence during the period of 1992-1993 in a historical perspective, due to the ERM crises. This is however not supported by previous studies by Kim and Haque (1997) stating that the international interdependence of stock markets increase during financial crises.

Hence, our hypothesis of an increased interdependence between the Scandinavian stock markets during the two periods studied is hard to either reject or verify. The correlation may display a higher degree of interdependence but this result is not confirmed by the granger-causality or the variance decomposition, thus make it hard to draw any conclusions. The second hypothesis saying that the interdependence between the Scandinavian markets and the larger EU markets has increased is distinctively verified, particularly the Finnish interdependency. Sweden and Finland are the Scandinavian markets which are most influenced by foreign shocks both from the larger EU markets and the US. The Danish market has evolved in a similar manner but in absolute numbers the Danish market is less influenced by foreign shocks than the Swedish and the Finnish markets. The Norwegian market's interdependence of foreign shocks has not evolved to the same extent. Despite the lack of increased Danish interdependence the empirical results verify our hypothesis.

4.3.1 The reliability and validity of the study

The validity of our study is rather strong since we have used a well-known and respected method to produce the results. However the VAR methodology is not unquestionable which is discussed in the methodology chapter. It is rather impossible to find a model which is fully valid and the VAR may be seen as a "least bad" choice regarding our purpose. Furthermore, the method makes it possible to compare our results with previous studies.

The reliability is also important to discuss in a paper like this. Since the variance decomposition which is one of the most important tests in the study is extremely sensitive to the order chosen. It is unfortunately plausible that another study on the same sample can reach another output. Since we are well aware of this, there is an extended discussion concerning this in the empirical finding chapter. We have exclusively used primary data from well known datasources. However there is always a risk that it has been manipulated by the human factor beyond our knowledge. Despite these problems discussed we find our results as valid and reliable as possible and we are well aware of the problems we have met during the production of the results.

5 Concluding remarks

In this chapter we will try to expound the empirical results of our study and discuss the factors behind them. We will further suggest future research that is related to our study.

There are two problems that have been studied in this paper. Firstly we wanted to determine how the Swedish and Finnish memberships of the EU and the Finnish membership of the EMU, have influenced the interdependence between the Scandinavian stock markets. Our results are indistinct and it is difficult to interpret any larger changes in the interdependence. What we find evidence for is an increased correlation and a more efficient response to foreign shocks which may indicate a higher degree of interdependence among the Scandinavian stock markets during the two periods studied.

The second problem was to see if the Swedish and Finnish memberships of the EU had had any impact on the larger European stock markets' interdependence with the Scandinavian stock markets. Regarding this problem our tests are more concordant. The Scandinavian stock markets' interdependency with the larger European stock markets has increased significantly particularly for Finland, which today is a highly integrated European stock market. This result is inconsistent with previous studies. Sweden is in absolute numbers the most integrated Scandinavian market with the larger European markets followed by Finland, Denmark and Norway.

However our results show that the interdependency between the US market and the Scandinavian markets also has increased significantly, which is evidence for an overall higher degree of international interdependence among stock markets. This may indicate that the results regarding the interdependence found between the Scandinavian markets and the larger EU markets is a result of a general global increase of stock market interdependence rather than a effect of the Swedish and Finnish EU memberships. However since the Finnish market has evolved the most regarding the integration with the larger EU markets, and Finland is the

only country that has joined both the European institutions that influence the financial integration, it is hard to overlook the importance of the EU and the EMU.

The reason why we chose to study the integration before and after the Swedish and Finnish memberships of the EU and the Finnish membership of the EMU, is as previous discussed the important impact of these institutions on the factors that have been pointed out by previous studies as relevant and decisive on stock market integration. From our tests it is impossible to sort out which of these factors that have evolved the transmission of stock market movements the most during this period. However below we discuss the factors that may partly explain our results.

