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A Study of the Excess Comovement

on the Swedish Stock Market
1985-2003

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Abstract

This paper is focused on two phenomenons that are called *excess comovement* and *financial contagion*. The excess comovement is defined as the comovement, or correlation, between normally uncorrelated assets, that can not be explained by economic fundamentals and financial contagion is the occurrence of excess comovement. Excess comovement has been observed on several stock markets by economic researchers in different countries and the purpose with this paper is to see if these phenomenons have been present on the Swedish stock market during the studied time span 1985-2003. Nine Swedish industry indexes have been used and as economic fundamentals six explanatory variables have been chosen, both American and Swedish. The method used is a linear multifactor model and the OLS residuals are used in the two measures for a mean of excess comovement and the financial contagion. The results are statistically significant and show that there is indeed excess comovement present on the Swedish stock market during the studied time span. It is difficult to explain why there is excess comovement on the Swedish market, but probably there are psychological factors affecting the investors to behave irrational. The knowledge of the existence of excess comovement on a stock market is important for anyone investing in the market since excess comovement can lead to difficulties of finding the desired risk profile of the portfolio.

Keywords: Excess comovement, financial contagion, portfolio theory, correlation, diversification.

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1 Introduction

1.1 Background

One important field in finance concerns investor's portfolio return, i.e. how people should invest their wealth and it is called *portfolio selection*. The *portfolio selection* strategy is individual and depends on factors such as wealth, length of investment horizon, the investor's age and the investor's willingness to take on risk. When the investor chooses his portfolio he has to consider the trade off between the level of expected return of the portfolio and its level of risk. The higher level of expected return the investor wants the higher risk he has to accept.[1]

An important part in portfolio managing is the ability to create portfolios with low risk and at the same time achieve high levels of expected revenues. According to the portfolio theory this is only possible if the investors are familiar with the characteristics of the market and that they are able to spread the risk correctly, namely to diversify the risk. To be able to diversify it is necessary to be able to distinguish between the levels of correlation between the assets. There have been evidence found, by economic researchers, that states that there exists in some markets comovement between different assets that are not related to nor can be explained by economic fundamentals but that have their origin in other areas of the complex stock market we know today.[2] This phenomenon is called *excess comovement* or *financial contagion.*

Excess comovement is defined as the comovement, or correlation, between normally uncorrelated assets beyond the degree that is justified by economic fundamentals.[3] The existence of excess comovement on the stock market that is inexplicable makes it difficult for those investing in the financial markets to make a correct risk spread. It is considered to be a riskier act to invest in two assets that are to some degree correlated with each other, than to invest in two uncorrelated assets. If there exists excess comovement among normally uncorrelated assets in a stock market it will be difficult for portfolio managers to make a correct diversification of the portfolio and they might take on extra risk without realizing it.

During the last twenty years the world has witnessed several financial crises and other events that have made the stock markets unstable and unpredictable. During these periods when the financial markets have been unstable, during for example financial crises, financial

[1] Bodie, Zvi – Merton, Robert C., *Finance*, p. 381-323
[2] Kallberg, Pasquarello, *Time series and cross-sectional excess co movement in stock indexes*, p. 1
[3] Kallberg, Pasquarello, *Time series and cross-sectional excess co movement in stock indexes*, p. 5

contagion has been observed between normally uncorrelated markets which have also made it difficult for investors to diversify the portfolio correctly. Financial contagion is defined as the circumstance of the occurrence of the excess comovement. [4]

This study is inspired by the article, *Time-Series and Cross-Sectional Excess Comovement in Stock Indexes,* written by two researchers at the Stern School of Business at the New York University, Jarl Kallberg and Paolo Pasquariello, in February 2003.

1.2 Purpose

The purpose of this paper is to study whether there exists excess comovement on the Swedish stock market between nine Swedish industry portofolios during the years 1985-2003. Six explanatory variables have been used, both Swedish and American. These are a Swedish general index (AFGX)[5], the exchange rate of the Swedish corona to the American dollar, an American general index[6], Book-to-market index (BM), a size factor (SF) and finally Carnegie Small Cap index. If there exists an excess comovement on the Swedish market I aim to give possible explanations to this.

1.3 Restrictions

The article *Time-Series and Cross-Sectional Excess Comovement in Stock Indexes* studies the American market. The Swedish market is smaller and less diversified than the American market which has forced me to exclude some of the variables used in the article. This study is based on weekly data and therefore some interesting data such as the inflation rate has not been included. The important Internet and Telecom sector has been excluded from this study because the data available from *Affärs Världen* covers only the years 1998-2003, which is three years shorter than the timespan I have used.

The method used is a modified version of the model used in the article written by Jarl Kallberg and Paolo Pasquarello and it can be argued if their method is the optimal way or not to measure the excess comovement phenomenon with.

[4] Kallberg, Pasquarello, *Time series and cross-sectional excess co movement in stock indexes*, p. 5
[5] Database EcoWin, Affärs Värlens Genaral Index
[6] Fama and French's homepage

1.4 Method

This study has its background in the financial theory and in the article *Time-Series and Cross-Sectional Excess Comovement in Stock Indexes* written by Jarl Kallberg and Paolo Pasquarello in 2003. I have empirically tested the hypothesis that there does not exist any excess comovement among nine Swedish industry portfolios after six economical fundaments have been considered. The regressions that I have used come from the Kallberg and Pasquarello article where a simple multifactor model has been regressed with six explanatory variables. The first step was to calculate the OLS residuals for each industry and for each timeperiod of 50 weeks during the years 1985-2003. The second step was to use these OLS residuals to calculate the measure of excess absolute comovement and a marketwide mesure of financial contagion. The industries that have been used are Bank, Chemical, Forest, Investment, Manufacturing, Real state and Construction, Retailing, Shipping and Transportation and Others. Six explanatory variables have been chosen, both Swedish and American. These are a Swedish general index (AFGX), the exchange rate of the Swedish krona to the American dollar, an American general index, Book-to-market index (BM), a size factor (SF) and finally Carnegie Small Cap index.

1.5 Target group

This paper is written mainly for students in financial economics who wish to increase their understanding of the excess comovement and financial contagion phenomenon. The study might also be interesting for those investing in the Swedish stock market since it investigates the inefficiencies of the market and indicates the existence of excess comovement and financial contagion.

1.6 Disposition

The first chapter contains the introduction, the background and purpose of this paper as well as the method and its target group. The theory chapter, which is the second chapter, presents the underlying theory of portfolio optimization and the importance of diversification of portfolio assets. Some theory critics and earlier research that have been done on the subject are also found in this chapter. The third chapter describes the method that has been used, explains the data, the portfolios, the factors and the regressions that have been done. The underlying hypothesis is then defined. Finally the basic regression has been made for each industry on various explanatory variables. In the fourth chapter the results obtained from the

regressions are analysed and possible explanation are discussed. The regression results are presented in the appendix in the end of this paper as well as some graphs.

2 Theory

To understand the excess comovement phenomenon it is important to be familiar with the theory of portfolio theory and how to construct an efficient asset portfolio. It is also important to understand what comovement is and that its definition is in financial theory still somewhat vague and not clearly defined.

