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Explaining the coherency of national stock indices with macroeconomic variables: Time-series correlation and Cross-sectional correlation approaches

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Abstract

The phenomenon of increasing correlation between asset returns in economic downturns will be investigated with two different approaches and tried to be explained by different macroeconomic variables. The first approach, namely the classic method of measuring correlation with time series is contrasted with an extended method of cross-sectional correlation measurement proposed by Solnik (2000). The method was applied to sub-indices of the German stock market. Adjacent to the sub-index returns several macroeconomic variables were used in OLS regressions as regressors. In order to test for time variability of the variables' explanatory power subsamples were built. The models were tested with monthly data starting in January 1991 and ending in December 2009. Furthermore, several econometric tests were accomplished to evaluate the econometric quality of the different approaches. Several results were found: The classic time series approach outperforms the cross-sectional approach in terms of econometric quality. Moreover, the former backed the theory of increasing correlations in down-states whereas the latter could not. Nevertheless, the findings of the regressions were very similar: No variable is consistent enough to be used as predictive variable, but in general the amount of credits given to enterprises and the number of unemployed people help to explain return correlation movements over time. However, all regressors suffer from time variability. Splitting the results to the different sub-indices and its appendent correlations gives further sector specific results.

Key words: time-series correlation, cross-sectional correlation, downside risk, DAX

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1. Introduction

The diversification of investors' assets plays the key role in modern portfolio theory. In his revolutionary work Markowitz (1952) could show that the risk of a portfolio with different assets is smaller than or at most equal to a single asset within the portfolio. This finding was the beginning of portfolio theory and the benefits of diversification. The investor's risk aversion would then determine the amount of risk an investment burdens itself.

One main assumption of modern portfolio theory is that assets do not perfectly correlate with each other. If so, diversification benefits would disappear as in case of shocks all kinds of assets would react in the same manner. It is therefore of vital interest to asset managers to allocate their investments in uncorrelated assets in order to eliminate the danger of substantial losses. However, the latest crises clarified that this risk is difficult to diversify away. Faber (2007, Update 2009) showed that returns of different asset classes (U.S. stocks, foreign stocks, commodities, Real Estate Investment Trusts) suffered substantial losses simultaneously during the latest crisis. One reason which was investigated is the difference of correlation between asset classes in upside risk and downside risk. It seems as when asset classes move towards bearish markets the correlation between different assets tend to +1 and the diversification effect vanishes when mostly needed. Okimoto (2008) and Campbell et al. (2002) could show that correlation increased in Bear markets because main assumptions of the Portfolio Theory are often incorrect. Markowitz' theory took for granted that the first two moments are sufficient to be able to choose between different assets. According to this theory, invested assets that were chosen to be in a portfolio as their correlation was low in the past would move linearly over time – even in downturns. If however this relation should not hold and change over time then the portfolio's risk would be fundamentally underestimated. As Okimoto et al. (2008) as well as Longin and Solnik (2001) could show that correlation varies in the manner just mentioned, several answers were given to evade this problem. On the one hand regime-switching models propose to have different compositions of portfolios for different regimes (e.g. bullish and bearish).

These models still assume normal distribution and are characterized by its importance of knowing the occurrence probability of the different regimes that are defined ex ante (see Ang et al. (2002)). On the other hand copula-approaches is a research area that doubts the pre-eminence of Markowitz' theory. Copula-approaches do not use normal distribution and stress extreme happenings. This means that tail occurrences are specially treated for each asset, can be linked thereafter and correlation dependencies in extreme situations are incorporated appropriately (see Sun et al. (2008)). With these approaches it should be possible to identify real correlations and therefore avoid overestimating the diversification effect. Nevertheless, this essay assumes to have normally distributed returns and as it doesn't try to solve a portfolio optimisation problem, the author sticks to two other correlation estimation methods:

The question that this essay answers is if correlation between different indices follows the pattern that in stock market downturns correlation increases and which macroeconomic variables can explain this development. This is investigated with two different models. On the one hand the classical time series approach and on the other hand a cross-sectional correlation measurement proposed by Solnik and Roulet (2000) including an extension they proposed[1]. Thereby, the investigation concentrates on the German Stock Market (DAX) by choosing nine sub-indices that are classified to different industries.

This market is known to be one of the biggest stock markets worldwide with respect to trading volume. Generally, the stock market is just one of several investment possibilities as investors could also enter bond markets, real estate markets or others. The stock market is characterized by higher risk as well as higher returns than most of the non-derivative markets and – in case of the German stock market – the risk of not finding a counterparty is smaller than on other markets. Flannery et al. (2002) could show that a consequence of a high market liquidity is that changes of macroeconomic variables can be observed in changes in stock returns. For asset managers it is therefore essential to put an eye onto macroeconomic news to react and if necessary change the portfolio composition. As mentioned before, assets' cross-correlations differ between assets over time which leads to the necessity to allow for this relationship when recomposing a portfolio.

[1] In the following the abbreviation CSC is sometimes used for Cross-sectional correlation model, whereas TSC stands for time-series correlation model

The main results have to be split against the background of two different models as they are not completely equal. In aid of the time-series correlation model the theory of increasing correlation in down-states can be supported. The significance of explanatory variables is affected by the sample length. Generally, the number of unemployed people, the index of production as well as the amount of lending to enterprises are significant in many cases. Looking closer at the sub-indices and the appendant correlation time series one can see further variables that have explanatory power. The cross-sectional correlation has an inferior position when comparing the outcomes of diagnostic tests of both models. Furthermore, it does not support the theory of higher correlation in economic downturns. Nonetheless, the movements can partly be explained very well depending again on the sample length. Again, the amount of credits given to enterprises and the number of unemployed people are significant, even more often than in the time-series model. Moreover, the different sub-indices have additional significant regressors that explain the movement of correlation time series.

The essay is ordered the following way: Chapter 2 summarizes previous research and is split up to which outcomes could be found in the area of correlation estimations and the results of which macroeconomic variables are able to explain special movements of indices. Chapter three introduces both used models, highlights its strengths and weaknesses and shows how these features can influence the results. Furthermore the regressional approaches are introduced. Thereafter the data are presented in chapter four. Chapter five gives an overview over all results and chapter six finally delivers a conclusion.

2. Previous Research

Time series correlation has been broadly used to estimate correlation between stocks, bonds, firms, markets et cetera. A broad range of scientific literature is based upon the time series application (e.g. Solnik et al. (1996), Erb et al. (1996), Lundin et al. (2001), Andersson et al (2008)). But even Solnik's idea of an applicable and practicable estimation method for asset managers was chosen to find results in different research areas (Adjaouté et al. (2003), de Silva et al. (2001)).

2.1. Correlation of market returns

Research about correlation over time between different indices was mostly explored for international markets. Authors therefore investigated co-movements between the most important stock indices of different countries. Erb et al. (1996) defined a down-state of a country when index return is lower than its mean and can demonstrate a higher correlation between the countries' returns if the countries are in the down-state. Longin's and Solnik's results in 2001 supported these examinations by monitoring the coherency of the most important markets with the US-market because they could see decreasing (increasing) correlations in bullish (bearish) markets. Ferreira and Gama (2004) extended these investigations by specialising on global industry portfolios. Their findings supported Longin's and Erb's results of increasing correlation within downside markets. Butler et al. (2002) investigated correlation over time with different models: They observed higher correlation in calm, bullish and bearish markets under three different distributions: the normal, the student-t and a restricted GARCH (1,1) of J.P. Morgan's RiskMetrics. They found significantly higher correlations between stock markets during downturns assuming a normal distribution as well as the RiskMetrics model of J.P. Morgan. A further proposal for measuring correlation between different markets is the dynamic conditional correlation model that was introduced by Engle in 2002 which outperforms most forms of measuring correlation as its results are less biased and more precise. Copula approaches as mentioned in the introduction and presented by Nelsen (1999) are notably able to estimate downside risk and along with this changing correlations in an appropriate way. A serious drawback of the copula approaches are its practical difficulties as solutions can only be found by using Monte Carlo Simulations that need a big amount of path replications to find correct weights of the portfolios' assets (see Ivanov et al. (2006)). This essay will nevertheless concentrate on the measurement techniques mentioned in the title.

2.2. Macroeconomic variables explaining index returns

Macroeconomic variables as well as business variables are mostly consulted as having most explanatory power to explain this special pattern. Though, it is possible to differentiate between factors that on the one hand try to explain changing correlation between returns directly and factors that on the other hand help to predict returns and therefore implicitly describe changing correlation. Most research discussed the latter whereas few essays can be found that try to explain correlation movements between indices. Flannery et al. (2002) included 17 macroeconomic factors that were tested to have explanatory power for index returns and found several factors to be significant: the consumer price index, money supply, Producer Price Index, the Balance of Trade, employment situation as well as housing starts. Boyd et al. (2005) specialised their investigations on the informative value of unemployment and could show that news about rising unemployment leads to increasing stock returns. The authors ascribe this observation to the fact that unemployment rates can be seen as an informational substitute for future interest rates, dividends and equity risk premiums. Interest rates, business cycles and inflation are further macroeconomic variables that seem to have significant expressiveness (e.g. Laopodis (2006)) which leads to an indirect relationship between stock markets and monetary policy. Literature hardly finds consensus of what drives the negative relation between inflation and stock returns. Interest rates are often included as explanatory variable and mostly seen as the most significant variable for explaining stock market movements (see Rapach et al (2005)). Rising short term key interest rate leads to a reduction of money supply. Theoretically, this modification should be reflected in a negative reaction of the stock markets. Rahman et al. (2008) confirm these results for the short term but not for a longer investment horizon. A further important macroeconomic variable is industrial production. Humpe et al. (2009) find that industrial production is positively related to stock prices. Trading volume does not seem to influence stock/index correlations (see De Medeiros (2006) or Zolotoy et al. (2007)). Most essays agree in inflation and short term key interest rate as significant macroeconomic variables that have explanatory power. Thereafter, the results differ from author to author. Nai-Fu et al. (1986) included the development of the oil price, long-term government bonds, expected as well as unexpected inflation and others. They found that industrial production is again a significant parameter that helps to explain the pricing of stocks. There are few analyses for the German Stock Market. Lockert (1996) couldn’t find any links between stock market movements and macroeconomic variables. Nowak (1994) could prove that the ifo business climate index is a significant explanatory variable whereas Sauer’s (1994) results had analogies to the results of his American counterparts. He found several macroeconomic variables having explicatory power: Industrial production, interest rates, inflation, volume of exports and exchange rate (DM/US-$). Bessler et al. (2003) partly backed their investigations with results of the latter essays. They found significant variables being returns of the sector-indices, long term interest rates, ifo business climate index and the exchange rate. Furthermore, they brought to light that most factors’ explanatory weights are time inconsistent.

Generally spoken, there is a consensus that macroeconomic variables influence the performance of stocks and movements of stock markets. Especially in the short run, macroeconomic shocks and unexpected changes tend to affect stock returns more than expected changes and long term shifts. But the importance and the amount of impact of different macroeconomic variables are subject of controversial discussion.

This study tries to survey the impact of the macroeconomic variables on the correlations of the index returns whereas the author reverts to these variables that are capable to explain stock index movements.