Earlier studies have found a low correlation between the Scandinavian stock markets which has been explained by the size of the stock markets, illiquidity and linear dependencies. Through the NOREX Alliance the shared trading platform, SAXESS may play a role in explaining the increased Scandinavian correlations. Copenhagen and Stockholm in 1999 were the first Scandinavian stock exchanges to share a joint trading system followed by Oslo and Helsinki in 2002 and 2004 respectively. This shared trading platform can reduce the costs of cross border transactions and attract new investors, which will lead to higher trading volumes followed by increased liquidity on the Scandinavian stock markets thus explaining the increased interdependence with the Scandinavian, EU and the US stock markets.

The increased integration of the Scandinavian markets and the larger EU stock markets may also be a result of EU's Investment Services Directive from 1996 and Financial Services Action Plan in 1999. These documents develop a common competitive internal market for financial services and integrate the capital markets, by ensuring the cross-border mobility of the financial intermediaries on the market, which in turn can result in higher integration of the stock markets on the back of increased liquidity.

The evolution of stock market integration between the larger EU markets and the Scandinavian may also be explained by the increased trade between countries, as a consequence of the EU's objective to create a common market for services and goods. This is

further pointed out by Frankle and Rose (1997) as a decisive factor for the increase of stock market interdependence.

As continuously discussed in this paper the increased integration may be caused by faster information transmission and processing due to technological advances, recent consolidation and merger of stock exchanges. It is difficult to disentangle the impact of EU from other channels that also might affect the Scandinavian stock market integration with the larger EU stock markets and the US stock market.

The findings of this paper have important implications for both investors and policy-makers. For investors, the higher degree of integration with the other EU stock markets means that the Scandinavian area has become a more attractive place for investment. However, higher integration also implies that there are fewer opportunities to diversify portfolios within the area, thus providing incentives to focus more on diversifying across sectors than across regions.

For policy-makers, the process of European financial integration poses challenges. Financial integration has increased competition and market efficiency and, at the same time, continuing financial integration has made individual European markets increasingly interdependent. Such rising interdependencies may thus require prudential supervisors and security market overseers to increasingly adopt a common approach.

5.1 Suggestions to future studies

Even if the interest of this topic among researchers has been extensive since the global stock market crashes during the eighties and nineties, there are still unanswered questions and undetected grounds, particularly since the integration of stock markets is continuously evolving. Problems that we find interesting to study are above all, the causes to the found interdependence in the region. Furthermore it would be interesting to see if our findings disperse using a GARCH method or using generalised variance decomposition on the same data.

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Appendices

Appendix 1

Table 10 Lag length criteria 1990-1994

VAR Lag Order Selection Criteria
Endogenous variables: US GERMANY UK FRANCE SPAIN NETHERLANDS SWEDEN NORWAY DENMARK FINLAND
Exogenous variables: C
Date: 01/19/06 Time: 10:36
Sample: 1/01/1990 12/30/1994
Included observations: 866

Lag	LogL	LR	FPE	AIC	SC	HQ
0	30345.2	NA	1.78E-43	-70.05819	-70.00318*	-70.03714
1	30569.57	443.0542	1.33e-43*	-70.34544*	-69.74032	-70.11385*
2	30649.25	155.4845	1.40E-43	-70.2985	-69.14328	-69.85638
3	30717.24	131.1190*	1.50E-43	-70.22458	-68.51926	-69.57193
4	30773.81	107.7775	1.66E-43	-70.12427	-67.86885	-69.26109
5	30833.39	112.1509	1.83E-43	-70.03093	-67.22541	-68.95723
6	30883.35	92.8688	2.05E-43	-69.91535	-66.55973	-68.63111
7	30936.12	96.89466	2.29E-43	-69.80628	-65.90056	-68.31152
8	31003.78	122.6565	2.48E-43	-69.73159	-65.27576	-68.02629

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 11 Lag length criteria 2000 - 2004

VAR Lag Order Selection Criteria
Endogenous variables: DENMARK FINLAND FRANCE GERMANY NETHERLANDS NORWAY SPAIN SWEDEN UK US
Exogenous variables: C
Date: 01/19/06 Time: 10:28
Sample: 1/03/2000 12/31/2004
Included observations: 879