2.1 Portfolio theory

The modern portfolio theory was first introduced by Harry Markowitz in 1952 in his paper *Portfolio Selection*[7] and his theory has then been revised by several researchers into what it is today.[8] The modern portfolio theory explains how a risk avert investor optimally should construct an asset portfolio while optimizing the expected return on the portfolio and at the same time minimizing its level of risk. One important factor in obtaining an efficient portfolio is to diversify the asset holdings between a numbers of risky assets. [9]

2.1.1 Diversification

Diversifying is when the investor is spreading the risk of a portfolio by holding several risky assets instead of only one. Risk is defined as a measure of the uncertainty that exists in the financial markets and one way to measure it, is to look at the volatility of the financial asset. The risk of an asset is divided into one part that is firm specific which is possible to diversify away (unsystematic risk) and a part that is market specific and cannot be reduced by diversification (systematic risk). [10]

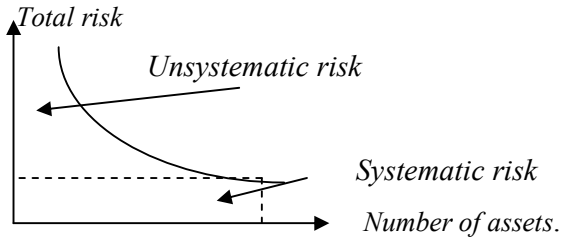

Figure 1. Diversification

Source: Ross, Webster och Jaffe, *Corporate Finance*, s. 250

[7] Markowitz, Harry, *Portfolio Selection,* p. 79
[8] Haugen, Robert A., *Modern Investment Theory*, p. 2
[9] Markowitz, Harry, *Portfolio Selection* ,p. 79
[10] Ross, Webster - Ross, Jaffe, *Corporate Finance*, p. 250

Figure 1 shows the principle of risk diversification and how it is possible to reduce the total level of risk in a portfolio. This can be done by increasing the number of not with each other perfectly correlated assets. The aim with diversifying is to reduce the level of risk while keeping the level of expected return of the portfolio.[11] To be able to obtain full effect of the diversifying it is necessary that the portfolio contains 8 - 15 different assets.[12] It is therefore crucial that the investor knows the degree of correlation between the assets.

2.2 Comovement

Comovement is vaguely defined in economic literature and there is no specific measure used to observe it. Dirk Baur is the author of the article *What is Co-Movement*[13], and according to him it is important to analyze the common stock market movements to be able to diversify portfolios efficiently. Baur continues that explicit definition of comovement is "a pattern of positive correlation"[14], but points out that the definition of "positive correlation" remains multiple and therefore vague.[15] Even the term comovement is undefined in the sense that it does not exist in any dictionary and is referred to with different spellings of the word, comovement is the term used by Kallberg and Pasquariello while Baur prefer co-movement. The Latin prefix "con", which means "with" is often shortened into "co" as in this case and the meaning of the word co movement is therefore "to move with".[16] The two definitions of comovement are according to Baur the following;

Definition 1,
"Co-movement is the movement of assets that is shared by all assets at time *t."*[17]

Definition 2,
*"*Relative co-movement is the relative movement of assets that is shared by all assets at time *t."* [18]

These definitions are understandable and explain the characteristics of comovement. Correlation is used often in this context and an exact definition and explanation is therefore necessary.

[11] Bodie, Zvi – Merton, Robert C, *Finance* , p.298
[12] Pålsson, Anne-Marie – Samuelsson, Per, *Värdepappersfonder som placeringsform*, p. 2
[13] Baur, Dirk, *What is Co-Movement?*
[14] Baur, Dirk, *What is Co-Movement?,*p. 5
[15] Baur, Dirk, *What is Co-Movement?*, p. 2
[16] Baur, Dirk, *What is Co-Movement?,* p. 4
[17] Baur, Dirk, *What is Co-Movement?,*p. 5
[18] Baur, Dirk, *What is Co-Movement?,*p. 6

2.2.1 Correlation

When two risky assets are combined in a portfolio the correlation between these two assets play an important role in determining the total risk of the investment. Correlation is measured as the degree to which the rates of asset return move together.[19] The correlation coefficient ρ can be both negative and positive where $-\rho$ implies that when the return of stock *a* moves upwards the return on stock *b* will move in the opposite direction. If the correlation coefficient is positive the returns of stock *a* and *b* will move in the same positive direction. A $\rho=0$ implies that the movement of stock *a* is independent of stock *b*.[20]

2.3 Excess Comovement

The definition of excess comovement is that it is the correlation, or comovement, between normally uncorrelated assets or markets that can not be explained by economic fundamentals as inflation, changes in aggregate demand, interest rates or exchange rates and so forth.[21] This phenomenon of excess comovement among otherwise uncorrelated assets is not specifically described or identified in the literature of financial economics that I have come across during this study. The explanations and definitions come exclusively from articles and research papers previously done on the subject.

According to research evidence it has been found that additionally to the correlation between assets that can be explained by economical fundaments such as macro variables like inflation, aggregate demand, foreign exchange or interest rate there exists excess comovement on several stock markets. This excessive correlation or comovement is also referred to as financial contagion and is often attributed to herding behaviour on the part of market participants.[22]

2.4 Theory Critics

Baur points out in his article that the correlation coefficient might not be adequate as a measure of comovement[23], which has been used in this study. Kallberg and Pasquariello mention in their article the debate taking place among researchers about which way is the most accurate one to measure excessive comovement and the difficulties of agreeing on one

[19] Bodie, Merton, *Finance*, p. 314
[20] Gujarati, *Basic Econometrics*, p. 64
[21] Pindyck, Rotemberg, *The excess co movement of commodity prices*, p. 1173
[22] Kallberg, Pasquariello, *Time series and cross-sectional excess comovement in stock indexes.* p. 2
[23] Baur, Dirk, *What is Co-Movement,* p. 3

specific measurement.[24] The method used in this study is only one among several other possible. Kallberg and Pasquariello points out that the estimation of OLS residuals in equation (2) for each asset separately might lead to underestimation of the degree of excess co variance across the assets. A test for excess comovement based on conditional measures of correlation that does not account for changes in volatility is biased toward acceptance of the alternative hypothesis.[25]

2.5 Earlier Research

There has been research done on the subject based on different kinds of markets where different explanatory variables have been used. There are two different sides in the literature treating the comovement issue and the first studies the Excess Comovement Hypothesis (ECM) and the second is studying the phenomenon of financial crises and contagion.[26]

The literature on ECM is mainly concentrated on the comovement between asset prices and stock prises that cannot be explained by economic fundamentals. Robert Shiller writes about this in his paper *The co movements in stock prices and co movements in dividends*. Shiller studies the comovement in real stock prices between two nations, the United Kingdom and the United States of America and he finds that the comovements in stock prices and in dividends are too large even after consideration taken to the possibility of information pooling. He has used the efficient markets model and the present value model. [27]

Robert S. Pindyck and Julio J. Rotemberg also use the present value model when they test if the comovements of individual stock prices can be explained by economic fundamentals in their paper *The co movement of stock prices*. They find proof of excess comovement and the explanation they give is that it might be caused by in part the size of the company and in part by institutional ownership.[28] Pindyck and Rotemberg have also studied the excess comovement among raw commodities such like wheat, cotton, gold and so forth in their article *The excess comovement of commodity prices*. Their results show that there exists an excess comovement between these commodities beyond what can be explained by economic variables such like inflation, changes in aggregated demand, interest rates and exchange rates.[29] The other part of the relevant literature treats the phenomenon of financial

[24] Kallberg, Pasquariello, *Time series and cross-sectional excess comovement in stock indexes.* p. 5
[25] Kallberg, Pasquariello, *Time series and cross-sectional excess comovement in stock indexes.* p. 17
[26] Kodres, Pritsker, *A Rational Expectations Model of Financial Contagion,* p. 770
[27] Shiller, Robert, *The co movements in stock prices and co movements in dividends*, p. 719
[28] Pindyck, Rotemberg, *The co movement of stock prices*, p. 1037
[29] Pindyck, Rotemberg, *The excess co movement of commodity prices,* p. 1173-1174

crises and contagion and this branch can be defined into three sub branches. The first of these sub branches emphasizes contagious currency crises, a second treats the contagion spreading as a result of linkages between financial institutions and the third branch focuses on contagion among financial markets. [30]