3. Methodology

Changing correlation is determined with two different models: Time-series correlation and cross-sectional correlation. Thereafter, the correlation time series are seen to be the regressand in an OLS-estimation. Different macroeconomic variables are tested to be significant regressors. Since it is assumed that correlation increases in downturns, one additionally has to define the latter. Downturns are seen under a certain angle. A down-state is eventuated following Erb et al. (1996) which will be explained in chapter 3.3. Nevertheless, an eye should be casted on the generally accepted recessions of Germany. In the sample that is observed the recessions always occurred after the financial crises starting in March 2000 and October 2008. But as Erb's methodology includes these months as down-states no special tests will be run for it.

3.1. Time-series correlation model

The time series correlation model is the classic approach to explore relationships between different time series. Firstly, daily prices were converted into logarithmic returns:

$$R_t = \log\left(\frac{P_t - P_{t-k}}{P_{t-k}}\right) \qquad (1)$$

t stands for the last day of one month and k signifies the number of trading days. Following Andersson et al. (2008) a time series of monthly correlations is generated by computing one correlation coefficient for each month. Thereby the dimension is converted from daily data to monthly data:

$$\rho_t = \frac{Cov(X,Y)_t}{\sqrt{Var(X)_t} * \sqrt{Var(Y)_t}} \qquad (2)$$

X and Y are the returns of the different sub-indices of the German Stock market and t signifies a one month time horizon. More exactly, the time horizon of one month differed slightly: mostly, one month had 22 trading days but slight deviations of a 22 day period were accounted for. 36 correlation time series were computed like that as nine sub-indices were included. The obvious strength of this deviation of correlation time series is its ease to compute. The classical computation of a correlation time series with a rolling window suffers different drawbacks as mentioned by Andersson (2008):

> *"[...] the rolling estimates cannot adequately measure the dynamics of cross-return linkages. […] the correlation estimates adjust rather slowly to new information. Additionally, unusually small or large return observations will not gradually diminish over time, but instead lead to jumps in the correlation estimates when these observations fall out of the estimation window."*

Solnik (2001) additionally adds that valid results are only received if the sample length is large enough. In this essay correlation coefficients were generated with a compound return strategy which could be done as daily data was used. Therefore, the jumps and the slow adjustment are avoided. A drawback of this method is that the results might be indistinct as a linear movement between the months is assumed. Nonetheless, this drawback is accepted.

3.2. Cross-sectional correlation model

The following model was derived by Solnik (2000) for international markets and is now adapted to national industry indices with an extension. In Solnik's model of cross-sectional correlation the standard deviation comes to the fore as a very important parameter. Firstly, an average return of all returns of the sub-indices is generated and will be called "total" return R_T:

$$R_T = \frac{1}{K} * \sum_{i=1}^{K} R_i \qquad (3)$$

K stands for the number of sub-indices. Calculating with monthly returns gives us a new time series of monthly "total" returns. Obviously, the higher the equality of the "total" return and the individual sub-index return, the smaller the dispersion between these time-series. The next step to take is to find the dispersion of the sub-index return around the "total" return. High dispersions would signify diversification benefits which mean that a high dispersion goes hand in hand with low correlation. This dispersion can be measured in standard deviations. As the sub-indices are dependent of the "total" index, one can form an OLS-Regression:

$$R_{it} = \alpha_i + R_{Tt} + e_{it} \qquad (4a)$$

α_i is a constant in the regression model and e_{it} is an error with mean zero and standard deviation of $\sigma_{ei}(t)$ that is dependent of t. Working with (4a) would imply the assumption that the sub-index walks linearly together with the "total" index as β is assumed to be one. Avoiding this simplification leads to more realistic estimates of real correlation. Therefore, the model is extended and the β_i can be included in (4a):

$$R_{it} = \alpha_i + \beta_i R_{Tt} + e_{it} \qquad (4b)$$

Regressing this equation leads to residual series for each sub-index and to a series of standard deviations $\sigma_{ei}(t)$ which varies over time. Thereafter the correlation between a sub-index and the "total" index can be computed the following way:

$$\rho_{it} = \frac{\sigma_T(t)}{\sigma_i(t)} = \frac{1}{\sqrt{1 + \frac{\sigma_{ei}^2(t)}{\beta_i^2 * \sigma_T^2(t)}}} \qquad (5)$$

With this method one receives a time series of correlations of a sub-index with a higher index that has to be built before. This approach has several strengths and weaknesses. A big advantage is that it is very handy. The model can not only be used for industry indices but even for national markets with which one can compose a world market. Furthermore it is again an easy approach working with data that can easily be found. "Total" correlation is received immediately as dispersions are instantaneously incorporated. Moreover a shorter sample length is sufficient for this approach in comparison to the time series approach.

Extending the model also leads to correlation estimates between different sub-indices:

$$\rho_{ij} = \frac{1}{\sqrt{1 + \frac{\sigma_{ei}^2(t)}{\beta_i^2 * \sigma_T^2(t)}} * \sqrt{1 + \frac{\sigma_{ej}^2(t)}{\beta_j^2 * \sigma_T^2(t)}}} \qquad (6)$$

Working with (6) – where i and j stand for two different sub-indices – gives again 36 correlation series. The different betas are received by regressing (4b) in order to get the different residual time series. As the total return is a composition of all indices, the probability of a negative beta is small especially if only nine indices frame the total index. One serious drawback of this model is that due to the assumption that each sub-index moves in the same direction with the "total" index the correlations between the sub-indices are seriously biased. By looking at (6) one can clearly observe that negative correlations between sub-indices are not possible. Later, we will see that this result differs from the outcomes of the time series correlation as negative values are allowed in the latter.

3.3. Identification of stock market downturns

For Germany, three recessions can be found: in 1993 when the boom of the German reunification was over, in 2000 as a consequence of the international Dotcom-crisis and the latest crisis in 2008. Bearish markets need to be identified cautiously as stock market prices can fall 20% but can be recognized as corrections ex post. Conservatively defined, the German stock market was bearish in 2000 as a consequence of the bursting dotcom-bubble and in 2007/2008 after the insolvency of Lehman Brothers which is demonstrated in figure 1.

Figure 1: German Stock Index (DAX), daily data, 1.1.1991 till 31.12.2009

As both definitions for a recession as well as for a bearish market are inconclusive this essay is going to follow the method of Erb et al. (1996) to identify down-states.

Furthermore, the question if whether correlations move together and especially when stock market downturns occur has to be tested. Graphically it can be seen that correlations between different sub-indices rather move together than move away from each other. This can be seen in figure two.

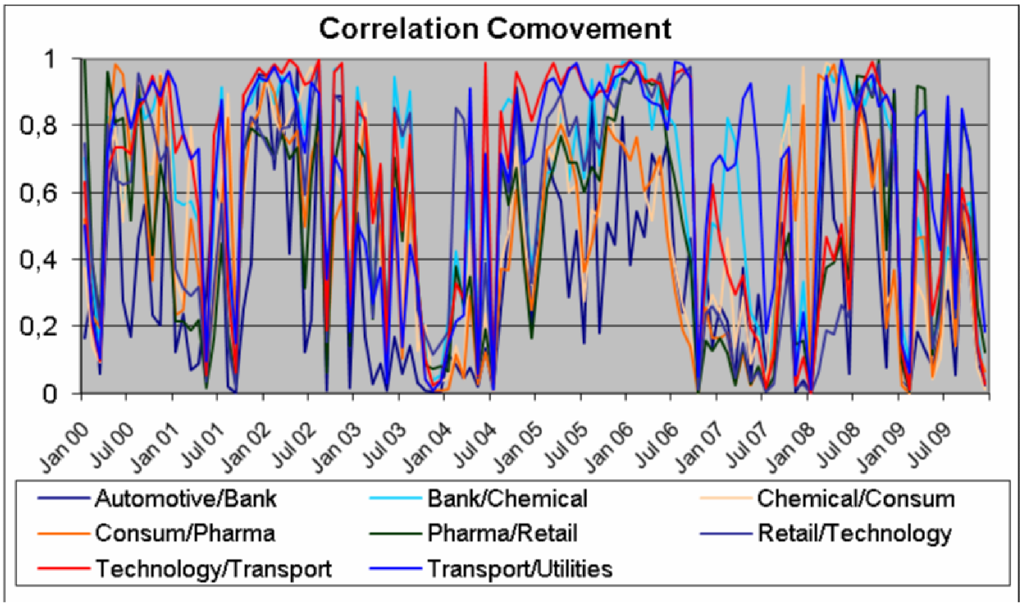

Figure 2: Randomly chosen correlations of the cross sectional correlation model, 2000-2009

In order to test how the correlation time series behave towards each other a statistical test for equal correlation was conducted. The test statistic is defined as

$$Z_t = \frac{(\rho_{1t} - \rho_{2t})}{\sqrt{\frac{1}{n_{1t} - 3} + \frac{1}{n_{2t} - 3}}}, \qquad t \in T \tag{7}$$

which is normally distributed and where n_1 and n_2 are the sample sizes for ρ_1 and ρ_2 respectively and t is one month and $T = \{Jan\,91, Feb91, ..., Dec09\}$. As the correlation coefficients always belong to one month, both n_1 and n_2 are chosen to be 22 as in the average 22 days of one month are trading days. A further simplification was made: for each model 36 correlation time series were generated which would make 630 tests for each t. A comparison would become fairly confusing. Therefore one correlation coefficient is calculated as the average correlation coefficient of all correlation time series belonging to one sub-index for each point of time:

$$\bar{\rho}_t = \frac{\sum_i \rho_{it}}{8}, \tag{8}$$

where i is one sub-index and thence ρ_{it} a correlation coefficient of this sub-index with another sub-index. It is divided by eight as nine sub-indices were included in the investigation. Thus, nine time series of average correlation coefficients were received and 36 tests for equal correlation for each t were accomplished. Thereafter the same procedure was conducted for the cross sectional correlation model.

Identifying down states was done by following Erb et al. (1996). Firstly, daily DAX data was logarithmised and transformed to monthly returns according to equation (12). Secondly, the long run mean of the monthly return was calculated. Finally, each monthly return was differenced with the long run mean. A down-state (up-state) was thereafter defined if the result was negative (positive). Following this method, a deviation time series was received. It should be stressed out that the deviation time series was received by using the DAX and not the sum of all sub-indices. Exemplarily it can be seen that after this definition the DAX was in a down-state for several months after the burst of the dotcom bubble in march 2000.

3.4. Included variables in the OLS-approach and its diagnostic tests

3.4.1. Diagnostic tests

Working with a model where macroeconomic variables are the only explanatory variables gives rise to some further econometric problems that additionally have to be solved besides the classic econometric tests a model has to pass. At least six assumptions have to be tested:

1. Expected value of the error term is equal to zero: violation of this assumptions highlights a specification error
2. Error term is independent of the explanatory variables: if not, the model suffers endogeneity
3. The error terms are independent: Dependence would mean autocorrelation
4. Variance of the error term is constant: if so, then the model is homoskedastic
5. Explanatory variables are not linearly related: linear dependence between regressors leads to multicollinearity
6. Error terms are normally distributed: non-normally distributed error terms results in Non-normality

It should furthermore be tested if the time series are stationary or non-stationary. Stationarity would mean that the time series are independent of time. Mean-reverting processes would moreover signal that a time series is not non-stationary. The augmented Dickey-Fuller and the KPSS test are the tests that will be used to make a conclusion about stationarity of the time series.