Lag	LogL	LR	FPE	AIC	SC	HQ
0	30371.98	NA	4.71E-43	-69.083	-69.02863*	-69.06221
1	30593.69	437.8667	3.57E-43	-69.35992	-68.76189	-69.13121*
2	30708.71	224.5477	3.45e-43*	-69.39410*	-68.25241	-68.95747
3	30778.89	135.4203	3.69E-43	-69.32626	-67.64091	-68.68172
4	30857.74	150.3436	3.88E-43	-69.27814	-67.04913	-68.42568
5	30925.07	126.8402	4.18E-43	-69.2038	-66.43112	-68.14342
6	31004.32	147.4947	4.38E-43	-69.15658	-65.84024	-67.88828
7	31071.74	123.9637	4.73E-43	-69.08247	-65.22247	-67.60625
8	31137.21	118.8667	5.12E-43	-69.00389	-64.60023	-67.31976
9	31226.11	159.3859*	5.27E-43	-68.97863	-64.03131	-67.08658
10	31291.16	115.1551	5.72E-43	-68.89911	-63.40813	-66.79914

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 2

Table 12 Variance decomposition 1990-1994

Variance Decomposition of US:

Period	S.E.	US	GERMANY	UK	FRANCE	SPAIN	NETHERLANDS	SWEDEN	NORWAY	DENMARK	FINLAND
10	0.006575	98.56760	0.364964	0.011056	0.352985	0.119159	0.021332	0.086432	0.108151	0.337182	0.031144
		(0.91690)	(0.41614)	(0.24023)	(0.36203)	(0.23774)	(0.19945)	(0.20052)	(0.25730)	(0.40552)	(0.17340)

Variance Decomposition of GERMANY:

Period	S.E.	US	GERMANY	UK	FRANCE	SPAIN	NETHERLANDS	SWEDEN	NORWAY	DENMARK	FINLAND
10	0.009491	12.17727	83.49781	1.896197	1.232437	0.039260	0.184916	0.605652	0.257482	0.015978	0.092998
		(1.98719)	(2.17755)	(0.78137)	(0.68799)	(0.21162)	(0.30517)	(0.49238)	(0.28432)	(0.13918)	(0.19819)

Variance Decomposition of UK:

Period	S.E.	US	GERMANY	UK	FRANCE	SPAIN	NETHERLANDS	SWEDEN	NORWAY	DENMARK	FINLAND
10	0.007536	14.34447	10.92036	72.18985	0.964399	0.041401	0.494925	0.284581	0.036907	0.148553	0.574556
		(1.99526)	(1.28622)	(2.04069)	(0.63484)	(0.17738)	(0.46190)	(0.34044)	(0.15250)	(0.26709)	(0.42058)

Variance Decomposition of FRANCE:

Period	S.E.	US	GERMANY	UK	FRANCE	SPAIN	NETHERLANDS	SWEDEN	NORWAY	DENMARK	FINLAND
10	0.009991	9.125615	21.71140	16.13829	51.81794	0.074442	0.264154	0.210349	0.106403	0.126205	0.425196
		(1.59328)	(1.98735)	(1.57968)	(2.23281)	(0.23704)	(0.38588)	(0.32929)	(0.19342)	(0.23440)	(0.40855)

Variance Decomposition of SPAIN:

Period	S.E.	US	GERMANY	UK	FRANCE	SPAIN	NETHERLANDS	SWEDEN	NORWAY	DENMARK	FINLAND
10	0.009504	7.382903	12.05617	9.812555	5.271769	63.86239	0.134042	0.997513	0.202363	0.153765	0.126530
		(1.65177)	(1.86617)	(1.41718)	(1.08420)	(2.42509)	(0.31458)	(0.58730)	(0.28761)	(0.26281)	(0.23736)

Variance Decomposition of NETHERLANDS:

