Master Thesis
Spring 2010

SCHOOL OF ECONOMICS
AND MANAGEMENT
Lund University

Time-Varying Beta of Scandinavian Industries: The Crisis Experience

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ABSTRACT

Title:	Time-Varying Beta of Scandinavian Industries: The Crisis Experience
Seminar date:	2010-06-07
Course:	Master thesis in Finance, (15 ECTS)
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Key words:	Time-varying beta; GARCH BEKK model, current financial crisis, volatility, Scandinavian industries, cyclical industries
Purpose:	Given the influence of the crisis on worldwide financial markets, the aim of this work is to empirically study the effects of the current financial crisis on the time-varying beta of industries in the Scandinavian region. The paper will consider such countries as Norway, Denmark, Finland and Sweden.
Methodology:	Gathering data for 14 Scandinavian industries during the 10 year period. Then, quantitative tools such as GARCH BEKK and OLS regression are applied to estimate the crisis influence on the time-varying beta.
Theoretical perspectives:	The theoretical framework involves limited research done in the area of time-variation of beta. Limited number of studies on crisis influence on beta is also consulted. Also, general background on crisis and industry cyclicality is provided for analysis.
Results:	The mean beta results and significance of regression coefficients present an evidence of the crisis effect on beta. The mean beta has changed in most cases as well as the coefficients for variables with dummy have been significant in many cases (but relatively weak). The mean values for beta during crisis have increased, while there has been a decline two industries, such as Health care and IT.
Conclusions:	Evaluation of the crisis impact on the time-varying beta has valuable outcomes for financial actors and governments. Depending on the results, investors can change their investment policies and apply effective hedging tools. Also, the study can be used in financial operations of companies and governments which desire to have some control over the crisis effects and its consequences.

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1. INTRODUCTION

In the introductory section the subject of this thesis is presented, starting with a problem discussion and background. The research questions and purpose are posed as well as limitations that are set up in the study.

Despite critiques[1] of the CAPM and extensive use of multi factor models, the one factor model (CAPM) stays widely used and beta coefficient remains central to many financial decisions, for instance, related to capital budgeting, portfolio management and performance evaluation. Beta is also a needed variable in testing the sensitivity of stock to the market. In the CAPM framework beta is considered to be constant, but many studies indicate that beta is instable and may be influenced by both macroeconomic and microeconomic factors.[2] Microeconomic factors related to the particular firm, for instance, operational changes in the company or changes in the business environment can impact time-varying beta. Macroeconomic variables, like rate of inflation, general business conditions and expectations about relevant future events may also trigger changes in the systematic risk (Bos, Newbold, 1984). Considering that beta is time-varying and can be influenced by the market environment, the current financial crisis that began 2007 has a potential effect on the systematic risk. The crisis has changed the expectations about business conditions and economic growth in the world. The volatility of the financial markets and capital flows in many countries of the world has increased. These changes in volatilities caused by the crisis phase of the market should influence time-varying beta by some means.

1.1. Problem Background and Discussion

The commonly applied Capital Asset Pricing Model (CAPM) developed by Sharpe (1964) and Lintner (1965), suggests that the risk measure in holding a given security is called a systematic risk, or beta, while the diversifiable component is referred to as unsystematic risk. As theory proposes, all other risk measures can be diversified away through portfolio formation. The CAPM also makes an assumption that beta is constant through time. Within the model, beta is defined as a slope coefficient of the linear relationship between the return on a security and the return on a market.

Global financial crisis started in USA as a collapse of a global housing bubble, but the roots themselves reclined deeper (Shah, 2009). Countries with large surpluses required investing their foreign exchange holdings. Money was flowing into developed countries, making money cheap as well as keeping low interest rates and facilitating the emergence of housing bubbles. High liquidity and low interest rates encouraged financial institutions and holders of assets to try to

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[1] CAPM critiques can be found in Tofallis (2008), Klarman (1991)

[2] Fabozzi and Francis (1978), Bos and Newbold (1984) , Collins, Ledolter, and Rayburn (1987), Woodward and Anderson (2009)

raise the rate of returns on their asset portfolios by increased leverage at the cost of higher risks. Often, those risks were underestimated (Wolf, interview, 2008). The results of the crisis were failure of financial institutions, banks and large businesses and recession in economic activities. During the crisis financial costs have increased due to changed bank lending rules, equity and market volatility has increased and profit fell. Alan Greenspan, a former U.S. Federal Reserve Chairman, said that while the economy was in worse shape in the Great Depression, the recent financial crisis was potentially more harmful than that in the 1930s because "never had short-term credit literally withdrawn" (Lawder, 2010).

1.2. Crisis Description

Scandinavian countries were influenced by the global crisis because of their high degree of openness and their dependence on exports of investment goods. This shock has been smaller than in many other countries, mainly because a financial crisis was not a new experience, since for example Norway and Sweden suffered severe crises in the early 1990s (Gylfason et al., 2010).

The downturn of the *Norwegian* economy started in early 2008, with a significant impact on foreign trade and international capital markets. The state authorities claim, the Norwegian economy is in recession (Norwegian National Bureau of Statistics, 2009). As in other Scandinavian countries, there are also domestic explanatory factors behind the decline in Norway. These are linked the continuous growing level of activity prior to the crisis especially in business sector investment and in residential construction (Norwegian National Bureau of Statistics, 2009). The slowdown was also reflected in the oil extraction when the prices of oil plummeted (OECD, 2008). Along that, money markets have not functioned normally and risk premiums have increased sharply. The market has been very volatile, with stock exchange indices fluctuating 10 per cent or more on some days. As in Sweden, refinancing market loans at home and abroad was problematic (Norwegian National Bureau of Statistics, 2008b).

At the end of 2008, *Sweden* entered a recession. The country was hit by the contraction in external demand of autos, telecommunications and construction equipment. Year-on-year exports fell 17% in June 2009 (U.S. Department of State, 2010). Swedish banking industry was affected as well. The financing of loans to corporations and households became problematic. Sectors with share holdings were affected by significant decreases in value later followed by the steep decline in the stock market (Swedish Bureau of Statistics, 2009a). The companies began to extensively use financial derivatives since the financial crisis began (Swedish Bureau of Statistics, 2009b).

The stock market in 2008 was distinguished by sharply falling rates and high volatility in Sweden. The Swedish National Bureau of Statistics reports that the Stockholm Exchange had a 42 percent downturn for the year of 2008 (Swedish Bureau of Statistics, 2009a).

In the automotive industry Sweden faced a significant challenge. Both car manufacturers and industry workers suffered. Swedish government responded by offering rescue loans for companies in the automotive industry that are in acute economic crisis. The purpose of such loans is help weakened companies as long as it takes to build up liquidation or restructuring plan (Regeringskansliet, 2009).

The financial stability in *Denmark* was also disrupted by the financial crisis. The collapse in the Danish real-estate market has hit both constructors and corporate investors. Residential investment is predicted to decline further on as well as sales of hosing forced by higher unemployment. This has a direct impact on the industrial goods and services sector (OECD, 2009a).

In the banking industry, bank's earnings have deteriorated and loan losses have surged. Cross-border money market transactions have deteriorated as well (OECD, 2009a). Comparing to 2007, the number of bankruptcies among businesses has increased by 61.6 per cent. The telecommunications sector and the transport industry were severely influenced (Fritsch, 2009).

OECD 2010 report states that *Finland* was affected most among the OECD. The trade collapse has occurred since Finnish exports are unique, with a high dependence on information and communication technology and capital goods (Statistics Finland, 2010).

As in the other Scandinavian countries, the financial market has also suffered. As for the banking industry, the low level of interest rates continues to pressure net interest income (Bank of Finland, 2010). Furthermore, banks' funding costs and credit risk premiums have risen as a result of the crisis. As a result, many companies encountered liquidity problems (Tervanen, 2009). Foreign investors have clearly reduced the weight of Finnish companies in their investments. Net subscriptions in domestic equity funds have been negative. Insurance institutions have also been under pressure to reduce their equity investments (Bank of Finland, 2008).

1.3. Purpose and Research Questions

Given the influence of the crisis on worldwide financial markets, the aim of this work is to empirically study the effects of the crisis on the time-varying beta of industries in the Scandinavian region. The paper will consider Scandinavian countries, such as Norway, Denmark, Finland and Sweden. To our knowledge, no other study investigates the influence of the current financial crisis on the time-varying beta of industries in the Scandinavian region. This research will aim to answer the following questions:

- Whether time-varying beta of the industries was affected by the financial crisis
- In which direction has higher market and industry volatility during crisis influenced time-varying beta coefficient

Weekly time-varying betas will be constructed from the conditional variances and covariance calculated using the bivariate GARCH model (BEKK). Mean betas for pre- and crisis period will be calculated. After time-varying beta construction the standard OLS regression will be applied to measure the impact and direction of the financial crisis on the beta.

Beta is an important part of modern finance. It is key in the asset pricing theory, calculation of abnormal returns, estimation of cost of the capital, the calculation of hedge ratios on futures markets, and so on (Moonis, 2003). Thus, beta is not only a theoretical tool, but a useful instrument in practice that measures systematic risk (one that cannot be diversified away). Since the importance of beta is unveiled, the results of this study might bring contribution for the financial decision makers.

1.4. Limitations

The limitation of the study includes investigating 14 supersectors (as defined by the Industry Classification Benchmark, ICB) [3] within Scandinavian region from 1 January 2000 till 30 April 2010. The research was based on ICB, though an alternative classification is available (Global Industry Classification Benchmark). Using NASDAQ OMX and Oslo Stock Exchange, only data according to ICB was provided. Also, those stock exchanges included a limited number of companies into a specific industry, which they have regarded as most representative.

This research does not consider all the individual sectors and subsectors of the industry (aggregates, such as supersectors are analyzed). Since the data was aggregated to represent the supersector of the particular industry, it can lack some values or any other relevant information.

1.5. Thesis Outline

CHAPTER 1. INTRODUCTION
In the introductory section the subject of this thesis is presented, starting with a problem discussion and background. The research questions and purpose are posed as well as limitations that are set up in the study.

CHAPTER 2. THEORETICAL FRAMEWORK
In this section, the general concept of beta is introduced and how it is used as a proxy for portfolio risk (or in this particular case industry risk) is presented. It is then followed by a discussion of how beta may change over time and present a GARCH method used to estimate the conditional beta.

CHAPTER 3. DATA AND METHODS
This part of the research provides a detailed description of the research method exploited. Chapter 3 gives a comprehensive outline of the data collection and data processing. The choice of regression method is presented, which is followed by the discussion of robustness check for the chosen models. The section concludes with the review of reliability and validity of the study

CHAPTER 4. RESULTS
In this chapter, the detailed discussion of obtained results is brought up. In a systematic manner the results are presented from the BEKK model and then followed by the regression results. The

[3] Note: industry, sector and supersector in this work are used interchangeably

section on regression analysis is divided into subsections to provide a deeper insight of the results.

CHAPTER 5. DISCUSSION AND ANALYSIS
The analysis chapter provides a deeper analysis of the results and provides explanation for such results. Outcomes of this research are compared the prior research and theoretical background. The discussion of crisis influence on the time-varying beta of Scandinavian industries is presented in detail. Graphs are given as a useful support tool for the results to draw valuable conclusions.

CHAPTER 6. CONCLUSIONS
In the last chapter concluding remarks are presented along with possible improvements for further research within the area of time varying beta and market crunches. Finally, the relevancy of this study is discussed and its value for investors and policy makers.

2. THEORETICAL FRAMEWORK

In this section, the general concept of beta is introduced and how it is used as a proxy for portfolio risk (or in this particular case industry risk) is presented. It is then followed by a discussion of how beta may change over time and present a GARCH method used to estimate the conditional beta.

2.1. Capital Asset Pricing Model (CAPM)

The systematic risk, beta, measures the volatility of a particular stock or a portfolio to the market. It is reflected in the degree to which returns a given stock tends to move up or down with the market. The purpose of beta coefficient is to measure this tendency of the stock. The beta determines how the stock affects the riskiness of a diversified portfolio. The concept of systematic risk (non diversifiable risk) or beta was first discussed under the frame work of capital asset pricing model (CAPM), presented by Sharpe (1964) and Lintner (1965). The model suggests that the expected returns of an asset are a positive function of three variables: beta, the risk free rate and the expected return in the market. The CAPM equation can be presented as:

$$R_i = R_f + (R_m - R_f)\beta_i \qquad (1)$$

The above equation of CAPM can be written as a simple time series model that is normally used to estimate betas in the CAPM context. This regression interpretation is

$$R_{it} - R_{ft} = \alpha_i + \beta_i \gamma_{it} + e_{it} \qquad (2)$$

where $\gamma_{it} = R_{mt} - R_{ft}$ and is known as risk premium. From the equation (2), β_i 's sensitivity is attributed to macroeconomic factors; ***e*** reflects non-systematic risk, the unexpected component that is sensible to unexpected events relevant only to the security *i* at time *t*. The expected return on an asset depends only on its systematic risk. No matter how much total risk an asset has, only the systematic portion is relevant in determining the expected return on that asset (Corrado and Jordan (2000), p.524).

CAPM that takes conditional expectations into consideration is known as conditional CAPM. The conditional CAPM provides a convenient way to incorporate the time-varying conditional variances and covariances. An asset's beta in the conditional CAPM can be expressed as the ratio of the conditional covariance between the forecast error in the asset's return, and the forecast's error of the market return and the conditional variance of the forecast error of the market return (Bodurtha and Mark, 1991).

2.2. Time-Varying Beta

In recent years, the general assumption of beta stationarity, which is fundamental to security return models such as CAPM has been argued. The evidence from research states that systematic risk varied across time.

In the research done by Rosenberg and Ohlson (1976), Bos and Newbold (1984), stock's beta coefficient was concluded to move randomly through time. Fabozzi and Francis (1978) and Bollerslev et al. (1992) provide tests of the CAPM that imply time-varying betas. Jagannathan and Wang (1996) and Lettau and Ludvigson (2001) suggest in their research that conditional CAPM with a time-varying beta is more efficient than the unconditional CAPM with a constant beta. Inaccurate estimates of beta can evolve if the econometric model is not able to mimic investor's learning process of time varying beta (Adrian and Franzoni (2004, 2005).

Berk, Green, and Naik (1999)) also suggest that if a firm's investment opportunities change over time, the firm's beta may be dynamic. Zhang (2003) decomposes the cash flow risks into two components: predictable from the firm's perspective (like demand changes or technology innovations) and one that is not. The latter component contains unpredictable systematic risks used in CAPM. Company's beta varies as the firm adjusts its business in response to predictable risks (Zhang 2003).

Several economic reasons suggest that beta may be time-varying:

- Beta is linked to the leverage of the firm (Hamada (1972), Mandelker & Rhee (1984). Fluctuations in stock prices lead to changes in leverage, thus frequent changes in beta can be expected (Black (1976), Braun et al. (1995))
- Beta is a measure of risk of an asset vis-a-vis the market. Rosenberg and Guy (1976) suggest, for example that if an event increases variance of the market returns but leaves the variance of a security unchanged, then such incidence will reduce the beta of that security.
- Equity can be viewed as a call option on the assets of the firm (Galai & Masulis (1976)). The research argues that beta of a stock is related to the beta of the firms assets through a factor that depends on the level of risk free interest rate. It is argued that if risk free interest rate is altered, then time-variation in beta can be expected.

There is evidence (Bollerslev et al. 1992) that stock and index returns show time-varying second moments. Because beta is equal to the ratio of covariance between market and stock returns to the variance of market returns, time-variation in the second moments of returns can generate time- variation in beta

2.2.1 . Impact of Market Conditions on Beta

Time-varying beta can be influenced by many factors such as macroeconomic and microeconomic forces (Bos and Newbold, 1984). Thus, the beta can be affected by changes in the business environment, market expectations and perception of risk and profitability.

Variety of research was conducted to test the relationship between beta and market conditions (individual securities (mutual funds (Fabozzi and Francis (1979)), size based portfolios (Bhardwaj and Brooks (1993)), risk based portfolios (Spiceland and Trapnell (1983)) and past performance based portfolios (Wiggins, 1992). The majority of these works determined the presence of the relationships but found the effect very feeble and mixed.

Woodward and Anderson (2009), in their study of beta reaction (24 Australian industries) to market conditions found strong and consistent evidence that security and portfolio betas have an impact by the market phase. The researchers found that betas, depending on the market phase, were different in most of cases. It was shown that beta was larger for the down market condition than for the up market.

According to the Choudhry's (2005) research, which tested effects of the Asian financial crisis of 1997-1998 on time-varying beta of several firms in Malaysia and Taiwan, the effect of excess market and firm's volatility had an effect on beta. The Choudhry's (2005) research has found a strong effect of the financial crisis and period after the crisis on time-varying beta of Malaysian firms. However, the results appear to be mixed— an increase in the beta of some firms and decrease in several instances. The effect of the firm volatility during the crisis and the period after was direct in half of the cases and the size of the effect was large (Choudhry, 2005). The market volatility during crisis period was significant for half of the companies and had negative impact on the beta in most cases (Choudhry, 2005).

According to King (2009), the changes in beta have both a statistical and economic explanation. Economically, the changing covariance of industry returns with market returns represents changing investors' decisions on the base of their perception of portfolio profitability and risk. Statistically, beta changes due to changes of covariance of industry returns with market returns and volatility of the market (King, 2009).

Greenhut (1991) argues that elasticity of demand of a particular industry has an impact on its volatility compared to the overall market trend. The industry with a generally elastic demand can be expected to coincide to the general market volatility, which will produce high beta (Greenhut, 1991). And industries with less elastic demand will have a lower changes in volatility compared to the market and, in turn, lower beta.

Beyond the aforementioned factors, industries are prone to economic cycles.[4] Cyclical industries are considered to be automobiles, housing and airlines which prosper in times of economic growth and stagnate in times of recession. The drug manufacturing and healthcare are generally non-cyclical industries (Business Dictionary, n.d.).

The cycles that such industries go through may not correlate with those of the overall economy and with a current crisis as well. On the contrary, there are some cyclical industries that react opposite to the overall economy and perform best during a recession. Berman and Pfleeger (1997) found that while the fluctuations of a large number of industries correlate with those in the aggregate economy, there were also many industries that are not sensitive to business cycles — such as the pharmaceutical, educational service and public service industries. Health service industry, for instance, even perform better during recessions. In general, the service sector shows fewer and less intense cyclical fluctuations than manufacturing industries, since it is less capital required, involves higher price and wage inflexibility and shows fewer swings in demand (Beyers, 2009).

2.2.2. Beta Estimation with GARCH Framework

GARCH models the variance of the error terms as a function of past values and additionally of its own past variance (Kroll, 2009). The most widely used GARCH specification asserts that the best predictor of the variance in the next period is a weighted average of the long-run average variance, the variance predicted for this period, and the new information in this period that is captured by the most recent squared residual (Engle, 2007).

GARCH is also less likely to break non-negative constraints. Using time dependent variance and covariance will enable the model to capture clustering effects in the data. It has been shown that variance in financial markets is high during certain periods and low during other (Brooks, 2008). When the variances change over time it means that the time series has heteroscedasticity, it has a changing volatility. Using GARCH will also allow mean reverting i.e. if there is a long term means periods of high volatility mean reverting will decrease volatility over time and periods with low volatility will increase over time (Brooks, 2008).
The covariance matrix (matrix of the covariance between the elements of a vector) is defined as follows:

$$V = \begin{matrix} \sigma_{11} & \sigma_{12} & \cdots & \sigma_{1n} \\ \sigma_{21} & \sigma_{22} & \cdots & \vdots \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{i1} & \cdots & \cdots & \sigma_{in} \end{matrix}$$

where $\sigma_{11} = var(x) = E[(X-\mu)^2]$ and $\mu = E(X)$

In the GARCH frame work this will be revaluated for every new observation.

[4] The industry life cycle can be defined as "patterns in industrial data of the industry, including sales, price, capital investment, and capacity. The duration of an industry cycle's phases (upturn or downturn) last more than a few months" (Tan, Mathews, 2010b).

The conditional variance estimates in GARCH(1,1), for instance, are used to generate the series of conditional time-varying betas. This approach has been applied in various studies to model time-varying betas (Mergner, Bulla, 2008). In the study done by Giannopoulos (1995) weekly local stock market data from 1984 until 1993 is used to estimate time-varying country betas. Conditional time-dependent betas for Australian industry portfolios are estimated in Brooks, Faff, and McKenzie (1998).

Although GARCH(1,1) is able to describe the volatility clustering in and other issues in returns, such as excess kurtosis, the standard GARCH model does not capture other important properties of volatility. Thus, an extension of basic GARCH model has been offered instead.

2.3 Hypotheses

The following hypotheses, which were constructed on the base of theoretical framework, will be tested:

Hypothesis 1:
Beta was influenced by the excess market and industry volatility during crisis period.

Hypothesis 2:
The beta mean is expected be larger during the crisis period.

Hypothesis 3
Excess volatility during crisis should have a positive effect on time-varying beta.

2. DATA AND METHODS

This part of the research provides a detailed description of the research method exploited. Chapter 3 gives a comprehensive outline of the data collection and data processing. The choice of regression method is presented, which is followed by the discussion of robustness check for the chosen models. The section concludes with the review of reliability and validity of the study.

3.1. Research Approach

The aim of this paper is to test empirically the effect of crisis on systematic risk, or beta. In particular, it is interesting to explore the impact of excess market and industry volatiles on beta. This is achieved by performing a quantitative analysis of Scandinavian industries during the period from 1 Jan. 2000 till 30 Apr 2010. Theoretical background was presented and previous studies were consulted. Deductive approach is applied: the abovementioned hypotheses would be tested and appropriate conclusions would be made.

Sources of Information

Database	**Description**
ELIN	Searching and collection of relevant articles, prior research and theoretical background in this study.
Datastream	Gathering data for industry indices under the research and MSCI Index
NASDAQ OMX/Oslo SE	Obtaining additional data, if there were missing values from Datastream
Statistical Central Agencies and Central Banks	Gathering data/information about the crisis in the Scandinavian region

3.2. Data Collection and description

The data used in this paper are weekly data for 14 industry portfolios, covering the period from 1 January 2000 to 30 April 2010. The information is retrieved from Datastream, a financial database from Thomson Financial Limited. From this source data regarding MSCI was also retrieved. If the data was unavailable within Datastream, NASDAQ OMX and Oslo SE were used. Weekly data is chosen to reduce the bias caused by infrequency of trading and the preference towards recent data. The frequency of data depends on the number of trades which is a function of firm size and is firm specific. Scholes and Williams (1977), Hung et al. (1995) Damodaran (1999) claim that when shares are traded very frequently or infrequently beta estimates are biased down and with average trading frequency the betas are biased up. In particular, non-trading on an asset during a return period can reduce correlation with the market index, and consequently the beta estimate (Damodaran, 1999). In a recent study of the financial crisis weekly series are used to avoid “overlapping problem and nonsynchronicity problem (Cheung et al., 2010, p.88). Authors argue that weekly data is better where global financial markets do not trade with the same exact trading hours and different opening or closing times between interacting global financial markets.

Table 1 presents an overview of the sectors according to the Industry Classification Benchmark[5] level 4 and the sector abbreviations utilized in the remainder of the paper.

Table 1. Subsector Classification According to Industry Classification Benchmark Structural Definitions

Subsector	Abbreviation
Automobiles and Components	Auto/Compo
Banks	Banks
Capital Goods	CAPGDS
Diversified Financial Services	FINS
Food, Beverage and Tobacco	FD/BV/TB
Healthcare	HC
Information Technology	IT
Industrial Goods and Services	IND
Media	Media
Oil and gas	Oil/gas
Real Estate	RE
Retail	RTL
Transportation	TRNSP
Utilities	UTIL

The companies included in each industry index are defined according to the stock exchange indices, OMX and Oslo SE respectively. In total there are 14 industries under the study and total of 827 companies with 195 in Denmark, 290 in Sweden, 202 in Norway and 140 in Finland. The industry index returns in local currencies were taken directly from OMX or Oslo SE.

Based on the CAPM theory, the stock returns have to be compared to the returns received from the market portfolio. One of the most commonly used market benchmarks is MSCI World Index (Pęksyk,2010). It is believed to reflect the world market returns and thus be the best proxy for the market portfolio. The index measures the developed equity market performance where markets that have reached a certain level of size, maturity, liquidity and with relatively few access restrictions, including convertibility of their currencies (Lyxor International Asset Management, n.d.). The MSCI World Index targets around 85% of each of the 23 global developed markets by free float-adjusted market capitalization. Deutsche Bank (2008) calls MSCI as a "recognized barometer of the world's developed economies. MSCI World Index is based on the basket of currencies.

Table 1 (Appendix 2) reports descriptive statistics for the initial data (skewness, kurtosis, and Jarque-Bera test statistics). A small probability value of Jarque-Bera test leads to the rejection of

[5] The Industry Classification Benchmark (ICB), the joint classification system launched by Dow Jones Indexes and FTSE Group. It is a detailed and comprehensive structure for sector and industry analysis, facilitating the comparison of companies across four levels of classification and national boundaries. Global financial institutions have integrated ICB into their investment workflow and financial services, including NASDAQ, NYSE/Euronext, the London Stock Exchange, the International Monetary Fund and the World Economic Forum, etc.

the null hypothesis of a normal distribution for all countries and industries. The series are asymmetric. Most of the data have positive skewness with the right tail of the distribution longer than the left. Swedish Food and Media industries have a negative sign of skeweness (distribution has a long left tail). Most of the series are leptokurtic, 8 series are platykurtic, and 3 series have kurtosis of the normal distribution.

3.3. Data Processing

The data processing involves computer software EViews, where the program code was used to implement GACRH BEKK model which was discussed in the theoretical background (section 3.3). After estimating variables from the BEKK model, the OLS regression is applied.

3.3.1. GARCH BEKK model

Multivariate GARCH models have been devised to model conditional covariance matrix of multiple time series. In such models, a stochastic vector series r_t with a dimension of (N×1), the conditional mean of r_t is an (N×1) vector μ_t and the conditional covariance of r_t is an (N×N) matrix H_t (Bollerslev et al., 1986). The GARCH BEKK model has been presented as a better alternative to other multivariate models, since it is able to capture the volatility spillover effects between different markets and ensure that H matrix is always positive definite. For the mean equation the following specification is used:

$yt=\mu t+\varepsilon t$, $\varepsilon t \sim N(0, H)$

where yt is a 2x1 vector, which contains industry and market returns; μt is 2x1 vector, which contains constants. The conditional covariance matrix is modeled by:

$$H_t = C'C + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + B'H_{t-1}B \quad (2)$$

C is N×N upper triangular matrix of constants, while A_i and B_i are N×N matrices of parameters. In the case of two variables (N=2) and p=q=1, the above equation can be written out in the following.

$$\begin{bmatrix} h_{11,t} & h_{12,t} \\ h_{21,t} & h_{22,t} \end{bmatrix} = \begin{bmatrix} c_{11} & c_{12} \\ 0 & c_{22} \end{bmatrix} \begin{bmatrix} c_{11} & 0 \\ c_{12} & c_{22} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} \varepsilon_{1,t-1}^2 & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon_{1,t-1}\varepsilon_{2,t-1} & \varepsilon_{2,t-1}^2 \end{bmatrix} \begin{bmatrix} a_{11} & a_{21} \\ a_{12} & a_{22} \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \begin{bmatrix} h_{11,t-1} & h_{12,t-1} \\ h_{21,t-1} & h_{22,t-1} \end{bmatrix} \begin{bmatrix} b_{11} & b_{21} \\ b_{12} & b_{22} \end{bmatrix} \quad (3)$$

A is a symmetric matrix that captures the ARCH effects. The parameters in A reflect to which extent the conditional variances of the two variables are correlated with past squared errors (Choudhry, 2005). The parameters b_{ij} in matrix B represent the persistence in conditional volatility between market *i* and market *j* (Worthington, 2004). Thus, the diagonal elements in matrices A_i and B_i– a_{11} ,a_{22} and b_{11} ,b_{22} capture the effects of own past shocks and volatility on its current conditional variance. The off-diagonal parameters in matrices A_i and B_i, a_{ij} and b_{ij}, measure the cross-market influences on the conditional variances and covariances, known as "volatility spillover" effects. Vector C represents constant components of covariances (Choudhry, 2005).

Figlewski (1997) emphasizes the importance of a GARCH-model that is sufficiently stable and hold over time. It takes into account excess kurtosis (fat tail behavior) and volatility clustering. Also, it provides accurate forecasts of variances and covariances of asset returns through its ability to model time-varying conditional variances (The Math Works, 2010). One disadvantage of the BEKK and other factor models is that the parameters cannot be easily interpreted. Also, the effects on the future variances and covariances are not readily seen (Tse, 2001). However, considering previous research in the area of beta variation and the nature of this research, GARCH BEKK model is sufficient to conduct the study and model beta volatility.

The parameters of the multivariate GARCH model can be estimated by maximizing the log likelihood function based on the assumption of conditional normality (Brooks, 2002):

$$L(\vartheta) = -\frac{TN}{2}\log 2\pi - \frac{1}{2}\sum_{i=1}^{t}(\log|H_t| + \varepsilon_t' H_t^{-1}\varepsilon_t)$$

where θ represents the unknown parameters to be estimated; N is the number of the series in the system; and T is the number of the observations.

The conditional variances and covariance are then used to construct a time series of time varying betas $\beta_{i,t}$ for any firm *i* at time *t* in the matrix form can be written as:

$$\beta_{i,t} = \widehat{H}_{12,t}/\widehat{H}_{22,t} \quad (4)$$

This formula is basically the same as the standard formula to calculate beta by dividing covariance of the market index and industry return by variance of industry:

$$\beta_{i,t} = \frac{\rho_{im}\sigma_{it}}{\sigma_{it}} \quad (5)$$

Given that conditional covariance and conditional variance are time-dependent, the stock/ industry beta will be time-dependent.

Though BEKK GARCH model is a valid model for time-varying beta estimation, there is a large variety of other models. Doing a similar analysis by using other estimation techniques can provide more insight into the problem. However, it is important to note that different beta estimation techniques are reported to behave differently in different markets. This indicates that it is very difficult to find a beta adjustment technique which succeeds well in all kinds of markets (Luoma et al., 1994). There might not be one single model that would fit exactly the same for all four countries; however, the study uses the model that best suits the research problem.[6]

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[6] Fama and Macbeth (1973), Fama and French (1997), Giannopoulos (1995), Faff, Hillier, and Hillier (2000), Koutmos, Kinf, 2002, Lewellen and Nagel (2005) Armitage and Brzeszczynski (2008)

3.3.2. Regression Model

A common tool in quantitative research is to use regression analysis in order to draw statistically significant conclusions.
The following regression is applied to investigate the effect of the crisis on the time-varying beta:

$$\beta_{it} = \alpha_0 + \gamma_0 D_t + \alpha_1 IV_{it} + \gamma_1 (IV_{it} D_t) + \alpha_2 MV_t + \gamma_2 (MV_t D_t) + \varepsilon_t \quad (6)$$

The dummy (D) takes the value of 0 from 1 January 2000 and 1 in the periods after 1 February, 2007. When the time variable dummy D is equal to 0, then the equation is reduced to:

$$\beta_{it} = \alpha_0 + \alpha_1 IV_{it} + \alpha_2 MV_t + \varepsilon_t \quad (7)$$

Where β_{it} is the individual industry time-varying beta as defined in Eq. (6), IV_{it} is the conditional volatility of the individual industry, MV_t is the market conditional volatility and ε_t is the random error term with the standard assumptions.

The financial crisis discussed before caused an increase in volatility of the financial markets in Scandinavia and around the world. There is a positive effect on beta by the *conditional volatility of the individual industry* (IV) and/or the *conditional volatility of the market* (MV) in the case when investors perceive a rise in the volatility as an increase in the risk of equity investment. The variables *IVD* and *MVD* assess possible effects of the *excess volatility of the individual industry* and *the market* during the financial crisis on the beta.

If the sign of parameters $\alpha_1$and α_2 is positive, then an increase of the industry or market should increase industry beta. As mentioned before, the effect of the crisis is studied by employing the time dummy in the regression. If $\gamma_1$and γ_2 are both significant and positive, then the industry and market *volatility during the crisis* directly affects the beta of the industries that are researched. Negative coefficients entail the opposite conclusion. Insignificant γ_1 and $\gamma_1$mean that *industry* and *market volatility during the crisis* had no additional (extra) impact on the time-varying beta.