The question of whether or not the model suffers a specification error can be answered by using a RESET misspecification test. Following Verbeek (2009) endogeneity occurs if the model suffers a measurement error or interdependent models in dynamic models.

As there are no reasons why one of these phenomena should be on hand, I forbear from testing for endogeneity. Heteroskedasticity will be tested with the Breusch-Pagan-Godfrey-test. Multicollinearity forms the most serious problem the model can suffer. Therefore, exogenous variables will be left out if their correlation exceeds a certain benchmark or lags are included if multicollinearity can thereby be handled. In order to find a reasonable benchmark, the Variation Inflation Factor will be used to justify an exclusion of a regressor. Non-normality will be tested with Jarque-Bera test. All tests can be summarized:

Test-name	***Null-hypothesis***
Augmented-Dickey-Fuller	The time series is non-stationary
Breusch-Pagan	No heteroskedasticity
Breusch-Godfrey	No autocorrelation
Jarque-Bera	The residuals' distribution is normal
Ramsey RESET	There is no misspecification

Table 1: Summary of all diagnostic tests conducted

If a model suffered heteroskedasticity the problem was solved by robust standard errors. Heteroskedasticity serves inconstant variances within the residual series of a regression. Regressing with ordinary least squares leads to a serious drawback: even though the coefficients of an OLS-approach are unbiased and consistent as the expected value of the coefficient stays the same, the inconstant variance leads to inefficient OLS coefficients and inexact standard errors. Therefore, White standard errors were used when heteroskedasticity emerged. These standard errors are more robust and consistent (Baltagi 2008, p. 99f). Thus heteroskedasticity is not averted but controlled.

A close problem to heteroskedasticity is autocorrelation. With this problem the ordinary standard errors are again wrong leading to inexact t-tests as well. Solving this problem was done by using Newey-West standard errors. If both heteroskedasticity and autocorrelation appeared then Newey-West standard errors were used.

The Advanced-Dickey-Fuller-test tests for non-stationarity. Accepting the null hypothesis of non-stationarity can lead to the serious problem of a spurious regression. This problem can occur if the regressand as well as the regressors are non-stationary. As several regressors are typical examples for non-stationary time series one needs to keep an eye on the characteristics of the explained variable.

A further problem that occurred in some regressions was a misspecification problem. Misspecification was tested with the RESET-test. The purpose of this essay is to find macroeconomic variables that can explain time-varying correlation. Hence, it is unavoidable to make a pre-selection of potential regressors. Business figures of firms that are included in the different sub-indices like enterprise value, book debt to capital ratio, payout ratio or dividend yield might have additional explanatory power. But this question is factored out as it would go beyond the scope of the topic. The RESET-test has a common null hypothesis for two problems: missing variables or a wrong misspecification of the model. As former can't be controlled it will be concentrated to the latter. There are several possibilities to adjust a model if RESET confirms misspecification. Using normal data instead of logarithmic data was not done as logarithmizing usually leads to reduction of heteroscedasticity (see Verbeek 2009, p. 116f). Another possibility – especially if heteroskedasticity and misspecification occur contemporaneously – is to include lags of the regressor and the regressand until the null hypothesis of no misspecification is accepted. This leads to a more dynamic model, additionally with higher explanatory power in most of the cases. This is what was done in this model. In only two of the cases where misspecification was detected more than one lag of the respective regressand had to be included.

3.4.2. Included macroeconomic variables

This essay will partly follow the essays mentioned in chapter two. Therefore, the included macroeconomic variables are the following: key interest rate, inflation, number of unemployed, money supply, order income, ifo business expectations, balance of trade, lending to enterprises and the index of production. All variables are included only under the assumption that multicollinearity is controllable and does not lead to an unacceptable aggravation of the regression's power. The variable "number of employed" was preferred to the unemployment rate because a change of the calculation method in 2004 would have led to a structural break. Furthermore, the index of production was favoured over industrial production as the latter variable is only published quarterly and an interpolation would have led to a loss of information. Moreover, order income was included. To the knowledge of the author this variable was not included in former investigations of stock index returns. Order income, business expectations as well as stock index developments are seen to be indicators for the business cycle and are assumed to predict future development of the economy. Hence, order income and business expectations are "special" under all "classic" macroeconomic variables.

3.4.3. OLS-approach

After having transformed all time series into monthly logarithmic data, ordinary least squares regressions were executed. The original regression equation was the following:

Corr(index 1 / index 2) = β_1 * returnindex1 + β_2 * returnindex2 + β_3 * balance of trade + β_4 * business expectations + β_5 * inflation + β_6 * key interest rate+ β_7 * money supply + β_8 * order income + β_9 * unemployed people + β_{10} * lending to enterprises *(9)*

In order to assure that the model didn't suffer multicollinearity, the correlations between the explanatory variables were calculated. The results can be seen in appendix 1. Mostly, correlation between the regressors are not high and do not constitute serious problems. However, the correlation coefficient between "Lending to enterprises" and "money supply" is extremely high and "order income" is highly correlated with the "index of production" and "lending to enterprises".

In order to create a benchmark which correlation is too high and leads to harmful multicollinearity the variance inflation factors (VIF) were calculated. The variance inflation factor is defined by:

$$VIF = \frac{1}{1 - R_i^2} \qquad (10)$$

where R_i^2 is the coefficient of determination of regressing the ith explanatory variables on all other explanatory variables (e.g. Kennedy 2008, p. 199). Table two shows the different VIF's for each regressor.

Regressors	**Variance inflation factor**
interest rate	2,406570629
inflation	1,164695969
Unemployed	1,632633217
Money supply	9,895396934
order income	2,237875916
Business expectations	1,103882649
Balance of trade	1,066552947
Lending to enterprises	4,785552144
index of production	1,066552947

Table 2: Variance inflation factor of the different regressors

Literature is not in accordance if the benchmark should be five or ten. In this paper the benchmark 5 was chosen to assure to avoid multicollinearity. Therefore, the explanatory variable "money supply" was excluded.

Hence, equation (9) was transformed:

Corr(index 1 / index 2) = β_1 **** returnindex1 +*** β_2 **** returnindex2 +*** β_3 **** balance of trade +*** β_4 **** business expectations +*** β_5 **** inflation +*** β_6 **** key interest rate+*** β_7 **** lending to enterprises +*** β_8 **** order income +*** β_9 **** unemployed*** *(11)*

Model (11) was estimated for three different samples. Firstly, the whole sample starting from January 1991 and ending in December 2009, secondly a sample from January 1991 till December 1999 and thirdly a sample from January 2000 until December 2009. With the division of the sample at 1999/2000, it should be tested if the significance of macroeconomic variables changes over time. As there are two financial crises within the time of the second sub-sample, it should be tried to tie this different framework to possible diverse observations.

4. Data

All stock index data are daily observations starting from January 1^{st} 1991 and ending on December 31^{st} 2009. The source for stock index prices was exclusively DataStream. The indices are adjusted to dividend payments and other corporate actions. These time series of daily prices firstly were converted in logged return following (1). Correlation was received by using (2) where daily data was simultaneously transformed to monthly data. As returns were also included in the regression, they had to be adjusted to a monthly base. Compound returns were used, following Campbell et al (1997):

$$R_t(k) = \frac{P_t}{P_{t-k}} - 1 \qquad (12)$$

P_t is the last logged daily return of the month and k is the the number of trading days in each month. Following (2) all correlation time series were calculated. Altogether, nine sub-indices of the German Stock Market were chosen: Automotive, bank, chemicals, consumer, pharma, retail, technology, transport and utilities. All listed firms' stocks are allocated to one sub-sector depending on the firm's main duty. Several sub-sectors generate one sector. Sectors in turn form a supersector. An example would be BMW. This firm belongs to the subsector "Automobile Manufacturers" in the sector "Automobile" which is again part of the supersector "Consumer Goods". The indices in this essay are all chosen from the level sector.

	mean	std. deviation	skewness	kurtosis	Jarque-Bera	Probability
Auto	0,009053	0,076651	-0,364773	3,204386	5,453096	0,065445
Bank	0,022021	0,040466	-0,014648	2,377610	3,688156	0,158171
Chemical	0,019100	0,031372	-0,235287	3,477823	4,272664	0,118087
Consumer	0,020777	0,030381	0,749577	4,377962	39,389290	0,000000
Pharma	0,023126	0,034420	0,305490	2,172810	10,046630	0,006583
Retail	0,012584	0,048920	0,464302	2,587190	9,810798	0,007406
Technology	0,021019	0,052683	-0,106348	2,600697	1,944484	0,378234
Transport	0,010937	0,055088	0,010879	2,456014	2,815748	0,244663
Utilities	0,010318	0,028038	0,309278	3,475601	5,783676	0,055474

Table 3: Stochastic moments and Jarque-Bera-test of normal monthly returns for all sectors, January 1991-December 2009

Table three shows the stochastic moments and the results of the Jarque-Bera-test. The null hypothesis of normal distribution can be accepted in six of nine cases and is rejected with a 99, 9% confidence only for the consumer index.

Most of the explanatory variables are also gained from DataStream. Order income, number of unemployed and the index of production were found at Destatis, the statistical bureau of Germany. Lending to enterprises and balance of trade are provided by Deutsche Bundesbank. All time series are monthly data and converted into logarithmic data.

The macroeconomic variables are exclusively absolute values. Index of production and order income are indices with basis 2005=100.

The software that were used are Microsoft Excel for preparing the time series on the one hand and Eviews for running regressions and econometric tests on the other hand.

5. Results

Each subsection is divided into the outcomes of the time-series correlation model and the cross-sectional correlation model, respectively. The last subchapter draws a comparison between both models. Firstly, the results of the generated correlation time series are drawn. Secondly, the OLS-approach and its results are described. Thereafter, the results of the regressions had to run different econometric diagnostic tests. These results are shown in 5.3.