Laura E. Kodres and Matthew Pritsker treat the third subject in their article *A rational expectations model of financial contagion*.[31] They develop a multiple asset rational expectations model of asset prices to explain financial market contagion during financial crises such like the Mexican crises of 1995 and that of Russia in 1998 among others. They state that financial contagion within the country suffering from the financial crises is to be expected due to the unstable market situation but that the comovement across countries is more difficult to explain. They argue that even countries weakly linked by trade or shared economic links show evidence of financial contagion and that much of the increased volatility and comovement across countries remain unexplained.[32]

Jeff Fleming, Chris Kirby and Barbara Ostdiek investigate the nature of volatility linkages in the stock, bond and money markets in their article *Information and volatility linkages in the stock, bond and money markets*.[33] They use a trade model to be able to study the degree of information spill over between markets and to see its implications on the volatility linkages between the markets. Their result shows that under their model of speculative trading traders include in their strategy the correlation between markets to be able to diversify the risk correctly. This behaviour creates strong volatility linkages between markets which has important implications for asset allocation and risk management strategies.[34]

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[30] Kodres, Laura E. – Pritsker, Matthew, *A rational expectations model of financial contagion*, p. 770
[31] Kodres, Laura E. – Pritsker, Matthew, *A rational expectations model of financial contagion*
[32] Kodres, Laura E. - Pritsker Matthew, *A rational expectations model of financial contagion*, p. 769-70
[33] Fleming, Jeff – Kirby, Chris – Ostdiek, Barbara, *Information and volatility linkages in the stock, bond and money markets*, p. 112
[34] Fleming, Jeff – Kirby, Chris – Ostdiek, Barbara, *Information and volatility linkages in the stock, bond and money markets*, p. 136

3 Method

3.1 Data

The data that have been used is collected from the database EcoWin, Fama and French's homepage and Carneige's homepage. It has not been possible to find the exact equivalent data for Sweden as those used for the study made by Kallberg and Pasquariello[35], so the American data available has been somewhat adjusted to be applicable on the Swedish market, and are treated here as global measures. Presented below are the industry portfolios and the factors that have been used in this study. The time span is between January 4th 1985 and March 25th 2003.

3.1.1 The industry portfolios

The data for the industry portfolios comes from the Swedish business magazine *Affärs Världen* made available by the database EcoWin. The nine industry portfolios used in this study are the following; Bank, Chemical, Forest, Investment, Manufacturing, Real state and Construction, Retailing, Shipping and Transportation and Others.[36] They present originally the daily closing price of industry portfolios, but this study is based on weekly data and therefore the closing price each Friday has been used. Holidays such like Christmas, Easter and other non-trading days have been removed. The data collected from *Affärs Världen* represent indices and to be able to use the data in this study the return price of each index had to be calculated. This calculation has been made for all of the nine industries.
(Price week 3/ price week 2)-1= % price change from previous week

3.1.2 The factors

The economic factors that have been used are the Swedish market index (AFGX)[37], Carniege Small Cap index (Cap)[38], SEK/USD exchange rate[39], the American market index (Rm us), size factor (SF) and Book-to Market (BM)[40]. In absence of Swedish variables equivalent to the last three, these three indices, originally based on the US dollar, have been transformed to be based on the Swedish krona and are used in this study as global factors. I use them to get a Swedish market effect beyond the global effect. The explanatory factors that have been used

[35] Kallberg, Pasquariello, *Time series and cross-sectional excess comovement in stock indexes.*
[36] Data base Eco Win
[37] Data base Eco Win
[38] Carnegie's homepage
[39] Data base Eco Win
[40] Fama and French's homepage

in this study come from two different countries and are therefore originally based on different currencies. The rate of return has then been calculated for the exchange rate variable. The American market index (Rm us), the Swedish market index (AFGX), the size factor (SF) and the Book-to Market (BM) factor has all been divided by 100 to get the numbers in percent. To adjust for the currency difference and base all of the factors on the Swedish krona a calculation have been made on the American indices and on the AFGX index.

Swedish market index: As the Swedish market index the Affärs Världens General Index (AFGX) has been used.

American market index: The American market index has been rebased into the Swedish krona and can be considered as a global index. Data is collected from F&F homepage and is there referred to as Mrf-rf, but to be able to use it the risk free rate has been re-added to mrf. Rm, the excess return on the market, is the value-weighted return on all NYSE, AMEX, and NASDAQ stocks minus the one-month Treasury bill rate.[41]

Sek/usd exchange rate: Is the exchange rate between the Swedish krona and the American dollar on a daily basis.[42]

Size Factor: The data has been collected from Fama and French's website and is there referred to as Small minus Big (SMB). SMB is the average return on three small portfolios minus the average return on three big portfolios. [43] The indices are divided by 100 to get the numbers in percent.

Carnegie Small Cap index: This index is based on Swedish firms with a market value less than 20, 2 billion Swedish krona. The index is calculated on a daily basis and is managed

[41] Fama and French's homepage
[42] Database Eco Win
[43] Fama and French's homepage

by SIX Findata, who also handles *Affärsvärldens* index AFGX and the index OMX.[44]

Book-to Market: The data is referred to as HML (High minus Low) at the Fama and French's homepage and is the average return on two value portfolios minus the average return on two growth portfolios.[45]

[44] Carnegie's homepage
[45] See Fama- French, 1993, *Common Risk Factors in the Returns on Stocks and Bonds*, Journal of Financial Economics, for a complete description of the factor returns.

3.2 Regressions

The regressions used in this study have been defined by Kallberg and Pasquariello in their article *Time-Series and Cross-Sectional Excess Comovement in Stock Indexes*. The intense debate in the literature concerning the Excess Comovement Hypothesis (ECM) and the phenomenon of financial crises and contagion is centred on the problem of identifying and measuring them. The researchers agree that even financial markets in tranquil periods show evidence of excess comovements of asset prices within and across developed and emerging financial markets.[46]

3.2.1 The basic estimation strategy

A simple measure of the degree of intertemporal excess comovement among a set of *K* asset prices is used. The regressions made are based on a multifactor model characterized by the following linear factor model. The equation (1) is a specification of a multi factor model of each asset's return with time varying sensitivities.

$$r_{kt} = u_{bt}\beta_{kt} + f_t\,\gamma_{kt} + e_{kt} \qquad (1)$$

In equation (1) r_{kt} is the return for the industry k at time t, u_{bt} is a $N\,x\,N_u$ matrix of systematic sources of risk affecting specific blocks of assets, f_t is a $N\,x\,N_f$ vector of systematic shocks affecting more than one block of assets. Equation (1) is further specified to control for return covariance driven by fundamentals in (2). All factors are defined at time t where T=900 is the total number of weeks studied.

$$r_{kt} = \alpha_{kt} + \beta_{exct}r_{exct} + \beta_{AFGXt}r_{AFGXt} + \beta_{Rmus,t}r_{Rmus,t} + \gamma_{BM,t}r_{BM,t} + \gamma_{SF,t}r_{SF,t} + \gamma_{CAP,t}r_{CAP,t} + e_{kt} \qquad (2)$$

In equation (2) α_{kt} is the constant term, r_{exct} is the exchange rate between the Swedish krona and the American dollar, r_{AFGXt} is the Swedish market return, $r_{Rmus,t}$ is the American market volatility, $r_{BM,t}$ is the High minus Low factor and $r_{SF,t}$ is the size factor (Small minus Big). The second regression is made on each industry to obtain the Ordinary Least Square (OLS) residuals, e_{kt}.