3.3.3. Choice of the crisis period

The choice of the start date for the crisis period is related to several factors.

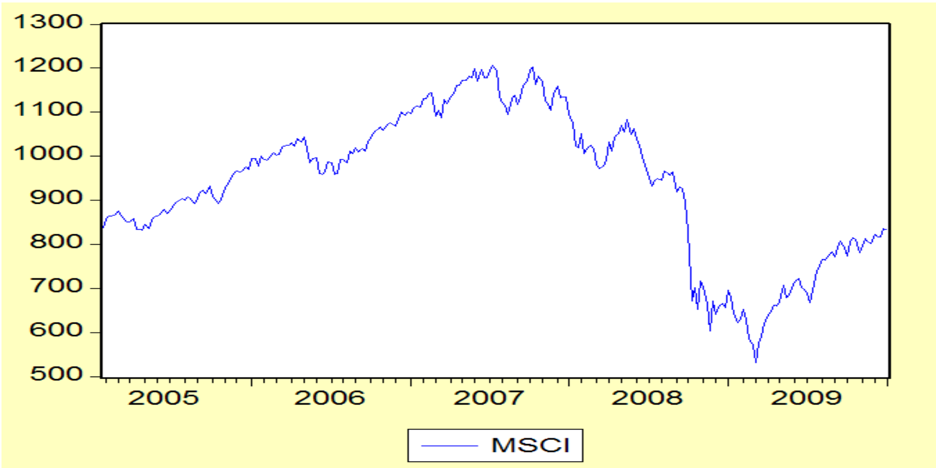
The year 2007 can be viewed as a beginning point of crisis by relating to the Figure 1 (Appendix 1) (Lamont Trading Advisers, 2008). Between November 2006 and March 2007 several events have occurred: ABX (Mortgage derivative) and banking indices reach their high points.

In February 2007, HSBC, the world's largest (2008) bank, wrote down its holdings of subprime-related mortgage backed securities by USD 10.5 billion, the first major subprime related loss to be reported (Le Vine, Magaldi, 2009).

Figure 2 (Appendix 1) shows the prices of US sub-prime mortgage credit default swaps (CDS), which began to fall in the late 2006. Between January and March 2007, swap contract prices began to decline, especially on those rated BBB and BBB-. It was an indicator of higher perceived default risk for the underlying assets. Besides that, global new CDO (collateralized debt obligations) issuance dropped sharply (see Figure 3, Appendix 1) and it became impossible to turn over outstanding stocks of commercial paper (Buiter, 2007).

The analysis of S&P500 and MSCI Indices also provides some insights as for the crisis dynamics. In March 2007, there has been a slight decline in the S&P Index, followed by the continuous spikes (Figure 4). The following figure shows the swings in the MSCI Index, which is used in the research as the market index.

Graph 1. MSCI World Index



Source:Datastream

Recent works done by Brunnermeier (2008) and Cheung et al. (2010) report on two dates of the interest period. The latter authors use July 2007 as the starting point of the global financial crisis. They argue that from that time and on the subprime crisis got more serious as AAA CDS (credit default swaps) got downgraded (Cheung et al., 2010). Though the study done by Brunnermeier (2008) reports another date from February 2007 as the starting point of the subprime mortgage default crisis (indicated by the drop of the ABX index (of CDS) backed by A, BBBB and BBB subprime mortgage). Cheung et al. 2010, however, argue that their alternative benchmark from July 2007 does not alter main results and conclusions. To capture the potential changes within the industries, this work will employ an earlier date from 1 February 2007.

3.3.4. Specification and Diagnostic Tests Used

Following issues will be targeted to ensure the adequacy of the model.

Heteroscedasticity

The regression model is tested for heteroscedasticity. Heteroscedasticity is present if the error term does not have constant variance (Anscombe, 1967). Heteroscedasticity can be identified using the White's test (1980), based on a heteroscedasticity-consistent covariance estimator. The test results are calculated by an auxiliary regression of the squared residuals on all possible crossproducts of the regressors (Brooks, 2008). The null hypothesis is that there is no heteroskedasticity in the series.

If heteroscedasticity is found in the data, the adjustment is made by available applications in the computer software. With the presence of heteroscedasticity flawed inferences can be made when testing the hypotheses (White, 1980).

Normality Assumption
The normality assumption states that variables follow normal distribution. A normal distribution is symmetric about its mean. However, financial data rarely displays this type of characteristics. Instead, it is rather skewed (Adcock, 2006). Therefore, the normality assumption is unlikely to hold when dealing with financial data.

A test is carried out on the distribution of the variables to check for normality, and the Jarque-Bera test is applied for this matter. For large sample sizes, violation of the normality assumption is almost negligible. According to the central limit theorem, the test statistics will asymptotically follow the appropriate distributions even in the absence of error normality (Brooks, 2008). If non-normality exists in the data set, one possible way is to relax the normality assumption in the OLS model, which might cause loss of model power (see further section Reliability and Validity).

Autocorrelation
Autocorrelation occurs when error terms from different (usually adjacent) time periods (or cross-section observations) are correlated. With first-order autocorrelation, errors in one time period are correlated directly with errors in the consequent time period. With positive autocorrelation, errors in one time period are positively correlated with errors in the next time period.

To test for autocorrelation several approaches can be applied. Ljung-Box test is a common portmanteau (general) statistic that tests linear dependence in time series (Brooks, 2008). Durbin-Watson also checks whether there is a relationship between an error and its immediately previous value. However, DW is valid only if a certain set of circumstances is fulfilled. First of all, a constant term in the regression must be present. Secondly, regressors have to be non-stochastic. Finally, there should be no lags of dependent variable in the regression. If there is a first order autocorrelation detected, it can be corrected by the AR(1) method of Generalized Least Squares. With the presence of lag dependent variable on right hand side, Breusch-Godfrey test has to be applied. It is more general than the DW test, since it does not impose the DW restrictions on the format of the first stage regression. The Breusch-Godfrey Test has the null hypothesis that there is no autocorrelation up to the specific number of lags (Brooks, 2008).

Stationarity
A stationary series can be defined as one with a constant mean, constant variance and constant autocovariances for each given lag. When data is non-stationary, spurious regressions may result. With non-stationarity, the t-statistic will not follow a t-distribution, and the F-statistic will not follow an F-distribution, etc. Also, a model with non-stationary coefficients will show that previous values of the error term have a non-declining effect on the current value of a dependent variable as time progresses (Brooks, 2008).The commonly applied stationarity tests to check for the above mentioned problems are Dickey-Fuller (DF), ADF (augmented Dickey-Fuller) and Philips-Peron (PP). They are used to test the input variables in the OLS regression. ADF tests individual series to ensure their stationarity. For the ADF null Hypothesis of having a unit root is

rejected if the t-statistics is less than the critical value. PP test is an extension of the Dickey-Fuller test and include an automatic correction to the Dickey-Fuller procedure to allow the autocorrelation in residuals (Brooks, 2008). According to Choi (1992), the PP test is more powerful than the ADF test for the aggregate data. The both tests are used to test the input variables in the OLS regression.

The robustness check is also ensured by taking a longer time frame of data (10 years) to compute time varying betas.

3.4. Methodological Problems

Problem of Missing Values

The problem of missing values is rather common in financial data. Three possible solutions are available to tackle this problem (Tucker, 1996): 1) Remove variables containing missing values; 2) The mean of the variable can be used to fill in the missing values across the sample; 3) Random values from the variable distribution can be used to fill in the gap. In this research, second suggestion 2 is implemented in the case of Finland, before the country introduced euro as its currency. Suggestion 1 is used in the case of Sweden for the Utility industry, since the available data covered the range from 1 Jan. 2000 till 10 Oct. 2003. Thus, there is no analysis done for Swedish Utility industry, since there are 343 missing variables from the period of Oct. 2003 till end of April 2010. The data was cross-referenced, in case that data missing from Datastream was due to the human factor mistake. However, same result was found when checking for historical index at the NASDAQ OMX.[7]

3.5. Reliability and Validity

Reliability

To ensure reliability of this study two areas have to be examined-- the reliability of the collected data and of the methods used.

Data was collected from Datastream, NASDAQ OMX and Oslo SE. Information retrieved from the primary source, Datastream database, is judged to be reliable. However, to verify data, few randomly chosen observations were cross referenced between Datastream and NASDAQ OMX and Datastream and Oslo SE. The checked variables have found to the same.
The MSCI Market Index was also cross referenced between Datastream and Bloomberg, which is an information service tool.

Central Bureau of statistics of each country is considered to be a highly reliable source and data extracted are considered accurate. Only human error in processing can influence data.

[7] NASDAX OMX Nordic website (section "Indices") was checked for available data.

BEKK and OLS regression were run using econometrics software EViews. OLS is based on several underlying assumptions that should hold to present the correct results. The result has to BLUE (Best Linear Unbiased Estimate), for example the residuals has to be normally distributed. The normal distribution assumption was relaxed since the sample is large enough. The problem of heteroscedastisity has also been found, but resolved by the means of White's method of Heteroscedasticity-Consistent Standard Errors & Covariance. It was used during the regression estimation as an option in Eviews. Other robustness checks were conducted: the Breusch–Godfrey test was used after the correction with AR(1) to check the presence of serial correlation; stationarity tests ADF, PP and KPSS. The robustness check is also done by taking a longer period of data (10 years) to compute time-varying betas.

Validity

Theoretical background on beta variation was central and it was found to explain the empirical findings of this research. However, it not only market and industry volatility are possible individual reasons for the beta variation during crisis. There may other external (economy wide) and internal factors (firm specific) contributing to the speculative bubble, which were not taken into account. The data collection methods were applicable in the context of this research and concepts under the study. OLS regression was used as a common statistical tool to analyze the relationship between dependent and independent variables. The analysis also adheres to the assumptions underlying OLS regression (BLUE). The choice of the crisis period is well argumented and can be applied as a reference point in the study.

4. RESULTS

In this chapter the detailed discussion of obtained results is brought up. In a systematic manner the results are presented from the BEKK model and then followed by the regression results. The section on regression analysis is divided into subsections to provide a deeper insight of the results.

4.1. BEKK GARCH Model Implementation and Results

Table 1 (Appendix 3) present the GARCH BEKK results. The ARCH coefficients (A_1 and A_2) are positive and statistically significant for all countries and industries implying that there is volatility clustering in both the industry and market returns.

The coefficients A and B are positive for all the other countries and the sum of A and B estimates in the conditional covariance equation is more than unity and consequently indicating the strong persistence of markets' volatility. That also means shocks in volatility do not vanish quickly with time. Based on the p value for z-statistics the null hypothesis of no cross effects is rejected. In other words, in all three cases (C, A, B) the statistical significance of the estimates shows the association between the variability of returns and MSCI World Index.

Table 2 (Appendix 3) reports descriptive statistics for results obtained from the GARCH BEKK (skewness, kurtosis and Jarque-Bera test statistics). A small probability value of Jarque-Bera test leads to the rejection of the null hypothesis of a normal distribution for most countries and industries. The associated p-value is bigger than 5% only for Norway's beta of the Capital goods, Real Estate, Transport industries, Denmark's beta of Banks, Capital goods, Finland's beta of Retail, Auto-compo industries. Thus, the data are normally distributed. The rest of the series are asymmetric. Most of the data have positive skewness with the right tails of the distribution longer than the left one. All variance data have positive skeweness. Sweden's beta of Capital goods, Banks, Health care, IT, Retail, Industrials, Denmark's beta of Health care, Transport, Industrials, Finland's beta of Banks, Capital goods, Food, IT, Industrials have negative sign of skewness (distribution has a long left tail). Most of the series are platykurtic, 22 series are leptokurtic.

After analysis of the data and application of the Ljung-Box test on standardized (normalized) residuals, all series are found to have serial correlation.[8] According to Figlewski (1997) correlation is rather common in financial time series. It might come from bid-ask bounce or from index series that are less liquid (Figlewski, 1997). However, in two industries (Auto/Compo and Industrials) the null hypothesis of no autocorrelation was accepted. The results are presented in Table 3 (Appendix 3).

The visual representation of beta from the GARCH BEKK model is shown in Figure 1 (Appendix 3). Some of the graphs show that time-varying beta is more volatile during the crisis (Banking industry, Div finance Norway and Sweden, real estate Finland, industrials sector for Norway and Sweden, food Denmark) but it is not very clearly shown.

Table 4 (Appendix 3) presents the mean values for beta pre-, during crisis and for the whole period. Most of the industries' beta has increased (auto/compo, banks, capital goods, industrials, oil/gas, real estate and utilities). The discussion of auto/compo, banks and capital goods industries is also presented in the crisis section, describing the impact of the crisis on those industries. Thus, the background information is consistent with our results. Diversified financial services, food/bev/tobacco, media, retail, transportation have remained approximately on the same levels.

Though Table 4 (Appendix 3) presents the beta during pre-crisis and crisis period, the mean value provides only general overview (for example, at times there are positive beta values and negative beta values).[9] By using the regression analysis it can obtain a deeper insight how the crisis has influenced beta.

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[8] p-values of Ljung-Box test for all other industries and countries (except Auto/Compo and Industrials) were equal 0.000

[9] By general results, we mean that there was no regression applied yet. Mean beta was calculated by dividing data into pools based on the date when the crisis started.

4.2. Regression Implementation Using Ordinary Least Squares Method

Before running the regression, the variables there checked for the unit-roots. ADF (augmented Dickey-Fuller) and Philips-Peron (PP) tests were used to test the variables. The results from PP test reject the null-hypothesis of non-stationarity at the 10 % level (Appendix 4, Table 1). The ADF test results support the conclusion with the exception of Finland Food, Norway Media, Finland Industrials. Therefore, the results in general indicate that the variables are stationary in levels so they can be used in standard OLS regression estimation.

After estimation of the equation (6) using Ordinary Least Squares Method, the White's (1980) general test for heteroscedasticity was conducted. It showed a presence of heteroscedasticity in residuals (Appendix 4, Table 2). In such case, OLS coefficients is not biased, but the variance of the coefficients will be underestimated and the standard errors may be wrong (Brooks, 2008). So, the coefficients obtained from the regressions seem to be statistically significant, but actually they do not differ from zero. Thus, in order to ensure the preciseness of OLS estimators, White's method of Heteroscedasticity-Consistent Standard Errors & Covariance was used during the regression estimation. The method has reduced the t-statistics for the estimators.

Serial correlation was found in the estimation. Low value of Durbin-Watson statistics (Appendix 4, Table 2) showed high positive first-order correlation in the residuals for all regressions. Breusch-Godfrey test for serial correlation in the residual was also conducted with 4 lags. 4 lags were chosen as the data are weekly. Breusch-Godfrey also strongly indicates similar result that null hypothesis (no serial correlation) cannot be rejected (Appendix 4, Table 3). However, the t-statistics on RESID(-2), RESID(-3) and RESID(-4) is low and probability value is high. That suggests a first-order AR(1) correlation. In case of autocorrelation, OLS estimators are unbiased, but they are not efficient and the standard errors can be wrong (Brooks, 2008). Thereby, in order to secure the estimators, all regressions are corrected for the autocorrelation by using the AR(1) method of generalized least squares (GLS) equation estimation. The method improves the behavior of the model and eliminates first-order serial correlation. The Breusch–Godfrey test was used after the correction to check the presence of serial correlation (Appendix 4, Table 4) as Durbin-Watson test is not valid if lagged dependent variables are present. Correction improved the results except for Denmark-Banks, Sweden- Food and Media industries.

4.3. Regression Results

56 regression estimations were conducted. The results of the estimations are presented in the Table 1 (Appendix 5). The diagnostic statistics shows satisfactory results. The coefficient of determination (R-squared) ranges from 0.277 to 0.952 with the average of 0.826.

a) Industry volatility ($\alpha_1 IV$)

The results show that industry volatility ($\alpha 1$) has a significant effect in 41 cases. In all cases the coefficient is positive. This implies that with increasing volatility of an industry, the beta for the industry increases (i.e. the systematic risk increases). The coefficient is significant for all countries in Industrials, Transport, Health care, DivFinance sectors. The highest effect is present in Health industry for Finland (0.169), in DivFinance for Norway (0.082), in Transport for both

Norway (0.059) and Finland (0.063). High $\alpha 1$ is present in the Industrials sector for the all countries (Norway (0.05), Sweden (0.046), Denmark (0.052), Finland (0.072)). The smallest effect of the industry volatility is found for Auto/Compo and Media sectors. Utilities and Food sectors have a significant coefficient only for Finland and Norway. Retail sector has significant coefficients for Norway and Finland.

b) Industry volatility during crisis period (γ_1IV)

The *industry volatility for the crisis period* ($\gamma 1$) has significant coefficients in 21 cases. In 5 cases the coefficient is positive (namely, Finland (Food/bev/tobacco and Media), Sweden (Retail), Norway (Utilities), Denmark (Utilities)). Negative coefficients indicate that the positive effect on beta of higher industry volatility (α_1IV) is reduced during the crisis.

Industrial sector has negative coefficients for the all countries. This effect is high comparing to other industries' coefficients (Norway (-0.03), Sweden (-0.024), Denmark (-0.04), Finland (-0.06)). The *industry volatility during the crisis period* has a relatively large effect on a Retail industry (Norway (-0.052), Sweden (0.051)), Food (Finland (0.051)), DivFinance (Norway (-0.043)). The least affected by the *industry volatility during crisis* are such industries Media, Oil/Gas, Transport, Health care, and Capital good sectors. Auto-compo, IT, Real Estate industries has not changed significantly by the *industry volatility during the crisis period* for any countries' beta.

In general, the *industry volatility during the crisis period* appears to have a smaller and, often, inverse impact on the betas comparing to the *industry volatility during overall period*.

c) Market Volatility (α_2 MV)

The market volatility (α_2) has a significant negative effect in 39 cases. IT was affected most for the all countries (Norway (-0.0567), Sweden (-0.09), Denmark (-0.05), Finland (-0.05)). Industrials sector also has quite high coefficients for the all countries (Norway (-0.045), Sweden (-0.048), Denmark (-0.04), Finland (-0.037)). Within the Transport sector the effect was approximately the same for the all countries (Norway (-0.04), Sweden (-0.04), Denmark (-0.031), Finland (-0.028)). Utility and Oil/Gas industries (with significant coefficient only for Finland and Norway) had the smallest effect.

d) Market Volatility during crisis period (γ_2MV)

The *market volatility for the crisis period* (γ_2) has the significant coefficients in 32 cases. The coefficient is relatively high and negative only in one case (Utility industry, Denmark -0.28). The coefficients indicate that the negative impact of market volatility (α_2 MV) is reduced during the crisis period. The positive coefficients mean that the negative impact of market volatility (α_2 MV) on the betas of the industries is increased by higher *market volatility during the crisis period*.

The Industrials, Transport, IT sectors have significant coefficients for the all countries. IT industry has the highest coefficient. It means that this industry was highly affected by the market volatility during the crisis period. Transport and Industrials were influenced by about the same intensity.

Some of the industries have rather small significant coefficients. For example, it is Oil/Gas and Real Estate in Norway (0.02 and 0.008 respectively); Food/bev/tobacco in Sweden (0.03); and Auto/Compo in Finland (0.02). The market volatility has no positive significant coefficients in the Utility sector.

e) Dummy variable (γ_0)

The *dummy variable* (γ_0) has significant coefficients in 20 cases. The coefficient is relatively high and positive in 13 cases. The Retail sector in Norway and IT in Finland have the highest coefficients (1.91 and -0.75 respectively). The crisis dummy positively influenced Denmark in all significant cases and negatively influenced Sweden in most significant cases. Industrials sector was influenced positively in all countries except for Sweden.

5. DISCUSSION AND ANALYSIS

This chapter provides a deeper analysis and explanation of the results. The outcomes of this research are compared the prior research and theoretical background. The discussion of crisis influence on the time-varying beta of Scandinavian industries is presented in detail. Graphs are given as a useful support tool for the results to draw valuable conclusions.

In general, the impact of the *market volatility on the time-varying beta during the crisis period* appears to be similar in size comparing to the *market volatility influence during total period*. However, *market volatility during the crisis period* has inverse coefficients.

Parameter $\gamma 0$ has significant coefficients in many cases. Coefficients are relatively high and positive in the most significant cases. It suggests the influence of the crisis on the beta.

There are no cases where parameters $\alpha 1$ and $\alpha 2$ were both significant and positive. Thus, there is no a clear evidence that the volatility of both the industry and market jointly increase industry beta. Also, there are no cases when coefficients $\gamma 1$ and $\gamma 2$ are both significant and positive. As a result, there is also no clear evidence that the *extra volatility of the industry and market during the crisis period* together directly affect the industries' betas.

It appears that the higher volatility during the crisis has similar (in case of *market volatility*) or smaller (in case of *industry volatility*) size effect on the time-varying beta of the Scandinavian countries' industries comparing to total volatility. The $\gamma 2$ coefficient (*market volatility during crisis period*) indicates that the negative impact of market volatility (α_2 MV) is reduced during the crisis period. So, the relationship between *the market volatility during the crisis period* and the betas is positive.

Interestingly enough, $\alpha 2$ (*market volatility during overall period*) decreases beta coefficient (in the most statistically significant cases $\alpha 2$ decreases beta). The parameters $\alpha 1$ (*industry volatility during total period*) and $\gamma 2$ (*market volatility during the crisis period*) have positive significant coefficient in all cases, except one. These results indicate that there is a positive influence of *industry volatility during total period* on the systematic risk. The *extra market volatility during the crisis period* reduces negative influence of market volatility during total period, which in a way has a positive effect on the systematic risk.

With regards to economic significance of the results, the estimated significant coefficients of market volatility are quite small in the range of 0.008- 0.169; most of the coefficients of market volatility are in the range of 0.01-0.09. The standard deviation of market volatility is 9.98. Thus, the "standard" effect on beta varies from 0.1 to 0.9. So, the estimated coefficients of market volatility are large enough for economic significance to be present.

The estimated significant coefficients of industry volatility are in the range of 0.0025-0.28; most of the coefficients are in the range of 0.01-0.06. The standard deviation of industry volatility is in the range of 175 (Norway, Auto/compo) - 2.27 (Finland, Transport). Thus, the "standard" effect on beta varies from 0.1 to 0.9 (except Health care in Finland 0.019 and Retail in Norway 0.055). So, the estimated coefficients of industry volatility are large enough for economic significance to be present.

5.1. General Results According to Individual countries

Norway

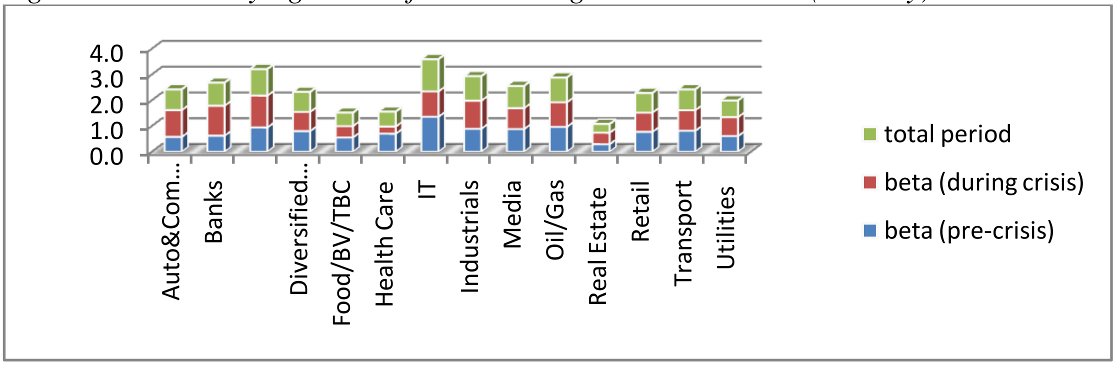
Estimated significant coefficients for Norway (Table 2, Appendix 5) indicate that the *industry volatility during total period* increases beta. The highest influence has DivFinance sector. Several industries (i.e. DivFinance, IT, Media, Oil/Gas, Real Estate, Retail, Transport, Industrials) experienced a reduction of negative influence of *market volatility during total period* as a result of higher *market volatility during the crisis period*. The IT industry has the highest coefficient. At the same time, the same industry betas experienced a reduction of positive influence of *industry volatility during total period* due to the higher *industry volatility during the crisis period*.

Extra *volatility during crisis* (in total, market plus industry volatility) has positive influence on beta of IT, Media, Real Estate, Transport and Utilities industries as it reduces negative influence of *volatility during total period*. *Total volatility for all periods* (mutually *market* and *industry volatility)* decreased beta in such cases— Capital Goods, Media and Retail industries. Auto/Compo, Capital Goods and Health Care sectors do not have significant coefficients for the crisis parameters. Utilities sector has positive coefficient for the excess *industry volatility during crises period* which indicates that this crisis volatility increased positive effect of the *industry volatility during total period*. Real Estate and Transport industries have the highest positive coefficients of the *overall volatility* influence. The effect of *volatility* on beta *during total period* is higher than for the *volatility* influence *during the crisis period* in all cases, except for IT, Transport and Utilities sectors.

Crisis dummy variable has positive significant influence on Auto-compo, Banks, Div/Finance and Retail and negative on Health care and Industrials sectors. The Retail industry is the most affected industry by the crisis as it has the highest positive coefficient (1.91).

The time-varying means of beta during pre-, during and total period are presented below.

Figure 1. Time-Varying Mean of Beta During Various Periods (Norway)



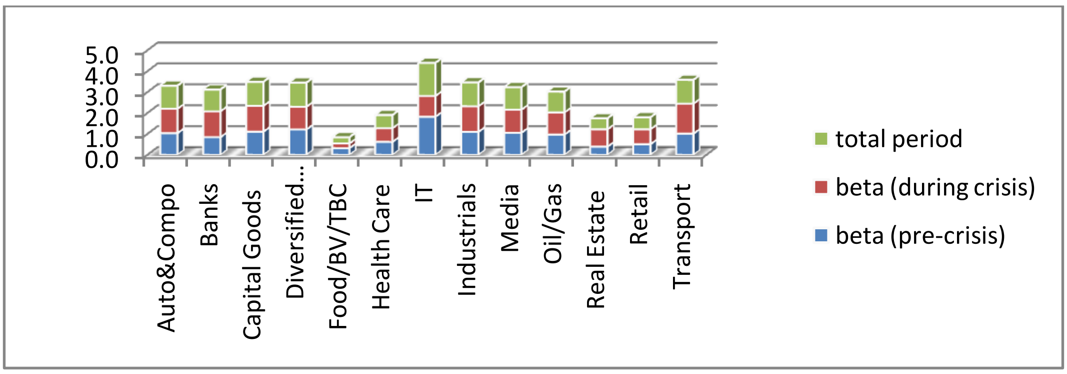
The graph indicates that the mean beta increased in 6 cases and remained nearly the same only in 3 cases. Both, mean beta and regression analysis indicate that the time-varying beta of the Norwegian industries was affected by the crisis. According to regression outputs, IT, Transport and Utilities sectors are the most affected industries by the *excess volatility during crisis period* (regardless the direction of the impact).

Sweden

Equation's significant estimators (Table 3, Appendix 5) indicate that the positive increase in beta is attributed to the *industry volatility during total period. Market volatility during the crisis period* reduces negative impact of *market volatility during the total period,* thus it has positive impact on the beta. The IT sector was hit most by the higher *volatility during crisis* (market volatility, 0.072). Retail sector also has quite high positive coefficient of the *crisis volatility* (industry volatility, 0.051); that indicates that this *crisis volatility* increased the positive effect of the *industry volatility during total period*. Auto/Compo, Oil/Gas and Real Estate sectors did not have a significant impact by the crisis volatility. Though, Auto/Compo industry has been struggling in Sweden, the results can be explained by the governmental intervention to help troubled companies. Changes in expectations could have been reflected in Banks, Capital Goods, Health Care, Media, Retail, and Industrials sectors which have been influenced by the *crisis volatility* more that by the *total volatility*.

Crisis dummy variable has negative significant influence on Food, IT, Retail industries and positive on the Transportation sector. The IT sector is the most affected by the crisis as it has the highest negative coefficient (-0.638).

Figure 2. Time-Varying Mean of Beta During Various Periods (Sweden)



Mean beta was increased in 10 cases. The results indicate that the time-varying beta of the Swedish industries was affected by the crisis. Banks, Capital Goods, Health Care, Media, Retail, and Industrials sectors are the most affected industries by the *excess volatility during crisis period*.

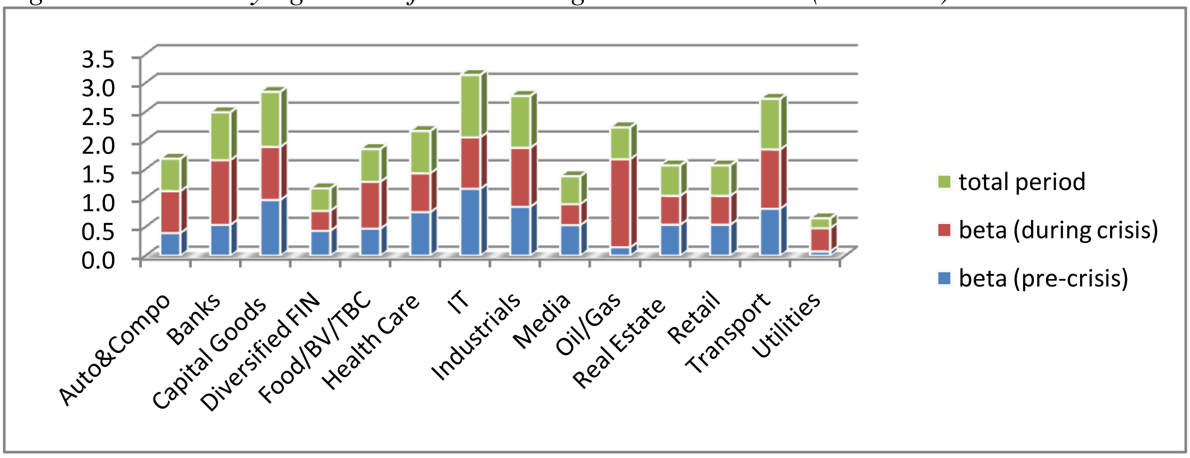
Denmark

Equation's significant estimators (Table 4, Appendix 5) show that Auto/Compo, Banks, Capital Goods, Food/Bev/Tobacco, Oil/Gas, Real Estate, Retail sectors do not have significant coefficients for the *volatility during crisis period*. IT and Media sectors were highly affected by the *volatility during crisis* (market volatility, 0.0265 and 0.0251, respectively*)*. Large impact on the telecom and transport industries is supported by Fritsch (2009) who explored the same sectors.

Utilities sector has positive coefficient for the excess *industry volatility during crisis period* while the *industry volatility during total period* does not have significant coefficients. This indicates positive influence of the excess *industry volatility during crisis* on Utilities' beta. Also, the sector has similar situation with market volatility with no significant coefficients for the volatility for total period and negative coefficient for crisis period.

Crisis dummy variable has positive significant influence on Oil/gas, Utilities and Industrials sectors. The sectors have large coefficients with Oil/gas sector as the most affected by the crisis (0.73).

Figure 3. Time-Varying Mean of Beta During Various Periods (Denmark)



In 7 cases crisis mean beta is higher than pre-crisis mean beta. Only in 3 cases mean beta have similar results for the both period. Thus, the time-varying beta of the Danish industries was affected by the crisis. According to the regression results, the most influenced industries are DivFinance, IT, Media and Transport sectors.