5.1. Correlation over time and in down-states

5.1.1. Results of the time-series approach

As explained with equation (8), average correlations of one sub-index with all other indices were built. Thereafter the test for equal correlation between the new calculated average correlations were run. The null hypothesis of equal correlation could only be rejected in 36 cases. This is a strong evidence for equal movement. However, preciseness was lost by calculating the averages. But the general result would only have differed slightly. This can be illustrated with a graphical example with randomly chosen correlation time series in Appendix 2. Like in the following regressions the whole sample was divided at 01.01.2000. The rejections of the null hypothesis were nearly equally distributed (17 rejections in sample one, 19 rejections in sample two). At first glance these findings seem to be counter intuitive as stock indices seem to move increasingly together, at least internationally (see Knif et al. (2005)). But a closer look confirms this intuition. All correlations that include the automotive index partly move diametrically in sub-sample two. After excluding the rejections of the null hypothesis that can be traced back to the automotive index another picture can be drawn: 15 rejections during 1991 and 1999 and no rejection during 2000 and 2009. Appendix 3 shows the average correlations of one sub-index with all others. A trend line was included in order to clarify the general movement of the correlation. Interestingly, the diametrical movement of correlation time series that included the automotive index only occurred in 2008, more exactly in the months September, October and November. All rejections of equal correlation happened to be in these months. During this time the correlation time series which included the automotive index even became negative. Thereafter these time series converge to the other time series. The automotive sub-index consists of five companies, amongst others Volkswagen. In connection with the merge between Volkswagen and Porsche the share of VW was a product of a big speculation bubble. On October 28th in 2008 Volkswagen was the most valuable car producing firm which ever existed with a value of 294 billions Euro. Figure 3 shows this exceptional share price movement. This occurrence led to a significant bias of the automotive index. Factoring out these special incidents leads to the result that the test of equal correlation was never rejected in sub-sample two and 15 times in sub-sample 1. Furthermore, it should be investigated if correlation increases if markets are in down states. For this purpose down-states were defined like mentioned on page eleven following Erb's method. Thereafter correlation coefficients between the correlation time series as calculated in (8) and the time series of deviations of the long run mean were calculated. Table four lists these values.

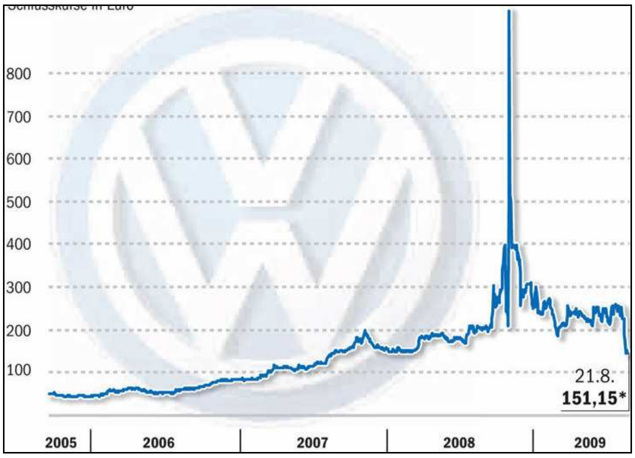

Figure 3: Share price of Volkswagen AG, 2005-2009

A negative coherence can be observed although it is not strong. But by looking closer at the data one can see that correlation equally decreases if the markets are in the up-state. The higher correlation coefficient between the deviation time series and the automotive correlation time series might also be explained with the exceptional happenings during autumn 2008.

deviation/automotive	-0,114301
deviation/bank	-0,270027
deviation/chemical	-0,251543
deviation/consum	-0,307212
deviation/pharma	-0,308972
deviation/retail	-0,299794
deviation/technology	-0,283962
deviation/transport	-0,253704
deviation/utilities	-0,233194

Table 4: Time-series correlation model: Correlation coefficients between correlation time series and deviation time series

Appendix 4 shows a graph of the deviation time series and different correlation time series. It can't be denied that to a certain extent these time series proceed diametrically. Factually, there is evidence that the diversification effect decreases in economic downturns. As these time series are varying over time one should also bear in mind that during up-states the correlation decreased. Thus, a development to the contrary would be preferable. Having obtained these results makes the interpretation of significant variables more straightforward and logic. On the one hand, the significant variables explain changing correlations directly. On the other hand, these regressors elucidate the economic state directly and the correlations of the sub-indices indirectly.

5.1.2. Results of the cross-sectional approach

Using equation (4b) in a regression gives us the different betas that express the relationship between the individual sub-indices and the total index. Table 5 lists the results. They all do not fluctuate much around one. This result is backed by the mathematical deviation of the model. Nevertheless, the automotive index, the consum index and the utilities index obviously run differently to the technology or the transport index.

This directly affects the correlation between one index and the total index (see equation 5) but additionally the correlation between two sub-indices (see equation 6).

Sub-index	beta
Automotive	0,563736
Bank	1,186163
Chemical	0,850831
Consum	0,629157
Pharma	0,900621
Retail	1,193862
Technology	1,365359
Transport	1,533932
Utilities	0,776338

Table 5: Betas of sub-indices with the total index

The correlation between transport and technology thus is higher than the correlation between consum and automotives which can be seen in figure 4.

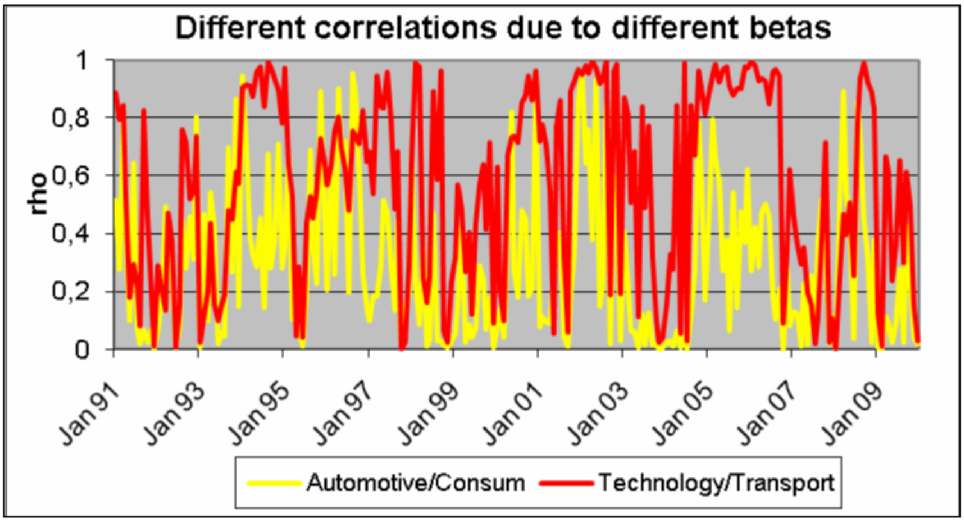

Figure 4: Betas and its implications to different correlations

The correlations that were generated by the cross-sectional correlation model were also tested for equal correlation on the one hand and for increased correlations in down-states. Former delivers very similar results to the time series correlation model. The null hypothesis of equal correlation could be rejected in 101 cases. All rejections of the null hypothesis could again be ascribed to the automotive index: correlations including this

index diverge more often than other correlations. Between 1991 and 1999 the hypothesis was rejected in 43 cases whereas between 2000 and 2009 it was rejected in 64 cases. It has to be brought out that the pattern of permanent rejections for the months September, October and November 2008 can not be found. Non-acceptances are widely distributed and do not follow a certain pattern although these rejections are mostly in the same months strengthening the assumption that the automotive index is the one affecting the correlations. Appendix 5 shows that the correlations move together. It is only the automotive index that sometimes diverges.
Furthermore, it should be investigated if correlations increase in down-states. Looking at the correlation coefficients between the time series of deviations of the long run mean of the DAX and the correlation time series does not give convincing results as seen in table six.

deviation/automotive	-0,02613304
deviation/bank	0,00046996
deviation/chemical	-0,04329986
deviation/consum	-0,08700093
deviation/pharma	-0,02531164
deviation/retail	-0,04586867
deviation/technology	-0,05271221
deviation/transport	-0,02616737
deviation/utilities	-0,06500763

Table 6: Cross sectional correlation model: Correlation coefficients between correlation time series and deviation time series

These outcomes are also backed by the graph in Appendix 6. The deviation time series partly moves together with the correlation time series. But as the coefficients are near to zero, no correlation at all can be observed. Solnik et al. (2000, p. 11) already mentioned this phenomenon:

> *"Clearly, the results […] suggest that correlation does not increase dramatically in periods of bear markets and are in contrast with the often-cited quote: "diversification fails us when we need it at most.""*

The reason why both models come to different results concerning correlation in bear markets will be discussed in the last chapter.

5.2. OLS-approach

In chapter three it was mentioned that the explanatory variable "money supply" was excluded as multicollinearity could be avoided by that. A further advantage of excluding this regressor was the circumvention of heteroskedasticity that occurred within in all samples for equation (9).

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	2.372274	Prob. F(10,97)	0.0147
Obs*R-squared	21.22265	Prob. Chi-Square(10)	0.0196
Scaled explained SS	17.86096	Prob. Chi-Square(10)	0.0574

Table 7: Regressing equation (9): Breusch-Pagan-Godfrey test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.391428	Prob. F(9,98)	0.2024
Obs*R-squared	12.23700	Prob. Chi-Square(9)	0.2003
Scaled explained SS	9.997555	Prob. Chi-Square(9)	0.3507

Table 8: Regressing equation (11): Breusch-Pagan-Godfrey test

Tables seven and eight show the different results of the Breusch-Pagan-Godfrey test for equation (9) and (11) after regressions on the same regressand. Even though the R^2 of (11) is slightly worse the amelioration within the heteroskedasticity problem outpaces this small drawback.

5.2.1. Findings of the time-series correlation model

Regressing correlation on the index returns and macroeconomic variables showed different outcomes depending on sample length and sub-index. Firstly, one should advert to the fact that the regressions' R squared are relatively low with an average of 30%. Nevertheless, this fact should not be overestimated. This criterion always has to be seen within its context – determining levels of quality exogenously with a certain R^2 factors out the context. Having a non-linear connection would additionally adulterate the informative value of this goodness-of-fit measure. Comparing R squared between the same regressions with different sample lengths is more helpful. At this juncture it is shown that lower R^2 come along with larger samples. Both sub-samples obtain better results.

All results were examined in two different ways. On the one hand the explanatory power of the variables were monitored in the context of sample length and on the other hand in context of the sub-index. By looking at the outcomes closer, different things can be asserted. Firstly, there is no common macroeconomic variable having explanatory power for all correlations for the whole sample. Correlations seemed to run independent of macroeconomic shocks or news. Obviously, as shown in table nine and ten, exploitable information is received nevertheless.