Period	S.E.	US	GERMANY	UK	FRANCE	SPAIN	NETHERLANDS	SWEDEN	NORWAY	DENMARK	FINLAND
10	0.007377	14.84559	26.47761	14.43662	4.616728	0.486560	37.82275	0.554601	0.116785	0.216343	0.426411
		(1.97003)	(1.72740)	(1.52372)	(0.81334)	(0.30476)	(1.79486)	(0.38263)	(0.20456)	(0.27239)	(0.33664)

Variance Decomposition of SWEDEN:

Period	S.E.	US	GERMANY	UK	FRANCE	SPAIN	NETHERLANDS	SWEDEN	NORWAY	DENMARK	FINLAND
10	0.010424	8.808149	9.538870	4.236445	2.433683	2.522095	1.424495	70.57645	0.164711	0.149285	0.145819
		(1.64479)	(1.71895)	(1.10112)	(0.83383)	(0.80061)	(0.54726)	(2.47645)	(0.21623)	(0.27563)	(0.21381)

Variance Decomposition of NORWAY:

Period	S.E.	US	GERMANY	UK	FRANCE	SPAIN	NETHERLANDS	SWEDEN	NORWAY	DENMARK	FINLAND
10	0.009553	7.307370	6.794652	2.876768	1.254189	0.356873	0.776826	3.725591	75.98480	0.146977	0.775959
		(1.41876)	(1.25668)	(1.05252)	(0.68736)	(0.34779)	(0.45006)	(1.16729)	(2.23986)	(0.23193)	(0.50267)

Variance Decomposition of DENMARK:

Period	S.E.	US	GERMANY	UK	FRANCE	SPAIN	NETHERLANDS	SWEDEN	NORWAY	DENMARK	FINLAND
10	0.007558	4.121080	7.407107	2.869551	0.255593	0.585499	0.648014	1.767319	1.413790	80.90151	0.030537
		(1.17136)	(1.62550)	(0.91989)	(0.39851)	(0.53643)	(0.57115)	(0.82651)	(0.72180)	(2.24593)	(0.18221)

Variance Decomposition of FINLAND:

Period	S.E.	US	GERMANY	UK	FRANCE	SPAIN	NETHERLANDS	SWEDEN	NORWAY	DENMARK	FINLAND
10	0.011519	2.496292	2.076199	1.006513	1.740325	1.157740	0.338588	5.406805	0.899894	0.458027	84.41962
		(0.96223)	(0.89725)	(0.67973)	(0.78570)	(0.75814)	(0.33916)	(1.30885)	(0.60787)	(0.41958)	(2.09704)

Cholesky Ordering: US GERMANY UK FRANCE SPAIN NETHERLANDS SWEDEN NORWAY DENMARK FINLAND
Standard Errors: Monte Carlo (100 repetitions)

Table 13 Variance decomposition 2000-2004

Variance Decomposition of US:

Period	S.E.	DENMARK	FINLAND	FRANCE	GERMANY	NETHERLANDS	NORWAY	SPAIN	SWEDEN	UK	US
10	0.010475	0.054238	0.032467	0.137812	0.389059	0.134597	0.209347	0.067115	0.498935	0.740122	97.73631
		(0.18541)	(0.17967)	(0.27940)	(0.35302)	(0.31816)	(0.28601)	(0.20534)	(0.46561)	(0.52063)	(0.97150)

Variance Decomposition of GERMANY:

Period	S.E.	DENMARK	FINLAND	FRANCE	GERMANY	NETHERLANDS	NORWAY	SPAIN	SWEDEN	UK	US
10	0.014061	0.146095	0.139680	0.088076	65.92210	0.135842	0.295806	0.117849	0.469835	0.204580	32.48014
		(0.24118)	(0.22379)	(0.25036)	(2.40673)	(0.23152)	(0.38406)	(0.22893)	(0.40598)	(0.25197)	(2.32863)

Variance Decomposition of UK:

Period	S.E.	DENMARK	FINLAND	FRANCE	GERMANY	NETHERLANDS	NORWAY	SPAIN	SWEDEN	UK	US
10	0.013539	0.288759	0.130501	0.263892	28.20962	0.119924	0.426920	0.084307	0.315651	44.61579	25.54464
		(0.29391)	(0.30800)	(0.36327)	(2.14843)	(0.23727)	(0.40527)	(0.24297)	(0.36947)	(1.97865)	(2.32968)