[46] Kallberg, Pasquarello, *Time series and cross-sectional excess comovement in stock indexes.* p. 5

$$\hat{e}_{kt}^{OLS} = r_{kt} - \hat{a}_{kt}^{OLS} - u_{bt}\beta_{kt}^{OLS} - f_t\gamma_{kt}^{OLS} \quad (3)$$

The next step is to test for excess comovement. The excess correlation coefficients, $\hat{\rho}_{knt}^{OLS}$, have then been computed for each k≠n, that is between two industries at time t.

$$\hat{\rho}_{knt}^{OLS} = \frac{\mathrm{cov}\left(\hat{e}_{kt}^{OLS}, \hat{e}_{nt}^{OLS}\right)}{\left[\mathrm{var}\left(\hat{e}_{kt}^{OLS}\right)\mathrm{var}\left(\hat{e}_{nt}^{OLS}\right)\right]^{\frac{1}{2}}} \quad (4)$$

To correct for the bias that may cause the null hypothesis to be rejected on false ground due to heteroscedasticity in the correlation coefficients like those in equation (4) the following correction has been made;

$$\rho_{knt}^{OLS} * = \frac{\hat{\rho}_{knt}^{OLS}}{\left\{1 + \hat{\delta}_{kt}^{OLS}\left[1 - \left(\hat{\rho}_{knt}^{OLS}\right)^2\right]\right\}^{1/2}} \quad (5)$$

Where;

$$\hat{\delta}_{kt}^{OLS} = \left[\mathrm{var}\left(\hat{e}_{kt}^{OLS}\right) / \mathrm{var}\left(\hat{e}_{kt}^{OLS}\right)_{LT}\right]^{1/2} - 1$$

$\mathrm{var}\left(\hat{e}_{kt}^{OLS}\right)_{LT}$ is the variance of the OLS residuals that have been calculated over a long time period, in this case the period is 100 weeks. The short time period is 50 weeks. To prevent coefficients with different signs to cancel each other out in the aggregation the measure of means of excess absolute comovement measures have been calculated for each index;

$$\hat{\rho}_{kt}^{OLS} * = \frac{1}{K-1}\sum_{\substack{n=1 \\ n\neq k}}^{K}\left|\hat{\rho}_{knt}^{OLS} *\right| \quad (6)$$

Where $k = 1, \ldots, K$. If $\hat{\rho}_{kt}^{OLS} * \neq 0$ it implies that there is excess comovement for the industry k at time t. The last equation is a market wide measure of financial contagion as a mean of means of excess correlation coefficients across all the traded assets;

$$\hat{\rho}_{t}^{OLS} * = \frac{1}{K}\sum_{k=1}^{K}\hat{\rho}_{kt}^{OLS} * \quad (7)$$

For the estimation of the residuals a rolling filter has been used, as they usually provide very accurate descriptions of historical variation (or comovement).[47] The short period (t-Δ,t) is 50 weeks and the long period is (t-gΔ,t) where g = 2 is 100 weeks. At each point in time *t* and for each industry *k* the model of equation (2) has been estimated twice, one time over the short period and one time over the long period. The results have been used in the correction term.

Finally the OLS estimates have been regressed on various explanatory variables, like AFGX and its standard deviation and the 30 day- interest rate. This has been done because it is sometimes possible to find the reason behind the excess comovement in these explanatory variables.

3.3 Hypotheses

To minimize the risk of accepting false results the following hypotheses have been formulated and tested.

H0: $\hat{\rho}_t^{OLS} * = 0$, $\hat{\rho}_{kt}^{OLS} * = 0$

This implies that there is no evidence found of excess comovement between the nine industry portfolios respectively after consideration have been taken to the six economic fundaments chosen. The portfolio returns r_{kt} are, after controlling for block common and systematic sources of risk, independent for each industry *k* at time *t*.

H1: $\hat{\rho}_t^{OLS} * \neq 0$, $\hat{\rho}_{kt}^{OLS} * \neq 0$

This implies that there is evidence found of excess comovement between the nine industry portfolios. The portfolio returns are therefore dependant of each other beyond what can be explained by the six economic fundamentals.

[47] Kallberg, Pasquarello, *Time series and cross-sectional excess co movement in stock indexes*. p. 8

4 Analyses

In portfolio managing it is important to be able to diversify the portfolio assets to obtain a desired level of risk and expected return. To be able to diversify correctly it is necessary that the investor knows to what degree the assets are correlated with each other. Recent research has prooved that there exists excess comovement in national stock markets and between countries that can not be explained by economic fundamentals. This paper has studied the Swedish stock market during the time span 1985-2003 with the purpose to see if there exists excess comovement between nine Swedish industry portfolios. The nine industry portfolios used are Bank, Chemical, Forest, Investment, Manufacturing, Real state and Construction, Retailing, Shipping and Transportation and Others. As explanatory variables the Swedish general index (AFGX), the exchange rate of the Swedish krona to the American dollar, an American general index, Book-to-market index (BM), a size factor (SF) and finally Carnegie Small Cap index have been used.

The table 1 reports summary statistics for the time series of weekly returns for the market and for the nine industry indexes computed over the interval January 4th 1985- March 25th 2003. N stands for number of industries, μ is the industry media, σ is the industry's standard error, and skew stands for the industry skewness around its media.

INDEX	N	μ%	σ%	skew
Market	9	0,27	3,82	0,63
Bank	1	0,33	4,53	1,54
Chemical	1	0,38	3,31	0,13
Forest	1	0,28	4,08	0,64
Investment	1	0,21	3,45	0,25
Manufacturing	1	0,28	3,94	0,13
Real state and Construction	1	0,20	3,60	1,51
Retailing	1	0,46	4,08	0,33
Shipping and transportation	1	0,08	4,36	0,20
Others	1	0,21	2,72	-0,08

Table 1. Descriptive statistics.

Table 2 reports summary statistics for the time series of weekly excess absolute correlation measures defined in equation (6), estimated using OLS residuals, and for the time series of benchmark correlations, constructed with the basic index return series, for the broad market

index and for the nine industry indexes. The measures are computed over the interval January 4th 1985- March 25th 2003. A star beside the number, *, means that the result is statistically significant on a 95% confidential level. The correlation coefficient $\hat{\rho}_t^{base}$ is regressed on the raw return series and calculated using the ordinary residuals instead of the OLS residuals, and is used as a benchmark. This is done in order to be able to see the difference between the ordinary comovement and the excess comovement between the industry indexes. The regression model of equation (2) has been estimated over the sample interval for all nine industry indexes in the data base using the OLS procedure across the rolling interval of 50 weeks. Then the corresponding estimated OLS residuals have been used to compute the unconditional measures of excess comovement.

Table 2. Descriptive statistics: OLS comovement

INDEX	ρ^{OLS} *				ρ^{BASE} *	
	μ	σ	ρ	Rρ%	μ	σ
Market	0,09*	0,01	0,57	18	0,48	0,16
Bank	0,09*	0,05	0,21	19	0,45	0,19
Chemicals	0,15*	0,07	0,23	39	0,40	0,20
Forest	0,07*	0,05	0,23	14	0,49	0,19
Investment	0,04*	0,04	0,34	7	0,60	0,14
Manufacturing	0,22*	0,07	-0,31	38	0,58	0,15
Real estate	0,06*	0,04	0,55	12	0,51	0,16
Retailing	0,05*	0,05	-0,02	13	0,39	0,19
Shipping	0,03*	0,02	-0,19	8	0,36	0,20
Other	0,08*	0,05	0,00	14	0,53	0,15

The summary statistics for $\hat{\rho}_t^{OLS}$ *, and $\hat{\rho}_t^{base}$ * are presented in table 2. This table reports summary statistics for the OLS comovement in the Swedish market. As all the $\mu\rho^{OLS}$ *are statistically significant which suggests that there exists comovement between the nine Swedish industry indexes beyond what can be explained by the economic fundamentals in equation (2). The degree of excess absolute correlation for the entire market average about 0,09 and is significantly different from zero over the entire sample and at each point in time t, and the null-hypothesis can therefore be rejected. The term RP is the percentage of $\hat{\rho}_t^{base}$ * that remains unexplained by the model of equation (2), computed as the ratio between the corresponding pair $\hat{\rho}_t^{OLS}$ *, and $\hat{\rho}_t^{base}$ *. From Table 2 this measure constitutes 18 procent of

the market benchmark correlation $\hat{\rho}_t^{base}$ *. $\hat{\rho}_t^{OLS}$ *, and $\hat{\rho}_t^{base}$ * are positively correlated with a degree of 0,57.