Time series correlation model								
In how many cases were the following macroeconomic variables significant? (in %)								
Sample	Balance of trade	Business expectations	Index of production	Inflation	Interest rate	Lending to enterprises	Order income	Unemployed
1991-2009	5,56	0,00	58,33	36,11	11,11	55,56	16,67	22,22
1991-1999	0,00	2,78	13,89	0,00	2,78	30,56	13,89	33,33
2000-2009	22,22	11,11	2,78	5,56	19,44	19,44	8,33	27,78

Table 9: TSC: Significance of the regressors for different sample lengths in %

Time-series correlation model Significant macroeconomic variables for the sub-index...in %										
Industry	Sample	Index of production	Interest rate	Lending to enterprises	Return of the Index	Business expectations	Order income	Balance of trade	Unemployed	Inflation
	1991-2009	37,5	12,5	75	12,5	0	37,5	12,5	12,5	0
Automotives	1991-1999	25	0	12,5	0	12,5	25	0	25	0
	2000-2009	0	25	12,5	0	0	12,5	12,5	12,5	0
	1991-2009	62,5	12,5	50	50	0	25	12,5	12,5	37,5
Bank	1991-1999	37,5	0	62,5	0	0	25	0	75	0
	2000-2009	0	12,5	37,5	37,5	25	0	12,5	62,5	0
	1991-2009	62,5	12,5	50	37,5	0	12,5	0	25	37,5
Chemical	1991-1999	0	0	25	0	0	0	0	25	0
	2000-2009	0	12,5	0	50	25	0	12,5	12,5	25
	1991-2009	75	0	25	0	0	12,5	0	0	50
Consum	1991-1999	0	0	25	0	0	0	0	12,5	0
	2000-2009	0	50	62,5	50	12,5	25	25	75	0
	1991-2009	37,5	37,5	25	25	0	12,5	12,5	12,5	62,5
Pharma	1991-1999	0	25	12,5	0	0	0	0	25	0
	2000-2009	0	12,5	25	0	12,5	12,5	12,5	25	12,5
	1991-2009	62,5	12,5	50	12,5	0	37,5	12,5	12,5	12,5
Retail	1991-1999	0	0	0	12,5	0	0	0	0	0
	2000-2009	0	0	0	12,5	0	0	12,5	25	0
	1991-2009	75	12,5	75	37,5	0	25	25	50	25
Technology	1991-1999	25	12,5	62,5	0	0	37,5	0	75	0
	2000-2009	0	12,5	25	25	0	0	25	37,5	0
	1991-2009	62,5	0	100	12,5	0	12,5	0	50	50
Transport	1991-1999	25	12,5	25	0	12,5	12,5	0	37,5	0
	2000-2009	0	25	12,5	87,5	37,5	12,5	62,5	12,5	12,5
	1991-2009	75	12,5	50	25	0	12,5	12,5	37,5	25
Utilities	1991-1999	12,5	0	12,5	12,5	12,5	12,5	0	25	0
	2000-2009	0	25	12,5	25	0	12,5	25	12,5	0

Table 10: TSC: Significance of the regressors for different industries in %

Working with the whole sample one can see that the variables “business expectations” and “balance of trade” are useless for explaining time-varying correlation. In only very few of the regressions these variables were statistically significant. “Interest rate” and “order income” perform nearly as weak as the former. “Inflation” was significant in

36% whereas number of "unemployed" helped to explain the model in 22%. "Lending to enterprises" and "index of production" were the best explanatory variables with more than 55%. These results might be valid enough to take them both as consistent explanatory variables and to make cogent predictions. After having split the sample into two sub-samples less solid results are received. For the first sub-sample (1991-1999) all variables except the number of "unemployed" lost explanatory power whereas "lending to enterprises" and "index of production" people can not be described as significant. But also "inflation", "interest rate" and "order income" lost in explanatory power and neither serve as consistent regressors. That said, it should be emphasized that no macroeconomic variable has enough statistical power to be a truly explaining variable helping to predict stock index correlation movements. These results can only partly be copied to the second sub-sample. Still, "unemployed", "lending to enterprises", "interest rate" and "balance of trade" are significant but with a decreasing frequency. Additionally, all other regressors are significant at a very low frequency. The reason why "lending to enterprises" is one of the most significant variables in the time series correlation model should not surprise: Giving credit to entrepreneurs is one of the main pre-conditions for economic growth. As more credits are supplied, firms' openings and further firm growth are provided leading not only to growth of listed companies but to the whole economy. Increasing credits to markets' participants should lead to higher returns of the members of the different sub-indices. Appendix 4 showed the diametric relationship between returns and correlation. This is also backed by the coefficient for the variable. It is always negative and therefore has a negative influence to the correlation. Decreasing lending to enterprises – that might provoke an economic downturn – induce increasing correlations. The number of unemployed people affects correlation positively. Its coefficient is always positive but permanently lower in absolute values than the coefficient of "lending to enterprises". As the number of unemployed people increase, the correlations increase as well. Generally, news about higher unemployment is absorbed negatively of the indices. But as Boyd et al. (2005) showed that news about higher unemployment can also be positive, interpretation needs to be refined. Higher unemployment mostly is a sign for recessional developments which mostly leads to decreasing returns of companies' shares and decreasing returns of indices. Therefore correlation increases contemporaneously. Surprisingly, the coefficients' signs change for sub-sample 2. This counterintuitive result is hard to explain. But this observation should not be overestimated as their explanatory power decreased fundamentally over time.

Furthermore, the correlations sorted to branches should be monitored. Intuitively, results should not differ significantly as most correlation time series move similarly. “Unemployed” and “lending to enterprises” are the very significant variables. For the correlation time series that are partly composed with the sub-index automotives the macroeconomic variables do not have a lot of explanatory power. Looking at the whole sample, the regressors “index of production” and “order income” were significant most frequently, but never more than 37,5%. Alongside to “unemployed” and “lending to enterprises” the correlations comprising the sub-index Bank is often explained by the “index of production”: 62,5% of the regressions in the whole sample contained the latter as significant regressor. Surprisingly, “interest rate” was rarely significant. One might have concluded that decreasing interest rates lead to relatively better performances of banks and higher returns in comparison to the other sub-indices.

Both, chemical and retail index’ correlation series movements are mostly not explained by any of the included variables. Only “index of production” is significant in 62,5% of all regressions when looking at the whole sample. The latter also plays the most important role – in addition to “unemployed” and “lending to enterprises” in sub-sample two – for correlations containing the consum index and correlations containing the technology index. This coefficient is permanently positive which stands in conflict to the general theory. The sub-index Pharma is surprisingly influenced by “inflation”, even though not strong, in the whole sample. A reason for that might be that the pharmaceutical industry is non-cyclical. Following Tessamoratis (2003), non-cyclical industries react more sensitive to inflation than cyclical industries. The pharmaceutical industry can be counted as one classic non-cyclical sector because people do not stop spending money for being healthy in economic downturns. Generally, inflation is seen to be negatively interrelated to index performances. More precisely, it is assumed to be negative if the samples are not too long. Boudoukh et al (1993) could show that indices and inflation run parallel in a sample of 1802 till 1990. This effect should be seen more clearly for sectors reacting more sensitively to inflation like the non-cyclical. Therefore, it is consequent that the correlations containing the pharma-index should also react more sensitively than other index backed correlations. The coefficients’ absolute values are entirely very low but they all have a negative sign. This backs the theory.

Correlations of the Transport Index partly have strongly significant explanatory variables: “Lending to enterprises” is significant in 100% of the regressions for the whole sample. Moreover, the return of the transport index serves in 87,5% of the regressions of sub-sample two as significant explanatory variable. “Balance of trade” has an elucidating fraction in 62,5% of sub-sample’s two regressions. The latter sounds intuitive. Due to an increasing economic integration within the Euro-zone but also at a global perspective, enterprises that are listed within the transport index benefit from Germany’s location as a trading platform in the middle of Europe on the one hand but also from the characteristics of Germany’s economy on the other hand. It is only the People’s Republic of China that exported more goods than Germany in 2009. As companies like Deutsche Lufthansa, Air Berlin, DHL and Deutsche Post are part of the sub-index Transport the whole index is affected by the amounts of exports and as a result of that by the variable “balance of trade”. The variable “Return Transport index” serves as a very significant regressor as well. Its coefficient is always highly negative. Surprisingly, this index return is the only return that serves as an explanatory variable. For other indices their returns have never been a significant regressor in more than 50% of their regressions. As the coefficient are highly negative, this variable backs the theory of higher correlation in down states as both time series stand in a negative relation to each other.

To sum it up, it has to be emphasized that a negative relation between correlation and up/down-states can be observed. Correlation increased during down-states and decreased in up-states. Moreover, the correlation series of different sub-indices can be explained by varying macroeconomic variables. “Unemployed” and “lending to enterprises” very often serve as explanatory variable whereas “balance of trade” and “business expectations” rarely lead to an amelioration of the model. Having a closer look at branches and its correlations, different outcomes can be found. “Inflation” as a significant variable for non-cyclical sectors like the pharmaceutical index and “balance of trade” for trade dependent branches like the transport index are well exploitable results. Nevertheless, there is no macroeconomic variable that appears to be highly significant throughout all branches and samples. Furthermore, importance should be attached to the fact that larger samples generally lead to more convincing results but did not have better econometric properties.

5.2.2. Findings of the cross-sectional approach

In chapter 5.3 the cross-sectional model's econometric characteristics are presented. Even though R squared and adjusted R squared have certain drawbacks some words should be said about its results already here. Generally, the R^2 lies in the average at around 30%. But differences can be seen if the models are ordered to their sample size. Small samples always obtain higher goodness-of-fit values than the large sample. In only three of 36 possibilities the regression within the large sample had a higher R squared. This was only due to the fact that lags were included as the original regressions suffered misspecification. In chapter 5.4. the time-series correlation model and the cross-sectional model will also be compared with a better goodness-of-fit measure, namely the Bayes Schwarz Criterion.

Cross sectional correlation model								
In how many cases were the following macroeconomic variables signicant? (in %)								
Sample	Balance of trade	Business expectations	Index of production	Inflation	Interest rate	Lending to enterprises	Order income	Unemployed
1991-2009	0,00	11,11	0,00	11,11	22,22	2,78	5,56	30,56
1991-1999	16,67	38,89	36,11	44,44	2,78	83,33	36,11	86,11
2000-2009	25,00	25,00	2,78	8,33	11,11	25,00	2,78	44,44

Table 11: CSC: Significance of the regressors for different sample lengths in %

For the large sample the outcomes are generally poor. “Balance of trade” and “Index of production” did not have any significant explanatory power to explain time-varying correlation movement. “Lending to enterprises” and “order income” perform nearly equally poor. In 11% of all regressions “business expectations” and “inflation” were significant variables whereas “interest rate” helped to explain the model in 22% of all cases. The number of “unemployed” was the economic variable that was significant most frequently. Nevertheless, 31% are not enough to be seen as a reliable economic variable that helps to consistently explain and predict correlation movements.

Both sub-samples deliver more appropriate results. Correlation movements are very well explained by “lending to enterprises” and number of “unemployed” in sub-sample one (1991-1999). Both regressors are significant in more than 83%. And even other variables perform much better than in the whole sample. “Business expectations”, “index of production”, “inflation” and “order income” were significant variables in approximately 40% of the regressions. “Interest rate” lost all its explanatory power whereas “balance of trade” ameliorated and was significant in nearly every fifth regression. Sub-sample two (2000-2009) does not come up with such results even though tendencies can still be observed. “Unemployed” is still the most important regressor with 44% significant appearance. “Index of production”, “inflation” and “order income” are significant less frequently whereas “interest rate” can regain its power and “balance of trade” can enlarge it to significance in every fourth regression.