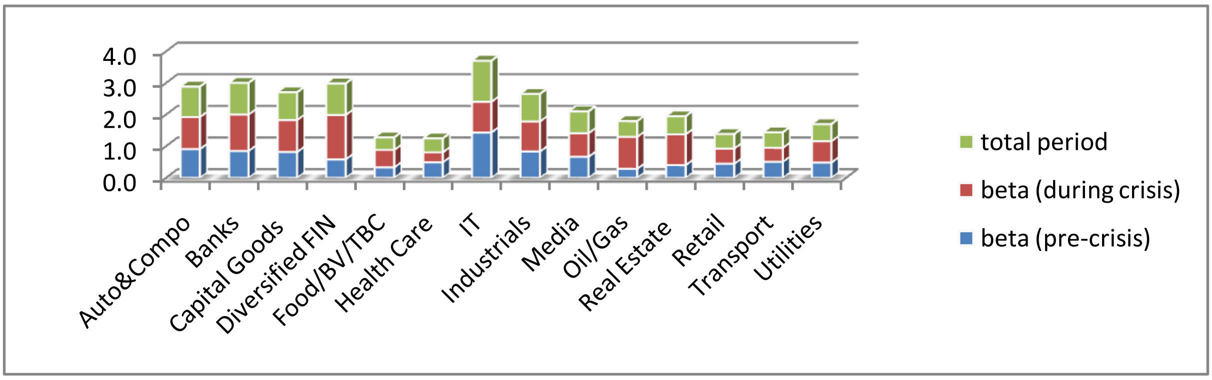
Finland

Equation's significant estimators (Table 5, Appendix 5) indicate that the absolute value of influence is higher for the *volatility during crisis period* than for *the volatility during the total period* (e.g. Banks, Food, Health Care, Media, Retail sectors. The result for the banking industry is consistent with the OECD 2010 and Bank of Finland (2010) reports (in the Crisis section 2.4.) on weakening of the banking sector. Oil/Gas and Real Estate sectors have no significant coefficients for *the volatility during crisis*. IT and Food sector has the highest positive effect of the excess *volatility during crisis* (market volatility, 0.04637 and industry volatility 0.05121, respectively). Figure 4 shows the mean beta during various periods.

Food and Media sectors have the positive coefficients for the excess *industry volatility during crisis period* while the *industry volatility during total period* does not have significant coefficient for the Food industry. This fact indicates that excess *industry volatility during crisis* on Food' beta was positively influenced. The same positive impact is observed for *industry volatility during total period* on Media's beta.

Crisis dummy variable has positive significant influence on Oil/gas, Utilities, Industrials and Banks sectors and negative coefficients of Food and IT sectors. The sectors have quite large coefficients (except Banks) with IT sector as the most negatively affected by the crisis (-0.75).

Figure 4. Time-Varying Mean of Beta During Various Periods (Finland)



The graph indicates that the mean beta increased in 10 cases and remained nearly the same only in 2 cases. According to regression outputs, Banks, Food, Health Care, Media, Retail sectors are the most affected industries by the *excess volatility during crisis period* (regardless the direction of the impact). The results indicate that the time-varying beta of the Finnish industries was affected by the crisis.

5.2. Analysis

Considering the mean beta results and significance of regression dummy coefficients, it can be concluded that *Hypothesis 1* is proved. There is a clear evidence of the effect of crisis on beta. The mean beta has changed in most cases as well as the coefficients for dummy and variables with dummy have been significant in many cases. The crisis dummy has fairly large significant coefficients. The mean values for beta during crisis have increased, while there has been a decline in two industries, such as health care and IT. This is consistent with *Hypothesis 2*.

Considering mutual effects of *market* and *industry volatility*, the results are mixed depending on industry and country. Such conclusions correspond to the previous research which tested the relationship between beta and market conditions.

Higher *industry volatility during crisis* affected beta by decreasing positive impact of *industry volatility of the total period* in the most significant cases, while *market volatility during crisis period* reduced negative impact of *market volatility during the total period.* The results of the interaction terms can conjecture a non-linear effect, when the impact on beta can depend on the amplitude of the volatility; it shows what the increasing *volatility during crisis* marginally decreases effect of *volatility during the total period*.

Three industries were affected most in Norway (IT, Transport and Utilities sectors), six industries in Sweden (Banks, Capital Goods, Health Care, Media, Retail, and Industrials sectors), four industries in Denmark (Div/Finance, IT, Media, Transport sectors), and five industries in Finland (Banks, Food/Bev/Tobacco, Health Care, Media, Retail sectors).

IT industry was influenced most among other industries by the higher *market volatility during the crisis period* in all countries. In Denmark and Norway IT sector has been influenced more during the crisis period comparing to total period.

According to the regression output, excess *market volatility during crisis* reduced negative impact of *market volatility during the total period,* thus it has the positive effect on the beta. On the other hand, *industry volatility during crisis* period is less often significant and affects beta by decreasing positive impact of *industry volatility of the total period* in the most significant cases. The results of the regression with negative signs of the coefficients of *industry volatility during crisis period* and positive signs of *market volatility during crisis'* coefficients contradict the conclusion of Choudhry's (2005) research.

Positive sign of *market volatility during crisis'* coefficients is consistent with *Hypothesis 3*. But the aggregated results of the interaction terms can conjecture a non-linear effect, when the impact on beta can depend on the amplitude of the volatility; it demonstrates what the increasing *volatility during crisis* marginally decreases the effect of *volatility during the total period*.

Positive sign of *the market volatility during crisis* appears to be logical. The global economic crisis, which started outside the region and had an intense impact on the global market volatility, had a severe impact on Scandinavian economies (discussion of crisis section 1.2). The latter are rather highly globalized and thus are subject to external influences.

As stated earlier, the changes of betas have both a statistical and economic explanation (King, 2009). In economic sense, the changing covariance of industry returns with market returns represents changing investors' decisions on the base of their perception of industry risk and profitability. In statistical sense, beta changes due to changes of covariance of industry returns with market returns and volatility of the market. The results show the effects. For instance, the covariance for Media industry of Denmark increases from the beginning of 2008, but rise in variance of market is increases even higher, leading to the decreased mean beta during crisis period. Thus, smaller betas of some industries during crisis period can be explained by a smaller covariance of industry returns with the market returns.

To some degree, changes in beta can be explained by a type of the industries which differ by the elastic demand for their products or services. The industries that are subject to a more elastic demand are expected to experience comovements with the overall market changes. Industries with less elastic demand will have lower changes in volatility compared to the market and, in turn, lower beta. Thus, for example, mean beta for Food/Bev/Tobacco (Norway, Sweden), Health Care (Norway, Denmark and Finland), Retail (Norway, Denmark) and Transport (Norway, Finland) industries is lower or similar during the crisis period.

This can be related not only to the elasticity of demand, but also the cyclical nature of those industries. For example, in Norway, total volatility for all periods (pre- and during crisis) decreased beta for the Capital Goods industry. In Sweden, on the other hand, beta for the same industry was influenced more by the crisis volatility. This shows that Capital Goods industry can be subject to individual country changes and specific cycles[10]. In essence, industry-specific factors may prompt industry cycles. This may cause a different pattern from the general business cycle. Thus, usage of business cycles as a common situation for firms may overlook heterogeneity that is present across industries (refer back to theory section 2.2.1., discussion of cyclicality and industries). An example of such heterogeneity can be done my looking at the Auto/Compo industry in Finland and Industrials in Denmark. By comparing these industries with the variance of MSCI index, during a stable period (approximately from 2003 to 2006) these industries exhibit cycles (consistent with Cabarello, 1990). On the other hand, service sector generally shows less cyclical and intense fluctuations, compared to manufacturing (same result reported by Berman, Pfleeger (1997) and Beyers (2009). This is can be seen on Health Care industry in Sweden and especially Finland (Figure 1, Appendix 5).

Regarding to the constant term, $\alpha 0$ is almost always significant and have quite large coefficients for the all countries. This coefficient represents the amount of beta value which is not determined by explanatory variables (*market* and *industry volatilities*). It is likely that other variables could have influenced beta. First of all, it can be attributed to the industry cycles mentioned before and industrial variables that could have an impact (i.e. sales, price, capital investment and capacity).

[10] There is little agreement in terms of definition of industry cycles as well as techniques to identify them (Axarloglou, 2003; McClean, 2001).

6. CONCLUSION

In the last chapter concluding remarks are presented along with possible improvements for further research within the area of time varying beta and market crunches. Finally, the relevancy of this study is discussed and its value for investors and policy makers.

The world financial crisis that started in 2007 has an intense effect on the economic situation of the Scandinavian region. One of the main effects is an increased risk of investment and raised financial market volatility as well as industries' volatility.

This research paper empirically studies whether the crisis had an effect on the time-varying beta of 14 supersectors (industries) in the Scandinavian region. Weekly time-varying betas were constructed from the conditional variances and covariance calculated using the bivariate GARCH model (BEKK). The weekly data from Datastream, NASDAQ OMX and Oslo SE data for 14 industry portfolios, covering the period from 1 January 2000 to 30 April 2010 were used in the model. Mean betas for pre- and crisis period were calculated, too.

After time-varying beta construction the standard OLS regression was applied to measure the impact of the financial crisis on the beta. To capture the potential changes within the industries, the research applied an earlier date from 1 February 2007 to determine the crisis period. The effect of crisis on time-varying betas was investigated by applying *conditional volatility* and *excess conditional volatility during crisis period* of the industry and the market as independent variables to the OLS regression.

The results obtained in the research provide a clear evidence of the crisis influence on the time-varying betas of the 14 industries in the Scandinavian region. The mean betas have changed as well as many coefficients of dummy variables have been significant. The mean values for the betas during crisis have increased in the most cases.

In regards to the direction of the higher volatility during crisis, the excess *market volatility during crisis* reduced negative impact of *market volatility during the total period*, while i*ndustry volatility* affected beta by decreasing positive impact of *industry volatility of the total period.*

Considering the mutual effects of excess market and industry volatility (due to the crisis), in general, the results are mixed and relatively weak depending on industry and country. It demonstrates what the excess *volatility during crisis* marginally decreases the effect of *volatility during the total period*.

The findings support the previous research concerning depending time-varying beta on the market phase and relationships between beta and market condition. Also, mean betas rise (in the most cases) during crisis period supports the previous evidence that beta is larger for the down market condition than for the up market.

Considering the signs of the excess *market* and *industry volatility during crisis period,* the results of regression analysis contradict previous research of an effect of the Asian financial crisis on time-varying beta of several firms (Choudhry, 2005).

The findings provide more clear understanding of the relationships between beta and changes in market conditions due to the crisis. The obtained results empirically confirm the presence of the connection between time-varying beta and excess volatility during crisis, but the link is relatively weak. As the beta coefficient provides information about the systematic risk and has impact on firms' share valuation, the investigation of the increase in beta due to the excess market and portfolio volatility has implications for the decisions in the portfolio management of the investors who have their own perception of portfolio risk and profitability. The higher market risk increases investors' claims for the higher risk premium. Thus, investors can change their investment policy and apply effective hedging tools. Also the study can be used in financial operations of companies and governments which desire to have some control over the crisis effects and its consequences.

Further research in this area could focus on several issues. Since there is a limited number of studies dealing with time-varying beta during the crisis, industries in other developed countries could be researched. There are no studies conducted on the Scandinavian industries during crisis period as well. [11]Another suggestion is to use other models available. This might yield some more accurate results. Finally, new research can be extended to use sectors and not supersectors of the industry.

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[11] A new study could compare banking/finance industry for Norway and Sweden, since those countries faced a banking crisis in the 1990s. Results from such research could be compared to the current crisis.

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APPENDIX 1

Figure 1. Credit Crisis Timeline (Lamont P., 2008)

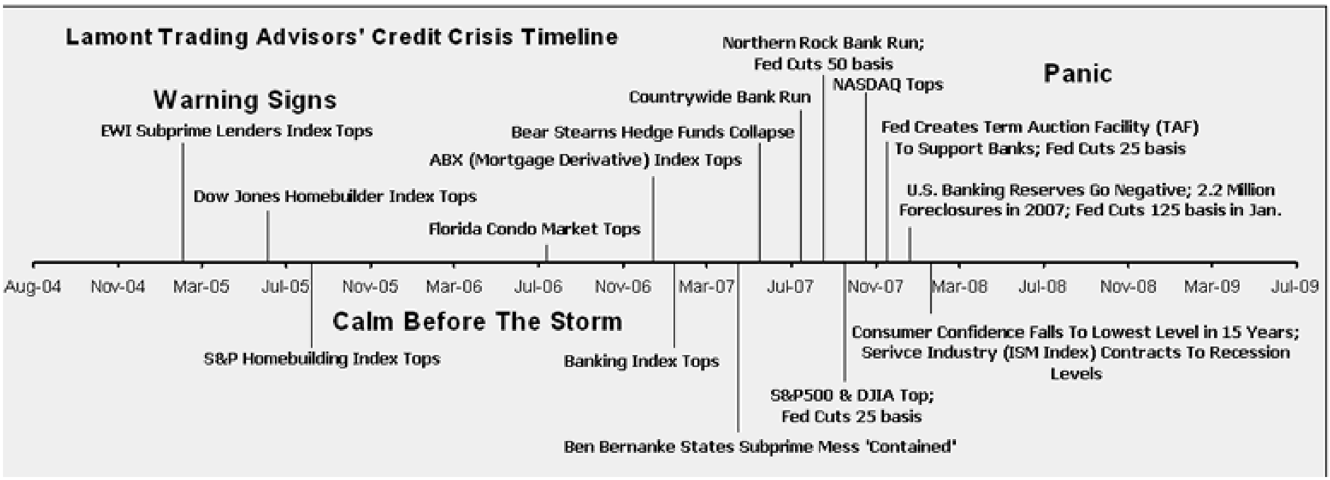
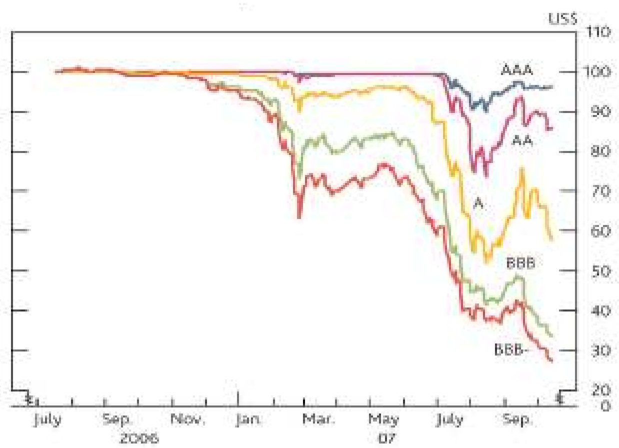
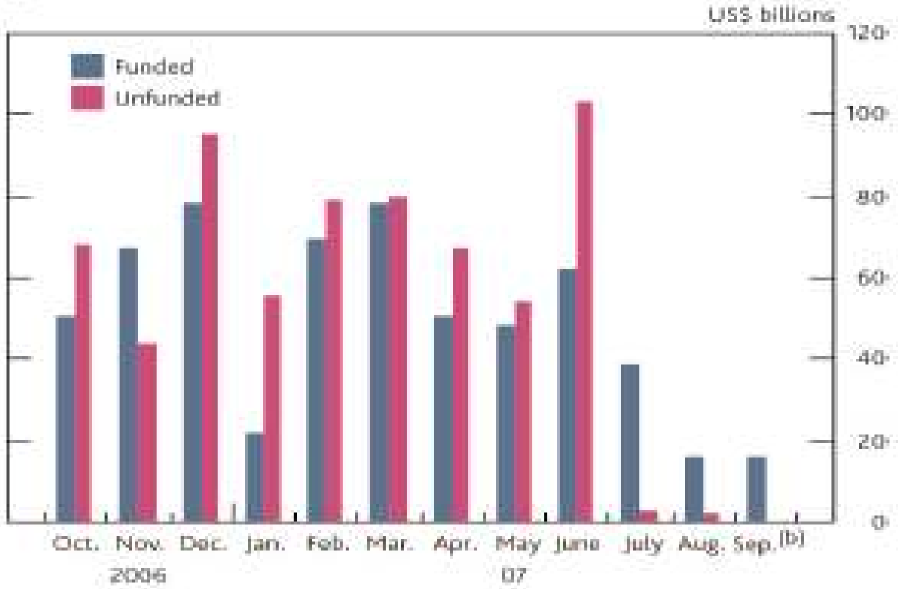


Figure 2. Prices of Us sub-prime Mortgage Credit Default Swaps.



Source: JPMorgan and Chase & Co. (in Buiter, 2007).

Figure 3. Global CDO Issuance



Note: funded CDOs refer to instruments backed by corporate bonds;
unfunded CDOs refer to instruments backed by credit default swaps
Source: JPMorgan Chase & Co. (in Buiter, 2007).

Figure 4. S&P 500 Index

Source: Finance Yahoo (2010).

APPENDIX 2

Table 1. Descriptive Statistics for the Initial Data.

Country/Sector	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability	Sum	Sum Sq. Dev.	Observation
Norway												
Auto-compo	11.1133	7.82	38.64	0.25	9.51707	1.21956	3.3531	131.3483	0	5767.82	46917.66	51
Banks	602.961	511.37	1104.14	253.2	262.587	0.36182	1.5468	56.99244	0	312936.9	35716954	51
Capital goods	177.808	158.73	435.41	72.11	83.321	1.19172	3.8602	138.8493	0	92282.46	3596157	51
Div Finance	319.69	255.06	760.73	89.34	192.613	0.75909	2.2792	61.07727	0	165919.2	19217574	51
Food/bev/tabaco	296.514	246.88	632.58	115.41	133.983	0.87825	2.7367	68.21785	0	153890.8	9298873	51
H_care	158.043	153.83	246.51	69.37	41.0293	0.04873	2.3984	8.031343	0.01803	82024.07	872002.8	51
IT	131.314	121.09	325.47	36.84	54.7164	0.94514	3.926	95.81396	0	68151.9	1550833	51
Media	174.076	163.15	371.24	71.58	72.4269	0.79146	3.0024	54.18471	0	90345.4	2717252	51
Oil/Gas	722.457	602.5	1557.24	301.6	313.002	0.48194	1.924	45.12792	0	374955	50748691	51
Real Estate	352.899	254.35	815	156.37	204.724	0.88805	2.3546	77.22531	0	183154.5	21710460	51
Retail	288.893	195.62	869.54	81.69	227.238	1.57257	4.4035	256.5106	0	149935.3	26747999	51
Transport	221.292	178.79	453.13	80.41	105.659	0.48493	1.7848	52.27749	0	114850.6	5782877	51
Utilities	199.683	115.09	558.8	59.55	134.148	0.84354	2.4232	68.7436	0	103635.6	9321767	51
Industrials	211.759	170.4	498.28	77.73	102.707	0.97607	3.0299	82.42897	0	109902.7	5464216	51
Sweden/Sector												
Auto-compo	145.52	135.99	235.51	60.98	42.9923	0.2656	1.8826	33.10177	0	75524.85	957440.4	51
Banks	335.83	314.82	572.8	148	95.9089	0.61522	2.5073	37.99028	0	174296	4764831	51
Capital goods	265.003	215.44	589.83	127.97	112.704	0.94508	2.8523	77.73111	0	137536.4	6579749	51
Div Finance	292.75	288.17	513.36	118.06	94.3477	0.26502	2.3729	14.57904	0.00068	151937	4610972	51
Food/bev/tabaco	354.388	342.41	579.03	119.07	125.501	-0.17097	1.897	28.83742	1E-06	183927.4	8158731	51
H_care	216.847	213.46	325.79	131.28	41.7573	0.49699	2.866	21.75392	1.9E-05	112543.4	903220.9	51
IT	288.851	214.05	1410.25	55.67	266.205	2.44625	8.2908	1122.974	0	149913.6	36708142	51
Media	180.124	188.36	354.16	49.3	61.19	-0.17052	2.0135	23.55802	8E-06	93484.23	1939501	51
Oil/Gas	595.073	492.2	1483.31	78.54	428.896	0.2765	1.4602	57.88322	0	308842.7	95287187	51
Real Estate	337.156	302.88	720.49	154.36	146.692	0.70284	2.5009	48.11646	0	174984	11146621	51
Retail	1233.04	1152.4	2137.56	666.1	395.777	0.54148	2.0366	45.43228	0	639948	81139295	51
Transport	109.908	99.82	266.47	35.91	47.7191	1.09287	4.1077	129.8451	0	57042.28	1179544	51
Industrials	253.008	210.49	534.21	126.73	95.7869	0.95335	2.9645	78.64575	0	131311.2	4752719	51
Denmark/Sector												
Auto-compo	228.773	81.03	874.66	42.43	249.742	1.2427	3.0028	133.5826	0	118733.2	32308159	51
Banks	374.054	318.56	719.25	120.81	149.059	0.69794	2.3071	52.51807	0	194133.9	11509288	51
Capital goods	306.169	256.51	777.62	81.63	183.999	1.00621	2.9446	87.64371	0	158901.9	17537300	51
Div Finance	92.091	96.55	175.23	39.52	36.8066	0.22647	1.7958	35.79421	0	47795.21	701746.3	51
Food/bev/tabaco	128.331	112.45	223.94	74.31	39.0404	0.71125	2.2938	54.54216	0	66603.59	789512.1	51
H_care	465.67	447.1	722.67	238.6	125.05	0.2918	2.0246	27.93939	1E-06	241682.8	8100213	51
IT	318.761	279.34	781.41	135.35	141.9	0.89649	3.1694	70.13989	0	165436.9	10430299	51
Media	132.216	95.62	441.33	51.08	77.5806	1.4234	4.719	239.1545	0	68619.83	3117710	51
Oil/Gas	133.519	92.54	287.5	56.41	59.0696	0.73624	2.2334	59.59532	0	69296.38	1807416	51
Real Estate	241.697	184.33	566.19	101.4	127.172	0.85577	2.3358	72.88837	0	125440.6	8377490	51
Retail	111.858	105.66	259.51	40.09	51.417	0.67732	2.7512	41.02131	0	58054.1	1369439	51
Transport	377.792	350.99	717.61	152.73	134.826	0.38943	2.229	25.973	2E-06	196073.9	9416246	51
Utilities	783.044	874.54	2174.08	83.66	540.037	0.55181	2.5012	31.71871	0	406400	1.51E+08	51
Industrials	320.553	284.41	640.05	134.26	117.884	0.74224	2.8173	48.3772	0	166366.9	7198434	51

Finland/Sector												
Auto-compo	371.767	303.79	1148.28	60.69	279.264	0.82928	2.711	61.29228	0	192947.2	40397962	51
Banks	109.174	104.29	180.86	56.51	32.2804	0.42806	2.1657	30.9008	0	56661.52	539768.3	51
Capital goods	195.508	149.54	468.77	81.37	108.867	0.84339	2.4406	68.29616	0	101468.5	6139287	51
Div Finance	100.155	92.33	151.6	49.41	20.4337	0.64942	2.5442	40.97439	0	51980.31	216284.1	51
Food/bev/tabaco	167.553	152.79	347.32	78.99	64.9625	0.65219	2.6273	39.79775	0	86959.96	2186025	51
H_care	171.18	108.71	371.19	56.26	95.8691	0.40778	1.5291	61.16907	0	88842.35	4760880	51
IT	36.3364	28.92	109.72	12.93	20.2905	1.79366	5.4786	411.1439	0	18858.6	213261.9	51
Media	94.9831	92.06	158.3	49.76	28.736	0.28421	1.8347	36.35353	0	49296.23	427742.1	51
Oil/Gas	108.676	100	181.71	51.25	27.3806	0.3761	2.7339	13.76708	0.00103	56402.81	388344.2	51
Real Estate	205.428	180.39	476.88	91.77	97.4288	0.87457	2.8653	66.55336	0	106617	4917043	51
Retail	125.866	111.74	231.76	60.81	50.7987	0.54224	1.7795	57.64441	0	65324.25	1336701	51
Transport	124.936	109.71	227.32	67.16	43.3695	0.86258	2.3841	72.5637	0	64841.76	974312.1	51
Utilities	391.573	319.33	1008.48	89.61	266.543	0.52262	1.9665	46.72274	0	203226.4	36801480	51
Industrials	186.884	142.98	440.22	81.98	99.5557	0.84604	2.4831	67.69298	0	96992.95	5134075	51
MSCI	887.183	864	1206.34	531.387	166.446	0.04834	1.9274	25.08272	4E-06	460448.2	14350824	51

APPENDIX 3

Table 1. GARCH BEKK Model Results

Industry/country	μ1	μ2	C1	C2	C3	A1	A2	B1	B22
Auto/Compo									
Norway	0.121	0.139	0.524	-0.021	1.297	0.436	0.339	0.882	0.948
p-val	0.19	0.747	0	0.952	0	0	0	0	0
z-stat	1.31	-0.323	6.124	-0.06	24.174	22.536	16.914	55.237	259.953
Sweden	0.1	0.171	0.351	0.333	0.481	0.326	0.347	0.939	0.939
p-val	0.28	0.31	0	0.001	0	0	0	0	0
z-stat	1.081	1.016	5.439	3.275	5.397	20.562	19.625	109.984	135.587
Denmark	0.13	0.235	0.414	0.557	2.257	0.357	0.522	0.923	0.794
p-val	0.165	0.296	0	0.068	0	0	0	0	0
z-stat	1.389	1.046	5.728	1.828	13.871	19.202	20.449	88.806	38.882
Finland	0.126	0.685	0.49	0.746	1.551	0.437	0.222	0.887	0.929
p-val	0.15	0.005	0	0	0	0	0	0	0
z-stat	1.44	2.803	6.934	3.648	5.615	19.605	7.964	62.588	42.555
Banks									
Norway	0.202	0.499	0.453	0.546	0.93	0.354	0.513	0.918	0.836
p-val	0.027	0	0	0	0	0	0	0	0
z-stat	2.206	3.529	7.379	3.741	8.555	19.023	19.751	92.257	45.845
Sweden	0.15	0.276	0.466	0.336	0.244	0.393	0.29	0.906	0.955
p-val	0.082	0.037	0	0	0.03	0	0	0	0
z-stat	1.74	2.088	7.078	4.717	2.172	13.608	10.468	63.484	107.265
Denmark	0.187	0.321	0.35	0.23	0.295	0.288	0.381	0.948	0.932
p-val	0.033	0.002	0	0	0	0	0	0	0
z-stat	2.129	3.119	5.163	4.072	4.169	11.127	16.239	91.8	100.435
Finland	0.134	0.234	0.375	0.301	0.382	0.323	0.308	0.936	0.947
p-val	0.153	0.1	0	0	0	0	0	0	0
z-stat	1.429	1.645	5.654	4.06	4.697	14.645	11.833	90.722	97.618
Capital Goods									
Norway	0.132	0.382	0.561	0.542	0.588	0.434	0.289	0.879	0.943
p-val	0.133	0.03	0	0	0	0	0	0	0
z-stat	1.503	2.166	8.071	6.653	5.128	18.529	15.311	58.539	135.874
Sweden	0.103	0.326	0.633	0.637	0.256	0.439	0.275	0.864	0.942
p-val	0.238	0.023	0	0	0.08	0	0	0	0

z-stat	1.18	2.266	9.161	7.496	1.754	16.112	13.008	49.584	106.701
Denmark	0.098	0.403	0.413	1.383	1.481	0.33	0.385	0.929	0.807
p-val	0.287	0.043	0	0	0	0	0	0	0
z-stat	1.066	2.027	6.203	3.62	7.868	22.358	12.53	91.989	18.236
Finland	0.087	0.385	0.506	0.58	0.37	0.474	0.259	0.872	0.941
p-val	0.279	0.004	0	0	0.007	0	0	0	0
z-stat	1.083	2.9	8.156	9.18	2.702	23.728	10.85	64.834	80.622
Diversified FINS									
Norway	0.094	0.286	0.456	0.503	0.376	0.412	0.165	0.899	0.969
p-val	0.281	0.056	0	0	0.128	0	0	0	0
z-stat	1.078	1.91	6.1	5.424	1.522	15.266	4.31	57.436	71.693
Sweden	0.118	0.268	0.354	0.597	0.387	0.275	0.243	0.951	0.949
p-val	0.213	0.074	0	0	0	0	0	0	0
z-stat	1.245	1.787	6.046	4.266	4.807	10.212	6.36	95.538	54.98
Denmark	0.103	0.197	0.507	0.177	0.224	0.441	0.224	0.883	0.969
p-val	0.232	0.072	0	0.001	0	0	0	0	0
z-stat	1.194	1.796	6.036	3.243	3.572	21.399	10.73	55.042	200.77
Finland	0.106	0.021	0.44	0.02	0.098	0.411	0.565	0.907	0.892
p-val	0.235	0.847	0	0.786	0	0	0	0	0
z-stat	1.187	0.193	7.036	0.271	6.179	13.875	17.393	72.772	124.006
FD/Bev/TBC									
Norway	0.125	0.287	0.396	1.231	1.699	0.366	0.445	0.92	0.69
p-val	0.167	0.077	0	0.003	0	0	0	0	0
z-stat	1.381	1.772	6.056	2.963	8.331	16.763	9.761	82.068	11.812
Sweden	0.101	0.373	0.458	2.49	-0.001	0.369	0.435	0.912	-0.074
p-val	0.271	0.002	0	0.037	1	0	0	0	0.82
z-stat	1.101	3.147	5.936	2.087	0	10.589	6.605	55.026	-0.228
Denmark	0.113	0.238	0.529	0.236	0.38	0.407	0.253	0.892	0.956
p-val	0.2	0.026	0	0	0	0	0	0	0
z-stat	1.281	2.234	6.792	3.608	5.67	22.303	12.127	61.448	117.891
Finland	0.12	0.32	0.504	0.186	0.289	0.419	0.206	0.889	0.971
p-val	0.171	0.002	0	0.004	0	0	0	0	0
z-stat	1.37	3.07	6.009	2.896	4.295	16.465	10.768	51.499	180.562
Health Care									
Norway	0.086	0.266	0.436	0.212	0.689	0.362	0.452	0.92	0.893
p-val	0.35	0.051	0	0.049	0	0	0	0	0
z-stat	0.934	1.95	5.73	1.97	6.021	22.297	13.518	79.249	59.776
Sweden	0.138	0.229	0.399	0.351	0.493	0.348	0.244	0.927	0.951
p-val	0.149	0.076	0	0	0	0	0	0	0
z-stat	1.444	1.776	5.752	3.769	4.628	10.658	9.087	66.219	75.764
Denmark	0.12	0.297	0.561	0.391	0.233	0.383	0.21	0.897	0.968
p-val	0.186	0.025	0	0	0.047	0	0	0	0
z-stat	1.322	2.237	6.53	7.866	1.988	12.29	8.611	48.966	145.923
Finland	0.109	0.299	0.531	0.542	1.639	0.434	0.017	0.879	0.937
p-val	0.226	0.244	0	0.556	0.713	0	0.833	0	0.006
z-stat	1.21	1.166	6.061	0.589	0.368	14.221	0.21	45.214	2.775
IT									
Norway	0.145	0.251	0.846	0.755	0.648	0.481	0.296	0.803	0.936
p-val	0.103	0.24	0	0	0	0	0	0	0
z-stat	1.629	1.175	8.484	5.645	4.112	20.96	9.193	31.824	75.831
Sweden	0.16	0.154	0.555	0.755	0.595	0.432	0.225	0.876	0.959
p-val	0.064	0.561	0	0	0	0	0	0	0
z-stat	1.855	0.582	7.318	7.21	4.455	21.586	12.104	55.917	171.19
Denmark	0.124	0.22	0.533	0.45	0.646	0.384	0.285	0.897	0.94
p-val	0.158	0.156	0	0	0	0	0	0	0
z-stat	1.412	1.419	7.597	5.633	6.898	19.231	13.08	63.987	105.777
Finland	0.157	0.048	0.593	0.624	-0.002	0.481	0.202	0.852	0.972
p-val	0.061	0.831	0	0	1	0	0	0	0
z-stat	1.875	0.214	7.687	5.418	0	22.261	16.953	46.424	292.488
Industrials									
Norway	0.116	0.352	0.528	0.534	0.612	0.402	0.275	0.893	0.935
p-val	0.187	0.019	0	0	0	0	0	0	0
z-stat	1.32	2.349	7.041	6.356	6.934	18.777	13.379	58.534	102.626
Sweden	0.117	0.313	0.64	0.636	0.293	0.435	0.289	0.864	0.937
p-val	0.181	0.025	0	0	0.013	0	0	0	0