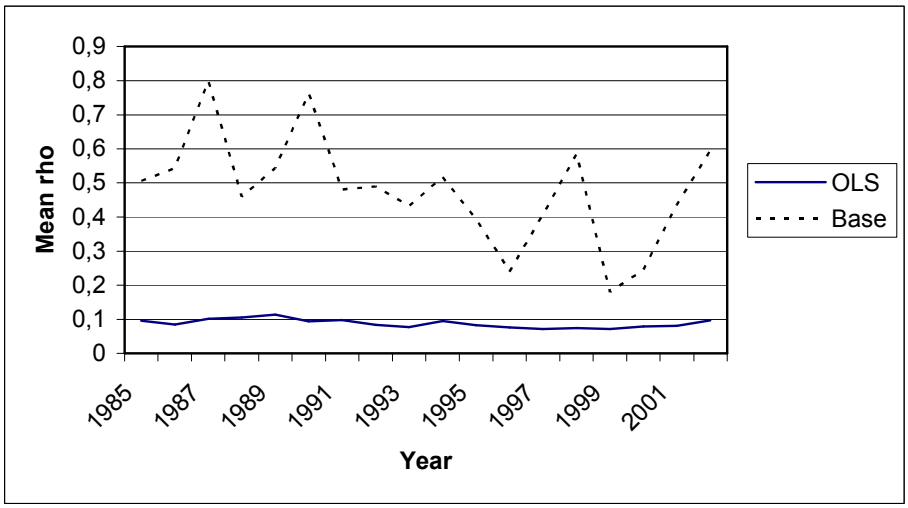


Figure 2a. Mean Excess Correlation

Figure 2a plots the mean excess correlation, $\hat{\rho}_t^{OLS}$ *, and the benchmark $\hat{\rho}_t^{base}$ *. Figure 2a shows how the $\hat{\rho}_t^{OLS}$ * remains constant through time with only small fluctuations around a mean of 0,1. The small fluctuations in the OLS variable are not very visible in this graphic due to the rough scaling of the arms of the graph. $\hat{\rho}_t^{BASE}$ * fluctuates more with distinctive peaks and troughs pointing out times of turbulence in the stock market. The oil crises in 1987, the financial crisis in the early 1990 and the IT bubble in 1999 are events that have had impact on the Swedish stock market and that have also had an impact on the benchmark measurement, shown in the figure 2a as high mean of $\hat{\rho}_t^{BASE}$ *. Figure 2b (see Appendix) shows the ratio between the two measures $\hat{\rho}_t^{OLS}$ *, and $\hat{\rho}_t^{base}$ *, and this graph shows a mirrored fluctuation from the one of $\hat{\rho}_t^{BASE}$ * in figure 2a. The time periods during which there has been turbulence on the Swedish stock market are in figure 2b clearly visible as sharp peaks in the OLS/base line. The oil crises in 1987 and the IT- bubble are clearly defined among other events.

Figure 3a-i in the Appendix shows the mean excess correlation for the nine industry portfolios separately. The nine industries all show evidence of excess comovement in both $\hat{\rho}_{kt}^{OLS}$ *, and $\hat{\rho}_{kt}^{base}$ *, although the magnitude of the excess correlation differ from one industry to another. During times of turbulence on the market the mean excess correlation

increases. The bank sector show high levels of mean excess correlation during "crises" like the "Black Monday" in 1987, the Swedish financial crises in 1991, the IT-bubble in 1999 and the terrorist attack in New York in 2001. The other sectors all show similar patterns although heavy industries like chemicals and forest seams to have reacted more greatly to the oil crises during 1980 than to the financial crises that came later.

Table 3 in the appendix shows the results for the basic regressions for OLS comovement on various explanatory variables. This table reports OLS estimates for the coefficients of the regressions of $\hat{\rho}_{it}^{OLS}$ * on various explanatory variables for each of the nine industry indexes. Dummy variables have been used for the market return AFGX and for the short Swedish interest rate SSVX. The dummy variable equals to one if $sign(afgx_{mt}) = sign(afgx_{mt-1}) = sign(afgx_{mt-2})$ and zero otherwise. Rf is the 30 days SSVX and the dummy variable works equally as the dummy for AFGX. The standard deviation term for the market, AFGX, is the return volatility over the 50 weeks interval. A fat number in the table indicates that the significance of the t-distribution for the one-sided test is at the 10 percent level or less. The results are not statistically significant for many variables for each industry and therefore it can be said that the explanatory variables, the return on AFGX, the standard deviation on AFGX and the short risk free rate can not explain the excess comovement on the Swedish market. How can the excess comovement then be explained?

Pindyck and Rotemberg writes in their article *The excess co-movement of commodity prices* that a possible explanation for the excess comovement among commodity prices is that the financial markets are characterized by what the authors call a "herd" behavior. By that they mean that the investors are bullish or bearish on all commodities for no plausible economic reason.[48] They continue to explain that these "herd" behavior might be caused by equilibrium "sunspots", "bubbles" or a change in "market psychology".[49] Kallberg and Pasquariello write in their article *Time series and cross-sectional excess co movement in stock indexes* that information asymmetry has been considered a cause of comovement across assets beyond what can be explained by economic fundamentals. Also generalized sales and purchases across industries may cause correlation in asset prices that are normally not correlated with each other. The motivation behind these generalized acts could be imitation,

[48] Pindyck, Rotemberg, *The excess co-movement of commodity prices*, p. 1173
[49] Pindyck, Rotemberg, *The excess co-movement of commodity prices,* p. 1186

injections and redemptions of cash in mutual funds, by irrational bubbles or by similar actions by investors. [50]

It is difficult to give any exact explanation to the excess comovement in asset prices between the nine Swedish industry indexes that has been found, but it is very likely that the reason behind is complex and difficult to measure in numbers. The short interest rate has no explanatory power and neither has the market trend represented by AFGX in table 3. The Swedish people have invested a large amount of savings in different funds which are managed mainly by the banks and the state through the pension system. It is possible that the fund managers react similarly to news, both national and international, and therefore they are likely to fall into the "herd" behaviour that Pindyck and Rotemberg mentions. The understanding of the excess comovement phenomenon is important to be able to make a correct judgement of where to invest and therefore the subject should be studied further.

[50] Kallberg, Pasquarello, *Time series and cross-sectional excess co movement in stock indexes*. p. 17

5 Conclusion

In this paper I have studied nine Swedish industry indexes during the time period between the years 1985-2003. The purpose was to study if the industry indexes were correlated with each other beyond what could be explained by six explanatory variables, the economic fundamentals. The results show that there exists statistically significant excess comovement on the Swedish market during the studied period. In an attempt to find the reason behind this excess comovement and financial contagion the results were regressed with explanatory variables such as the short interest rate and the standard deviation of the general market index AFGX. None of these variables proved to be statistically significant at any explanatory level.

The results are important to any actor on the stock market, especially for investors interested in reducing their level of risk by diversification. For them it is crucial to be able to distinguish between correlated and uncorrelated assets and in a market with a high degree of excess comovement and financial contagion this is difficult.

This is an area in Financial Theory that not has been much studied and therefore the measuring methods and the explanations to what causes the excess comovement are vague and uncertain. The most likely explanation to the excess comovement on the Swedish market is that it is caused by factors difficult to measure in numbers. The investors might react in a similar way to national and international news entering the market.