The signs of the different coefficients draw a homogenous picture over time and branches except for “business expectations”. The coefficient for “unemployed” is always positive, the one for “lending to enterprises” always negative as well as for “balance of trade” following the argumentation within the time-series correlation approach. As the correlation coefficients in table eleven show no correlation between economic states and correlation time series, the justification of significant variables and its associated coefficients partly have to be rethought. Changes in correlations cannot be linked to changes of economic states like in the time-series correlation model. Now changes of correlations are traced back to unequal impacts of the regressors on the individual sub-indices, especially if the regressor’s impact is negative. A higher (lower) number of unemployed people has a positive (negative) effect on correlations meaning that returns move into the same direction. Therefore, it is unnecessary to follow Boyd’s (2005) argumentation of negative or positive impact of unemployment on returns: more important is the fact that the sub-indices are affected by it in the same manner. Here it follows the argumentation line mentioned at the results of the time-series correlation approach. The fact that “lending to enterprises” bears on the correlation time series in a negative manner means that “lending to enterprises” affects certain sub-indices more than others. Keep in mind that correlation time series in the cross-sectional correlation model move between zero and one by definition. This means that changes in the amount of lending affects industry sectors differently strong but not diametrically. Credit demand should be independent of the firm’s belonging to a certain industry. Nevertheless, one might think about industrial areas where the possibility of borrowing is more important than in others. Taking the results of both sub-samples of the bank index backs this theory: In 100% of sub-sample’s one and 37,5% of sub-sample’s two regressions this variable is significant which gives the best overall result. “Order income’s” coefficient can be interpreted reasonably as well. Increasing order income obviously affects certain indices differently. During the analysis one should bear in mind that “order income” is also seen as an economic indicator. Therefore, cyclical industries will show stronger reactions in the same directions than non-cyclical industries. The variable “inflation” is always accompanied by a negative coefficient.

Cross sectional correlation model

Significant macroeconomic variables for the sub-index...in %

Industry	Sample	Index of production	Interest rate	Lending to enterprises	Return of the Index	Business expectations	Order income	Balance of trade	Unemployed	Inflation
	1991-2009	0	12,5	0	0	0	0	0	12,5	0
Automotive	1991-1999	75	0	87,5	0	0	50	0	62,5	12,5
	2000-2009	0	12,5	0	12,5	0	0	12,5	12,5	0
	1991-2009	0	37,5	12,5	25	25	0	0	75	0
Bank	1991-1999	50	0	100	0	62,5	62,5	12,5	100	62,5
	2000-2009	0	12,5	37,5	25	62,5	0	12,5	75	0
	1991-2009	0	25	0	25	0	0	0	25	0
Chemical	1991-1999	12,5	0	75	12,5	37,5	50	0	62,5	37,5
	2000-2009	12,5	25	37,5	12,5	12,5	0	12,5	50	0
	1991-2009	37,5	50	75	37,5	0	37,5	0	0	12,5
Consum	1991-1999	12,5	0	75	0	25	50	12,5	100	37,5
	2000-2009	0	12,5	0	25	25	12,5	25	0	0
	1991-2009	0	0	0	50	0	12,5	0	25	12,5
Pharma	1991-1999	25	12,5	62,5	0	25	50	0	62,5	37,5
	2000-2009	0	0	37,5	87,5	0	12,5	75	50	12,5
	1991-2009	0	0	0	12,5	0	12,5	0	12,5	0
Retail	1991-1999	50	0	75	12,5	75	62,5	12,5	75	87,5
	2000-2009	0	0	37,5	0	12,5	0	37,5	62,5	0
	1991-2009	0	0	0	0	0	0	0	62,5	0
Technology	1991-1999	0	0	75	0	75	0	62,5	62,5	75
	2000-2009	12,5	0	62,5	12,5	50	0	12,5	87,5	12,5
	1991-2009	0	37,5	12,5	12,5	25	12,5	0	50	12,5
Transport	1991-1999	62,5	25	100	0	37,5	37,5	0	100	25
	2000-2009	0	12,5	0	25	50	0	0	25	37,5
	1991-2009	0	37,5	0	12,5	25	0	0	25	37,5
Utilities	1991-1999	75	12,5	100	0	12,5	12,5	25	100	12,5
	2000-2009	0	37,5	12,5	50	37,5	0	25	37,5	12,5

Table 12: CSC: Significance of the regressors for different industries in %

Obviously higher inflation has a negative impact to correlation. Assuming that decreasing (increasing) correlation is attended by increasing (decreasing) overall economic performance, this relationship might be comprehensible. But as McCandless et al. (1995) found for 110 countries that economic growth and inflation are uncorrelated, interpretation becomes more difficult. Again, one plausible explanation for this phenomenon is that an overall rise in prices leads to different effects for different branches. Products whose price elasticities of demand are lower because of the people's necessity to buy these goods are not hit as hard as firms' products with higher price elasticities of demand. Industry sectors like the pharmaceutical sector or the retail sector including groceries will not suffer buying resistance as much as other sectors

when prices rise. Therefore, returns differ due to inflation. The consequence is lower correlation between the sub-indices.
The coefficient "interest rate" which is not often significant always affects the correlation in a positive way. Dinenis et al. (1998) could show for the UK-market that returns of not only financial industry but also other industries are negatively related to the interest rate. This might be seen as plausible. Lower key interest rates usually make investors leave the more unprofitable bond markets and enter the riskier stock market leading to higher prices and higher returns. As this association is rather weak, implications should not be overestimated. Increasing correlation that is affected by increasing key interest rates can be explained by the monetary policy of the European Central Bank / Deutsche Bundesbank. If the central bank follows its Taylor-rule consistently so that expectations of market participants are rational the latter will be able to interpret key interest rate movements correctly. Higher interest rates would therefore mean that generally all sub-indices' returns decrease contemporaneously and correlations increase. Following Dinenis (1998) correlations between financial and industrial sectors shouldn't increase as much as correlation in-between industrial sectors because financial firms react more sensitive to key interest rate changes.
The sub-index Automotive can come up with useful results only in sub-sample one: "Index of production" is significant in 75% of the regressions, "lending to enterprises" in 87,5% and "unemployed" in 62,5% of all regressions. The whole sample regressions perform very poor. For the second sub-sample the results of the first sub-sample cannot be transferred. It is again the variable "unemployed" which is the most consistent one when explaining correlations which contain the Bank index. During 1991 and 1999 this coefficient is always significant and for the whole sample as well as for the second sub-sample three of four regressions are explained in aid of the number of unemployed people. A further variable that interestingly is significant in many cases is "business expectations". Surprisingly, its influence is not constant. Its coefficient provides an indication of time variability: in sub-sample one it is positive whereas in sub-sample two it becomes negative. As the negative coherency between correlation and economic states is not given in the cross-sectional correlation model, an attempt to interpret changing influence of the variable "business expectation" would only be speculative. But even other variables like "order income", "inflation" and "index of production" help significantly to explain correlation movements in sub-sample one. As the correlations that contain the bank sub-index are negatively influenced by "inflation",

this can only mean that a decreasing inflation rate makes the bank index move more similar to all other sub-indices. In sub-sample two these variables completely lose their explanatory power where only “unemployed” and “business expectations” are significant in 75% and 62,5% of all regressions, respectively. The chemical index obtains macroeconomic explanations especially in sub-sample one where again “lending to enterprises” in 75% and “unemployed” in 62,5% of all regressions are most significant. As seen for the previous indices, the latter regressors are still the most significant ones but on a less frequent level. The sub-index consum has some special characteristics: the regressor “unemployed” is significant in 100% of the regressions during 1991 and 1999 and never significant during 2000 and 2009. Regressions within the whole sample lead to convincing results for “lending to enterprises” which can be found again for regressions in sub-sample one but not in sub-sample two. Furthermore, the variable “interest rate” has explanatory power within the large sample for every second regression. The index of pharmaceutical companies’ correlations follows the pattern of more convincing results for smaller samples. While there’s only the return of the pharmaceutical index helping to explain correlation movement in 50% of all regressions in the whole sample, both sub-samples receive better results. Again, “lending to enterprises” and “unemployed” serve as very well explaining variables. Furthermore, “balance of trade” and the “return of pharmaceutical index” even outperform the former variables in the second sub-sample as they are significant in 75% and 87,5%, respectively. Hereby, a trade surplus affects correlations including the pharma index negatively. The pharmaceutical sector is traditionally export orientated. This industry earned more than 60% of its total sales in foreign countries in the last twelve months. Due to this fact the industry is disproportionately highly affected by changes of the balance of trade.[2] The returns of the pharmaceutical index are positively interrelated to its generated correlations. Obviously, the sub-sector dominates its respective counterpart at correlation changes. For the retail index a similar pattern as before can be found: Most significance is received in sub-sample one. The large sample performs very poorly, the second sub-sample’s regressions are affected by “unemployed” in 62,5% of all tests. During 1991-1999 “Inflation” is significant in 87,5% of the regressions, “Lending to enterprises”, “business expectations” and “unemployed” have explanatory power in 75% of the tests and even “order income”

[2] The web site www.dbresearch.com delivers up to date data of the different industry sectors. Go to *sector research* and then click to *chartbooks*. Here different key figures can be compared.

help to explain changing correlations in 62,5% of all cases. But as most of the other observations, only "unemployed" is still significant in 62,5% of all cases in sub-sample two. The correlations containing the technology index deliver nearly the same results as correlations containing the retail index: "Inflation", "lending to enterprises", "Business expectations" and "unemployed" are significant in sub-sample one whereas the latter is explanatory in the whole sample as well. Furthermore, "balance of trade" can be included as a significant variable. This sector does not exactly follow the paradigm from before: "Lending to enterprises" is still significant and "unemployed" could even enlarge its importance as explanatory variable. Both, transport index correlations and utilities index correlations follow more or less the same paradigm: No convincing results for the whole sample and sub-sample two and very significant variables in sub-sample one: In both cases "lending to enterprises" and "unemployed" are significant in 100% of the regressions and "index of production" helps to explain the model in 62,5% and 75%, respectively.

In summary several results can be found. There is no macroeconomic variable that consistently helps to explain correlation movements by looking at the large sample. By dividing the latter in two sub-samples the model shows different outcomes: The variables "unemployed" and "lending to enterprises" are highly significant for sub-sample one and still significant for sub-sample two even if they lose explanatory power. As a consequence these variables are very often significant when investigating the results for each sub-index. Furthermore, the economic variable "business expectations" has good explanatory power for the correlations that include the sub-indices bank, technology and transport. Moreover, the correlations generated in aid of the pharmaceutical index are positively influenced by the latter.

5.3. Diagnostic tests

Several tests were conducted as mentioned in chapter five. Appendix 7 shows all results of the diagnostic tests for both models.

Testing for non-stationarity was done with the Augmented-Dickey-Fuller-test. The null-hypothesis of non-stationarity was always rejected. Therefore differenced data implying a great loss of information didn't have to be used. As it is of vital interest to assure that the time-series are stationary to exclude the possibility of spurious regression, another test for unit root was adopted as the ADF-test is of poor power. The second test is called KPSS-test (Kwiatkowski-Phillips-Schmidt-Shin test) and has the null hypothesis stationarity (Kwiatkowski et al. 1992). The results of this test are not found in the appendix as they only strengthened the results received by the ADF-test.

As mentioned in chapter 5.2., the problem of heteroskedasticity could be diminished by excluding the explanatory variable "money supply". But the problem could not be factored out completely as the results in appendix 7 show. By looking at the outcomes there are two interesting patterns: Firstly, the probability of heteroskedasticity increases with the sample length. In both models the sub-samples have fewer heteroskedastic cases than the original samples. Table thirteen shows the frequency of heteroskedastic appearances for both models and all samples.