z-stat	1.338	2.237	9.203	7.956	2.496	15.938	13.758	49.056	98.341
Denmark	0.118	0.277	0.578	0.499	0.555	0.413	0.253	0.882	0.946
p-val	0.19	0.081	0	0	0	0	0	0	0
z-stat	1.309	1.743	6.958	5.267	4.02	21.998	9.626	53.559	76.113
Finland	0.091	0.379	0.482	0.543	0.259	0.429	0.22	0.891	0.953
p-val	0.255	0.001	0	0	0.079	0	0	0	0
z-stat	1.139	3.385	8.152	10.572	1.755	24.109	9.464	77.66	93.006
Media									
Norway	0.102	0.213	0.458	0.332	0.5	0.382	0.272	0.909	0.954
p-val	0.237	0.193	0	0	0	0	0	0	0
z-stat	1.182	1.303	7.365	4.025	5.416	21.96	13.429	82.061	155.069
Sweden	0.128	0.204	0.618	0.476	0.565	0.424	0.335	0.874	0.929
p-val	0.149	0.208	0	0	0	0	0	0	0
z-stat	1.443	1.26	6.704	4.578	5.799	20.109	12.697	46.949	92.725
Denmark	0.119	-0.186	0.613	0.28	0.246	0.466	0.17	0.856	0.982
p-val	0.182	0.325	0	0.003	0.084	0	0	0	0
z-stat	1.333	-0.985	6.866	2.932	1.728	18.484	8.169	41.509	241.85
Finland	0.094	0.063	0.596	1.201	1.075	0.467	0.874	0.871	0.598
p-val	0.28	0.582	0	0	0	0	0	0	0
z-stat	1.081	0.551	6.683	4.349	4.379	22.196	34.754	52.337	24.285
Oil and Gas									
Norway	0.1	0.327	0.532	0.674	0.765	0.418	0.264	0.888	0.93
p-val	0.239	0.044	0	0	0	0	0	0	0
z-stat	1.179	2.012	6.86	7.486	4.594	20.004	7.681	57.039	49.583
Sweden	0.097	0.418	0.402	0.607	1.027	0.365	0.298	0.922	0.933
p-val	0.291	0.067	0	0	0	0	0	0	0
z-stat	1.056	1.835	5.85	4.101	5.039	15.966	9.912	79.759	67.172
Denmark	0.158	-0.023	0.776	-0.016	0.079	0.61	0.778	0.789	0.876
p-val	0.026	0.782	0	0.832	0	0	0	0	0
z-stat	2.229	-0.277	9.008	-0.212	6.138	19.08	28.088	41.06	183.05
Finland	0.131	0.001	0.526	-0.001	0.013	0.492	0.957	0.869	0.733
p-val	0.126	0.947	0	0.943	0	0	0	0	0
z-stat	1.53	0.067	7.207	-0.071	6.649	23.192	20.61	65.231	56.304
Real Est									
Norway	0.122	0.318	0.572	0.202	0.424	0.461	0.235	0.866	0.957
p-val	0.16	0.005	0	0.004	0	0	0	0	0
z-stat	1.406	2.79	6.509	2.924	4.962	17.756	8.85	44.168	104.065
Sweden	0.168	0.394	0.355	0.168	0.448	0.336	0.325	0.932	0.931
p-val	0.057	0	0	0.002	0	0	0	0	0
z-stat	1.901	3.917	5.164	3.071	8.939	14.146	17.062	78.704	92.718
Denmark	0.116	0.078	0.606	0.339	0.793	0.468	0.319	0.86	0.915
p-val	0.196	0.579	0	0	0	0	0	0	0
z-stat	1.294	0.555	6.766	3.771	8.769	20.421	10.571	44.325	70.652
Finland	0.148	0.305	0.433	0.275	0.689	0.375	0.329	0.913	0.922
p-val	0.117	0.025	0	0.001	0	0	0	0	0
z-stat	1.567	2.245	6.449	3.313	9.498	20.656	15.033	81.55	104.985
Retail									
Norway	0.123	0.021	0.57	0.21	0.003	0.444	0.008	0.871	1
p-val	0.183	0.957	0	0.239	1	0	0.876	0	0
z-stat	1.331	0.055	6.235	1.179	0	16.447	0.156	43.299	356.152
Sweden	0.11	0.256	0.54	0.326	0.093	0.422	0.201	0.886	0.974
p-val	0.226	0.08	0	0	0.677	0	0	0	0
z-stat	1.211	1.751	7.108	5.185	0.417	22.645	12.118	63.374	242.234
Denmark	0.149	0.193	0.425	0.958	2.07	0.382	0.686	0.914	0.683
p-val	0.09	0.249	0	0.01	0	0	0	0	0
z-stat	1.694	1.154	5.929	2.567	11.208	17.26	18.169	76.902	35.406
Finland	0.125	0.256	0.487	0.209	0.326	0.406	0.195	0.897	0.976
p-val	0.159	0.073	0	0.006	0	0	0	0	0
z-stat	1.409	1.79	5.875	2.726	3.567	18.181	8.729	55.365	184.394
Transport									
Norway	0.108	0.295	0.506	0.499	0.681	0.37	0.199	0.906	0.95
p-val	0.235	0.064	0	0	0.001	0	0	0	0
z-stat	1.188	1.851	6.416	4.236	3.233	17.936	6.382	59.426	46.37
Sweden	0.108	0.181	0.394	0.719	1.364	0.328	0.368	0.933	0.896
p-val	0.261	0.41	0	0.003	0	0	0	0	0

z-stat	1.125	0.824	5.646	3.028	7.537	20.081	12.264	92.777	43.852
Denmark	0.126	0.221	0.599	0.498	0.441	0.44	0.217	0.869	0.963
p-val	0.151	0.208	0	0	0.05	0	0	0	0
z-stat	1.437	1.259	7.269	4.823	1.957	21.686	7.025	51.262	82.688
Finland	0.104	0.106	0.536	0.285	0.434	0.411	0.149	0.889	0.975
p-val	0.242	0.448	0	0	0.029	0	0	0	0
z-stat	1.17	0.759	6.555	3.699	2.18	17.104	4.042	51.253	69.156
Utilities									
Norway	0.136	0.418	0.567	0.535	1.17	0.459	0.346	0.869	0.896
p-val	0.112	0.026	0	0	0	0	0	0	0
z-stat	1.591	2.227	6.156	3.721	7.614	10.413	9.549	35.513	47.624
Sweden	(missing data)								
Denmark	0.112	0.536	0.227	0.094	1.648	0.2	0.587	0.978	0.824
p-val	0.321	0.016	0.001	0.82	0	0	0	0	0
z-stat	0.992	2.416	3.445	0.228	15.12	7.091	27.792	169.614	70.375
Finland	0.124	0.513	0.509	0.243	0.703	0.372	0.285	0.907	0.942
p-val	0.186	0.001	0	0.001	0	0	0	0	0
z-stat	1.324	3.269	5.999	3.248	5.862	12.392	15.089	52.33	103.115

Table 2. Descriptive Statistics for Data Used in the Regression.

Country/Sector	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability	Sum	Sum Sq. Dev.	Observations
Norway												
Auto-compo	139.858	64.8228	1043.238	16.52252	175.0934	1.95895	7.33379	738.0964	0	72586.4	15880690	519
beta	0.71196	0.004158	5.921671	-2.32697	1.223103	1.303444	4.12741	174.4471	0	369.505	774.9184	519
Banks	27.792	10.17635	590.6763	4.46008	57.54735	4.915953	33.4037	22250.35	0	14535.2	1728706	519
beta	0.78092	0.704728	2.798611	-0.5186	0.536198	0.868785	3.84417	80.69947	0	405.299	148.9293	519
Capital goods	22.5813	16.40246	142.5081	7.761922	18.7499	2.794056	12.5388	2663.273	0	11810	183513.6	519
beta	1.03004	1.055517	2.204254	-0.01276	0.383297	-0.00809	2.69841	1.972565	0.372961	534.59	76.10277	519
Div Finance	11.6579	10.73955	23.45529	8.121265	2.858656	1.893634	6.4348	569.6618	0	6097.07	4265.739	519
beta	0.78595	0.732847	1.564117	0.223946	0.341211	0.264178	1.89627	32.38079	0	407.906	60.30798	519
Food/bev/tabaco	13.7749	11.02045	165.0803	8.505993	10.18008	8.279466	104.388	229982.3	0	7204.25	54096.96	519
beta	0.5212	0.483316	2.276616	-0.33385	0.345602	0.799737	4.84443	128.8903	0	270.503	61.87013	519
H_care	19.0124	11.87862	187.6293	3.394771	22.3828	3.68988	20.3263	7728.681	0	9943.47	261516.5	519
beta	0.5768	0.528757	2.113957	-0.75215	0.406168	0.423101	3.96984	35.82507	0	299.358	85.45557	519
IT	27.2717	20.6998	164.6898	9.776619	17.62294	2.772174	16.6791	4747.462	0	14263.1	162116.5	519
beta	1.25066	1.22799	4.318252	-0.04409	0.435264	0.996219	9.1913	914.7815	0	649.092	98.13764	519
Media	20.5398	12.97411	97.19811	5.894358	16.39544	1.98723	7.00234	688.001	0	10660.2	139243.9	519
beta	0.86183	0.82018	2.010728	-0.03187	0.354306	0.373747	2.90872	12.26309	0.002173	447.29	65.0258	519
Oil/Gas	16.3274	13.71386	94.49583	8.864468	10.36686	4.38281	25.2556	12372.64	0	8473.91	55670.43	519
beta	0.96274	0.973511	2.032665	0.282103	0.35377	0.208243	2.48564	9.47235	0.008772	499.662	64.82925	519
Real Estate	8.02573	6.020737	39.48738	4.148904	5.881313	2.99754	12.1693	2595.386	0	4165.35	17917.54	519
beta	0.33758	0.358796	1.094564	-0.40483	0.215912	-0.2038	2.87771	3.916053	0.141137	175.206	24.14813	519
Retail	36.0438	36.10021	45.35208	26.58115	5.393363	-0.01212	1.82978	29.6263	0	18706.8	15067.78	519
beta	0.25094	0.23409	0.55486	0.022165	0.126469	0.353731	2.24685	23.08985	0.00001	130.239	8.285108	519

Transport	12.4135	11.37337	31.96563	8.298599	3.729615	2.507023	10.7992	1859.059	0	6442.58	7205.395	519
beta	0.80985	0.813764	1.491478	-0.00439	0.236762	-0.10257	3.25533	2.319698	0.313534	420.311	29.03703	519
Utilities	19.7102	16.06262	104.5884	8.697593	11.64674	2.511143	12.4465	2475.19	0	10229.6	70264.91	519
beta	0.64616	0.623095	2.826176	-0.44628	0.434228	0.973751	6.34662	324.2151	0	335.358	97.67113	519
Industrials	14.777	11.44187	79.34634	7.119591	11.34774	3.457368	15.72	4532.834	0	7669.26	66703.45	519
beta	0.90066	0.916521	1.453968	0.102471	0.267867	-0.41167	2.8634	15.06259	0.000536	467.443	37.16799	519
Sweden												
Auto-compo	25.9458	14.45081	182.4153	5.37387	30.51361	2.655146	10.1359	1724.176	0	13569.7	486024	519
beta	1.07659	1.026682	3.060251	0.078813	0.383892	0.836546	5.19448	164.6739	0	558.751	76.33928	519
Banks	19.2235	10.34691	142.9265	3.540314	25.56119	2.964491	11.2958	2265.75	0	10053.9	341061.3	519
beta	0.96137	0.985412	2.199393	-0.67109	0.433215	-0.63364	5.38182	157.4102	0	498.949	97.21579	519
Capital goods	13.533	10.00979	71.07838	5.402356	10.45388	3.048861	13.1958	3075.614	0	7077.78	57046.03	519
beta	1.14692	1.172858	1.799026	0.286018	0.259496	-0.47481	3.22403	20.58629	0.000034	595.254	34.88104	519
Div Finance	12.5145	10.26357	54.44161	6.503549	7.888567	3.168207	14.4137	3713.79	0	6545.07	32483.79	519
beta	1.17833	1.212652	1.746182	0.717303	0.197446	0.063373	2.13961	16.35583	0.000281	611.553	20.19429	519
Food/bev/tabaco	7.65316	6.728855	61.89243	6.236649	3.5734	10.05164	135.952	394001.8	0	4002.6	6665.518	519
beta	0.29421	0.282856	1.195938	-0.6974	0.214626	0.297439	5.06307	99.6944	0	152.694	23.86128	519
H_care	9.91798	8.2279	42.87488	5.030025	5.563105	3.184627	15.5848	4335.328	0	5187.11	16154.92	519
beta	0.63122	0.675633	1.309012	-0.34297	0.296696	-0.42638	3.20134	16.60217	0.000248	327.604	45.59869	519
IT	38.4331	35.08278	113.6471	14.59621	21.20934	1.08965	4.01693	126.0321	0	20100.5	234814.4	519
beta	1.58159	1.642852	2.930683	0.216384	0.575161	-0.27373	2.5374	11.10891	0.00387	820.843	171.3597	519
Media	23.8369	16.06003	128.8377	5.836388	21.49662	2.084338	7.55065	823.6165	0	12371.3	239370.2	519
beta	1.07219	1.061106	2.760632	0.203527	0.333376	0.534776	4.91015	103.6405	0	556.468	57.57019	519
Oil/Gas	33.11	26.59953	141.8132	15.48476	20.35794	2.784017	13.0257	2844.07	0	17184.1	214683	519
beta	0.99581	0.976729	3.011498	-0.44777	0.568887	0.604964	3.91893	49.91825	0	516.825	167.6415	519
Real Estate	8.63825	5.213424	92.0684	2.322288	11.76446	4.444052	25.1454	12313.68	0	4483.25	71692.53	519
beta	0.52126	0.446566	1.400261	-0.20196	0.328356	0.336788	2.36605	18.50244	0.000096	270.531	55.84941	519
Retail	18.0876	13.30555	63.32496	4.760525	13.31711	1.062964	3.18468	98.47331	0	9387.44	91864.97	519
beta	0.76461	0.749328	1.754526	-0.66314	0.299653	-0.19984	5.97297	194.5874	0	396.831	46.51208	519
Transport	39.9739	24.44249	360.276	13.89274	45.23374	3.984273	21.6657	8907.467	0	20746.5	1059875	519
beta	1.13826	1.105616	2.653503	0.249087	0.433519	0.604322	3.5014	37.02684	0	590.755	97.35216	519
Industrials	12.8661	9.237383	70.56629	5.035324	10.25221	3.096252	13.8044	3353.632	0	6677.51	54445.85	519
beta	1.13763	1.16479	1.734846	0.321041	0.246542	-0.44297	3.19726	17.8143	0.000135	590.432	31.48569	519
Denmark												
Auto-compo	48.4238	27.33939	919.1839	14.693	78.77908	6.130669	50.2133	51851.92	0	25325.7	3239607	519
beta	0.49223	0.414436	2.688557	-1.23545	0.589274	0.729022	4.71879	109.858	0	255.465	179.8726	519
Banks	17.2075	7.962572	190.5197	1.535984	29.81955	3.499028	15.5389	4493.367	0	8999.54	464165.2	519
beta	0.70855	0.667279	1.926099	-0.43096	0.429021	0.14254	3.28472	3.510522	0.172862	367.737	95.34254	519
Capital goods	22.3667	16.7784	280.3772	12.35742	22.77534	7.531424	71.9731	108613.6	0	11697.8	270769.7	519

beta	0.95481	0.962711	2.314262	-0.06035	0.414526	0.169396	2.75605	3.769007	0.151904	495.547	89.0088	519
Div Finance	8.61535	7.265754	27.96009	2.293508	5.59787	1.199026	3.8679	141.731	0	4505.83	16357.47	519
beta	0.40738	0.391824	1.239671	-0.21348	0.241937	0.617253	3.71872	44.1271	0	211.43	30.32031	519
Food/bev/tabaco	11.5486	6.750221	95.06469	3.392823	14.78473	3.554546	16.1687	4880.335	0	6039.91	114103	519
beta	0.57019	0.553717	1.442792	-0.06409	0.277817	0.538779	3.62226	33.48274	0	295.926	39.98045	519
H_care	10.8512	8.517244	30.14098	4.993267	5.230649	1.119564	3.59384	116.9416	0	5675.19	14281.76	519
beta	0.73281	0.755219	1.153308	0.201213	0.189549	-0.4549	2.91098	18.07121	0.000119	380.33	18.61121	519
IT	23.2623	14.14912	97.73245	7.376978	18.75664	1.676734	5.21417	351.8984	0	12166.2	183645.7	519
beta	1.08308	0.984074	3.278743	-0.03632	0.496086	1.319764	5.34201	269.2773	0	562.116	127.4806	519
Media	22.8534	18.18595	67.06913	7.645914	12.57296	0.957954	3.35977	82.1779	0	11860.9	81885.07	519
beta	0.48238	0.444809	2.161768	-0.23142	0.30169	0.848219	5.6275	211.5288	0	250.355	47.14661	519
Oil/Gas	88.8961	34.02879	1229.37	0.028972	158.8617	3.984847	23.3261	10307.87	0	46137.1	13072793	519
beta	0.55189	0.101424	5.599176	-6.89702	1.336663	-0.17258	7.18031	380.4736	0	286.431	925.4941	519
Real Estate	11.453	8.445276	61.28948	5.013045	8.223311	2.852164	12.5828	2689.506	0	5944.12	35028.63	519
beta	0.52744	0.507998	2.001758	-0.29628	0.321847	0.772246	5.10688	147.5771	0	273.741	53.65742	519
Retail	37.3229	19.25424	1151.809	9.933231	73.77905	9.257786	118.262	294710.9	0	19370.6	2819654	519
beta	0.56957	0.485013	4.879288	-2.39964	0.69195	1.120315	9.16371	930.1286	0	295.608	248.0155	519
Transport	18.6389	15.4954	59.41666	9.442994	9.919893	2.280743	7.73813	935.4335	0	9673.58	50973.41	519
beta	0.8787	0.894009	1.560636	0.023367	0.325764	-0.31808	2.48079	14.58102	0.000682	456.045	54.97129	519
Utilities	47.2516	25.13345	1102.276	8.819816	91.75826	6.549976	56.9565	66667.93	0	24519.6	4361341	519
beta	0.17075	0.100296	7.365803	-1.67254	0.502965	6.081414	84.1935	145759.3	0	88.617	131.0403	519
Industrials	14.777	11.44187	79.34634	7.119591	11.34774	3.457368	15.72	4532.834	0	7669.26	66703.45	519
beta	0.90066	0.916521	1.453968	0.102471	0.267867	-0.41167	2.8634	15.06259	0.000536	467.443	37.16799	519
Finland												
Auto-compo	34.8062	30.89963	110.6666	23.95759	12.45726	2.743839	12.0188	2428.76	0	18203.7	81005.63	519
beta	0.94194	0.935733	2.389956	-0.786	0.482615	0.091328	2.9109	0.893161	0.639812	488.868	120.6509	519
Banks	18.6672	12.06878	139.2994	3.588648	21.89939	3.010527	12.3257	2685.195	0	9762.94	250342.4	519
beta	0.9398	0.95498	1.909148	-0.13216	0.364107	-0.27626	4.09801	32.67356	0	487.757	68.67337	519
Capital goods	10.9186	8.49543	48.22515	4.969427	7.126696	2.875692	12.5562	2710.869	0	5710.41	26512.28	519
beta	0.87565	0.908744	1.700898	-0.85194	0.403181	-0.88465	5.0365	157.3816	0	454.46	84.20335	519
Div Finance	31.2118	15.81807	269.2722	0.050118	47.67225	2.728585	10.8969	2007.91	0	16323.8	1186320	519
beta	0.82597	0.796264	3.193272	-0.88785	0.787433	0.450265	2.67103	19.87712	0.000048	428.676	321.1866	519
Food/bev/tabaco	8.96903	7.3714	25.4729	3.201994	4.773888	0.945199	3.05179	77.93992	0	4690.8	11896.38	519
beta	0.39641	0.399651	1.228399	-0.60559	0.269235	-0.52486	4.49262	72.00705	0	205.735	37.54865	519
H_care	24.5876	24.56508	25.69403	24.20146	0.114604	4.819624	41.0892	33639.89	0	12859.3	6.855997	519
beta	0.44116	0.400369	1.059677	0.039391	0.234733	0.49656	2.47036	27.39462	0.000001	228.963	28.54149	519
IT	41.4003	32.74436	178.4069	12.62722	30.39189	1.768408	6.72708	575.3035	0	21652.4	482154.1	519
beta	1.30001	1.327768	3.148365	-1.32263	0.612762	-0.96223	6.76386	386.4436	0	674.705	194.4971	519
Media	20.4587	9.529706	1551.974	4.13844	75.61048	17.00603	331.533	2359082	0	10618.1	2961377	519
beta	0.69082	0.659516	9.48E+00	-2.14567	0.657892	5.52777	73.6149	110475.5	0	358.535	224.2019	519

Oil/Gas	26.2103	0.001554	442.1008	0.000353	48.90005	3.845753	25.5832	12308.09	0	13603.1	1238649	519
beta	0.49829	6.90E-05	5.129307	-1.21194	0.848999	1.710735	6.5818	530.5856	0	258.612	373.3738	519
Real Estate	14.8257	8.877828	132.5166	4.711632	18.41189	3.647734	17.3361	5595.419	0	7694.52	175600.7	519
beta	0.57155	0.541365	1.561484	-0.19895	0.387216	0.280622	2.07066	25.48889	0.000003	296.632	77.66688	519
Retail	14.9459	11.53938	40.56877	5.282643	7.925592	0.955424	3.11943	79.26864	0	7756.9	32538.18	519
beta	0.45681	0.469089	1.05415	-0.15154	0.218961	-0.07438	3.17043	1.106696	0.575021	237.082	24.835	519
Transport	10.1339	9.594197	17.09356	6.624819	2.273268	0.743004	2.79961	48.62109	0	5259.48	2676.894	519
beta	0.48986	0.481066	0.974147	0.059868	0.192068	0.170914	2.29316	13.33116	0.001274	254.236	19.10914	519
Utilities	17.9263	12.86376	141.7453	7.188647	18.96623	4.363762	23.5673	10794.82	0	9303.74	186333.9	519
beta	0.54103	0.510101	1.689038	-0.31398	0.373933	0.395896	3.20627	14.4775	0.000718	280.793	72.42965	519
Industrials	8.86752	7.178693	34.64017	4.591172	5.112081	2.765483	11.5065	2226.346	0	4602.24	13537.09	519
beta	0.86934	0.882894	1.592905	0.153526	0.313501	-0.02264	2.28034	11.24411	0.003617	451.186	50.91037	519
MSCI variance	6.94245	4.54883	100.541	1.690202	9.98695	5.391194	37.8109	28940.59	0	3630.9	52063.85	519

Table 3. Autocorrelation/Partial Autocorrleation Functions and Ljung-Box statistics

Auto/Compo Sweden					Denmark			
Lags	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.051	0.051	1.346	0.246	-0.051	-0.051	1.3626	0.243
2	-0.003	-0.006	1.3509	0.509	0.058	0.055	3.1025	0.212
3	-0.031	-0.03	1.8407	0.606	0.007	0.013	3.1287	0.372
4	-0.01	-0.007	1.8933	0.755	-0.03	-0.033	3.6076	0.462
5	-0.07	-0.07	4.507	0.479	0.019	0.015	3.7984	0.579
6	0.071	0.078	7.1487	0.307	-0.034	-0.029	4.4142	0.621
7	0.001	-0.008	7.1496	0.413	0.082	0.078	7.9266	0.339
8	-0.066	-0.07	9.4503	0.306	0.031	0.042	8.4481	0.391
9	0.031	0.043	9.9564	0.354	0.018	0.014	8.6195	0.473
10	-0.086	-0.097	13.869	0.179	0.049	0.044	9.8999	0.449
11	-0.034	-0.017	14.478	0.208	-0.084	-0.077	13.615	0.255
12	0.045	0.045	15.544	0.213	0.027	0.013	13.996	0.301
13	0.073	0.053	18.404	0.143	-0.062	-0.049	16.071	0.245
14	0.017	0.025	18.562	0.182	-0.027	-0.035	16.454	0.286
15	0.024	0.005	18.865	0.22	0.054	0.048	18.002	0.263

Auto/Compo Finland					Norway			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
Lags								
1	-0.051	-0.051	1.3736	0.241	-0.034	-0.034	0.6106	0.435
2	-0.086	-0.089	5.2349	0.073	0.007	0.006	0.6347	0.728
3	0.025	0.016	5.5567	0.135	-0.011	-0.011	0.7012	0.873
4	0.001	-0.004	5.5578	0.235	0.071	0.07	3.3161	0.506
5	0.04	0.044	6.4101	0.268	-0.031	-0.026	3.815	0.576
6	0.066	0.071	8.7043	0.191	0.06	0.058	5.728	0.454
7	-0.038	-0.023	9.4633	0.221	0.037	0.043	6.4495	0.488
8	0.06	0.068	11.373	0.181	-0.047	-0.051	7.6301	0.47
9	-0.014	-0.016	11.472	0.245	-0.059	-0.058	9.4601	0.396
10	0.055	0.065	13.09	0.219	0.033	0.022	10.045	0.437
11	0.088	0.086	17.244	0.101	-0.045	-0.047	11.119	0.433
12	-0.055	-0.038	18.835	0.093	0.026	0.028	11.486	0.488
13	-0.006	0.001	18.855	0.128	0.017	0.022	11.645	0.557
14	0.029	0.008	19.307	0.154	-0.112	-0.117	18.341	0.192
15	-0.017	-0.014	19.459	0.194	-0.095	-0.085	23.138	0.081

Industrials

Denmark					Sweden			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	-0.026	-0.026	0.352	0.553	-0.064	-0.064	2.1633	0.141
2	-0.066	-0.067	2.624	0.269	-0.015	-0.019	2.2827	0.319
3	0.035	0.032	3.2658	0.352	0.078	0.076	5.485	0.14
4	-0.016	-0.018	3.3957	0.494	0.007	0.017	5.5119	0.239
5	-0.046	-0.042	4.4931	0.481	0.003	0.007	5.5155	0.356
6	-0.06	-0.066	6.3754	0.382	-0.012	-0.017	5.5877	0.471
7	0.082	0.074	9.8768	0.196	-0.012	-0.015	5.658	0.58
8	0.041	0.04	10.748	0.216	0.01	0.007	5.7122	0.679
9	0.069	0.085	13.281	0.15	-0.017	-0.014	5.8574	0.754
10	0.028	0.029	13.702	0.187	-0.038	-0.038	6.6138	0.761
11	-0.019	-0.012	13.885	0.239	0.011	0.005	6.681	0.824
12	0.051	0.054	15.277	0.227	0.024	0.027	6.9885	0.858
13	0.011	0.028	15.348	0.286	0.034	0.044	7.6046	0.868
14	-0.013	0.003	15.435	0.349	0.003	0.008	7.6086	0.909
15	0.098	0.104	20.544	0.152	0.045	0.043	8.6737	0.894

Finland					Denmark			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	-0.04	-0.04	0.8525	0.356	0.017	0.017	0.1494	0.699
2	-0.052	-0.054	2.2579	0.323	-0.063	-0.063	2.1885	0.335
3	-0.011	-0.016	2.3237	0.508	-0.055	-0.053	3.7778	0.286
4	0.049	0.045	3.5763	0.466	0.005	0.003	3.7923	0.435
5	0.017	0.02	3.7245	0.59	0.069	0.063	6.3276	0.276
6	-0.045	-0.039	4.8019	0.569	-0.04	-0.045	7.1557	0.307
7	-0.008	-0.009	4.8367	0.68	0.023	0.033	7.4429	0.384
8	0.024	0.018	5.149	0.742	0.021	0.023	7.6831	0.465
9	-0.036	-0.038	5.8189	0.758	0.031	0.029	8.1905	0.515
10	-0.064	-0.062	7.9623	0.633	-0.006	-0.005	8.2077	0.609
11	0.031	0.025	8.4761	0.67	0.002	0.014	8.2099	0.694
12	0.004	-0.004	8.4852	0.746	0.053	0.05	9.716	0.641
13	0.017	0.02	8.6437	0.799	0.003	0.001	9.7207	0.717
14	0.025	0.036	8.9671	0.833	-0.066	-0.064	12.075	0.6
15	0.031	0.033	9.4721	0.852	0.046	0.057	13.213	0.586

Banks								
Norway					Sweden			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	-0.149	-0.149	11.642	0.001	0.906	0.906	428.83	0
2	0.098	0.077	16.657	0	0.847	0.143	804	0
3	-0.118	-0.095	23.914	0	0.812	0.138	1149.1	0
4	0.073	0.038	26.691	0	0.772	0.012	1461.8	0
5	0.083	0.118	30.292	0	0.717	-0.088	1732	0
6	0.058	0.068	32.043	0	0.679	0.043	1975.1	0
7	0.094	0.112	36.689	0	0.633	-0.061	2187	0
8	0.062	0.107	38.743	0	0.607	0.095	2382	0
9	-0.057	-0.05	40.445	0	0.58	0.013	2560.2	0
10	0.037	0.015	41.176	0	0.557	0.039	2725.2	0
11	0.048	0.058	42.394	0	0.533	0.007	2876.7	0
12	-0.176	-0.233	58.947	0	0.51	-0.02	3015.6	0
13	0.163	0.094	73.178	0	0.495	0.05	3146.6	0
14	-0.028	0.034	73.609	0	0.473	-0.046	3266.2	0
15	0.142	0.058	84.383	0	0.454	0.027	3376.7	0

Denmark					Finland			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.888	0.888	411.43	0	0.92	0.92	442.02	0
2	0.847	0.278	786.76	0	0.865	0.116	832.98	0
3	0.804	0.071	1125.2	0	0.826	0.108	1190.9	0
4	0.776	0.084	1441.2	0	0.796	0.068	1523.5	0
5	0.73	-0.046	1721.6	0	0.754	-0.055	1822.7	0

6	0.69	-0.028	1972.5	0	0.728	0.079	2101.7	0
7	0.636	-0.091	2186.1	0	0.699	-0.011	2359.4	0
8	0.609	0.054	2382.1	0	0.693	0.16	2613.6	0
9	0.563	-0.048	2550.1	0	0.662	-0.114	2846.2	0
10	0.528	-0.004	2698	0	0.634	-0.003	3060	0
11	0.49	-0.001	2825.8	0	0.604	-0.039	3254.2	0
12	0.439	-0.103	2928.7	0	0.579	-0.013	3433	0
13	0.407	0.029	3017.4	0	0.565	0.107	3603.6	0
14	0.374	-0.001	3092.4	0	0.542	-0.074	3760.8	0
15	0.349	0.037	3157.7	0	0.521	0.047	3906.3	0

CAPITAL GOODS								
Norway					Sweden			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.816	0.816	347.62	0	0.714	0.714	266.03	0
2	0.706	0.118	607.95	0	0.599	0.183	453.88	0
3	0.624	0.059	811.7	0	0.536	0.119	604.63	0
4	0.554	0.024	972.77	0	0.444	-0.022	707.94	0
5	0.488	-0.005	1097.9	0	0.384	0.018	785.39	0
6	0.416	-0.042	1189.1	0	0.327	-0.005	841.86	0
7	0.364	0.015	1259.2	0	0.284	0.013	884.39	0
8	0.328	0.031	1316.2	0	0.272	0.059	923.54	0
9	0.286	-0.02	1359.5	0	0.255	0.031	958.07	0
10	0.267	0.053	1397.3	0	0.244	0.031	989.79	0
11	0.244	0.003	1429	0	0.243	0.036	1021.3	0
12	0.234	0.035	1458.2	0	0.244	0.038	1053.1	0
13	0.217	-0.005	1483.4	0	0.23	-0.002	1081.3	0
14	0.209	0.025	1506.8	0	0.21	-0.011	1105	0
15	0.222	0.073	1533.2	0	0.216	0.045	1130	0

Denmark					Finland			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.773	0.773	311.99	0	0.872	0.872	396.91	0
2	0.684	0.214	556.48	0	0.783	0.096	717.93	0
3	0.569	-0.032	725.86	0	0.719	0.073	988.59	0
4	0.478	-0.017	845.74	0	0.649	-0.025	1210.1	0
5	0.388	-0.031	925.14	0	0.591	0.013	1393.7	0
6	0.345	0.064	987.94	0	0.539	0.004	1546.6	0
7	0.313	0.054	1039.5	0	0.493	0.011	1674.8	0
8	0.272	-0.019	1078.6	0	0.452	0.007	1782.8	0
9	0.234	-0.024	1107.6	0	0.404	-0.042	1869.2	0
10	0.201	-0.005	1129.1	0	0.366	0.011	1940.3	0
11	0.167	-0.01	1143.9	0	0.343	0.046	2002.7	0
12	0.149	0.028	1155.8	0	0.317	0.002	2056.2	0
13	0.136	0.018	1165.6	0	0.301	0.036	2104.6	0
14	0.123	-0.001	1173.7	0	0.286	0.006	2148.3	0
15	0.112	0	1180.5	0	0.264	-0.02	2185.7	0