There are no easy explanations of why this phenomenon seams to be present on the Swedish market, but it is a fact that it is present and it is important to study this subject further to increase the understanding of the complex stock market we have today.

References

Literature

Bodie, Zvi, - Merton, Robert C, *Finance*, Prentice Hall, 2000.

Campbell, John Y – Lo, Andrew W - MacKinlay A., Craig, *The Econometrics of Financial Markets*, Princeton University Press, 1997.

Gujarati, Damodar N, *Basic Econometrics*, Third Edition, McGraw-Hill, Inc 1995.

Haugen, Robert A., *Modern Investment Theory*, Fifth Edition, Prentice Hall, 2001.

Ross, Stephen A – Westerfield, Randolph W – Jaffe, Jeffrey, *Corporate Finance*, Irwin, 1999.

Articles

Baur, Dirk, *What is co movement?,* European Commission, Joint Research Center, Ispra(VA) Italy, 2003.

Fleming, Jeff – Kirby, Chris – Ostdiek, Barbara, *Information and volatility linkages in the stock, bond and money markets*, Journal of Financial Economics 49, 1998.

Kallberg, Jarl – Pasquariello, Paolo, *Time-Series and Cross-Sectional Excess Co movement in Stock Indexes*, Stern School of Business, 2003.

Kodres, Laura E.- Pritsker, Matthew, *A rational expectations model of financial contagion*, 2002, The Journal of Finance, vol. LVII, No. 2, 2002.

Pindyck, Robert S – Rotemberg, Julio J, *The Co movement of Stock Prices, The Quarterly Journal of Economics*, Vol. 108, No 4, 1993.

Pindyck, Robert S – Rotemberg, Julio J, *The excess co movement of commodity prices*, The Economic Journal, Vol. 100, No. 403, 1990.

Pålsson, Anne-Marie – Samuelsson, Per, "*Värdepappersfonder som placeringsform"*, Report No18, Reports from the personal Finance and business Research Program, Lunds Universitet, 2001.

Shiller, Robert J, *Comovements in Stock Prices and Co movements in Dividends*, The Journal of Finance, Vol. 44, No 3, 1989.

Electronic references

Fama and French's homepage;
mba.tuck.dartmouth.edu/pages/faculty/ken.french, 8/9/2004

Affärs Världen's homepage;
www.affarsvarlden.se, 8/9/2004

Carnegie's homepage;
www.carnegie.se, 4/10/2004

EcoWin's database, 5-15/9/2004

Appendix

Figure 2. Mean Excess correlation: OLS procedures

Figure 2a plots the time series of mean excess absolute correlations: $\hat{\rho}_t^{OLS}$ * (equation 7) and a measure of absolute correlation $\hat{\rho}_t^{BASE}$ * , computed using the raw return series in equation (4) instead of the computed OLS residuals.

2a)

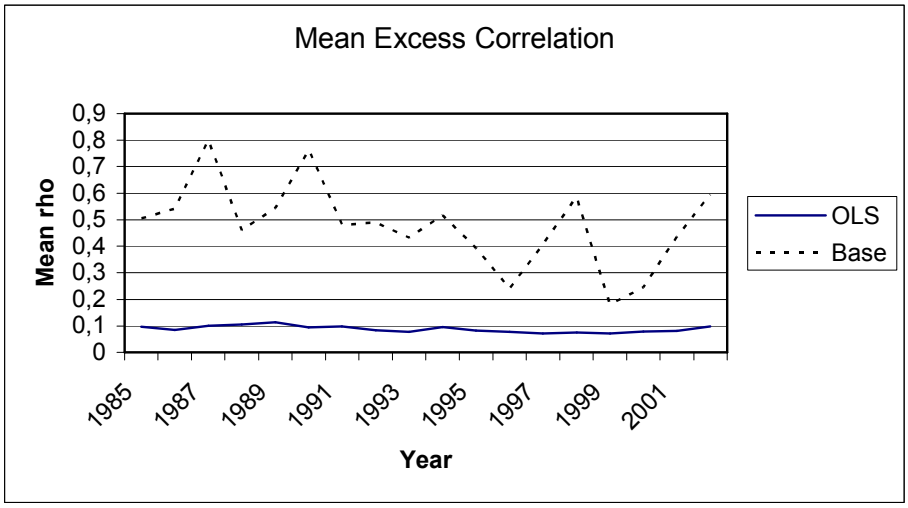


Figure 2b plots the ratio between $\hat{\rho}_t^{OLS}$ * and $\hat{\rho}_t^{BASE}$ *.

2b)

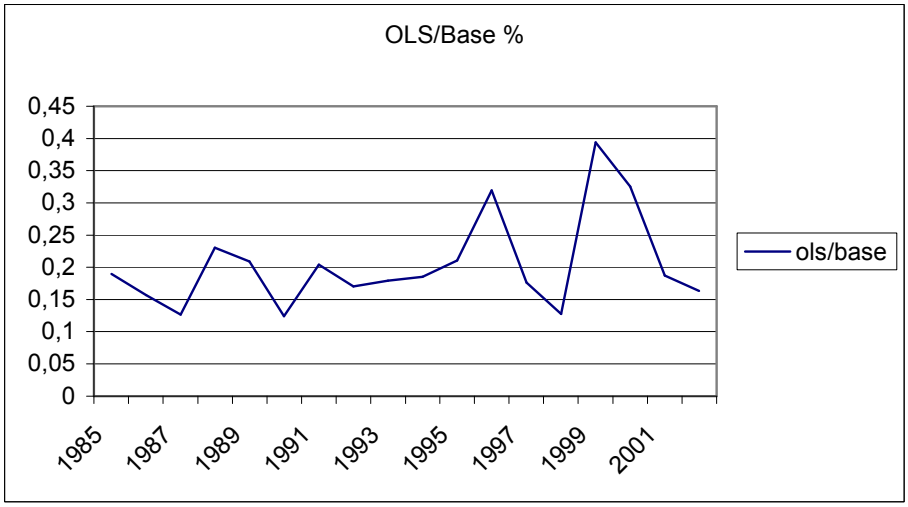
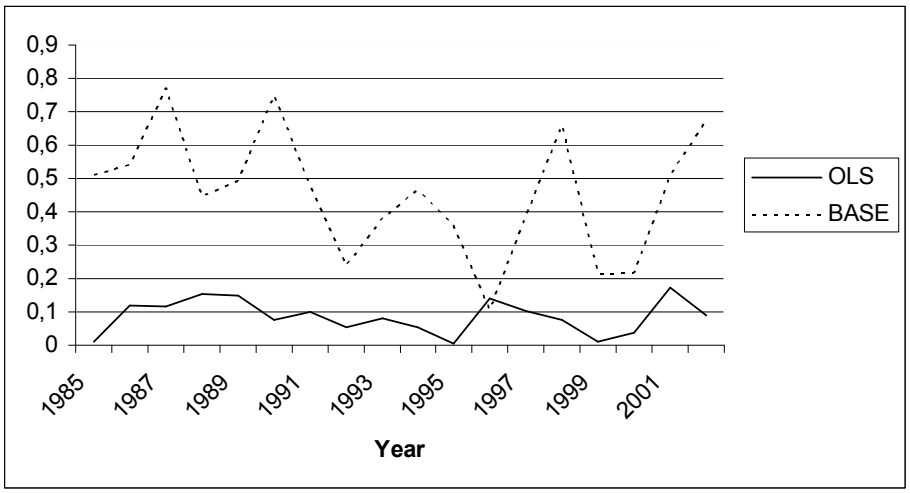