	1991-2009	*1991-1999*	*2000-2009*
Cross-sectional correlation model	47,22	36,11	8,33
Time-series correlation model	13,89	8,33	8,33

Table 13: Heteroskedastic appearances in percent

Secondly, heteroskedasticity appears more often in the cross-sectional model than in the time series model. In both models the frameworks were equal and the regressors the same. The difference between the sub-samples and the whole sample within the time-series correlation model are rather negligible at least for the time-series model. The correlation series that are received by the cross-sectional model obviously was the decisive factor to a more frequent violation of homoskedasticity especially for a large sample. As mentioned in chapter five, Heteroskedasticity was handled by using White standard errors or Newey-West standard errors. The latter were used when both heteroskedasticity and autocorrelation occurred.

Autocorrelation posed a more serious problem in both models which can be seen in table fourteen.

	1991-2009	*1991-1999*	*2000-2009*
Cross-sectional correlation model	97,22	66,67	80,56
Time-series correlation model	69,44	5,56	25,00

Table 14: Appearances of autocorrelation in percent

Again, the larger samples as well as the regressions of the cross-sectional model are more susceptible than small samples and the time-series model. As mentioned in chapter 3.4.1., autocorrelation mostly is a sign for having left out explanatory variables. However, the regressors in both models were the same and it is obviously the input for the explained variable that leads to undesirable characteristics. Comparing results of the

RESET-test and its necessity to adjust the models leads to the same conclusion: Misspecification that can be due to left out variables was discovered more often in the cross-sectional model than in the time series model.

The test for normality provided bad results as expected. It can be seen in table fifteen. Theoretically non-normality doesn't affect the estimated coefficients. Nevertheless, the standard errors, the t-stat and the p-value are biased. Testing for significance of the different parameters can lead to wrong results.

	1991-2009	*1991-1999*	*2000-2009*
Cross-sectional correlation model	94,44	33,33	50,00
Time-series correlation model	94,44	61,11	41,66

Table 15: Appearances of non-normality in percent

Fortunately, this problem can be ignored due to the central limit theorem.

In summary, the diagnostic tests show that both models suffer certain drawbacks whereupon the cross-sectional correlation model performs poorer than the classic time series approach.

5.4. Comparison of both models

In chapter 5.3 the results of the diagnostic tests were already mentioned: Tests for heteroskedasticity, autocorrelation and non-normality clearly showed the supremacy of the time-series correlation model even though all results were affected by the sample length. Even though the goodness-of-fit measure R squared is very popular it has certain drawbacks. Therefore both models will be compared with the measure called "Bayes-Schwarz-Information-Criterion" (BIC) which is defined as following:

$$BIC = \log \frac{1}{N} * \sum_{i=1}^{N} e_i^2 + \frac{K}{N} * \log N \qquad (13)$$

In this contest N stands for the sample size, K for the number of parameters and $\Sigma\, e_i^2$ for the sum of the residuals. The R squared has the property to increase if a further regressor is included – even though it does not have any explanatory power. BIC penalises this more severely. A drawback is that the value which BIC displays can hardly be interpreted. The smaller it is, the better the model. Unfortunately, there doesn't exist a benchmark like at R squared (between zero and one). But if models should be compared it is a very helpful measure. One assumption is that the models are similar. As the estimation method and all regressors are exactly equal this doesn't cause any problems. After having tested the regressions of all sample sizes of both models a clear conclusion can be drawn. In 96% of 108 regression comparisons the time-series correlation model outperforms the cross-sectional correlation model.

The diagnostic weaknesses of the cross-sectional model have already been mentioned. It was ascribed to the input for the regressand since the estimation method and the explanatory variables did not change. So one should have a closer look at the deviation of the cross-sectional correlations. Solnik (2000) praises many advantages of his model, that is amongst others the immediate reaction of correlation which makes time-variation analysis more meaningful. He sees the time-series weakness in the rolling window of observations with overlapping data leading to the necessity of a long sample to recognize any changes in correlations. Thus, historical data is not needed. The problem can be circumvented if – when working with daily data and a large sample – one correlation coefficient is calculated for each month. Thence, the data would not overlap. Another advantage that is mentioned by Solnik (2000) is that the cross-sectional model relates each sub-index to a benchmark which leads to a different interpretation of returns: In the cross-sectional model returns are seen as relative since they are compared to a benchmark whereas the returns in the time-series correlation model are seen in absolute values. The former approach

> *"is more appropriate for the current asset management paradigm, where performance is measured relative to a benchmark rather than in absolute terms."* (Solnik, 2000, p. 10)

Even though this might be the case two certain drawbacks should be announced: Firstly, including too little indices would lead to biased and non-convincing results. The bigger drawback is that due to the mathematical deviation a sub-index cannot move diametrically to the benchmark that was generated by all sub-indices. However, the biggest problem is that negative correlations between two sub-indices are even impossible by using equation (6). This is probably the main reason why the cross-sectional correlation model has poorer diagnostic results.

The regressions' results partly differ, too. Firstly, in the time-series correlation model the most convincing results were gained when working with the large sample whereas the division of the sample brought better results in the cross-sectional model. The qualitative outcomes of both models do not diverge fundamentally. By looking at the whole sample no model has a very significant variable which helps to explain correlation movements. Nevertheless, the time-series correlation model has two explanatory variables being significant in more than half of the regressions: “Lending to enterprises” and “index of production”. The former doesn’t appear in any of the cross-sectional regressions as significant when working in the whole sample. But generally, a tendency can clearly be seen: the regressors “unemployed” and “lending to enterprises” help best to explain correlation movements within both models. Even though their significance can be seen best in the whole sample for the time-series model and in the split sample for the cross-sectional model, having a closer look at the sub-indices leads to further common but also divergent results. A breakdown to sample lengths will be left undone now.

Correlations containing the automotive index do not have equal strong explanatory regressors. Bank-index correlations as well as technology-index correlations have the variables “index of production”, “lending to enterprises” and “unemployed” as significant variables in common. “Business expectations” only gives explanatory help in the cross-sectional model. The chemical-index as well as the consum-index rely again on “lending to enterprises” and “unemployed” in both models whereupon the “index of production” is only significant in the time-series based model. The pharmaceutical-index has divergent results. “Inflation” is the only significant variable in the one model whereas “lending to enterprises”, “return of the pharmaceutical index”, “unemployed” and “balance of trade” are the ones in the other model. Divergent results can also be observed when comparing correlations generated with the retail index. For the transport-index common variables can be found again: “index of production” and “lending to enterprises”. The number of “unemployed” people helps to explain cross-sectional correlations whereas “balance of trade” and the “return of the transport index” are helpful to explain the time-series correlations. Generally, one can see that both models deliver many equal results but also have their divergences. Having a closer look at the outcomes lets the observer conclude that predicting correlation movements would be difficult and speculative.

6. Conclusion

“Diversification vanishes when mostly needed.” This statement which is brought up as criticism on Markowitz’ theory of diversification very often finds its corroboration in results of financial and economic research. Different advanced models are proposed to avoid this effect and constructively support decision rules for asset managers. The models used in this essay – a time-series correlation model and a cross-sectional correlation model – partly support the phenomenon of increasing correlation in economic downturns. The time-series correlation model could back this result whereas the cross-sectional model did not find any relationship between the economic state and correlation between different indices. This is partly due to the fact of how the correlation time series are derived in this model. Nevertheless, it is not desirable that two similar models do not find the same results as its interpretation might lead to different consequences for investment decisions. Working with the cross-sectional model lets decision makers conclude not to change a portfolio's composition. The time-series correlation models' results, however, support to reconsider the arrangement of investments or at least decide to invest in aid of a regime-switching model strategy. For both models monthly data from January 1991 until December 2009 were used. Nonetheless, the results of the regressions are very similar. On the one hand one cannot see that one macroeconomic variable consistently helps to make predictions of how correlations are going to develop over time in the future. For this, the same regressors need to be significant more often. This is a result of the regressions after having divided the sample into two sub-samples. Firstly, the results of the OLS regression within the whole sample were not satisfactory. Secondly, significant variables of sub-sample one lost explanatory power in sub-sample two. Looking at the results without making a claim for predictions of correlation movements delivers some productive observations.

Firstly, the econometric quality of both models differs when comparing them with each other and is dependent of the sample length. The time-series correlation model outperforms the cross-sectional correlation model in nearly all diagnostic tests and when comparing those with a goodness-of-fit measure. That said, it has to be emphasized that both models come to similar conclusions. Two macroeconomic variables, namely the amount of credits given to enterprises and the number of unemployed people help to explain stock index co-movements in general. The amount of regressions with these variables being significant is dependent of the sample length. Further variables with explanatory power can be found when observing the results of the sub-indices and the appendant correlation time series solely.

Solnik (2000) wrote in this work's underlying essay that results of the different models might differ slightly. This predication could be backed in this essay. The further statement that his model would not receive the same results as the time-series correlation model when observing correlation over time could be badged in this essayas well. Solnik's acknowledged strengths of his model might be reflected by the fact that the significances appear more often in the cross-sectional model. However, the drawback which it certainly suffers is its econometric performance.

It would be a further question of interest how the models' results could be exploited for a portfolio optimisation procedure. Generating a portfolio with different country indices and optimising this based on these two different models would be an interesting comparison. If the correlations derived in aid of the cross-sectional correlation model lead to new loadings and a better performance than a portfolio whose loadings are ascribed to the time-series correlation model, it is at least the asset manager who will overlook the econometric weaknesses of it.

7. References

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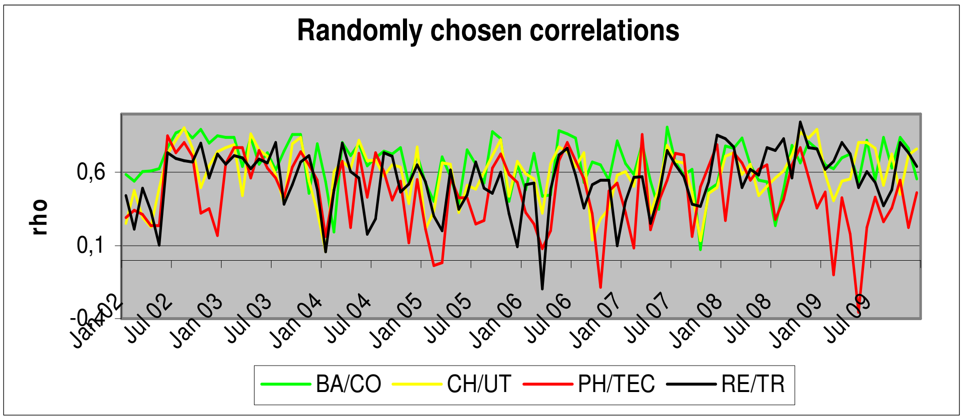
8. Appendix