DIV Finance								
Norway					Sweden			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.828	0.828	357.73	0	0.794	0.794	328.98	0
2	0.725	0.128	633.01	0	0.708	0.21	591.19	0
3	0.667	0.122	866.38	0	0.688	0.219	839.5	0
4	0.587	-0.048	1047.1	0	0.636	0.031	1051.9	0
5	0.507	-0.041	1182.1	0	0.553	-0.082	1212.9	0
6	0.433	-0.042	1280.8	0	0.49	-0.05	1339.7	0
7	0.399	0.085	1364.8	0	0.454	0.017	1448.8	0
8	0.345	-0.041	1427.6	0	0.429	0.06	1546.1	0
9	0.283	-0.045	1470.1	0	0.376	-0.028	1620.9	0
10	0.238	-0.017	1500.2	0	0.324	-0.043	1676.6	0
11	0.209	0.026	1523.5	0	0.327	0.088	1733.5	0
12	0.176	-0.005	1540	0	0.324	0.06	1789.4	0
13	0.152	0.027	1552.4	0	0.308	0.047	1840.2	0
14	0.155	0.068	1565.4	0	0.3	0.025	1888.5	0
15	0.143	-0.019	1576.3	0	0.303	0.018	1937.9	0

Denmark					Finland			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.823	0.823	353.19	0	0.777	0.777	315.03	0
2	0.71	0.102	616.61	0	0.689	0.216	563.32	0
3	0.631	0.072	825.46	0	0.63	0.113	771.33	0
4	0.57	0.044	995.78	0	0.555	-0.005	933.29	0
5	0.502	-0.019	1128.6	0	0.5	0.017	1065	0
6	0.424	-0.064	1223.4	0	0.442	-0.016	1167.9	0
7	0.378	0.044	1299	0	0.343	-0.134	1230.2	0
8	0.338	0.006	1359.3	0	0.286	-0.017	1273.5	0
9	0.282	-0.054	1401.4	0	0.254	0.043	1307.7	0
10	0.234	-0.011	1430.5	0	0.177	-0.091	1324.4	0
11	0.193	-0.013	1450.4	0	0.139	0.007	1334.7	0
12	0.165	0.008	1464.8	0	0.082	-0.058	1338.3	0
13	0.123	-0.046	1472.8	0	0.032	-0.027	1338.8	0
14	0.102	0.038	1478.4	0	0.018	0.035	1339	0
15	0.097	0.039	1483.5	0	0.001	0.016	1339	0

FOOD/Bev/Tobacco								
Norway					Sweden			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.712	0.712	264.26	0	0.159	0.159	13.256	0

2	0.571	0.131	434.84	0	0.177	0.156	29.675	0
3	0.397	-0.102	517.45	0	0.156	0.112	42.357	0
4	0.275	-0.029	557.28	0	0.134	0.078	51.833	0
5	0.176	-0.017	573.61	0	0.068	0.002	54.233	0
6	0.112	0.003	580.26	0	0.076	0.023	57.29	0
7	0.066	-0.003	582.56	0	0.067	0.023	59.644	0
8	0.042	0.009	583.49	0	0.112	0.078	66.327	0
9	0.013	-0.025	583.57	0	0.062	0.016	68.385	0
10	-0.001	-0.004	583.57	0	0.062	0.012	70.407	0
11	-0.053	-0.085	585.04	0	0.132	0.091	79.623	0
12	-0.037	0.062	585.79	0	0.052	-0.007	81.092	0
13	-0.052	-0.016	587.21	0	0.125	0.079	89.4	0
14	-0.066	-0.049	589.53	0	0.054	-0.01	90.944	0
15	-0.074	-0.012	592.49	0	0.074	0.016	93.874	0

Denmark					Finland			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.797	0.797	331.6	0	0.88	0.88	404.14	0
2	0.695	0.163	583.89	0	0.784	0.043	725.59	0
3	0.576	-0.048	757.87	0	0.713	0.066	991.87	0
4	0.467	-0.054	872.33	0	0.642	-0.02	1208.2	0
5	0.428	0.133	968.77	0	0.579	0.005	1384.4	0
6	0.368	-0.01	1040.2	0	0.508	-0.066	1520.2	0
7	0.347	0.054	1103.6	0	0.463	0.072	1633.2	0
8	0.312	-0.009	1155.1	0	0.402	-0.087	1718.8	0
9	0.257	-0.06	1190.2	0	0.362	0.063	1788.2	0
10	0.199	-0.068	1211.3	0	0.345	0.076	1851.5	0
11	0.145	-0.012	1222.6	0	0.318	-0.018	1905.3	0
12	0.12	0.041	1230.3	0	0.303	0.04	1954.2	0
13	0.092	-0.015	1234.8	0	0.296	0.051	2001.1	0
14	0.069	-0.025	1237.4	0	0.286	-0.019	2044.8	0
15	0.043	-0.033	1238.3	0	0.274	0.007	2085.1	0

Health Care								
Norway					Sweden			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.715	0.715	266.93	0	0.912	0.912	433.81	0
2	0.526	0.029	411.48	0	0.858	0.159	818.69	0
3	0.414	0.058	501.37	0	0.825	0.133	1175	0
4	0.33	0.015	558.53	0	0.781	-0.021	1495.6	0
5	0.266	0.013	595.7	0	0.745	0.025	1787.7	0
6	0.227	0.031	622.93	0	0.712	0.01	2055	0
7	0.15	-0.081	634.88	0	0.689	0.064	2305.8	0
8	0.094	-0.015	639.54	0	0.664	0.008	2539	0
9	0.091	0.06	643.9	0	0.64	0.012	2755.9	0
10	0.107	0.056	649.99	0	0.618	0.007	2958.6	0
11	0.132	0.061	659.28	0	0.601	0.034	3150.6	0

12	0.127	-0.014	667.88	0	0.592	0.065	3337.4	0
13	0.098	-0.029	673.04	0	0.573	-0.026	3512.8	0
14	0.073	-0.014	675.9	0	0.563	0.047	3682.6	0
15	0.061	-0.003	677.91	0	0.554	0.012	3847.2	0

Denmark					Finland			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.853	0.853	380.03	0	-0.027	-0.027	0.3939	0.53
2	0.711	-0.062	644.58	0	-0.061	-0.062	2.3569	0.308
3	0.597	0.019	831.16	0	0.017	0.013	2.5038	0.475
4	0.497	-0.017	960.7	0	0.072	0.07	5.237	0.264
5	0.399	-0.05	1044.5	0	-0.052	-0.046	6.6517	0.248
6	0.344	0.096	1107.1	0	-0.056	-0.051	8.2788	0.218
7	0.315	0.053	1159.5	0	0.03	0.02	8.7591	0.27
8	0.3	0.048	1207.2	0	0.013	0.006	8.8535	0.355
9	0.269	-0.053	1245.5	0	-0.054	-0.043	10.395	0.319
10	0.252	0.041	1279.1	0	0.025	0.028	10.721	0.38
11	0.223	-0.043	1305.5	0	0.016	0.004	10.863	0.455
12	0.205	0.05	1328	0	-0.01	-0.007	10.917	0.536
13	0.194	0.03	1348.2	0	0.041	0.052	11.832	0.541
14	0.203	0.068	1370.3	0	0.023	0.017	12.11	0.597
15	0.195	-0.039	1390.6	0	0.022	0.024	12.377	0.65

IT Industry								
Norway					Sweden			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.648	0.648	219.18	0	0.7	0.7	255.45	0
2	0.485	0.113	342.36	0	0.559	0.137	419.16	0
3	0.371	0.033	414.56	0	0.506	0.145	553.56	0
4	0.254	-0.043	448.54	0	0.472	0.096	670.59	0
5	0.17	-0.021	463.78	0	0.426	0.036	766.2	0
6	0.076	-0.07	466.86	0	0.352	-0.043	831.6	0
7	0.04	0.015	467.7	0	0.344	0.081	894.27	0
8	0.013	-0.001	467.79	0	0.302	-0.028	942.67	0
9	-0.096	-0.159	472.64	0	0.264	-0.003	979.69	0
10	-0.156	-0.073	485.63	0	0.222	-0.026	1005.8	0
11	-0.211	-0.078	509.36	0	0.2	0.01	1027.2	0
12	-0.207	0.019	532.13	0	0.211	0.058	1050.9	0
13	-0.177	0.034	548.84	0	0.187	-0.005	1069.7	0
14	-0.152	0.015	561.18	0	0.15	-0.035	1081.8	0
15	-0.158	-0.076	574.53	0	0.129	-0.005	1090.7	0

Denmark					Finland			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.747	0.747	291.14	0	0.836	0.836	364.55	0
2	0.685	0.288	536.52	0	0.712	0.045	629.72	0

3	0.588	0.022	717.72	0	0.632	0.087	839.16	0
4	0.562	0.117	883.56	0	0.553	-0.016	999.52	0
5	0.483	-0.036	1006.4	0	0.49	0.026	1125.6	0
6	0.448	0.021	1112.1	0	0.435	0.003	1225.2	0
7	0.402	0.015	1197.3	0	0.4	0.053	1309.8	0
8	0.391	0.056	1278	0	0.363	-0.009	1379.4	0
9	0.305	-0.121	1327.3	0	0.29	-0.122	1423.8	0
10	0.274	-0.012	1367.1	0	0.226	-0.038	1450.9	0
11	0.208	-0.057	1390.3	0	0.18	0	1468.2	0
12	0.201	0.036	1411.8	0	0.137	-0.016	1478.2	0
13	0.146	-0.038	1423.2	0	0.093	-0.036	1482.8	0
14	0.14	0.026	1433.7	0	0.066	0.017	1485.2	0
15	0.104	-0.014	1439.5	0	0.049	0.008	1486.5	0

MEDIA								
Norway					Sweden			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.851	0.851	377.92	0	0.781	0.781	318.3	0
2	0.741	0.06	664.72	0	0.587	-0.059	498.44	0
3	0.634	-0.032	875.6	0	0.454	0.039	606.68	0
4	0.552	0.027	1035.6	0	0.367	0.034	677.4	0
5	0.477	-0.008	1155.2	0	0.24	-0.146	707.68	0
6	0.411	-0.007	1244.2	0	0.133	-0.028	717.04	0
7	0.352	-0.008	1309.5	0	0.086	0.055	720.97	0
8	0.304	0.008	1358.3	0	0.036	-0.066	721.66	0
9	0.238	-0.087	1388.4	0	-0.02	-0.036	721.88	0
10	0.19	0.007	1407.5	0	-0.084	-0.072	725.66	0
11	0.139	-0.031	1417.8	0	-0.101	0.025	731.09	0
12	0.111	0.031	1424.4	0	-0.116	-0.032	738.3	0
13	0.087	0.009	1428.4	0	-0.124	0.002	746.51	0
14	0.071	0.01	1431.1	0	-0.118	0.019	753.96	0
15	0.058	0.003	1432.9	0	-0.123	-0.065	762.1	0

Denmark					Finland			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.781	0.781	318.72	0	0.372	0.372	72.211	0
2	0.639	0.073	532.28	0	0.214	0.088	96.26	0
3	0.529	0.024	679.01	0	0.103	-0.002	101.87	0
4	0.454	0.045	787.17	0	0.019	-0.04	102.06	0
5	0.384	-0.003	864.69	0	-0.007	-0.012	102.08	0
6	0.329	0.011	921.61	0	0.042	0.063	103.02	0
7	0.325	0.117	977.44	0	0.033	0.008	103.58	0
8	0.277	-0.071	1018	0	0.039	0.014	104.37	0
9	0.201	-0.1	1039.5	0	-0.002	-0.036	104.38	0
10	0.132	-0.047	1048.8	0	-0.006	-0.002	104.4	0
11	0.091	0.003	1053.3	0	-0.127	-0.137	112.99	0
12	0.076	0.04	1056.4	0	-0.139	-0.062	123.23	0

13	0.051	-0.017	1057.7	0	-0.195	-0.114	143.45	0
14	0.06	0.055	1059.7	0	-0.125	0.006	151.85	0
15	0.04	-0.058	1060.5	0	-0.135	-0.066	161.66	0

Oil/GAS								
Norway				Sweden				
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.808	0.808	341.12	0	0.867	0.867	392.8	0
2	0.718	0.187	611.03	0	0.771	0.075	703.82	0
3	0.632	0.024	820.01	0	0.68	-0.016	946.08	0
4	0.549	-0.018	978.11	0	0.61	0.039	1141.5	0
5	0.518	0.115	1119.3	0	0.562	0.068	1307.7	0
6	0.473	0.013	1237.3	0	0.506	-0.036	1442.7	0
7	0.439	0.016	1338.9	0	0.469	0.049	1559	0
8	0.396	-0.023	1421.9	0	0.427	-0.015	1655.4	0
9	0.346	-0.034	1485.2	0	0.383	-0.028	1733.2	0
10	0.308	-0.002	1535.6	0	0.346	0.006	1796.9	0
11	0.277	0.013	1576.5	0	0.31	-0.004	1848.1	0
12	0.238	-0.036	1606.7	0	0.289	0.035	1892.7	0
13	0.206	-0.018	1629.4	0	0.265	-0.009	1930.3	0
14	0.186	0.022	1647.9	0	0.24	-0.015	1961.1	0
15	0.171	0.024	1663.6	0	0.216	-0.008	1986	0

Denmark					Finland			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.706	0.706	260.48	0	0.472	0.472	116.42	0
2	0.473	-0.052	377.36	0	0.248	0.032	148.55	0
3	0.308	-0.013	427.12	0	0.24	0.143	178.62	0
4	0.203	0.006	448.73	0	0.134	-0.044	188.05	0
5	0.171	0.074	464.05	0	0.154	0.108	200.59	0
6	0.146	0.006	475.27	0	0.128	-0.006	209.2	0
7	0.141	0.042	485.83	0	0.057	-0.025	210.93	0
8	0.153	0.053	498.17	0	0.176	0.169	227.28	0
9	0.148	0.011	509.86	0	0.198	0.059	248.12	0
10	0.116	-0.032	516.99	0	0.1	-0.046	253.48	0
11	0.061	-0.049	518.96	0	0.012	-0.108	253.55	0
12	0.062	0.076	521.03	0	-0.019	-0.023	253.75	0
13	0.033	-0.063	521.6	0	0.008	0.021	253.78	0
14	0.015	-0.003	521.72	0	-0.053	-0.104	255.3	0
15	0.02	0.023	521.94	0	-0.125	-0.085	263.73	0

Real Estate								
Norway					Sweden			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.834	0.834	363.07	0	0.832	0.832	361.51	0

2	0.718	0.073	632.42	0	0.749	0.184	655.12	0
3	0.635	0.065	843.93	0	0.689	0.09	903.62	0
4	0.55	-0.029	1002.7	0	0.619	-0.014	1104.9	0
5	0.465	-0.038	1116.6	0	0.552	-0.027	1264.9	0
6	0.398	0.002	1200	0	0.495	-0.004	1394	0
7	0.359	0.062	1268	0	0.431	-0.044	1491.9	0
8	0.322	0.012	1322.9	0	0.402	0.076	1577.5	0
9	0.258	-0.095	1358.1	0	0.379	0.05	1653.7	0
10	0.208	-0.017	1381.1	0	0.358	0.032	1721.7	0
11	0.176	0.017	1397.5	0	0.337	0.007	1782.1	0
12	0.133	-0.038	1406.9	0	0.324	0.021	1838.2	0
13	0.111	0.049	1413.5	0	0.337	0.099	1898.7	0
14	0.091	-0.011	1417.9	0	0.319	-0.042	1953.1	0
15	0.061	-0.049	1419.9	0	0.31	0.017	2004.8	0

Denmark					Finland			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.763	0.763	303.51	0	0.837	0.837	366.1	0
2	0.697	0.276	557.57	0	0.729	0.093	644.08	0
3	0.584	-0.028	736.54	0	0.636	0.016	856.28	0
4	0.494	-0.038	864.77	0	0.572	0.06	1028.4	0
5	0.436	0.044	964.78	0	0.516	0.02	1168.6	0
6	0.375	0.008	1039	0	0.476	0.04	1287.9	0
7	0.339	0.028	1099.7	0	0.424	-0.032	1382.8	0
8	0.27	-0.071	1138.2	0	0.356	-0.082	1449.7	0
9	0.221	-0.032	1164.2	0	0.316	0.043	1502.5	0
10	0.132	-0.118	1173.5	0	0.291	0.042	1547.5	0
11	0.094	0.01	1178.2	0	0.277	0.036	1588.4	0
12	0.059	0.029	1180.1	0	0.256	-0.011	1623.3	0
13	0.031	-0.005	1180.6	0	0.244	0.032	1655.3	0
14	0.012	-0.013	1180.7	0	0.22	-0.022	1681.1	0
15	0.018	0.066	1180.9	0	0.194	-0.017	1701.3	0

Retail								
Norway					Sweden			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.11	0.11	6.3166	0.012	0.854	0.854	380.84	0
2	0.029	0.017	6.7604	0.034	0.74	0.039	667.38	0
3	0.07	0.066	9.3156	0.025	0.641	0.001	882.85	0
4	0.052	0.038	10.753	0.029	0.583	0.101	1061.1	0
5	-0.011	-0.024	10.818	0.055	0.546	0.074	1217.8	0
6	0	-0.002	10.818	0.094	0.498	-0.029	1348.7	0
7	0.015	0.01	10.938	0.141	0.449	-0.012	1455.3	0
8	0.044	0.042	11.942	0.154	0.368	-0.128	1527	0
9	0.066	0.059	14.235	0.114	0.294	-0.049	1572.8	0
10	0.017	0.001	14.389	0.156	0.23	-0.028	1600.9	0
11	0.069	0.06	16.925	0.11	0.2	0.057	1622.2	0

12	0.026	0.001	17.276	0.139	0.159	-0.061	1635.7	0
13	0.067	0.059	19.661	0.104	0.123	-0.002	1643.8	0
14	0.044	0.026	20.684	0.11	0.099	0.044	1649	0
15	-0.047	-0.064	21.853	0.112	0.089	0.062	1653.3	0

Denmark					Finland			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.664	0.664	230.34	0	0.842	0.842	369.77	0
2	0.426	-0.028	325.05	0	0.722	0.047	642.56	0
3	0.279	0.013	365.83	0	0.639	0.069	856.55	0
4	0.175	-0.016	381.82	0	0.571	0.03	1027.9	0
5	0.113	0.008	388.52	0	0.501	-0.024	1159.9	0
6	0.057	-0.03	390.21	0	0.427	-0.044	1255.9	0
7	0.019	-0.01	390.4	0	0.359	-0.027	1323.8	0
8	0.006	0.009	390.42	0	0.309	0.017	1374.4	0
9	-0.029	-0.053	390.88	0	0.268	0.007	1412.5	0
10	-0.042	0	391.83	0	0.231	0.001	1440.8	0
11	-0.033	0.016	392.4	0	0.216	0.066	1465.7	0
12	-0.029	-0.007	392.85	0	0.198	-0.002	1486.7	0
13	-0.051	-0.051	394.26	0	0.174	-0.022	1502.9	0
14	-0.05	0.013	395.61	0	0.152	-0.006	1515.2	0
15	-0.037	0.009	396.34	0	0.127	-0.028	1523.9	0

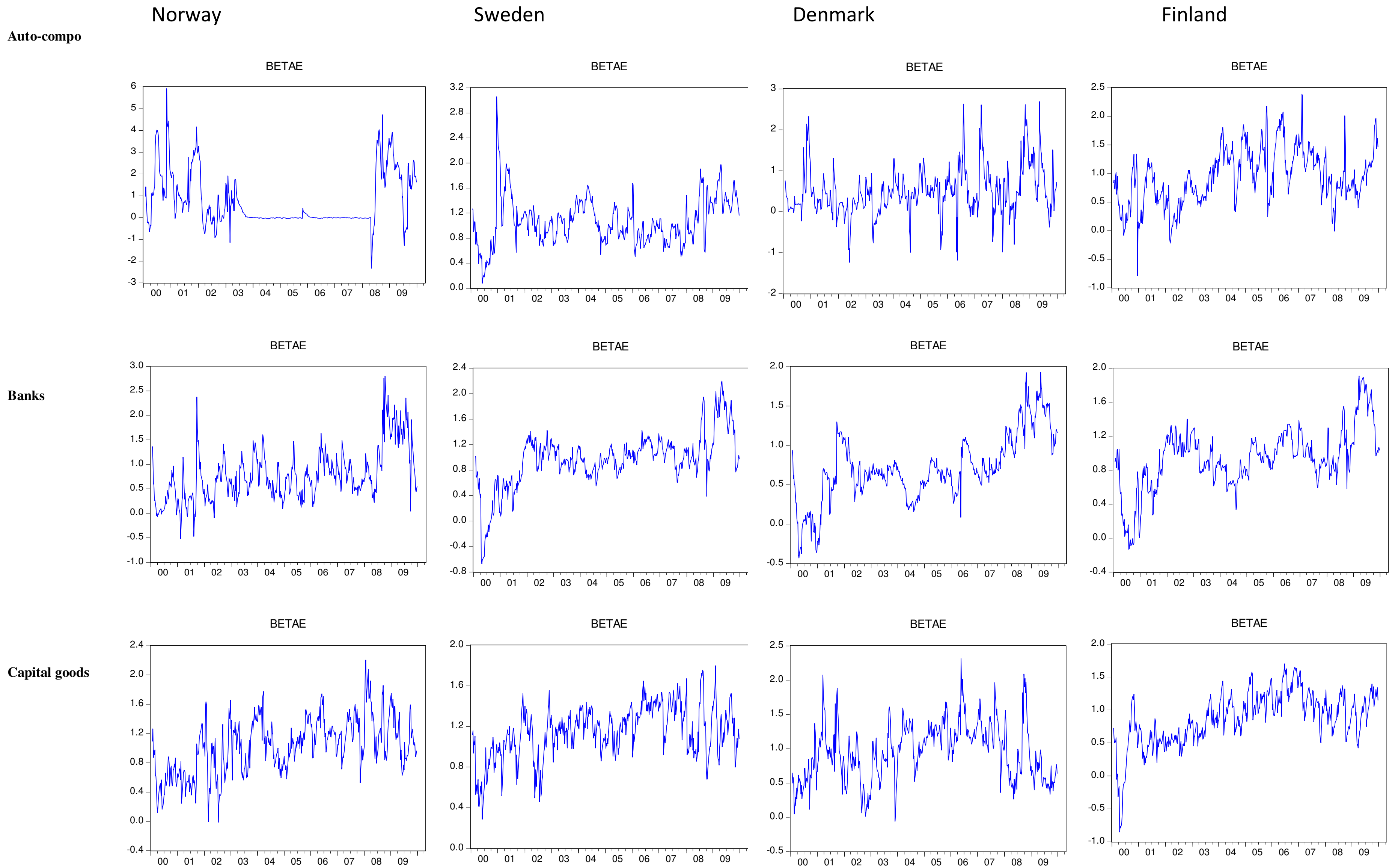
Transportation Norway					Sweden			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.756	0.756	298.33	0	0.726	0.726	275.32	0
2	0.626	0.126	503.03	0	0.601	0.157	464.5	0
3	0.548	0.094	660.66	0	0.512	0.065	601.85	0
4	0.479	0.028	780.91	0	0.429	0.006	698.28	0
5	0.444	0.076	884.51	0	0.382	0.05	774.94	0
6	0.387	-0.021	963.57	0	0.342	0.029	836.5	0
7	0.365	0.064	1034.1	0	0.325	0.058	892.23	0
8	0.308	-0.061	1084.3	0	0.282	-0.023	934.38	0
9	0.258	-0.02	1119.5	0	0.268	0.041	972.52	0
10	0.221	-0.011	1145.5	0	0.231	-0.026	1001	0
11	0.22	0.076	1171.3	0	0.224	0.045	1027.7	0
12	0.188	-0.047	1190.2	0	0.221	0.032	1053.6	0
13	0.153	-0.018	1202.7	0	0.199	-0.009	1074.8	0
14	0.15	0.039	1214.8	0	0.165	-0.044	1089.4	0
15	0.168	0.084	1230	0	0.165	0.046	1103.9	0

Denmark					Finland			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.807	0.807	339.55	0	0.802	0.802	335.99	0
2	0.671	0.058	574.78	0	0.675	0.089	574.54	0
3	0.593	0.106	759.06	0	0.588	0.066	755.87	0
4	0.502	-0.045	891.11	0	0.493	-0.041	883.24	0
5	0.421	-0.008	984.32	0	0.387	-0.079	962.14	0
6	0.354	-0.013	1050.2	0	0.305	-0.017	1011.2	0
7	0.337	0.116	1110.1	0	0.246	0.015	1043.3	0
8	0.302	-0.024	1158.2	0	0.192	-0.004	1062.9	0
9	0.267	0.012	1196.1	0	0.141	-0.02	1073.4	0
10	0.226	-0.055	1223.2	0	0.121	0.047	1081.2	0
11	0.198	0.019	1244	0	0.119	0.051	1088.7	0
12	0.177	0.007	1260.7	0	0.119	0.032	1096.2	0
13	0.148	-0.007	1272.4	0	0.111	-0.008	1102.8	0
14	0.153	0.072	1284.9	0	0.125	0.048	1111.2	0
15	0.144	-0.017	1296	0	0.111	-0.056	1117.8	0

Utilities Norway					Denmark			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.831	0.831	360.73	0	0.443	0.443	102.34	0
2	0.697	0.018	614.6	0	0.312	0.144	153.15	0
3	0.573	-0.037	786.37	0	0.302	0.153	200.97	0
4	0.456	-0.049	895.33	0	0.235	0.042	229.94	0
5	0.348	-0.044	959.12	0	0.056	-0.147	231.61	0
6	0.256	-0.025	993.66	0	0.059	0.008	233.47	0
7	0.16	-0.077	1007.2	0	0.098	0.069	238.59	0
8	0.088	-0.006	1011.3	0	0.084	0.049	242.29	0
9	0.031	-0.006	1011.8	0	0.115	0.091	249.25	0
10	-0.025	-0.053	1012.1	0	0.112	0.004	255.93	0
11	-0.056	0.022	1013.8	0	0.116	0.014	263.04	0
12	-0.087	-0.036	1017.8	0	0.104	0.01	268.79	0
13	-0.123	-0.06	1025.9	0	0.078	-0.016	272	0
14	-0.136	0.019	1035.8	0	0.055	0.001	273.64	0
15	-0.105	0.117	1041.7	0	0.022	-0.03	273.9	0

Finland				
	AC	PAC	Q-Stat	Prob
1	0.755	0.755	297.32	0
2	0.612	0.099	493.22	0
3	0.48	-0.025	613.93	0
4	0.372	-0.018	686.43	0
5	0.345	0.133	749.06	0
6	0.291	-0.022	793.81	0
7	0.269	0.038	831.98	0
8	0.237	-0.002	861.75	0
9	0.186	-0.04	880.05	0
10	0.173	0.044	896.01	0
11	0.13	-0.042	905.04	0
12	0.105	-0.007	910.94	0
13	0.117	0.074	918.31	0
14	0.104	-0.01	924.11	0
15	0.08	-0.058	927.57	0

Figure 1. Time-varying betas from GARCH BEKK model



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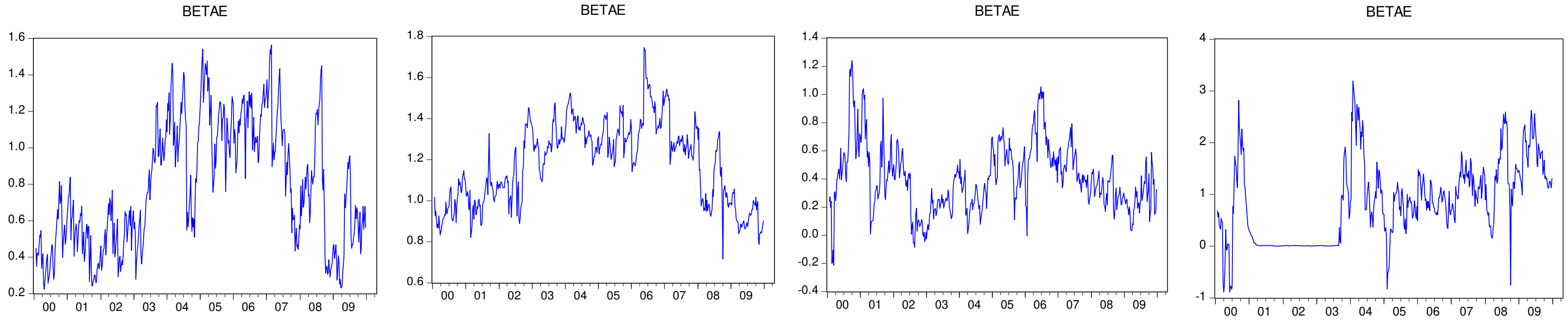
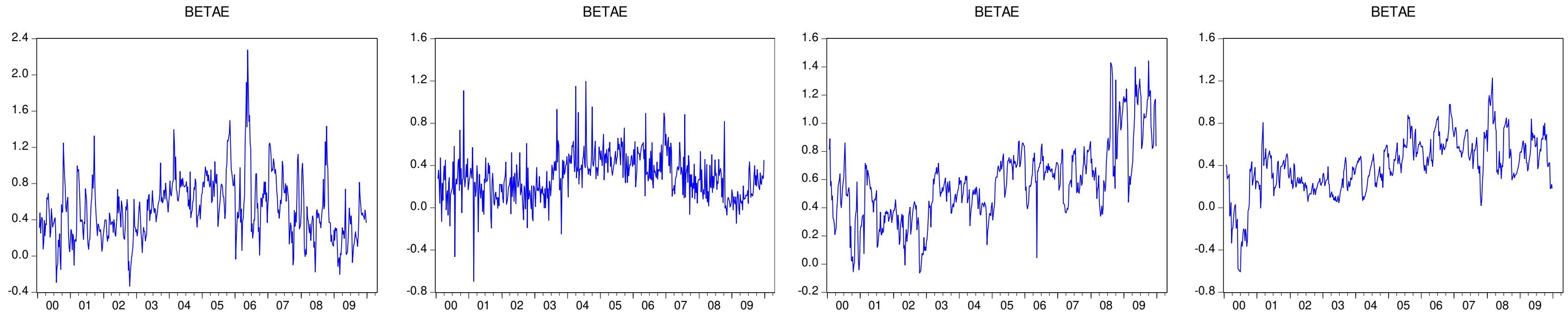
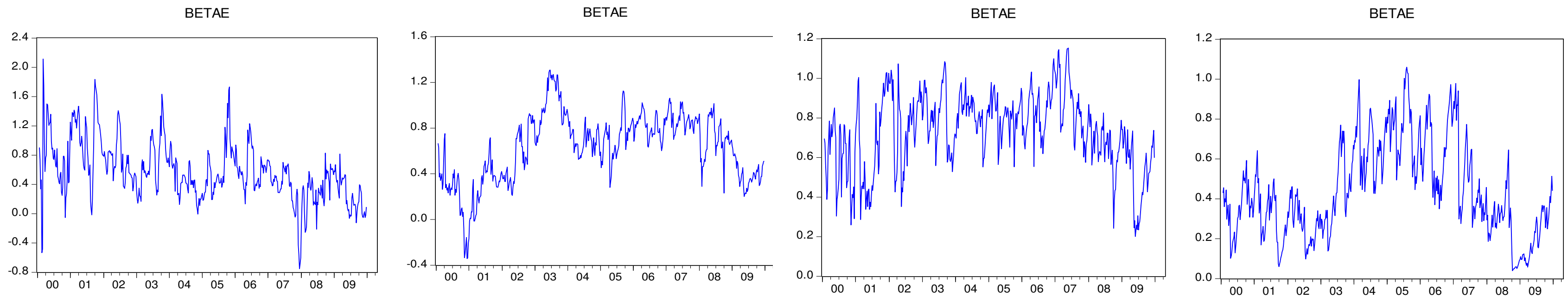