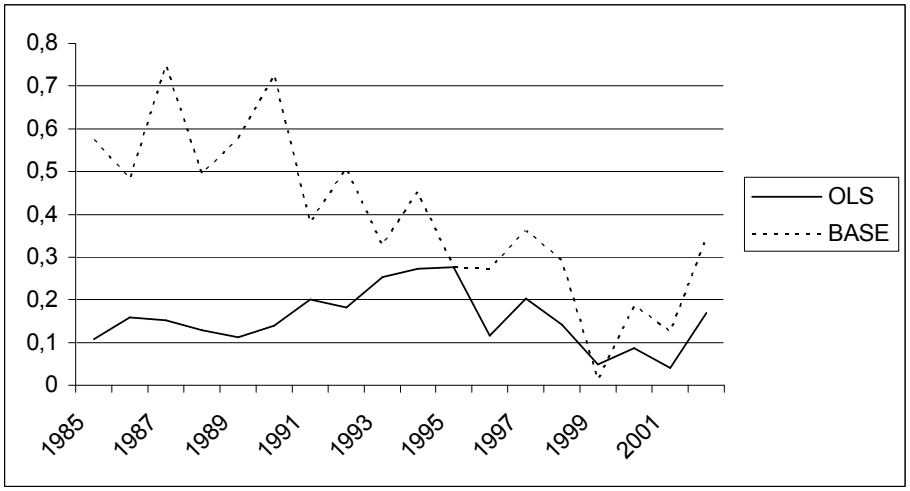
Figure 3. Mean excess correlation for sectors: OLS procedures

Figures 3a to 3i plot the time series of mean excess absolute correlation $\hat{\rho}_{it}^{OLS}$ * for each of the nine industries. In each figure a measure of absolute correlation has been plotted, $\hat{\rho}_{it}^{BASE}$ * using the raw return series r_{kt} in equation 4 instead of the estimated residuals $\hat{e}_{kt}^{OLS}$.