Variance Decomposition of FRANCE:

Period	S.E.	DENMARK	FINLAND	FRANCE	GERMANY	NETHERLANDS	NORWAY	SPAIN	SWEDEN	UK	US
10	0.015365	0.233702	0.023584	20.52743	43.59689	0.344626	0.200922	0.122979	0.352013	5.587156	29.01070
		(0.24582)	(0.16662)	(1.02016)	(1.91134)	(0.35583)	(0.32777)	(0.20777)	(0.38008)	(0.74671)	(2.07707)

Variance Decomposition of SPAIN:

Period	S.E.	DENMARK	FINLAND	FRANCE	GERMANY	NETHERLANDS	NORWAY	SPAIN	SWEDEN	UK	US
10	0.014107	0.258054	0.067454	8.756629	36.17212	0.228812	0.061004	28.31959	0.376475	4.249591	21.51027
		(0.28583)	(0.19320)	(1.08768)	(2.29424)	(0.31115)	(0.24960)	(1.55310)	(0.41687)	(0.81646)	(2.00012)

Variance Decomposition of NETHERLANDS:

Period	S.E.	DENMARK	FINLAND	FRANCE	GERMANY	NETHERLANDS	NORWAY	SPAIN	SWEDEN	UK	US
10	0.009584	0.302157	0.079027	6.630126	39.86314	19.51301	0.335976	0.381396	0.179326	5.681962	27.03389
		(0.29450)	(0.24752)	(0.78838)	(2.03673)	(1.09894)	(0.33661)	(0.30257)	(0.33874)	(0.93353)	(2.14121)

Variance Decomposition of SWEDEN:

Period	S.E.	DENMARK	FINLAND	FRANCE	GERMANY	NETHERLANDS	NORWAY	SPAIN	SWEDEN	UK	US
10	0.013017	0.203581	0.123514	3.304214	29.64786	0.470040	0.344606	0.497361	37.41328	3.172985	24.82256
		(0.26346)	(0.18853)	(0.76978)	(1.90209)	(0.45510)	(0.41487)	(0.30679)	(1.89913)	(0.66833)	(2.44309)

Variance Decomposition of NORWAY:

Period	S.E.	DENMARK	FINLAND	FRANCE	GERMANY	NETHERLANDS	NORWAY	SPAIN	SWEDEN	UK	US
10	0.015182	0.141540	0.032515	2.751739	14.80434	0.753208	60.78309	0.786138	1.006274	3.907626	15.03353
		(0.26462)	(0.18004)	(0.86064)	(1.69197)	(0.46884)	(2.38248)	(0.44166)	(0.52535)	(0.91854)	(1.81920)

Variance Decomposition of DENMARK:

Period	S.E.	DENMARK	FINLAND	FRANCE	GERMANY	NETHERLANDS	NORWAY	SPAIN	SWEDEN	UK	US
10	0.010673	59.64888	0.050657	2.991619	14.70748	2.027426	2.421352	0.814516	2.842414	2.138895	12.35676
		(2.02635)	(0.17745)	(0.91086)	(1.94076)	(0.69241)	(0.72579)	(0.48987)	(0.84990)	(0.74797)	(1.89714)

Variance Decomposition of FINLAND:

Period	S.E.	DENMARK	FINLAND	FRANCE	GERMANY	NETHERLANDS	NORWAY	SPAIN	SWEDEN	UK	US
10	0.010429	0.471658	39.45763	5.122461	20.50629	0.806719	1.642874	0.783321	6.796165	1.823044	22.58983
		(0.34369)	(1.92416)	(0.96966)	(1.76594)	(0.53509)	(0.53434)	(0.33630)	(1.15352)	(0.53272)	(2.10680)

Cholesky Ordering: US GERMANY UK FRANCE SPAIN NETHERLANDS SWEDEN NORWAY DENMARK FINLAND
Standard Errors: Monte Carlo (100 repetitions)