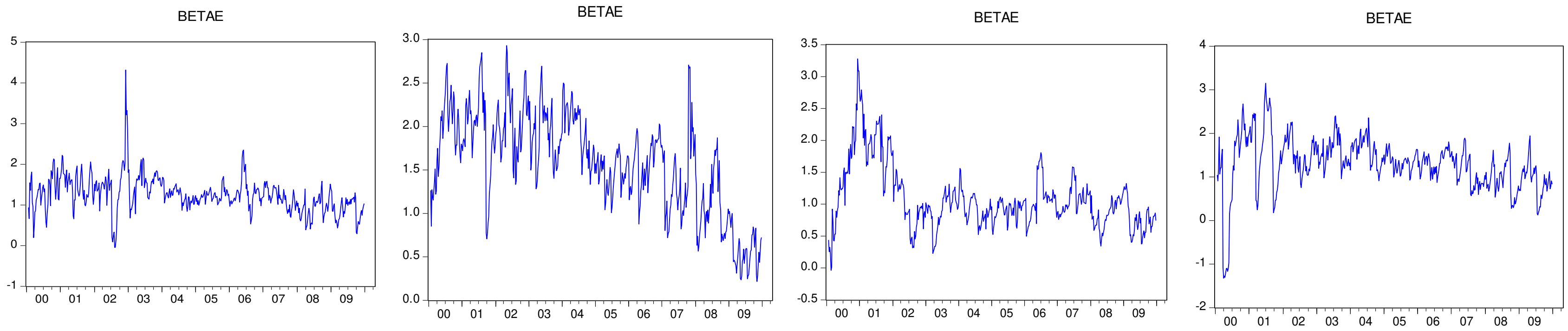
Food/bev/tabaco



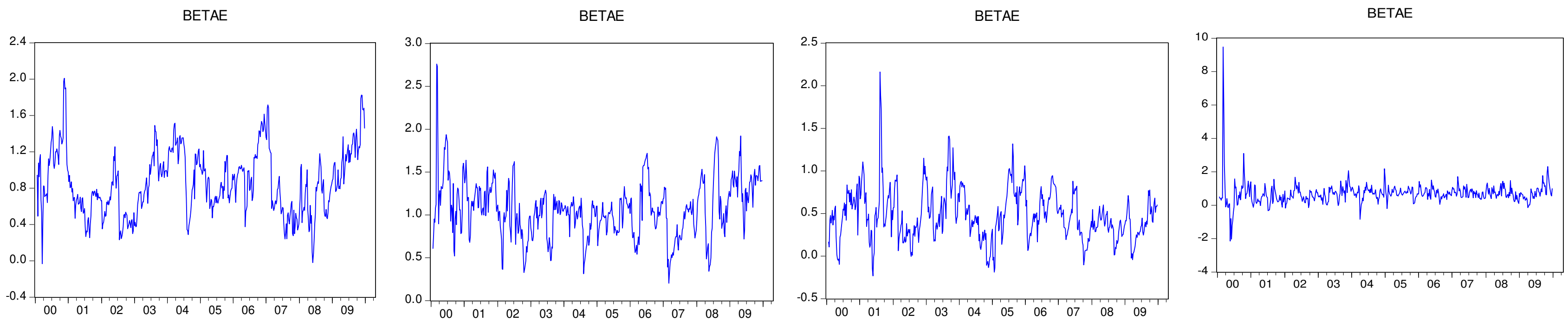
H_care



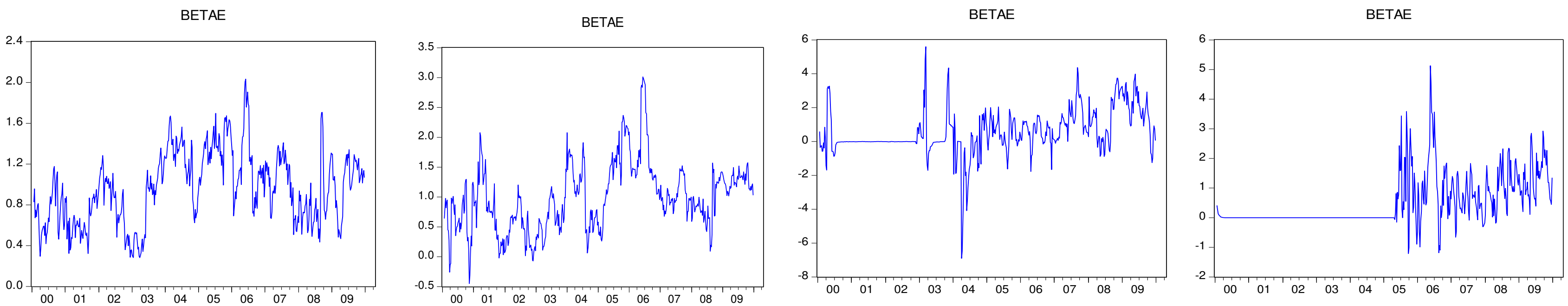
IT



Media



Oil/Gas



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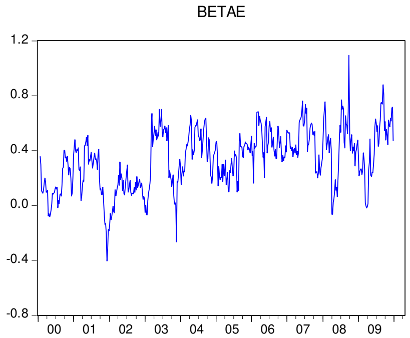

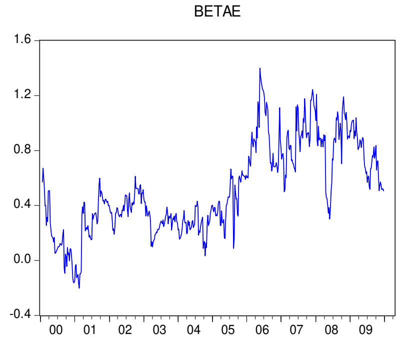

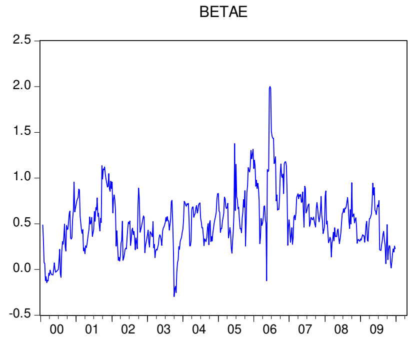

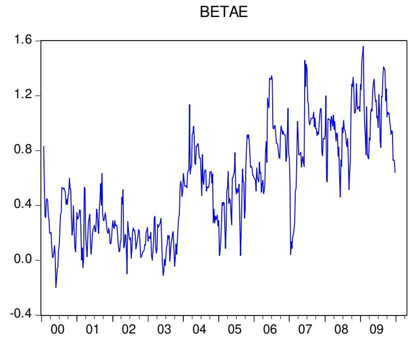

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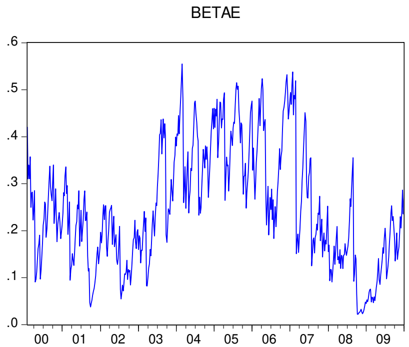

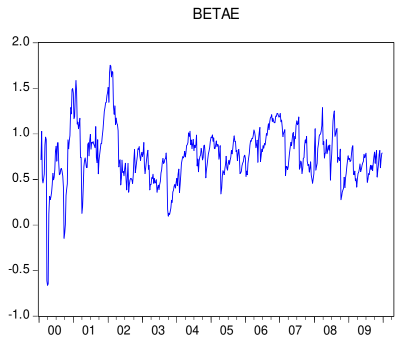

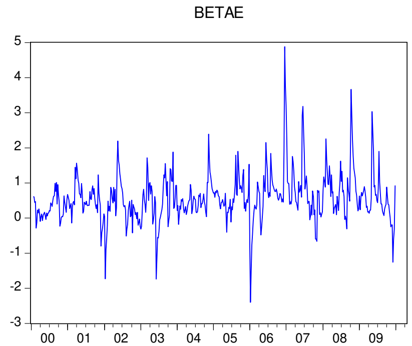

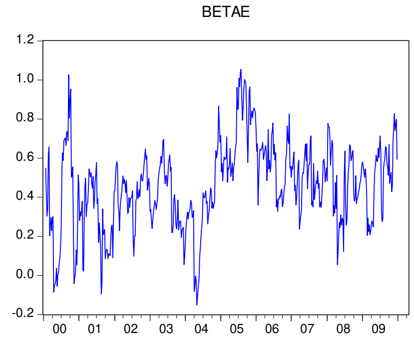

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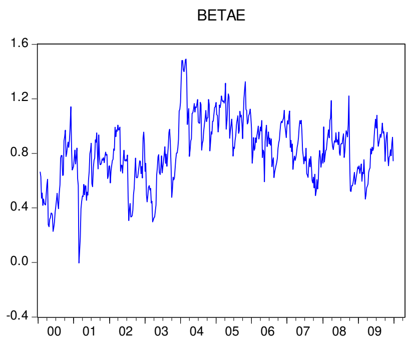
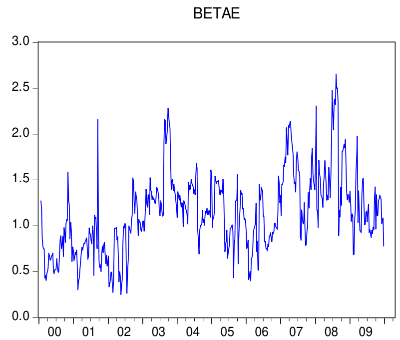
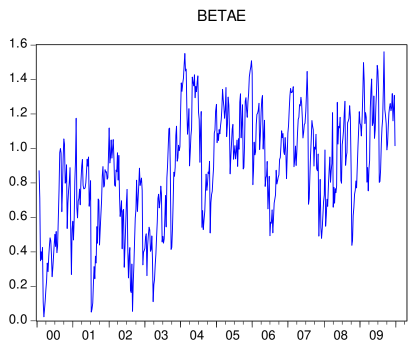
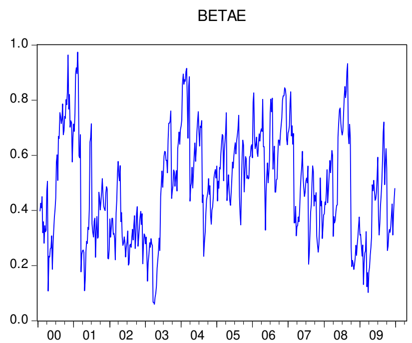
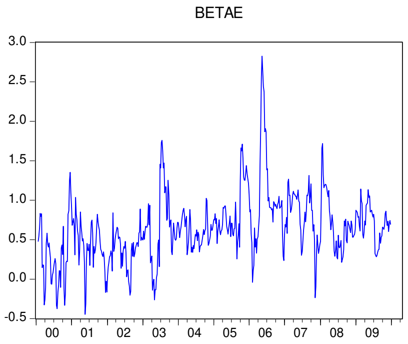


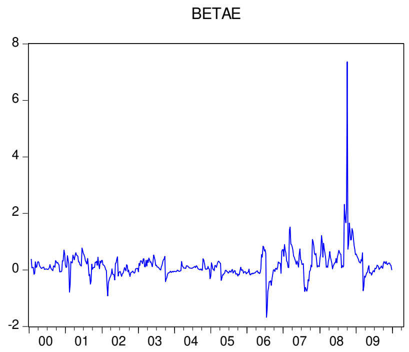


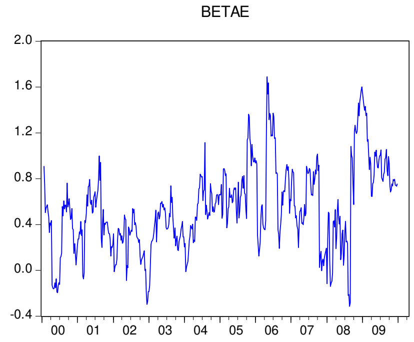




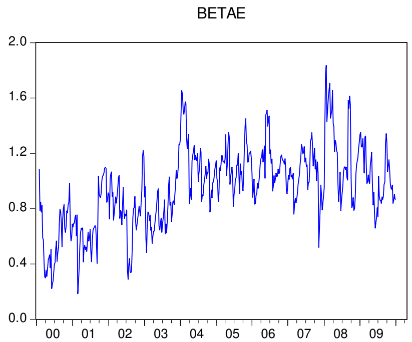
Utilities

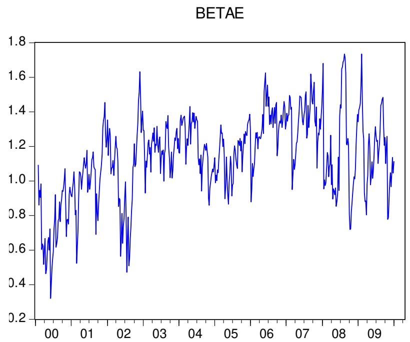


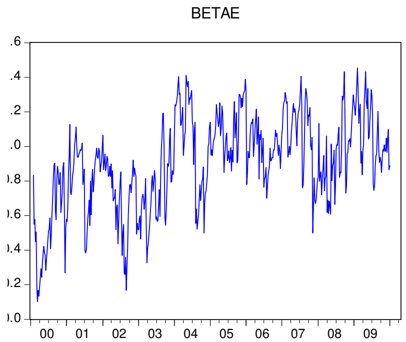




Industrials







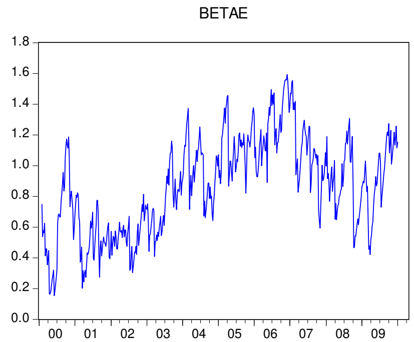


Table 4. Mean Betas for Pre-Crisis and Post-Crisis Periods

Industry	**Country**			
Auto&Compo	Norway	Sweden	Denmark	Finland
beta (pre-crisis)	0.576	1.039	0.395	0.913
beta (crisis)	1.039	1.168	0.728	1.012
total period	0.808	1.103	0.561	0.962
Banks	Norway	Sweden	Denmark	Finland
beta (pre-crisis)	0.622	0.847	0.536	0.853
beta (crisis)	1.164	1.236	1.124	1.150
total period	0.893	1.042	0.830	1.001
Capital Goods	Norway	Sweden	Denmark	Finland
beta (pre-crisis)	0.944	1.110	0.968	0.819
beta (crisis)	1.237	1.237	0.922	1.012
total period	1.030	1.147	0.955	0.876
Diversified FIN	Norway	Sweden	Denmark	Finland
beta (pre-crisis)	0.803	1.216	0.432	0.587
beta (crisis)	0.745	1.088	0.347	1.404
total period	0.774	1.152	0.390	0.995
Food/BV/TBC	Norway	Sweden	Denmark	Finland
beta (pre-crisis)	0.554	0.322	0.470	0.332
beta (crisis)	0.441	0.226	0.812	0.552
total period	0.521	0.294	0.570	0.396
Health Care	Norway	Sweden	Denmark	Finland
beta (pre-crisis)	0.701	0.622	0.757	0.493
beta (crisis)	0.278	0.652	0.674	0.315
total period	0.577	0.631	0.733	0.441
IT	Norway	Sweden	Denmark	Finland
beta (pre-crisis)	1.361	1.824	1.162	1.437
beta (crisis)	0.985	0.995	0.894	0.969
total period	1.251	1.582	1.083	1.300
Industrials	Norway	Sweden	Denmark	Finland
beta (pre-crisis)	0.892	1.101	0.849	0.834
beta (crisis)	1.091	1.226	1.025	0.952
total period	0.950	1.138	0.901	0.869
Media	Norway	Sweden	Denmark	Finland
beta (pre-crisis)	0.883	1.059	0.530	0.669
beta (crisis)	0.810	1.104	0.366	0.745
total period	0.862	1.072	0.482	0.691
Oil/Gas	Norway	Sweden	Denmark	Finland
beta (pre-crisis)	0.966	0.970	0.146	0.286
beta (crisis)	0.954	1.058	1.531	1.010
total period	0.963	0.996	0.552	0.498
Real Estate	Norway	Sweden	Denmark	Finland

beta (pre-crisis)	0.293	0.392	0.538	0.405
beta (crisis)	0.445	0.833	0.501	0.973
total period	0.338	0.521	0.527	0.572
Retail	Norway	Sweden	Denmark	Finland
beta (pre-crisis)	0.772	0.509	0.538	0.446
beta (crisis)	0.748	0.716	0.501	0.482
total period	0.765	0.570	0.527	0.457
Transport	Norway	Sweden	Denmark	Finland
beta (pre-crisis)	0.816	1.015	0.816	0.510
beta (crisis)	0.796	1.435	1.029	0.442
total period	0.810	1.138	0.879	0.490
Utilities	Norway	Sweden	Denmark	Finland
beta (pre-crisis)	0.608	Missing	0.075	0.486
beta (crisis)	0.738	data	0.403	0.674
total period	0.646		0.171	0.541

APPENDIX 4

Table 1. ADF and PP test for stationary. Volatility and time-varying beta.

*, **and *** denote statistical significance at 10, 5 and 1% level.

Industry/country variances	industry volatility		time-varying beta	
	ADF	PP	ADF	PP
Auto-compo				
Norway				
p-value	0.025	0.0259	0.0001	0.0003
t-stat	-3.130487**	-3.117773**	-4.607963***	-4.442169***
Sweden				
p-value	0.007	0.0197	0	0
t-stat	-3.557981***	-3.215137**	-5.231099***	-5.165721***
Denmark				
p-value	0	0	0	0
t-stat	-6.474511***	-6.498753***	-7.975916***	-7.839672***
Finland				
p-value	0.0012	0.0003	0	0
t-stat	-4.074017***	-4.405509***	-5.588302***	-5.127769***
Banks				
Norway				
p-value	0.0017	0	0.0001	0
t-stat	-3.96719***	-6.017171***	-4.813831***	-5.403266***
Sweden				
p-value	0.0805	0.0963	0.0074	0.0089
t-stat	-2.667887*	-2.607629*	-3.536782***	-3.480682***
Denmark				
p-value	0.0277	0.0286	0.1062	0.0778
t-stat	-3.093517**	-3.080945**	-2.541742*	-2.681951*
Finland				
p-value	0.0329	0.095	0.0086	0.021
t-stat	-3.029435**	-2.592928*	-3.491039***	-3.191859**
Capital goods				
Norway				
p-value	0.0152	0.0156	0	0
t-stat	-3.305029**	-3.296115**	-5.57616***	-5.409773***
Sweden				
p-value	0.1106	0.0923	0	0
t-stat	-2.522649	-2.606228*	-5.738521***	-5.601212***
Denmark				
p-value	0	0	0	0
t-stat	-7.419354***	-6.816681***	-5.609966***	-5.350703***

Finland				
p-value	0.0809	0.0431	0.0015	0.0029
t-stat	-2.665044*	-2.925449**	-3.999251***	-3.821367***
Div Finance				
Norway				
p-value	0.1016	0.1075	0.0023	0.0063
t-stat	-2.562248*	-2.535882*	-3.887932***	-3.591449***
Sweden				
p-value	0.0214	0.0151	0.0127	0.0259
t-stat	-3.186194**	-3.305976**	-3.364278**	-3.117181**
Denmark				
p-value	0.1388	0.143	0	0
t-stat	-2.412098	-2.397324	-5.090695***	-5.047772***
Finland				
p-value	0.0001	0.0012	0.0011	0.0017
t-stat	-4.593932***	-4.077691***	-4.098381***	-3.966851***
Food/bev/tabaco				
Norway				
p-value	0	0	0	0
t-stat	-8.682866***	-11.65801***	-7.149958***	-7.091789***
Sweden				
p-value	0	0	0	0
t-stat	-7.942248***	-22.42943***	-5.405069***	-20.16735***
Denmark				
p-value	0.0192	0.0713	0	0.0002
t-stat	-3.224123**	-2.719581*	-4.950522***	-4.55005***
Finland				
p-value	0.1388	0.0943	0.0006	0.0008
t-stat	-2.412098	-2.606548*	-4.233166***	-4.173944***
H_care				
Norway				
p-value	0	0	0	0
t-stat	-5.768657***	-5.853187***	-6.515761***	-6.373225***
Sweden				
p-value	0.0078	0.0078	0.0074	0.0166
t-stat	-3.523129***	-3.523129***	-3.538945***	-3.273996**
Denmark				
p-value	0.1	0.0747	0	0
t-stat	-2.56963*	-2.699911*	-5.954824***	-5.694646***
Finland				
p-value	0	0	0.0016	0.0008
t-stat	-6.136986***	-6.089136***	-3.995088***	-4.165667***
IT				

Norway				
p-value	0.0002	0.0003	0	0
t-stat	-4.562634***	-4.394969***	-7.327579***	-7.34861***
Sweden				
p-value	0.11	0.1909	0.0002	0.0006
t-stat	-2.57363*	-2.244451	-4.591916***	-4.24231***
Denmark				
p-value	0.0697	0.0414	0.0073	0.0029
t-stat	-2.729564*	-2.941109**	-3.543523***	-3.824741***
Finland				
p-value	0.1023	0.1095	0	0
t-stat	-2.56983*	-2.53683*	-5.307913***	-5.52647***
Media				
Norway				
p-value	0.1647	0.1004	0	0.0001
t-stat	-2.324243	-2.568007*	-4.851728***	-4.721858***
Sweden				
p-value	0.0201	0.0149	0	0
t-stat	-3.208199**	-3.310401**	-6.938713***	-7.105085***
Denmark				
p-value	0.1013	0.1024	0	0
t-stat	-2.56852*	-2.567907*	-6.5961***	-6.635478***
Finland				
p-value	0	0	0	0
t-stat	-5.586865***	-15.38847***	-11.9233***	-11.62041***
Oil/Gas				
Norway				
p-value	0.0004	0.0071	0	0.0001
t-stat	-4.337233***	-3.553357***	-4.900485***	-4.782781***
Sweden				
p-value	0.0042	0.002	0.0002	0.0002
t-stat	-3.714378***	-3.920859***	-4.517837***	-4.517837***
Denmark				
p-value	0	0	0	0
t-stat	-5.081422***	-5.231661***	-7.293445***	-7.090398***
Finland				
p-value	0.0022	0	0	0
t-stat	-3.897632***	-7.627249***	-7.625395***	-7.31381***
Real Estate				
Norway				
p-value	0.101	0.1297	0	0
t-stat	-2.57653*	-2.445821	-5.624491***	-5.624491***
Sweden				

p-value	0.0039	0.0055	0.0215	0.0794
t-stat	-3.730505***	-3.628692***	-3.183378**	-2.67322*
Denmark				
p-value	0	0	0	0
t-stat	-5.564151***	-5.827021***	-5.184459***	-5.78319***
Finland				
p-value	0.0081	0.0094	0.0014	0.0059
t-stat	-3.510359***	-3.462891***	-4.033557***	-3.607231***
Transport				
Norway				
p-value	0.0204	0.0061	0	0
t-stat	-3.203132**	-3.596968***	-5.097128***	-4.882651***
Sweden				
p-value	0.0003	0.0011	0	0
t-stat	-4.461244***	-4.10041***	-6.222916***	-5.835803***
Denmark				
p-value	0.112	0.1005	0	0
t-stat	-2.58851*	-2.524782*	-5.649527***	-5.373669***
Finland				
p-value	0.1011	0.1065	0	0
t-stat	-2.56997*	-2.534761*	-5.6281***	-5.571316***
Utilities				
Norway				
p-value	0	0	0	0
t-stat	-6.290949***	-6.208895***	-5.821598***	-5.966216***
Denmark				
p-value	0	0	0	0
t-stat	-7.698065***	-7.66267***	-6.43084***	-12.46576***
Finland				
p-value	0.0037	0.0202	0	0
t-stat	-3.753405***	-3.205378**	-5.18327***	-5.017617***
Industrials				
Norway				
p-value	0.0015	0.0109	0	0
t-stat	-4.008919***	-3.413991**	-5.155511***	-5.002769***
Sweden				
p-value	0.0596	0.0632	0	0
t-stat	-2.795532*	-2.770704*	-5.679411***	-5.537376***
Denmark				
p-value	0.0253	0.031	0	0
t-stat	-3.126669**	-3.051307**	-5.858469***	-5.445882***
Finland				
p-value	0.2208	0.1085	0.0014	0.0032

t-stat	-2.161815	-2.53183*	-4.025106***	-3.789017***
MSCI volatility				
p-value	0	0		
t-stat	-5.292824***	-5.240643***		

Table 2. Results of the Regression before the Correction for Autocorrelation and Heteroskedasticity. The White's test.

Industry/country	constant a0	dummy y0	IV a1	IVD y1	MV a2	MVD y2	D-W	Heteroskedasticity Test: White			
Auto-compo											
Norway	0.002268	0.103829	0.005473	-5.38E-05	0.001266	-0.026225	0.250787	F-statistic	27.45566	Prob. F	0
p-value	0.9767	0.4136	0	0.9322	0.9328	0.1074					
t-stat	0.029196	0.818212	11.82116	-0.085093	0.084363	-1.612841					
Sweden	0.955345	-0.051604	0.016946	-0.002329	-0.045796	0.013091	0.231935	F-statistic	5.927534	Prob. F	0
p-value	0	0.1894	0	0.1132	0	0.0305					
t-stat	37.06576	-1.314179	20.30031	-1.586775	-9.993956	2.16932					
Denmark	0.466832	-0.026854	0.002572	0.000294	-0.03308	3.73E-02	0.521949	F-statistic	16.18886	Prob. F	0
p-value	0	0.7151	0.0005	0.7545	0.0001	0.0002					
t-stat	9.340492	-0.365156	3.506133	0.312897	-3.858399	3.716646					
Finland	1.585562	-0.676941	-0.012114	0.018942	-0.056793	0.042932	0.289294	F-statistic	11.61188	Prob. F	0
p-value	0	0.0001	0	0.0002	0	0					
t-stat	19.64217	-4.080838	-5.310204	3.693902	-9.941251	5.980742					
Banks											
Norway	0.589032	0.28386	0.022139	-0.016573	-0.052994	0.047036	0.390587	F-statistic	6.869939	Prob. F	0
p-value	0	0	0	0	0	0					
t-stat	16.92929	5.470007	11.01829	-7.753375	-6.117499	4.675493					
Sweden	0.853497	0.178071	0.022795	-0.011779	-0.052468	0.033765	0.130534	F-statistic	9.347379	Prob. F	0
p-value	0	0.0007	0	0.0049	0	0					
t-stat	24.04618	3.408158	5.605287	-2.8266	-7.202656	4.411699					
Denmark	0.449768	0.537185	-0.004219	0.020284	0.025695	-0.069471	0.14686	F-statistic	13.12707	Prob. F	0
p-value	0	0	0.1739	0	0.0008	0					
t-stat	14.73749	11.67768	-1.361595	5.425135	3.379503	-6.101846					
Finland	0.863701	0.103596	0.005626	0.006753	-0.017204	-0.002569	0.119394	F-statistic	9.459765	Prob. F	0
p-value	0	0.0249	0.1373	0.0856	0.0606	0.788					
t-stat	27.71299	2.248946	1.488175	1.722206	-1.8802	-0.269075					
Capital goods											
Norway	0.919744	0.111591	0.014423	-0.003265	-0.045929	0.029787	0.273241	F-statistic	9.721627	Prob. F	0
p-value	0	0.0437	0	0.1591	0	0					
t-stat	27.08529	2.021608	8.163052	-1.410096	-9.270516	5.3685					
Sweden	0.981195	0.223348	0.046631	-0.038134	-0.071082	0.057146	0.356021	F-statistic	44.17623	Prob. F	0
p-value	0	0	0	0	0	0					
t-stat	34.41027	5.473056	12.7979	-9.494096	-17.49194	12.96315					
Denmark	0.945642	-0.115438	0.022559	-0.012447	-0.087189	0.068035	0.331484	F-statistic	31.80451	Prob. F	0
p-value	0	0.0471	0	0	0	0					
t-stat	21.63799	-1.990535	8.527504	-4.266956	-10.75608	7.637616					
Finland	1.20589	-0.14983	-0.017159	0.021311	-0.048291	0.039555	0.173997	F-statistic	101.7724	Prob. F	0
p-value	0	0.0727	0.0112	0.013	0	0					
t-stat	23.72464	-1.798278	-2.545719	2.493451	-9.744558	6.91639					
Div Finance											
Norway	0.239441	0.849258	0.082346	-0.098818	-0.062773	0.054209	0.210804	F-statistic	42.63508	Prob. F	0
p-value	0.0217	0	0	0	0	0					
t-stat	2.302617	5.940987	8.5467	-8.049194	-18.10333	14.01009					
Sweden	1.217776	-0.347216	0.041854	0.024485	-0.096071	0.018406	0.171356	F-statistic	32.22649	Prob. F	0
p-value	0	0	0	0.0001	0	0.0134					
t-stat	66.5009	-10.47043	14.66045	4.061166	-20.46829	2.481883					
Denmark	0.385827	0.01556	0.024695	-0.026844	-0.036475	0.033447	0.254733	F-statistic	8.916633	Prob. F	0
p-value	0	0.7536	0	0	0	0					
t-stat	19.69346	0.314035	13.33003	-4.122561	-11.95077	10.3723					
Finland	0.678421	0.481014	0.014241	-0.005399	-0.065636	0.039507	0.279689	F-statistic	25.28049	Prob. F	0
p-value	0	0	0	0.0002	0	0					
t-stat	13.14877	6.132061	13.58565	-3.786426	-9.095374	4.833372					
Food/bev/tabaco											
Norway	0.396635	-0.040313	0.027114	-0.014678	-0.03746	0.027016	0.493753	F-statistic	22.24724	Prob. F	0

p-value	0	0.457	0	0	0	0					
t-stat	9.628709	-0.74437	9.486313	-4.31286	-8.014556	5.297006					
Sweden	0.438944	-0.228513	0.005387	0.00567	-0.033565	0.027363	1.656296	F-statistic	40.216	Prob. F	0
p-value	0	0	0.2451	0.3017	0	0					
t-stat	11.96235	-5.078042	1.163663	1.033844	-10.89896	8.2831					
Denmark	0.531673	0.122	0.00456	0.010797	-0.019317	0.002608	0.292264	F-statistic	7.381391	Prob. F	0
p-value	0	0.0007	0.2584	0.0111	0	0.4965					
t-stat	18.96899	3.40395	1.131368	2.547781	-5.946055	0.680459					
Finland	0.578762	-0.252031	-0.024054	0.047989	-0.014144	0.007836	0.19763	F-statistic	12.18926	Prob. F	0
p-value	0	0	0	0	0	0.026					
t-stat	22.68344	-4.218155	-8.410865	9.267772	-4.283639	2.232718					
H_care											
Norway	0.455177	-0.254018	0.006966	-0.006692	0.022155	-0.015803	0.424989	F-statistic	5.757891	Prob. F	0
p-value	0	0	0	0.0071	0.0001	0.0102					
t-stat	15.65586	-5.497539	9.496655	-2.701342	4.052604	-2.577691					
Sweden	0.585203	-0.268241	0.026383	0.04739	-0.042569	-0.00248	0.119458	F-statistic	9.285083	Prob. F	0
p-value	0	0.0003	0	0.0001	0	0.7635					
t-stat	15.68781	-3.655647	6.149718	3.949918	-8.563239	-0.301006					
Denmark	0.803988	0.029126	-0.001031	-0.013288	-0.007664	0.008615	0.291769	F-statistic	7.444186	Prob. F	0
p-value	0	0.4773	0.739	0.0051	0.0996	0.0805					
t-stat	34.76637	0.711103	-0.333307	-2.81325	-1.649978	1.751325					
Finland	-8.210302	55.6637	0.362512	-2.278623	-0.04513	0.039595	0.301782	F-statistic	79.168	Prob. F	0
p-value	0	0.0003	0	0.0003	0	0					
t-stat	-5.411188	3.636463	5.88405	-3.65573	-20.98442	17.06973					
IT											
Norway	1.147082	-0.307219	0.016098	-0.003587	-0.053449	0.03973	0.44431	F-statistic	8.016596	Prob. F	0
p-value	0	0	0	0.2779	0	0					
t-stat	34.41429	-4.609795	16.96462	-1.086313	-10.34837	6.718478					
Sweden	1.585893	-1.158654	0.016086	0.010641	-0.089663	0.065449	0.339463	F-statistic	11.68838	Prob. F	0
p-value	0	0	0	0.0001	0	0					
t-stat	46.3101	-15.11311	16.90485	4.056798	-14.75059	10.12889					
Denmark	0.897114	-0.225172	0.026215	-0.002097	-0.079477	0.053705	0.24305	F-statistic	7.849961	Prob. F	0
p-value	0	0.0001	0	0.6672	0	0					
t-stat	30.78671	-3.881294	28.61558	-0.430183	-14.04829	6.653378					
Finland	1.837926	-0.895272	-0.002528	0.008474	-0.057764	0.046615	0.252763	F-statistic	107.0654	Prob. F	0
p-value	0	0	0.0049	0.0402	0	0					
t-stat	36.82007	-7.610749	-2.82462	2.056649	-7.727471	5.872334					
Media											
Norway	1.00652	-0.551699	0.005186	0.01202	-0.044633	0.033151	0.242361	F-statistic	11.70807	Prob. F	0
p-value	0	0	0	0	0	0					
t-stat	33.45573	-9.195696	4.801719	5.697012	-8.983426	6.226376					
Sweden	0.927133	0.02335	0.009576	0.000821	-0.013397	-0.002661	0.35256	F-statistic	12.83697	Prob. F	0
p-value	0	0.6113	0	0.6444	0.0147	0.6616					
t-stat	32.72739	0.508566	8.341377	0.461839	-2.447304	-0.438005					
Denmark	0.395733	-0.008357	0.012033	-0.011162	-0.039235	0.036555	0.340422	F-statistic	10.82719	Prob. F	0
p-value	0	0.9106	0	0.0415	0	0					
t-stat	11.96646	-0.112364	9.357292	-2.043752	-9.381086	8.28359					
Finland	0.72	-0.07635	0.005637	0.009802	-0.032293	0.017884	0.832662	F-statistic	74.42487	Prob. F	0
p-value	0	0.2651	0	0.0002	0	0.008					
t-stat	17.39468	-1.115616	19.9407	3.781477	-5.25438	2.660665					
Oil/Gas											
Norway	0.43762	0.388739	0.065898	-0.053128	-0.075193	0.061008	0.266615	F-statistic	10.85868	Prob. F	0
p-value	0	0	0	0	0	0					
t-stat	6.916038	5.135458	13.14	-9.483249	-16.81071	11.70964					
Sweden	0.957201	-0.142763	0.016148	-0.003471	-0.101616	0.08238	0.222455	F-statistic	16.27256	Prob. F	0
p-value	0	0.1835	0	0.5234	0	0					
t-stat	14.20953	-1.331762	8.183291	-0.638624	-12.93149	6.245683					
Denmark	0.147801	0.869543	-0.000424	0.007677	0.004159	-0.05153	0.535851	F-statistic	63.02307	Prob. F	0
p-value	0.1044	0	0.4564	0	0.698	0.0003					
t-stat	1.626629	6.165765	-0.74536	7.002885	0.388207	-3.613438					
Finland	0.051712	0.669804	0.017415	-0.009623	-0.002139	-0.008591	0.768746	F-statistic	27.08515	Prob. F	0
p-value	0.3107	0	0	0	0.7538	0.2523					
t-stat	1.014714	8.39347	18.66751	-7.271716	-0.313816	-1.146131					
Real Estate											
Norway	0.399375	0.048355	-0.001321	0.004255	-0.020058	0.01669	0.274634	F-statistic	22.41183	Prob. F	0
p-value	0	0.4231	0.8725	0.625	0	0					
t-stat	7.589397	0.801667	-0.160528	0.489097	-7.784669	5.622804					
Sweden	0.141203	0.552109	0.080354	-0.046485	-0.029214	-0.010921	0.240279	F-statistic	31.12931	Prob. F	0
p-value	0	0	0	0	0	0.1819					
t-stat	5.527625	15.32865	16.98714	-6.404283	-8.286391	-1.336598					