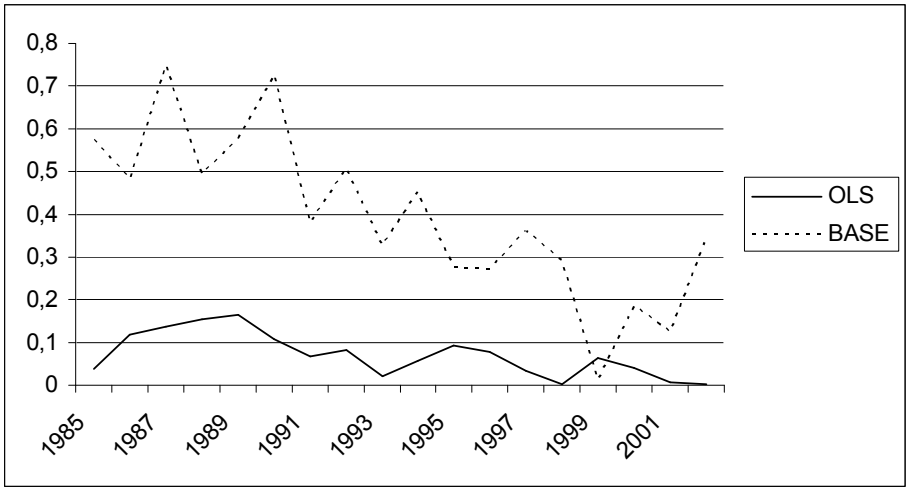
3a) Bank



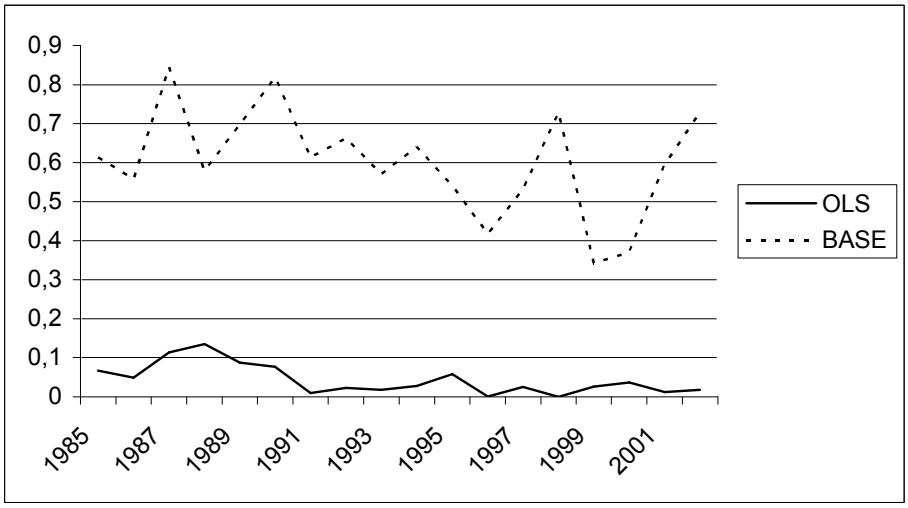
3b) Chemical



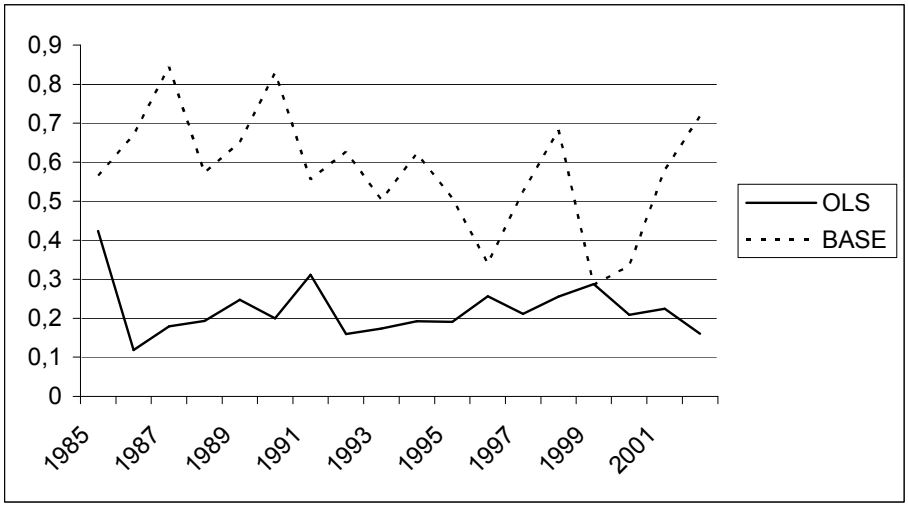
3c) Forest



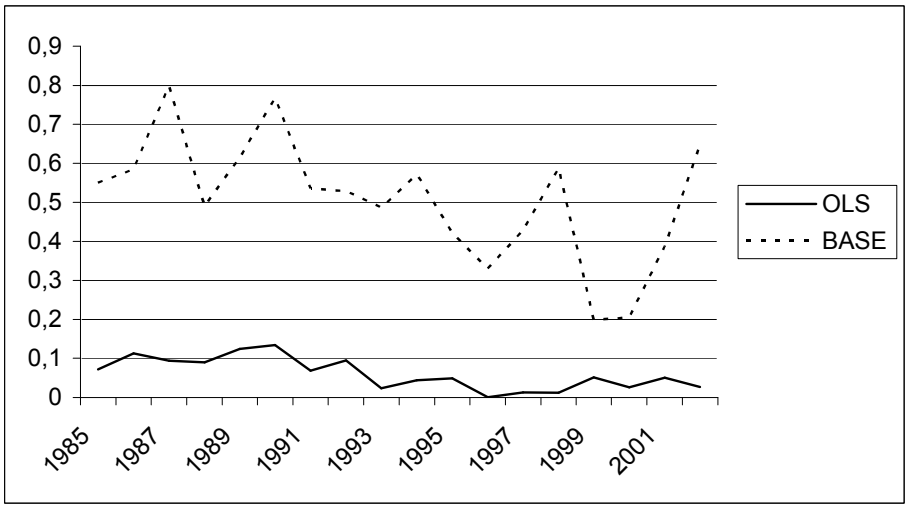
3d) Investment



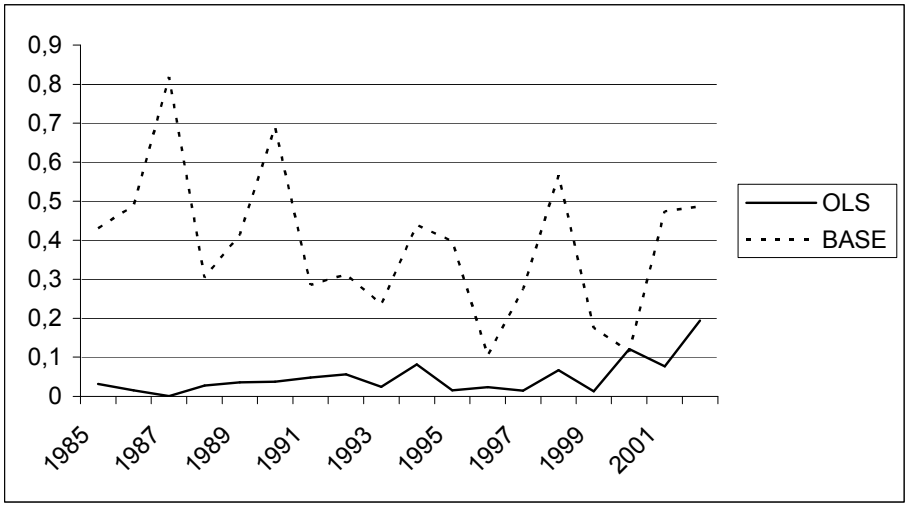
3e) Manufacturing



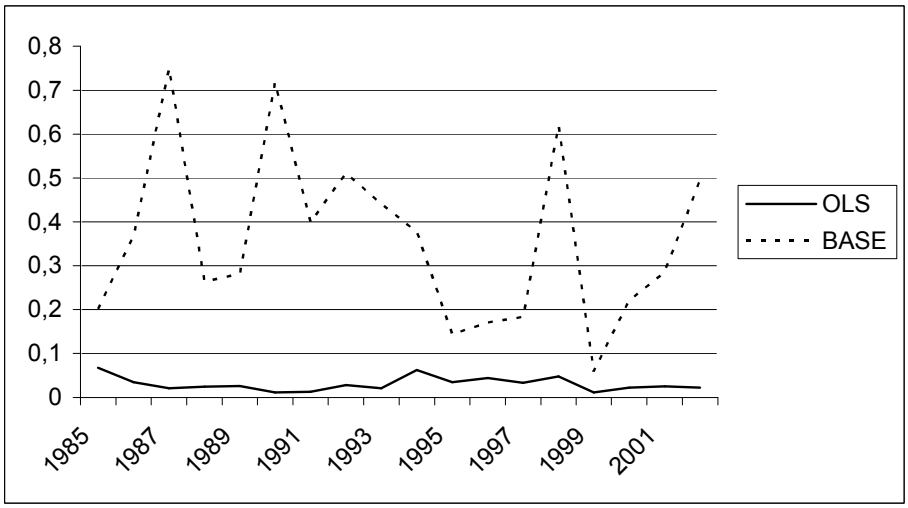
3f) Real state and Construction



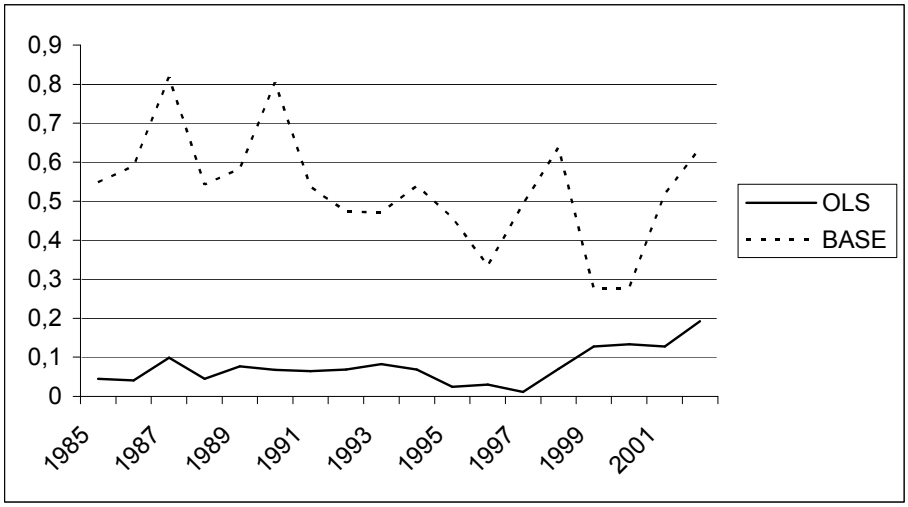
3g) Retailing



3h) Shipping and Transportation



3i) Other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1985
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1991
1993
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1997
1999
2001
OLS
BASE

Table 3. Market and Sectors: basic regressions for OLS comovement

This table reports OLS estimates for the coefficients of the regressions of $\hat{\rho}_{it}^{OLS*}$ on various explanatory variables for each of the nine industry indexes. One is the constant term, stdav is the return volatility over the 50 weeks interval. D afgx is a dummy variable equal to one if $sign(afgx_{mt}) = sign(afgx_{mt-1}) = sign(afgx_{mt-2})$ and zero otherwise. Rf is the 30 days SSVX and the dummy variable works equally as the dummy for afgx. A fat number indicates significance at the 10 percent level or less.

Market

one	stdav	d afgx	d rf	rf	corr. R2
0,098	-0,362				0,011
0,106	-0,422	-0,014			0,295
0,097	-0,347		0,010		0,026
0,078	-0,186			0,002	0,284

Bank

one	stdav	d afgx	d rf	rf	R2
0,113	-0,930				-0,033
0,130	-1,067	-0,031			0,007
0,100	-0,807		**0,083**		0,214
0,126	-1,044			-0,001	-0,094

Chemicals

one		d afgx	d rf	rf	R2
0,208	-1,882				0,062
0,178	-1,650	**0,052**			0,213
0,222	-2,017		-0,091		0,248
0,175	-1,593			0,003	0,089

Forest

one	stdav	d afgx	d rf	rf	R2
0,131	-2,116				0,142
0,160	-2,345	-0,052			0,407
0,128	-2,093		0,015		0,151
0,056	-1,469			0,007	0,384

Investment

one	stdav	d afgx	d rf	rf	R2

0,073	-1,033				0,058
0,096	-1,215	**-0,041**			0,344
0,072	-1,025		0,005		0,060
0,019	-0,573			**0,005**	0,268

Manufactoring

one	stdav	d afgx	d rf	rf	R2
0,273	-1,787				0,055
0,280	-1,846	-0,013			0,064
0,270	-1,766		0,014		0,059
0,252	-1,609			0,002	0,064

Realestate

one	stdav	d afgx	d rf	rf	R2
0,056	0,138				0,001
0,090	-0,126	**-0,059**			0,554
0,052	0,183		0,030		0,059
-0,039	0,966			0,009	0,627

Retailing

one	stdav	d afgx	d rf	rf	R2
-0,010	2,080				0,159
-0,017	2,134	0,012			0,176
-0,011	2,096		0,010		0,164
0,030	1,732			-0,004	0,241

Shipping

one	stdav	d afgx	d rf	rf	R2
0,047	-0,570				0,105
0,043	-0,542	0,006			0,147
0,048	-0,580		-0,006		0,122
0,047	-0,576			0,000	0,105

Other

one	stdav	d afgx	d rf	rf	R2
-0,004	**2,842**				0,321
-0,006	**2,855**	0,003			0,322
-0,009	**2,889**		0,032		0,373
0,037	**2,487**			-0,004	0,413