Denmark	0.38847	-0.099638	0.025595	0.007043	-0.029066	0.015692	0.319245	F-statistic	31.30832	Prob. F	0
p-value	0	0.1075	0	0.3483	0	0.0015					
t-stat	14.95897	-1.61238	14.67094	0.938769	-7.583306	3.192447					
Finland	0.450638	0.348193	0.016662	-0.006754	-0.038322	0.026869	0.248736	F-statistic	16.13317	Prob. F	0
p-value	0	0	0.0018	0.2316	0	0					
t-stat	9.76555	6.136608	3.139607	-1.197779	-9.244837	4.874507					
Retail											
Norway	0.021068	1.142258	0.010661	-0.032975	-0.019355	0.016174	0.352815	F-statistic	38.20606	Prob. F	0
p-value	0.6114	0	0	0	0	0					
t-stat	0.508372	6.954097	9.250415	-8.398982	-16.299	12.95469					
Sweden	0.837598	-0.044172	0.001047	0.002164	-0.017801	0.009872	0.259371	F-statistic	18.75402	Prob. F	0
p-value	0	0.4847	0.381	0.632	0.0003	0.0663					
t-stat	30.1795	-0.699307	0.876809	0.479215	-3.608502	1.840345					
Denmark	0.614395	-0.08029	0.000901	0.003276	-0.026924	0.02211	0.6027	F-statistic	44.9871	Prob. F	0
p-value	0	0.3655	0.2863	0.0013	0.0052	0.0361					
t-stat	10.30934	-0.90582	1.06746	3.236188	-2.803861	2.101233					
Finland	0.559259	-0.084407	0.001263	0.000558	-0.026779	0.024222	0.281229	F-statistic	5.508698	Prob. F	0
p-value	0	0.0941	0.5623	0.8584	0	0					
t-stat	20.80734	-1.677225	0.57977	0.17854	-7.991788	6.696707					
Transport											
Norway	0.365665	0.299271	0.069529	-0.051279	-0.074701	0.062263	0.293045	F-statistic	9.102556	Prob. F	0
p-value	0	0.0006	0	0	0	0					
t-stat	6.499343	3.472159	12.43506	-6.328492	-20.3304	14.22064					
Sweden	0.941819	0.485166	0.019446	-0.019066	-0.088481	0.086663	0.392789	F-statistic	14.11835	Prob. F	0
p-value	0	0	0	0	0	0					
t-stat	23.0416	8.351378	10.54166	-9.895796	-11.36483	10.40711					
Denmark	1.11683	-0.197281	-0.006225	0.015143	-0.042355	0.031736	0.318062	F-statistic	17.58049	Prob. F	0
p-value	0	0.0069	0.1422	0.001	0	0					
t-stat	19.34612	-2.714275	-1.470039	3.296553	-8.972419	6.337425					
Finland	0.462048	0.104454	0.021609	-0.027289	-0.034578	0.029289	0.289977	F-statistic	33.4969	Prob. F	0
p-value	0	0.1422	0	0.0002	0	0					
t-stat	10.42281	1.469737	4.37249	-3.787999	-12.30123	9.875724					
Utilities											
Norway	0.607722	-0.234035	0.009096	0.016973	-0.034831	0.019247	0.282528	F-statistic	51.22478	Prob. F	0
p-value	0	0.0075	0	0.0004	0	0.0022					
t-stat	13.52162	-2.686254	4.842116	3.553149	-6.404078	3.078215					
Denmark	0.007945	0.387357	-0.000352	0.003928	0.014339	-0.03907	0.810112	F-statistic	165.3056	Prob. F	0
p-value	0.8746	0	0.4944	0	0.1105	0.0001					
t-stat	0.157857	5.368888	-0.683879	6.917032	1.598526	-4.009242					
Finland	0.057223	0.318896	0.049731	-0.035927	-0.041357	0.0301	0.333937	F-statistic	6.459572	Prob. F	0
p-value	0.2259	0	0	0	0	0					
t-stat	1.212401	5.581302	14.8542	-8.879444	-9.319921	4.476504					
Industrials											
Norway	0.552506	0.35705	0.072446	-0.055603	-0.088476	0.069898	0.355393	F-statistic	9.192022	Prob. F	0
p-value	0	0	0	0	0	0					
t-stat	16.09222	8.006443	17.12229	-12.14465	-20.64321	14.74994					
Sweden	0.977676	0.205642	0.047736	-0.038039	-0.069968	0.055363	0.354443	F-statistic	37.56486	Prob. F	0
p-value	0	0	0	0	0	0					
t-stat	41.08861	5.691735	14.83694	-10.35984	-17.94444	12.92437					
Denmark	0.632485	0.264006	0.046322	-0.034941	-0.064035	0.051809	0.326159	F-statistic	15.9462	Prob. F	0
p-value	0	0	0	0	0	0					
t-stat	12.83339	4.524294	8.399448	-5.989838	-13.20173	9.66047					
Finland	0.606103	0.488828	0.086846	-0.09077	-0.074534	0.067585	0.237221	F-statistic	100.7056	Prob. F	0
p-value	0	0	0	0	0	0					
t-stat	12.30669	6.844086	10.95221	-9.667791	-21.55716	16.70437					

Table 3. Breusch-Godfrey Serial Correlation LM Test with 4 lags without correction

Industry/country	Breusch-Godfrey Serial Correlation LM Test with 4 lags						
Auto-compo						t-Statistic	Prob.
Norway	F-statistic	417.7505	Prob. F(4,509)	0	RESID(-1)	18.97337	0
	Obs*R-squared	397.8207	Prob. Chi-Square(4)	0	RESID(-2)	1.21068	0.2266
					RESID(-3)	-0.519951	0.6033
					RESID(-4)	-0.18449	0.8537
Sweden	F-statistic	458.6283	Prob. F(4,509)	0	RESID(-1)	21.21915	0
	Obs*R-squared	406.2756	Prob. Chi-Square(4)	0	RESID(-2)	-1.627967	0.1042
					RESID(-3)	0.373644	0.7088
					RESID(-4)	0.478683	0.6324
Denmark	F-statistic	154.8641	Prob. F(4,509)	0	RESID(-1)	16.45787	0
	Obs*R-squared	284.9006	Prob. Chi-Square(4)	0	RESID(-2)	1.218118	0.2237

					RESID(-3)	-1.456908	0.1458
					RESID(-4)	0.351665	0.7252
Finland	F-statistic	350.8292	Prob. F(4,509)	0	RESID(-1)	18.66129	0
	Obs*R-squared	380.8581	Prob. Chi-Square(4)	0	RESID(-2)	-0.424896	0.6711
					RESID(-3)	0.624245	0.5327
					RESID(-4)	0.773191	0.4398
Banks							
Norway	F-statistic	249.3124	Prob. F(4,509)	0	RESID(-1)	18.8042	0
	Obs*R-squared	343.6167	Prob. Chi-Square(4)	0	RESID(-2)	-1.637967	0.1041
					RESID(-3)	1.575268	0.1129
					RESID(-4)	-1.466908	0.1448
Sweden	F-statistic	891.5459	Prob. F(4,509)	0	RESID(-1)	20.56373	0
	Obs*R-squared	454.1757	Prob. Chi-Square(4)	0	RESID(-2)	-0.355988	0.722
					RESID(-3)	1.158576	0.2472
					RESID(-4)	-0.410934	0.6813
Denmark	F-statistic	798.4635	Prob. F(4,509)	0	RESID(-1)	17.22265	0
	Obs*R-squared	447.6575	Prob. Chi-Square(4)	0	RESID(-2)	1.68417	0.0928
					RESID(-3)	2.109742	0.0354
					RESID(-4)	-0.551136	0.5818
Finland	F-statistic	990.7157	Prob. F(4,509)	0	RESID(-1)	20.12294	0
	Obs*R-squared	459.926	Prob. Chi-Square(4)	0	RESID(-2)	0.253755	0.7998
					RESID(-3)	-0.34005	0.734
					RESID(-4)	1.545268	0.1229
Capital goods							
Norway	F-statistic	375.1777	Prob. F(4,509)	0	RESID(-1)	19.11505	0
	Obs*R-squared	387.5527	Prob. Chi-Square(4)	0	RESID(-2)	-0.209368	0.8342
					RESID(-3)	0.077734	0.9381
					RESID(-4)	0.758657	0.4484
Sweden	F-statistic	269.5065	Prob. F(4,509)	0	RESID(-1)	18.06417	0
	Obs*R-squared	352.5434	Prob. Chi-Square(4)	0	RESID(-2)	-0.292165	0.7703
					RESID(-3)	1.160099	0.2466
					RESID(-4)	-0.339607	0.7343
Denmark	F-statistic	293.8936	Prob. F(4,509)	0	RESID(-1)	17.62015	0
	Obs*R-squared	362.1824	Prob. Chi-Square(4)	0	RESID(-2)	1.532085	0.1261
					RESID(-3)	0.529349	0.5968
					RESID(-4)	-1.351442	0.1772
Finland	F-statistic	647.7351	Prob. F(4,509)	0	RESID(-1)	21.71672	0
	Obs*R-squared	433.7819	Prob. Chi-Square(4)	0	RESID(-2)	-0.909362	0.3636
					RESID(-3)	-0.75282	0.4519
					RESID(-4)	1.120064	0.2632
Div Finance							
Norway	F-statistic	498.6863	Prob. F(4,509)	0	RESID(-1)	20.73443	0
	Obs*R-squared	413.4897	Prob. Chi-Square(4)	0	RESID(-2)	-0.977924	0.3286
					RESID(-3)	1.356106	0.1757
					RESID(-4)	-1.199588	0.2309
Sweden	F-statistic	658.3975	Prob. F(4,509)	0	RESID(-1)	21.66857	0
	Obs*R-squared	434.9385	Prob. Chi-Square(4)	0	RESID(-2)	-1.462908	0.1328
					RESID(-3)	1.544168	0.1119
					RESID(-4)	-1.053301	0.2927
Denmark	F-statistic	405.8792	Prob. F(4,509)	0	RESID(-1)	19.77368	0
	Obs*R-squared	395.1224	Prob. Chi-Square(4)	0	RESID(-2)	-0.445614	0.6561
					RESID(-3)	0.911214	0.3626
					RESID(-4)	-0.773412	0.4396
Finland	F-statistic	377.8432	Prob. F(4,509)	0	RESID(-1)	18.56394	0
	Obs*R-squared	388.2464	Prob. Chi-Square(4)	0	RESID(-2)	0.556531	0.5781
					RESID(-3)	-0.697599	0.4857
					RESID(-4)	1.925302	0.0547
Food/bev/tabaco							
Norway	F-statistic	173.7213	Prob. F(4,509)	0	RESID(-1)	16.26243	0
	Obs*R-squared	299.5679	Prob. Chi-Square(4)	0	RESID(-2)	1.543258	0.1132
					RESID(-3)	-0.874746	0.3832
					RESID(-4)	-0.243617	0.8075
Sweden	F-statistic	10.02369	Prob. F(4,509)	0	RESID(-1)	2.655505	0.0082
	Obs*R-squared	37.89725	Prob. Chi-Square(4)	0	RESID(-2)	3.262295	0.0012
					RESID(-3)	2.112334	0.0351
					RESID(-4)	1.742565	0.082
Denmark	F-statistic	336.4984	Prob. F(4,509)	0	RESID(-1)	19.63537	0
	Obs*R-squared	376.5893	Prob. Chi-Square(4)	0	RESID(-2)	-0.040455	0.9677
					RESID(-3)	-0.719409	0.4722
					RESID(-4)	0.226978	0.8205

Finland	F-statistic	550.8619	Prob. F(4,509)	0	RESID(-1)	20.9063	0
	Obs*R-squared	421.6079	Prob. Chi-Square(4)	0	RESID(-2)	-0.662035	0.5082
					RESID(-3)	-0.311193	0.7558
					RESID(-4)	0.884633	0.3768
H_care							
Norway	F-statistic	218.2346	Prob. F(4,509)	0	RESID(-1)	19.62088	0
	Obs*R-squared	327.8402	Prob. Chi-Square(4)	0	RESID(-2)	-1.656967	0.1052
					RESID(-3)	1.546343	0.1131
					RESID(-4)	-0.065596	0.9553
Sweden	F-statistic	989.9731	Prob. F(4,509)	0	RESID(-1)	19.78806	0
	Obs*R-squared	459.8867	Prob. Chi-Square(4)	0	RESID(-2)	1.354541	0.1762
					RESID(-3)	-0.218577	0.8271
					RESID(-4)	0.176462	0.86
Denmark	F-statistic	349.4548	Prob. F(4,509)	0	RESID(-1)	20.01484	0
	Obs*R-squared	380.4599	Prob. Chi-Square(4)	0	RESID(-2)	-1.036321	0.3005
					RESID(-3)	0.793757	0.4277
					RESID(-4)	-0.287723	0.7737
Finland	F-statistic	331.8276	Prob. F(4,509)	0	RESID(-1)	20.30236	0
	Obs*R-squared	375.1403	Prob. Chi-Square(4)	0	RESID(-2)	-1.840347	0.0663
					RESID(-3)	1.041447	0.2982
					RESID(-4)	-0.079973	0.9363
IT							
Norway	F-statistic	196.8155	Prob. F(4,509)	0	RESID(-1)	17.82525	0
	Obs*R-squared	315.2056	Prob. Chi-Square(4)	0	RESID(-2)	0.438028	0.6616
					RESID(-3)	-0.351904	0.7251
					RESID(-4)	-0.894611	0.3714
Sweden	F-statistic	283.611	Prob. F(4,509)	0	RESID(-1)	17.76542	0
	Obs*R-squared	358.2577	Prob. Chi-Square(4)	0	RESID(-2)	0.052627	0.958
					RESID(-3)	0.174753	0.8613
					RESID(-4)	1.310532	0.1906
Denmark	F-statistic	379.5657	Prob. F(4,509)	0	RESID(-1)	18.57031	0
	Obs*R-squared	388.6908	Prob. Chi-Square(4)	0	RESID(-2)	-0.422496	0.6728
					RESID(-3)	1.749874	0.0807
					RESID(-4)	-0.463893	0.6429
Finland	F-statistic	411.8374	Prob. F(4,509)	0	RESID(-1)	20.1364	0
	Obs*R-squared	396.4916	Prob. Chi-Square(4)	0	RESID(-2)	-0.605186	0.5453
					RESID(-3)	-0.749702	0.4538
					RESID(-4)	1.564012	0.1184
Media							
Norway	F-statistic	432.9174	Prob. F(4,509)	0	RESID(-1)	19.70938	0
	Obs*R-squared	401.1018	Prob. Chi-Square(4)	0	RESID(-2)	1.107073	0.2688
					RESID(-3)	-1.103585	0.2703
					RESID(-4)	-0.00026	0.9998
Sweden	F-statistic	269.9658	Prob. F(4,509)	0	RESID(-1)	20.95908	0
	Obs*R-squared	352.7359	Prob. Chi-Square(4)	0	RESID(-2)	-3.048474	0.0024
					RESID(-3)	1.521237	0.1288
					RESID(-4)	-0.627613	0.5305
Denmark	F-statistic	279.9959	Prob. F(4,509)	0	RESID(-1)	18.55271	0
	Obs*R-squared	356.8308	Prob. Chi-Square(4)	0	RESID(-2)	0.267357	0.7893
					RESID(-3)	-1.030415	0.3033
					RESID(-4)	1.400887	0.1619
Finland	F-statistic	67.61252	Prob. F(4,509)	0	RESID(-1)	12.09117	0
	Obs*R-squared	180.0803	Prob. Chi-Square(4)	0	RESID(-2)	2.161841	0.0311
					RESID(-3)	-0.697863	0.4856
					RESID(-4)	-0.163675	0.8701
Oil/Gas							
Norway	F-statistic	389.8805	Prob. F(4,509)	0	RESID(-1)	18.53878	0
	Obs*R-squared	391.29	Prob. Chi-Square(4)	0	RESID(-2)	0.135058	0.8926
					RESID(-3)	0.447773	0.6545
					RESID(-4)	0.594343	0.5525
Sweden	F-statistic	479.4241	Prob. F(4,509)	0	RESID(-1)	19.89172	0
	Obs*R-squared	410.1397	Prob. Chi-Square(4)	0	RESID(-2)	-0.173032	0.8627
					RESID(-3)	-0.274297	0.784
					RESID(-4)	0.900797	0.3681
Denmark	F-statistic	149.8659	Prob. F(4,509)	0	RESID(-1)	18.24099	0
	Obs*R-squared	280.6783	Prob. Chi-Square(4)	0	RESID(-2)	-1.791894	0.0737
					RESID(-3)	-0.062917	0.9499
					RESID(-4)	0.016043	0.9872
Finland	F-statistic	84.81268	Prob. F(4,509)	0	RESID(-1)	15.88991	0
	Obs*R-squared	207.5697	Prob. Chi-Square(4)	0	RESID(-2)	-1.638967	0.1054

					RESID(-3)	0.972452	0.3113
					RESID(-4)	1.433161	0.1532
Real Estate							
Norway	F-statistic	374.151	Prob. F(4,509)	0	RESID(-1)	18.24948	0
	Obs*R-squared	387.2836	Prob. Chi-Square(4)	0	RESID(-2)	1.274094	0.2032
					RESID(-3)	-0.335664	0.7373
					RESID(-4)	-0.156495	0.8757
Sweden	F-statistic	451.0259	Prob. F(4,509)	0	RESID(-1)	19.42561	0
	Obs*R-squared	404.7937	Prob. Chi-Square(4)	0	RESID(-2)	-1.050713	0.2943
					RESID(-3)	1.743232	0.0897
					RESID(-4)	-1.023438	0.3156
Denmark	F-statistic	308.8903	Prob. F(4,509)	0	RESID(-1)	17.56884	0
	Obs*R-squared	367.5745	Prob. Chi-Square(4)	0	RESID(-2)	1.08285	0.2794
					RESID(-3)	0.438032	0.6615
					RESID(-4)	-0.252791	0.8005
Finland	F-statistic	412.1267	Prob. F(4,509)	0	RESID(-1)	19.66638	0
	Obs*R-squared	396.5573	Prob. Chi-Square(4)	0	RESID(-2)	-0.437238	0.6621
					RESID(-3)	0.374737	0.708
					RESID(-4)	0.308097	0.7581
Retail							
Norway	F-statistic	241.6201	Prob. F(4,509)	0	RESID(-1)	18.70623	0
	Obs*R-squared	339.9593	Prob. Chi-Square(4)	0	RESID(-2)	-0.504619	0.614
					RESID(-3)	0.654671	0.513
					RESID(-4)	-0.863822	0.3881
Sweden	F-statistic	415.0215	Prob. F(4,509)	0	RESID(-1)	20.54394	0
	Obs*R-squared	397.2109	Prob. Chi-Square(4)	0	RESID(-2)	-0.497813	0.6278
					RESID(-3)	-1.637967	0.1041
					RESID(-4)	1.549368	0.1112
Denmark	F-statistic	122.8082	Prob. F(4,509)	0	RESID(-1)	16.54883	0
	Obs*R-squared	254.8905	Prob. Chi-Square(4)	0	RESID(-2)	-0.800499	0.4238
					RESID(-3)	0.051903	0.9586
					RESID(-4)	-0.357929	0.7205
Finland	F-statistic	360.4932	Prob. F(4,509)	0	RESID(-1)	18.99049	0
	Obs*R-squared	383.5952	Prob. Chi-Square(4)	0	RESID(-2)	-0.476708	0.6338
					RESID(-3)	0.651906	0.5148
					RESID(-4)	0.378124	0.7055
Transport							
Norway	F-statistic	344.7844	Prob. F(4,509)	0	RESID(-1)	18.73128	0
	Obs*R-squared	379.0891	Prob. Chi-Square(4)	0	RESID(-2)	0.932457	0.3515
					RESID(-3)	-1.522683	0.1285
					RESID(-4)	1.47465	0.1409
Sweden	F-statistic	232.5703	Prob. F(4,509)	0	RESID(-1)	17.51061	0
	Obs*R-squared	335.4563	Prob. Chi-Square(4)	0	RESID(-2)	0.523872	0.6006
					RESID(-3)	-0.055021	0.9561
					RESID(-4)	0.366959	0.7138
Denmark	F-statistic	310.3308	Prob. F(4,509)	0	RESID(-1)	18.67663	0
	Obs*R-squared	368.073	Prob. Chi-Square(4)	0	RESID(-2)	-0.433936	0.6655
					RESID(-3)	1.617276	0.0975
					RESID(-4)	-1.425647	0.1556
Finland	F-statistic	347.0968	Prob. F(4,509)	0	RESID(-1)	19.3701	0
	Obs*R-squared	379.7712	Prob. Chi-Square(4)	0	RESID(-2)	0.438975	0.6609
					RESID(-3)	-0.379567	0.7044
					RESID(-4)	-0.38897	0.6975
Utilities							
Norway	F-statistic	361.7456	Prob. F(4,509)	0	RESID(-1)	20.41461	0
	Obs*R-squared	383.942	Prob. Chi-Square(4)	0	RESID(-2)	-0.422053	0.6732
					RESID(-3)	0.347131	0.7286
					RESID(-4)	-1.428827	0.1537
Denmark	F-statistic	70.82655	Prob. F(4,509)	0	RESID(-1)	13.09486	0
	Obs*R-squared	185.5797	Prob. Chi-Square(4)	0	RESID(-2)	0.172354	0.8632
					RESID(-3)	1.112791	0.2663
					RESID(-4)	-0.640552	0.5221
Finland	F-statistic	290.8239	Prob. F(4,509)	0	RESID(-1)	19.54271	0
	Obs*R-squared	361.0309	Prob. Chi-Square(4)	0	RESID(-2)	-0.107434	0.9145
					RESID(-3)	-1.121278	0.2627
					RESID(-4)	0.793842	0.4277
Industrials							
Norway	F-statistic	273.1342	Prob. F(4,509)	0	RESID(-1)	17.60417	0
	Obs*R-squared	354.0515	Prob. Chi-Square(4)	0	RESID(-2)	0.500528	0.6169
					RESID(-3)	0.03267	0.974

					RESID(-4)	0.981587	0.3268
Sweden	F-statistic	270.6008	Prob. F(4,509)	0	RESID(-1)	18.02852	0
	Obs*R-squared	353.0012	Prob. Chi-Square(4)	0	RESID(-2)	-0.14526	0.8846
					RESID(-3)	1.063413	0.2881
					RESID(-4)	-0.36419	0.7159
Denmark	F-statistic	300.4911	Prob. F(4,509)	0	RESID(-1)	18.45094	0
	Obs*R-squared	364.6011	Prob. Chi-Square(4)	0	RESID(-2)	0.247187	0.8049
					RESID(-3)	0.962109	0.3365
					RESID(-4)	-1.195727	0.2324
Finland	F-statistic	449.0208	Prob. F(4,509)	0	RESID(-1)	20.94055	0
	Obs*R-squared	404.3963	Prob. Chi-Square(4)	0	RESID(-2)	-0.947069	0.3441
					RESID(-3)	-0.85201	0.3946
					RESID(-4)	1.479304	0.1397

Table 4. Breusch-Godfrey Serial Correlation LM Test after correction

Industry/country	Breusch-Godfrey Serial Correlation LM Test 2 lags			
Auto-compo				
Norway	F-statistic	0.817537	Prob. F	0.4421
	Obs*R-squared	1.658657	Prob. Chi-Square	0.4363
Sweden				
	F-statistic	1.68137	Prob. F	0.1872
	Obs*R-squared	3.399738	Prob. Chi-Square	0.1827
Denmark				
	F-statistic	1.206156	Prob. F	0.3002
	Obs*R-squared	2.443386	Prob. Chi-Square	0.2947
Finland				
	F-statistic	2.333592	Prob. F	0.0997
	Obs*R-squared	4.71132	Prob. Chi-Square	0.0988
Banks				
Norway				
	F-statistic	1.58137	Prob. F	0.1271
	Obs*R-squared	3.219738	Prob. Chi-Square	0.1227
Sweden				
	F-statistic	1.158048	Prob. F	0.3149
	Obs*R-squared	2.346373	Prob. Chi-Square	0.3094
Denmark				
	F-statistic	9.207551	Prob. F	0.0001
	Obs*R-squared	18.08637	Prob. Chi-Square	0.0001
Finland				
	F-statistic	0.294595	Prob. F	0.745
	Obs*R-squared	0.598914	Prob. Chi-Square	0.7412
Capital goods				
Norway				
	F-statistic	0.399624	Prob. F	0.6708
	Obs*R-squared	0.812104	Prob. Chi-Square	0.6663
Sweden				
	F-statistic	1.563041	Prob. F	0.2105
	Obs*R-squared	3.161936	Prob. Chi-Square	0.2058
Denmark				
	F-statistic	2.679661	Prob. F	0.0696
	Obs*R-squared	5.397255	Prob. Chi-Square	0.0673
Finland				
	F-statistic	0.0753	Prob. F	0.9275
	Obs*R-squared	0.153218	Prob. Chi-Square	0.9263
Div Finance				
Norway				
	F-statistic	1.783315	Prob. F	0.1691
	Obs*R-squared	3.604438	Prob. Chi-Square	0.1649
Sweden				
	F-statistic	0.788434	Prob. F	0.4551
	Obs*R-squared	1.599793	Prob. Chi-Square	0.4494
Denmark				
	F-statistic	0.298059	Prob. F	0.7424
	Obs*R-squared	0.605948	Prob. Chi-Square	0.7386
Finland				
	F-statistic	0.076893	Prob. F	0.926

	Obs*R-squared	0.156458	Prob. Chi-Square	0.9248
Food/bev/tabaco				
Norway				
	F-statistic	2.338168	Prob. F	0.0975
	Obs*R-squared	4.715696	Prob. Chi-Square	0.0946
Sweden				
	F-statistic	11.25289	Prob. F	0
	Obs*R-squared	21.9339	Prob. Chi-Square	0
Denmark				
	F-statistic	0.304551	Prob. F	0.7376
	Obs*R-squared	0.619132	Prob. Chi-Square	0.7338
Finland				
	F-statistic	0.197243	Prob. F	0.8211
	Obs*R-squared	0.40115	Prob. Chi-Square	0.8183
H_care				
Norway				
	F-statistic	2.317148	Prob. F	0.0995
	Obs*R-squared	4.700296	Prob. Chi-Square	0.0977
Sweden				
	F-statistic	0.149541	Prob. F	0.8611
	Obs*R-squared	0.304191	Prob. Chi-Square	0.8589
Denmark				
	F-statistic	0.114023	Prob. F	0.8923
	Obs*R-squared	0.231974	Prob. Chi-Square	0.8905
Finland				
	F-statistic	1.68073	Prob. F	0.1873
	Obs*R-squared	3.398452	Prob. Chi-Square	0.1828
IT				
Norway				
	F-statistic	0.24668	Prob. F	0.7815
	Obs*R-squared	0.501596	Prob. Chi-Square	0.7782
Sweden				
	F-statistic	1.656893	Prob. F	0.1918
	Obs*R-squared	3.350566	Prob. Chi-Square	0.1873
Denmark				
	F-statistic	2.312552	Prob. F	0.0998
	Obs*R-squared	4.71021	Prob. Chi-Square	0.0989
Finland				
	F-statistic	0.203048	Prob. F	0.8163
	Obs*R-squared	0.412947	Prob. Chi-Square	0.8134
Media				
Norway				
	F-statistic	0.43939	Prob. F	0.6447
	Obs*R-squared	0.892777	Prob. Chi-Square	0.6399
Sweden				
	F-statistic	4.285371	Prob. F	0.0143
	Obs*R-squared	8.577851	Prob. Chi-Square	0.0137
Denmark				
	F-statistic	0.450086	Prob. F	0.6378
	Obs*R-squared	0.914472	Prob. Chi-Square	0.633
Finland				
	F-statistic	1.307697	Prob. F	0.2713
	Obs*R-squared	2.648033	Prob. Chi-Square	0.2661
Oil/Gas				
Norway				
	F-statistic	1.476374	Prob. F	0.2294
	Obs*R-squared	2.987627	Prob. Chi-Square	0.2245
Sweden				
	F-statistic	1.768706	Prob. F	0.1716
	Obs*R-squared	3.575113	Prob. Chi-Square	0.1674
Denmark				
	F-statistic	2.808301	Prob. F	0.0612
	Obs*R-squared	5.65353	Prob. Chi-Square	0.0592
Finland				
	F-statistic	2.532208	Prob. F	0.0892
	Obs*R-squared	5.016324	Prob. Chi-Square	0.0874
Real Estate				
Norway				
	F-statistic	0.938783	Prob. F	0.3918
	Obs*R-squared	1.903743	Prob. Chi-Square	0.386

Sweden				
	F-statistic	2.335042	Prob. F	0.0978
	Obs*R-squared	4.725712	Prob. Chi-Square	0.0957
Denmark				
	F-statistic	1.745469	Prob. F	0.1756
	Obs*R-squared	3.528465	Prob. Chi-Square	0.1713
Finland				
	F-statistic	0.570598	Prob. F	0.5655
	Obs*R-squared	1.158777	Prob. Chi-Square	0.5602
Retail				
Norway				
	F-statistic	0.371778	Prob. F(2,510)	0.6897
	Obs*R-squared	0.755576	Prob. Chi-Square	0.6854
Sweden				
	F-statistic	1.179078	Prob. F	0.3084
	Obs*R-squared	2.388786	Prob. Chi-Square	0.3029
Denmark				
	F-statistic	1.161848	Prob. F	0.3137
	Obs*R-squared	2.354036	Prob. Chi-Square	0.3082
Finland				
	F-statistic	2.499208	Prob. F	0.0832
	Obs*R-squared	5.037329	Prob. Chi-Square	0.0806
Transport				
Norway				
	F-statistic	0.605927	Prob. F	0.546
	Obs*R-squared	1.230352	Prob. Chi-Square	0.5405
Sweden				
	F-statistic	0.223201	Prob. F	0.8
	Obs*R-squared	0.453897	Prob. Chi-Square	0.797
Denmark				
	F-statistic	2.347092	Prob. F	0.0967
	Obs*R-squared	4.73353	Prob. Chi-Square	0.0938
Finland				
	F-statistic	0.511728	Prob. F	0.5998
	Obs*R-squared	1.039462	Prob. Chi-Square	0.5947
Utilities				
Norway				
	F-statistic	0.641748	Prob. F	0.5268
	Obs*R-squared	1.302904	Prob. Chi-Square	0.5213
Denmark				
	F-statistic	2.687264	Prob. F	0.069
	Obs*R-squared	5.412409	Prob. Chi-Square	0.0668
Finland				
	F-statistic	0.554688	Prob. F	0.5746
	Obs*R-squared	1.126537	Prob. Chi-Square	0.5693
Industrials				
Norway				
	F-statistic	1.147807	Prob. F	0.3182
	Obs*R-squared	2.325716	Prob. Chi-Square	0.3126
Sweden				
	F-statistic	1.187205	Prob. F	0.3059
	Obs*R-squared	2.405174	Prob. Chi-Square	0.3004
Denmark				
	F-statistic	1.443898	Prob. F	0.237
	Obs*R-squared	2.922278	Prob. Chi-Square	0.232
Finland				
	F-statistic	0.939269	Prob. F	0.3916
	Obs*R-squared	1.904725	Prob. Chi-Square	0.3858

APPENDIX 5

Table 1. Regression Results for Each Industry

Industry/country	**constant a0**	**dummy y0**	**IV a1**	**IVD y1**	**MV a2**	**MVD y2**	**Diagnostics**	
Auto-compo								
Norway	0.0085463	0.4526923	0.0053674	-0.002415	0.0164661	-0.036459	R^2	0.87771

p-value	0.9586	0.0994	0.0323	0.4941	0.4771	0.1288	SSE	0.43062
t-stat	0.051982	1.650805	2.146073	-0.684261	0.711508	-1.521436	SSR	94.7572
Sweden	0.873	0.060	0.018298	-0.006722	-0.033869	0.009597	R^2	0.90544
p-value	0	0.3591	0	0.1558	0.0001	0.5374	SSE	0.11883
t-stat	18.16103	0.917879	11.46632	-1.421554	-3.991711	0.617103	SSR	7.21535
Denmark	0.342796	0.076816	0.002497	0.000441	-0.007951	0.013834	R^2	0.65883
p-value	0	0.5268	0.0137	0.753	0.3865	0.1817	SSE	0.34647
t-stat	5.392709	0.633307	2.472719	0.314853	-0.866798	1.337452	SSR	61.3426
Finland	1.095283	-0.400461	-0.000657	0.013683	-0.034299	0.020396	R^2	0.80683
p-value	0.0078	0.3682	0.9634	0.3855	0.0002	0.0297	SSE	0.21355
t-stat	2.669478	-0.900701	-0.045937	0.868637	-3.75864	2.179772	SSR	23.3042
Banks								
Norway	0.514334	0.367177	0.015928	-0.012612	-0.015923	0.01458	R^2	0.85324
p-value	0	0.0141	0	0	0.188	0.3418	SSE	0.20658
t-stat	7.360656	2.463382	8.200591	-5.821185	-1.318371	0.951504	SSR	21.8063
Sweden	0.797163	0.019852	0.023544	-0.008738	-0.044888	0.032511	R^2	0.9318
p-value	0	0.8622	0.0311	0.4414	0.002	0.0323	SSE	0.1139
t-stat	6.137299	0.173605	2.161607	-0.770456	-3.102146	2.146521	SSR	6.6297
Denmark	0.51765	0.105657	0.008263	0.000986	0.019718	-0.033795	R^2	0.94374
p-value	0	0.2722	0.4667	0.9312	0.4528	0.2069	SSE	0.10243
t-stat	4.719847	1.099122	0.728445	0.086393	0.751348	-1.263813	SSR	5.3613
Finland	0.730542	0.082263	0.024518	-0.014399	-0.029165	0.021828	R^2	0.9339
p-value	0	0.0644	0	0.0015	0.0014	0.0351	SSE	0.09425
t-stat	8.376978	1.853505	5.979659	-3.188167	-3.209822	2.113257	SSR	4.53936
Capital goods								
Norway	0.760969	0.042729	0.019807	-0.002764	-0.031075	0.014511	R^2	0.84047
p-value	0	0.7012	0.0029	0.7104	0.0056	0.2217	SSE	0.15414
t-stat	7.585864	0.383882	2.993967	-0.37148	-2.779229	1.223442	SSR	12.1403
Sweden	0.866092	0.093418	0.046586	-0.026302	-0.048153	0.034508	R^2	0.84654
p-value	0	0.4109	0	0.0208	0	0	SSE	0.10235
t-stat	9.685452	0.822988	4.447748	-2.319469	-6.52395	4.175159	SSR	5.35268
Denmark	0.778107	0.102854	0.01232	-0.00647	-0.003591	-0.013282	R^2	0.81408
p-value	0	0.242	0.0226	0.2488	0.8278	0.4513	SSE	0.17986
t-stat	11.56533	1.171466	2.28784	-1.154497	-0.217697	-0.753865	SSR	16.5312
Finland	0.838536	0.031937	0.020334	-0.006008	-0.033767	0.024331	R^2	0.90533
p-value	0	0.8455	0.2832	0.7651	0.0005	0.0135	SSE	0.12488
t-stat	5.40856	0.194927	1.074239	-0.299003	-3.518349	2.478951	SSR	7.96922
Div Finance								
Norway	0.070399	0.310761	0.082447	-0.043272	-0.035916	0.029006	R^2	0.9173
p-value	0.6146	0.076	0	0.0072	0	0.0001	SSE	0.0987
t-stat	0.503852	1.778069	6.434614	-2.697244	-5.148233	3.999499	SSR	4.97787
Sweden	1.025843	-0.051775	0.037954	0.002673	-0.054771	0.012247	R^2	0.9524
p-value	0	0.2923	0	0.5172	0	0.0321	SSE	0.04335
t-stat	16.36172	-1.054231	15.0166	0.648049	-13.45298	2.149393	SSR	0.96005
Denmark	0.276474	-0.072323	0.027006	0.00061	-0.020576	0.017519	R^2	0.85044
p-value	0.0001	0.6253	0.0063	0.9776	0	0	SSE	0.09416
t-stat	3.90944	-0.488605	2.745506	0.028029	-5.22781	4.380247	SSR	4.53047
Finland	0.506146	0.183168	0.011296	-0.005742	0.00236	0.004996	R^2	0.91437
p-value	0.0004	0.3071	0	0.0143	0.8004	0.6431	SSE	0.23199
t-stat	3.567826	1.02228	5.009251	-2.456846	0.252924	0.46368	SSR	27.5021
Food/bev/tabaco								
Norway	0.362933	0.060618	0.015723	-0.009363	-0.001563	-0.004722	R^2	0.71746
p-value	0	0.5141	0.0001	0.0216	0.8534	0.592	SSE	0.18489
t-stat	6.800284	0.652873	4.028856	-2.303733	-0.184832	-0.536216	SSR	17.4683
Sweden	0.419606	-0.204882	0.00734	0.002623	-0.032607	0.026852	R^2	0.2772
p-value	0	0.0258	0.5432	0.8434	0	0	SSE	0.18371
t-stat	5.208062	-2.235441	0.608316	0.197618	-5.596376	4.558378	SSR	17.2466
Denmark	0.358061	0.109661	0.025271	-0.002745	-0.011162	-0.005968	R^2	0.87119
p-value	0.0002	0.3066	0.1542	0.8816	0.0469	0.3462	SSE	0.10032
t-stat	3.819437	1.023358	1.427019	-0.149007	-1.991689	-0.942885		

Finland	0.398627	-0.403841	-0.001511	0.051214	-0.014283	0.008736	R^2	0.88623
p-value	0	0.0002	0.9181	0.0014	0.0487	0.2402	SSE	0.09143
t-stat	4.199078	-3.70174	-0.102926	3.206015	-1.976072	1.175963	SSR	4.27192
H_care								
Norway	0.411242	-0.207062	0.009768	-0.003946	0.016452	-0.016019	R^2	0.79121
p-value	0	0.0236	0.0117	0.3965	0.1963	0.2121	SSE	0.18674
t-stat	7.755523	-2.269709	2.528919	-0.848538	1.293918	-1.249403	SSR	17.8196
Sweden	0.46979	-0.058582	0.027682	0.010847	-0.025222	0.009748	R^2	0.92462
p-value	0	0.5092	0	0.1353	0	0.0666	SSE	0.08201
t-stat	4.878933	-0.660529	6.388964	1.495998	-6.10545	1.838512	SSR	3.4371
Denmark	0.376378	0.10671	0.050954	-0.025723	-0.037716	0.033032	R^2	0.81784
p-value	0.0002	0.2285	0	0.0548	0	0	SSE	0.08145
t-stat	3.79695	1.205665	4.549204	-1.925042	-5.27153	4.357106	SSR	3.38995
Finland	-3.588216	8.934232	0.169446	-0.368643	-0.027628	0.024621	R^2	0.90434
p-value	0.0004	0.5475	0	0.5424	0	0.0003	SSE	0.0731
t-stat	-3.549767	0.601921	4.143523	-0.609555	-4.218864	3.667348	SSR	2.73019
IT								
Norway	0.984315	-0.18977	0.022194	-0.008902	-0.056832	0.0474	R^2	0.80628
p-value	0	0.1292	0	0.1199	0	0.0001	SSE	0.19279
t-stat	13.08397	-1.519672	8.584504	-1.557612	-4.980178	4.056676	SSR	18.9919
Sweden	1.145066	-0.638161	0.023996	0.007241	-0.09048	0.071985	R^2	0.91216
p-value	0	0.0697	0	0.1702	0	0	SSE	0.17158
t-stat	7.066564	-1.817519	6.072327	1.373338	-8.455159	6.515541	SSR	15.044
Denmark	0.774727	-0.108468	0.02584	-0.000798	-0.049609	0.0265	R^2	0.92473
p-value	0	0.2637	0	0.9147	0	0.0189	SSE	0.13681
t-stat	12.06127	-1.118855	7.969406	-0.107175	-5.052008	2.35494	SSR	9.56361
Finland	1.824572	-0.750857	-0.004066	0.009969	-0.054432	0.04637	R^2	0.83405
p-value	0	0.0689	0.7304	0.3903	0.0001	0.0009	SSE	0.25128
t-stat	4.13772	-1.822865	-0.344815	0.859857	-4.058317	3.341154	SSR	32.266
Media								
Norway	0.786522	-0.207575	0.009982	0.004039	-0.021847	0.015482	R^2	0.84077
p-value	0	0.2302	0.1655	0.6532	0.0096	0.077	SSE	0.14234
t-stat	7.716297	-1.201202	1.388867	0.449652	-2.599763	1.771962	SSR	10.3527
Sweden	0.844241	0.046226	0.019129	-0.008736	-0.033727	0.024183	R^2	0.76823
p-value	0	0.551	0	0.0796	0	0.0007	SSE	0.16129
t-stat	14.19167	0.596662	4.38838	-1.756728	-5.119804	3.405579	SSR	13.2928
Denmark	-0.154233	0.094463	0.031839	-0.000808	-0.027701	0.025122	R^2	0.78073
p-value	0.385	0.6387	0.0001	0.9626	0	0	SSE	0.14208
t-stat	-0.869459	0.469729	3.941552	-0.046973	-6.728142	5.757413	SSR	10.316
Finland	0.640157	0.003141	0.005146	0.007321	-0.014451	0.003824	R^2	0.65725
p-value	0	0.9672	0	0.0032	0.1177	0.6859	SSE	0.38776
t-stat	10.33879	0.041182	6.047824	2.957292	-1.567285	0.404695	SSR	76.8335
Oil/Gas								
Norway	0.470427	0.227843	0.048215	-0.026867	-0.035719	0.020807	R^2	0.87108
p-value	0	0.1777	0	0.0316	0	0.0104	SSE	0.12787
t-stat	5.547546	1.349764	6.704563	-2.154799	-5.546297	2.570611	SSR	8.3556
Sweden	0.555466	0.050285	0.015928	0.00231	-0.009899	-0.012144	R^2	0.8743
p-value	0.0001	0.7114	0.0061	0.7819	0.5363	0.5093	SSE	0.20299
t-stat	3.865152	0.370133	2.754557	0.276973	-0.618844	-0.660417	SSR	21.056
Denmark	0.196491	0.732318	-0.000324	0.006714	-0.002343	-0.033677	R^2	0.69171
p-value	0.4278	0.0136	0.9428	0.1491	0.9354	0.2617	SSE	0.74723
t-stat	0.79352	2.477354	-0.071796	1.444759	-0.081139	-1.123714	SSR	285.319
Finland	0.14072	0.598695	0.012137	-0.005156	-0.003086	-0.007189	R^2	0.72844
p-value	0.0145	0	0.0049	0.2787	0.3306	0.1315	SSE	0.44544
t-stat	2.452801	4.671407	2.825012	-1.084403	-0.973746	-1.51073	SSR	101.39
Real Estate								
Norway	0.081483	0.087989	0.0466	-0.019514	-0.013904	0.007981	R^2	0.81736
p-value	0.5	0.5216	0.0544	0.4475	0	0.0036	SSE	0.0929
t-stat	0.674985	0.641306	1.927844	-0.760136	-6.17262	2.92618	SSR	4.41031
Sweden	0.404467	0.074832	0.022792	-0.00151	-0.00771	-0.012716	R^2	0.93742

p-value	0	0.5769	0.3526	0.9516	0.2741	0.1613	SSE	0.0827
t-stat	4.407714	0.558306	0.930474	-0.060711	-1.094905	-1.402727	SSR	3.49472
Denmark	0.386962	-0.118276	0.019723	0.014449	-0.017072	0.005027	R^2	0.80656
p-value	0	0.1368	0.005	0.13	0.004	0.4152	SSE	0.14252
t-stat	6.634773	-1.490004	2.821719	1.516658	-2.893523	0.815478	SSR	10.3792
Finland	0.379577	0.239946	0.017721	-0.003784	-0.012969	-0.007421	R^2	0.90214
p-value	0	0.179	0.0502	0.6817	0.0361	0.2879	SSE	0.1219
t-stat	4.680658	1.345602	1.963126	-0.410419	-2.100848	-1.063812	SSR	7.5935
Retail								
Norway	0.008709	1.916256	0.010257	-0.05026	-0.016663	0.014983	R^2	0.89321
p-value	0.9427	0.0099	0.0048	0.0035	0	0.0003	SSE	0.04157
t-stat	0.071907	2.587998	2.830338	-2.938058	-4.170751	3.658266	SSR	0.88475
Sweden	1.144714	-0.572057	-0.018424	0.051224	-0.022896	0.013124	R^2	0.79675
p-value	0	0.0002	0.1393	0.0004	0.0468	0.2589	SSE	0.13601
t-stat	6.483851	-3.812308	-1.480634	3.568484	-1.993091	1.130202	SSR	9.45308
Denmark	0.523797	0.095095	0.000799	0.00218	-0.007483	0.001011	R^2	0.57959
p-value	0	0.5708	0.7165	0.3555	0.5771	0.95	SSE	0.45172
t-stat	6.284018	0.567178	0.363397	0.924726	-0.558012	0.062772	SSR	104.268
Finland	0.245109	-0.022734	0.022026	-0.004523	-0.020004	0.015467	R^2	0.78612
p-value	0.0039	0.8412	0.0056	0.633	0.0046	0.0326	SSE	0.10194
t-stat	2.90314	-0.200425	2.781029	-0.477741	-2.84844	2.142985	SSR	5.3098
Transport								
Norway	0.324342	0.015657	0.059209	-0.012876	-0.044103	0.028046	R^2	0.87442
p-value	0.0007	0.9063	0	0.2795	0	0	SSE	0.08444
t-stat	3.420704	0.117731	5.927457	-1.082532	-8.82308	5.135737	SSR	3.64383
Sweden	0.828598	0.321444	0.015303	-0.011286	-0.040993	0.035869	R^2	0.79682
p-value	0	0.0045	0	0.0003	0.0198	0.0581	SSE	0.19672
t-stat	10.35835	2.84994	6.926541	-3.615101	-2.337519	1.899088	SSR	19.7758
Denmark	0.648334	0.030215	0.020439	-0.002229	-0.031511	0.020881	R^2	0.81664
p-value	0.0002	0.8617	0.0927	0.8565	0	0.011	SSE	0.14045
t-stat	3.751309	0.174314	1.684317	-0.180967	-4.151429	2.55067	SSR	10.0795
Finland	-0.001174	0.11843	0.063297	-0.023747	-0.027841	0.023579	R^2	0.82361
p-value	0.9964	0.7173	0.031	0.5045	0	0.0003	SSE	0.0812
t-stat	-0.004461	0.362225	2.162745	-0.667903	-4.536961	3.67492	SSR	3.36913
Utilities								
Norway	0.640579	-0.362962	0.004252	0.019919	-0.014137	0.002693	R^2	0.78977
p-value	0	0.0211	0.5495	0.0103	0.165	0.7948	SSE	0.20043
t-stat	5.337422	-2.312955	0.598937	2.57546	-1.390436	0.260189	SSR	20.5274
Denmark	0.709885	0.502177	-0.000721	0.005149	0.047542	-0.279915	R^2	0.64148
p-value	0.3142	0.0476	0.5736	0.0109	0.2992	0.0001	SSE	0.30316
t-stat	1.007478	1.985713	-0.563116	2.55484	1.039275	-3.988092	SSR	46.9625
Finland	0.059532	0.359694	0.042742	-0.029336	-0.023826	0.010215	R^2	0.84856
p-value	0.4833	0.0006	0	0.0014	0.0147	0.4134	SSE	0.14637
t-stat	0.701528	3.45969	5.530597	-3.218505	-2.448969	0.818573	SSR	10.9483
Industrials								
Norway	0.582998	0.166003	0.050362	-0.026925	-0.045373	0.026373	R^2	0.88203
p-value	0	0.012	0	0	0	0.0009	SSE	0.09916
t-stat	11.93294	2.522317	10.00397	-4.097833	-6.478304	3.352735	SSR	5.02448
Sweden	0.874339	0.066957	0.046846	-0.023815	-0.048042	0.032425	R^2	0.85352
p-value	0	0.5322	0	0.0552	0	0.0002	SSE	0.095
t-stat	10.4365	0.625146	4.099097	-1.921696	-6.072534	3.699717	SSR	4.61168
Denmark	0.463833	0.301292	0.052442	-0.035032	-0.040689	0.025813	R^2	0.82291
p-value	0	0.0068	0	0.0009	0	0.0009	SSE	0.11349
t-stat	5.786809	2.717777	5.835198	-3.335605	-5.990078	3.340682	SSR	6.58145
Finland	0.531555	0.374586	0.071895	-0.058813	-0.037329	0.028029	R^2	0.91719
p-value	0	0.0018	0	0.0001	0	0	SSE	0.09082
t-stat	5.326692	3.136188	5.760012	-3.883157	-5.94928	4.197466	SSR	4.21478

Table 2. Norway Results from Table 1

Norway/Sector	constant a0	dummy y0	IV a1	IVD y1	MV a2	MVD y2
Auto-compo	0.008546	0.45269***	0.005367**	-0.002415	0.016466	-0.036458
Banks	0.514334*	0.367177*	0.015928*	-0.012612*	-0.015923	0.01458
Capital goods	0.760969*	0.042729	0.019807*	-0.002764	-0.031075*	0.014511
Div Finance	0.070399	0.310761***	0.082447*	-0.043272*	-0.035916*	0.029006*
Food/bev/tabaco	0.362933*	0.060618	0.015723*	-0.009363**	-0.001563	-0.004722
H_care	0.411242*	-0.207062**	0.009768**	-0.003946	0.016452	-0.016019
IT	0.984315*	-0.18977	0.022194*	-0.008902	-0.056832*	0.0474*
Media	0.786522*	-0.207575	0.009982	0.004039	-0.021847*	0.015482***
Oil/Gas	0.470427*	0.227843	0.048215*	-0.026867**	-0.035719*	0.020807*
Real Estate	0.081483	0.087989	0.0466***	-0.019514	-0.013904*	0.007981*
Retail	0.008709	1.916256*	0.010257*	-0.05026*	-0.016663*	0.014983*
Transport	0.324342*	0.015657	0.059209*	-0.012876	-0.044103*	0.028046*
Utilities	0.640579*	-0.362962**	0.004252	0.019919*	-0.014137	0.002693
Industrials	0.582998*	0.166003**	0.050362*	-0.026925*	-0.045373*	0.026373*

*/**/*** significant at 1/5/10 percent levels

Table 3. Sweden results from Table 1

Sweden/Sector	constant a0	dummy y0	IV a1	IVD y1	MV a2	MVD y2
Auto-compo	0.873479*	0.060	0.018298*	-0.006722	-0.033869*	0.009597
Banks	0.797163*	0.019852	0.023544**	-0.008738	-0.044888*	0.032511**
Capital goods	0.866092*	0.093418	0.046586*	-0.026302**	-0.048153*	0.034508*
Div Finance	1.025843*	-0.051775	0.037954*	0.002673	-0.054771*	0.012247**
Food/bev/tabaco	0.419606*	-0.204882**	0.00734	0.002623	-0.032607*	0.026852*
H_care	0.46979*	-0.058582	0.027682*	0.010847	-0.025222*	0.009748***
IT	1.145066*	-0.6381***	0.023996*	0.007241	-0.09048*	0.071985*
Media	0.844241*	0.046226	0.019129*	-0.00873***	-0.033727*	0.024183*
Oil/Gas	0.555466*	0.050285	0.015928*	0.00231	-0.009899	-0.012144
Real Estate	0.404467*	0.074832	0.022792	-0.00151	-0.00771	-0.012716
Retail	1.144714*	-0.572057*	-0.018424	0.051224*	-0.022896**	0.013124
Transport	0.828598*	0.321444*	0.015303*	-0.011286*	-0.040993**	0.035869***
Industrials	0.874339*	0.066957	0.046846*	-0.02381***	-0.048042*	0.032425*

*/**/*** significant at 1/5/10 percent levels

Table 4. Denmark results from Table 1

Denmark/Sector	constant a0	dummy y0	IV a1	IVD y1	MV a2	MVD y2
Auto-compo	0.342796*	0.076816	0.002497**	0.000441	-0.007951	0.013834
Banks	0.51765*	0.105657	0.008263	0.000986	0.019718	-0.033795
Capital goods	0.778107*	0.102854	0.01232*	-0.00647	-0.003591	-0.013282
Div Finance	0.276474*	-0.072323	0.027006*	0.00061	-0.020576*	0.017519*
Food/bev/tabaco	0.358061*	0.109661	0.025271	-0.002745	-0.011162**	-0.005968
H_care	0.376378*	0.10671	0.050954*	-0.02572***	-0.037716*	0.033032*
IT	0.774727*	-0.108468	0.02584*	-0.000798	-0.049609*	0.0265**
Media	-0.154233	0.094463	0.031839*	-0.000808	-0.027701*	0.025122*

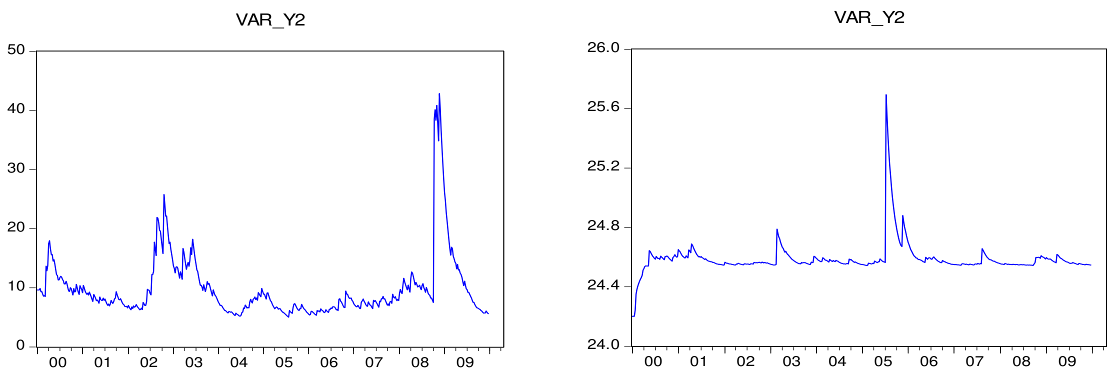
Oil/Gas	0.196491	0.732318**	-0.000324	0.006714	-0.002343	-0.033677
Real Estate	0.386962*	-0.118276	0.019723*	0.014449	-0.017072*	0.005027
Retail	0.523797*	0.095095	0.000799	0.00218	-0.007483	0.001011
Transport	0.648334*	0.030215	0.02043***	-0.002229	-0.031511*	0.020881**
Utilities	0.709885	0.502177**	-0.000721	0.005149**	0.047542	-0.279915*
Industrials	0.463833*	0.301292*	0.052442*	-0.035032*	-0.040689*	0.025813*

Table 5. Finland results from Table 1

Finland/Sector	constant a0	dummy y0	IV a1	IVD y1	MV a2	MVD y2
Auto-compo	1.095283*	-0.400461	-0.000657	0.013683	-0.034299*	0.020396**
Banks	0.730542*	0.08226***	0.024518*	-0.014399*	-0.029165*	0.021828**
Capital goods	0.838536*	0.031937	0.020334	-0.006008	-0.033767*	0.024331**
Div Finance	0.506146*	0.183168	0.011296**	-0.005742**	0.00236	0.004996
Food/bev/tabaco	0.398627*	-0.403841*	-0.001511	0.051214*	-0.014283**	0.008736
H_care	-3.588216*	8.934232	0.169446*	-0.368643	-0.027628*	0.024621*
IT	1.824572*	-0.75085***	-0.004066	0.009969	-0.054432*	0.04637*
Media	0.640157*	0.003141	0.005146*	0.007321*	-0.014451	0.003824
Oil/Gas	0.14072**	0.598695*	0.012137*	-0.005156	-0.003086	-0.007189
Real Estate	0.379577*	0.239946	0.017721**	-0.003784	-0.012969**	-0.007421
Retail	0.245109*	-0.022734	0.022026*	-0.004523	-0.020004*	0.015467**
Transport	-0.001174	0.11843	0.063297**	-0.023747	-0.027841*	0.023579*
Utilities	0.059532	0.359694*	0.042742*	-0.029336*	-0.023826**	0.010215
Industrials	0.531555*	0.374586*	0.071895*	-0.058813*	-0.037329*	0.028029*

*/**/*** significant at 1/5/10 percent levels

Figure 1. Health Care Industry Volatility (Sweden/ Finland)



APPENDIX 6

Code of the program for Eviews which was used to apply bivariate BEKK GARCH model adjusted from EViews example files

```
' BV_GARCH.PRG
' restricted version of
' bi-variate BEKK of Engle and Kroner (1995):
'  y = mu + res
'  res ~ N(0,H)
'  H = omega*omega' + beta H(-1) beta' + alpha res(-1) res(-1)' alpha'
' where
'     y = 2 x 1
'     mu = 2 x 1
'      H = 2 x 2 (symmetric)
'          H(1,1) = variance of y1   (saved as var_y1)
'          H(1,2) = cov of y1 and y2 (saved as var_y2)
'          H(2,2) = variance of y2   (saved as cov_y1y2)
'  omega = 2 x 2 low triangular
'   beta = 2 x 2 diagonal
'  alpha = 2 x 2 diagonal


smpl @all
series y1 = 100*dlog(msci)
series y2 = 100*dlog(norway)

' set sample - adjustment for lag length
sample s0 01/01/00 01/05/10
sample s1 02/01/00 01/05/10
' initialization of parameters and starting values
smpl s0

'get starting values from univariate GARCH
equation eq1.arch(m=100,c=1e-5) y1 c
equation eq2.arch(m=100,c=1e-5) y2 c

' declare coef vectors to use in bi-variate GARCH model
coef(2) mu
 mu(1) = eq1.c(1)
 mu(2)= eq2.c(1)

coef(3) omega
 omega(1)=(eq1.c(2))^.5
 omega(2)=0
 omega(3)=eq2.c(2)^.5

coef(2) alpha
 alpha(1) = (eq1.c(3))^.5
 alpha(2) = (eq2.c(3))^.5

coef(2) beta
 beta(1)= (eq1.c(4))^.5
 beta(2)= (eq2.c(4))^.5
```

```
' constant adjustment for log likelihood
!mlog2pi = 2*log(2*@acos(-1))

' use var-cov of sample in "s1" as starting value of variance-covariance matrix
series cov_y1y2 = @cov(y1-mu(1), y2-mu(2))
series var_y1 = @var(y1)
series var_y2 = @var(y2)
series sqres1 = (y1-mu(1))^2
series sqres2 = (y2-mu(2))^2
series res1res2 = (y1-mu(1))*(y2-mu(2))
' ...........................................................
' LOG LIKELIHOOD
' set up the likelihood
' 1) open a new blank likelihood object (L.O.) name bvgarch
' 2) specify the log likelihood model by append
' ...........................................................
logl bvgarch
bvgarch.append @logl logl
bvgarch.append sqres1 = (y1-mu(1))^2
bvgarch.append sqres2 = (y2-mu(2))^2
bvgarch.append res1res2 = (y1-mu(1))*(y2-mu(2))

' calculate the variance and covariance series
bvgarch.append var_y1 = omega(1)^2 + beta(1)^2*var_y1(-1) + alpha(1)^2*sqres1(-1)
bvgarch.append var_y2 = omega(3)^2+omega(2)^2 + beta(2)^2*var_y2(-1) + alpha(2)^2*sqres2(-1)
bvgarch.append cov_y1y2 = omega(1)*omega(2) + beta(2)*beta(1)*cov_y1y2(-1) + alpha(2)*alpha(1)*res1res2(-1)
' determinant of the variance-covariance matrix
bvgarch.append deth = var_y1*var_y2 - cov_y1y2^2

' inverse elements of the variance-covariance matrix
bvgarch.append invh1 = var_y2/deth
bvgarch.append invh3 = var_y1/deth
bvgarch.append invh2 = -cov_y1y2/deth

' log-likelihood series
bvgarch.append logl =-0.5*(!mlog2pi + (invh1*sqres1+2*invh2*res1res2+invh3*sqres2) + log(deth))

' remove some of the intermediary series
' bvgarch.append @temp invh1 invh2 invh3 sqres1 sqres2 res1res2 deth

' estimate the model
smpl s1
bvgarch.ml(showopts, m=100, c=1e-5)
' change below to display different output
show bvgarch.output
graph varcov.line var_y1 var_y2 cov_y1y2
show varcov
'calculate time-varying beta
bvgarch.append  betaE=cov_y1y2/var_y1
' LR statistic for univariate versus bivariate model
scalar lr = -2*( eq1.@logl + eq2.@logl - bvgarch.@logl )
scalar lr_pval = 1 - @cchisq(lr,1)
```