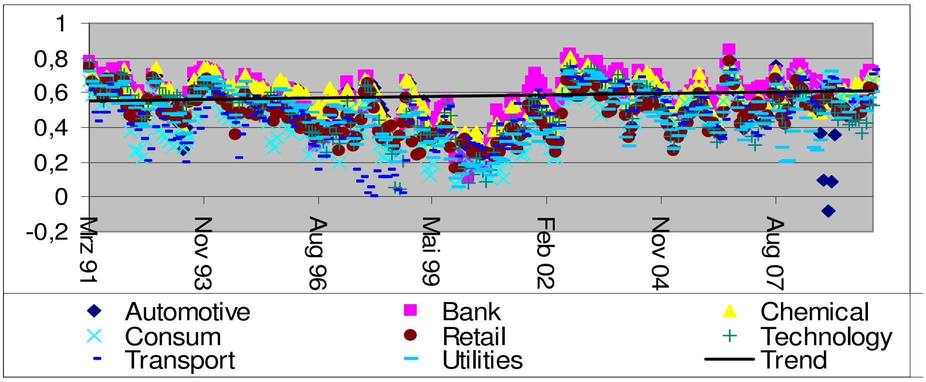
Appendix 1: Correlation coefficients between regressors

	IR	IN	UN	MS	OI	BE	BT	LE	IP
Interest rate (IR)	1,00								
Inflation (IN)	0,51	1,00							
Unemployed (UN)	-0,60	-0,02	1,00						
Money supply (MS)	-0,75	-0,33	0,53	1,00					
Order income (OI)	-0,35	-0,09	0,30	0,74	1,00				
Business expectations (BE)	-0,03	0,09	0,23	-0,06	0,24	1,00			
Balance of trade (BT)	-0,34	-0,09	0,44	0,45	0,28	-0,02	1,00		
Lending to enterprises (LE)	-0,70	-0,29	0,58	0,97	0,75	-0,03	0,45	1,00	
Index of production (IP)	-0,20	-0,07	0,05	0,57	0,88	0,14	0,20	0,57	1,00

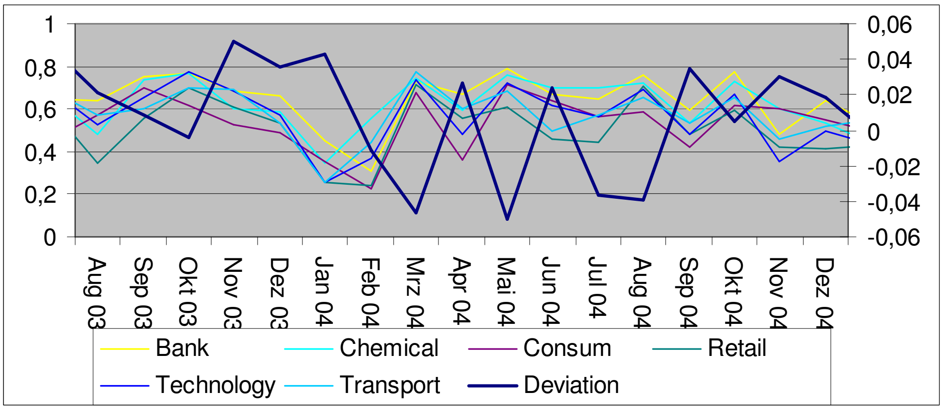
Appendix 2: Time series correlation model: Randomly chosen correlations



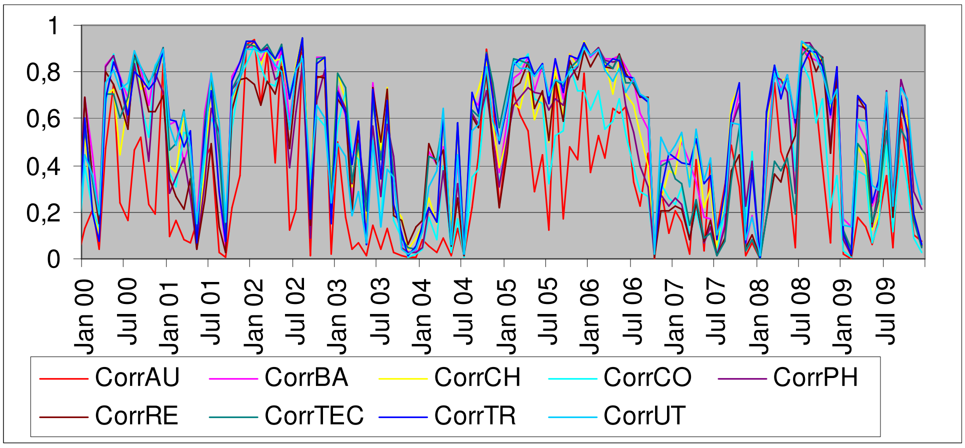
Appendix 3: Correlation trend



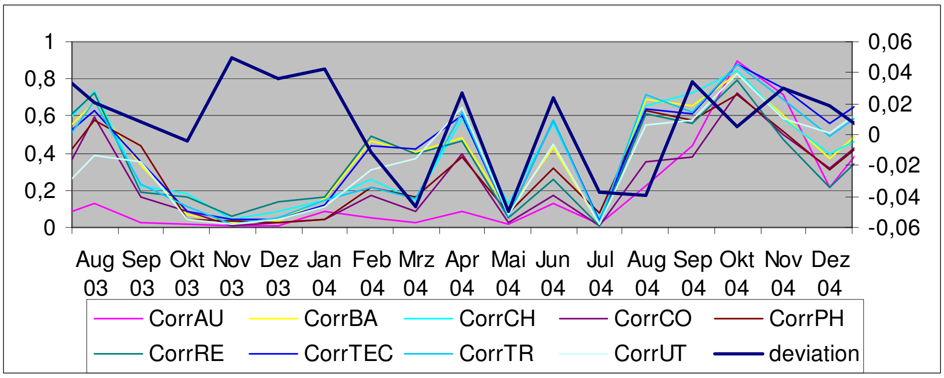
Appendix 4: Time-series correlation model: Deviation time series (right) and correlation time series (left): negative coherence, 08/03 – 12/04



Appendix 5: Cross sectional correlation model: Correlation over time



Appendix 6: Cross-sectional correlation model: Deviation time series (right) and correlation time series (left): negative coherence, 08/03 – 12/04



Appendix 7: Diagnostic tests

Diagnostic tests of the regressions within the time-series correlation model			
In how many cases was the null hypothesis not rejected? In percent			
Correlations containing the automotive index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	75	75	100
Breusch-Godfrey	37,5	100	50
Jarque-Bera	0	12,5	12,5
Ramsey RESET	87,5	100	87,5
Correlations containing the bank index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	75	75	75
Breusch-Godfrey	0	100	75
Jarque-Bera	0	25	12,5

Ramsey RESET	100	100	100
Correlations containing the chemical index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	87,5	100	87,5
Breusch-Godfrey	37,5	100	75
Jarque-Bera	0	0	62,5
Ramsey RESET	100	100	87,5
Correlations containing the consum index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	100	100	100
Breusch-Godfrey	50	75	75
Jarque-Bera	12,5	62,5	100
Ramsey RESET	100	100	100
Correlations containing the pharma index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	100	75	87,5
Breusch-Godfrey	62,5	62,5	87,5
Jarque-Bera	25	62,5	87,5
Ramsey RESET	75	100	100
Correlations containing the retail index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	87,5	75	100
Breusch-Godfrey	62,5	87,5	62,5
Jarque-Bera	12,5	62,5	75
Ramsey RESET	87,5	100	100
Correlations containing the technology index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	75	87,5	87,5
Breusch-Godfrey	0	87,5	50
Jarque-Bera	0	62,5	25
Ramsey RESET	100	100	100
Correlations containing the transport index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	100	100	87,5
Breusch-Godfrey	0	100	75
Jarque-Bera	0	12,5	37,5
Ramsey RESET	75	100	100
Correlations containing the utilities index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	62,5	87,5	100
Breusch-Godfrey	12,5	100	62,5
Jarque-Bera	0	50	75
Ramsey RESET	100	100	100

Diagnostic tests of the regressions within the cross-sectional correlation model			
In how many cases was the null hypothesis not rejected? In percent			
Correlations containing the automotive index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	100	100	100
Breusch-Godfrey	0	100	50
Jarque-Bera	0	0	0
Ramsey RESET	87,5	100	87,5
Correlations containing the bank index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	50	75	87,5
Breusch-Godfrey	0	25	0
Jarque-Bera	0	37,5	37,5
Ramsey RESET	100	100	100
Correlations containing the chemical index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	50	25	75
Breusch-Godfrey	0	37,5	12,5
Jarque-Bera	0	75	37,5
Ramsey RESET	100	100	87,5
Correlations containing the consum index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	25	75	87,5
Breusch-Godfrey	0	12,5	12,5
Jarque-Bera	0	87,5	87,5
Ramsey RESET	100	100	100
Correlations containing the pharma index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	75	25	100
Breusch-Godfrey	0	12,5	37,5
Jarque-Bera	0	75	62,5
Ramsey RESET	75	100	100
Correlations containing the retail index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	25	37,5	100
Breusch-Godfrey	0	25	0
Jarque-Bera	0	87,5	87,5
Ramsey RESET	87,5	100	100
Correlations containing the technology index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	25	87,5	100
Breusch-Godfrey	0	25	0

Jarque-Bera	0	100	37,5
Ramsey RESET	100	100	100
Correlations containing the transport index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	62,5	62,5	100
Breusch-Godfrey	0	12,5	25
Jarque-Bera	0	75	25
Ramsey RESET	75	100	100
Correlations containing the utilities index			
Sample	1991-2009	1991-1999	2000-2009
Augmented-Dickey-Fuller	0	0	0
Breusch-Pagan	62,5	87,5	100
Breusch-Godfrey	0	50	12,5
Jarque-Bera	0	87,5	25
Ramsey RESET	100	100	100

Appendix 8: Coefficients, standard errors and t-statistics of both models

Time series correlation				
Significant explanatory variables for sample 1991 - 2009				
Correlation	Significant variables	Coefficient	standard error	t-statistic
Automotive/Bank	Return Auto Index	2,039077	0,988193	2,063440
	Return Bank Index	-4,350011	1,816088	-2,395264
	Index of production	1,451154	0,546581	2,654967
	Lending to enterprises	-0,884568	0,333102	-2,655546
Automotive/Chemical	Index of production	1,473854	0,566690	2,600809
	Lending to enterprises	-0,764005	0,272465	-2,804052
Automotive/Consum	Return Consum Index	-7,325885	3,699564	-1,980202
Automotive/Pharma	Return Pharma Index	-4,892922	2,373155	-2,061780
Automotive/Retail	Index of production	-4,892922	2,373155	-2,061780
	Interest rate	0,218109	0,088315	2,469680
	lending to enterprises	-0,665993	0,303837	-2,191945
Automotive/Technology	Return Technology Index	-3,647640	1,327857	-2,747013
	Lending to enterprises	-1,096198	0,373330	-2,936269
Automotive/Transport	Return Transport Index	-3,668531	1,611929	-2,275864
	Lending to enterprises	-1,025531	0,398754	-2,571837
Automotive/Utilities	Lending to enterprises	-1,059951	0,339429	-3,122748
	Unemployed	0,917122	0,349284	2,625720
Bank/Chemical	Return Chemical Index	-4,841212	2,405035	-2,012948
	Order Income	-0,429263	0,205073	-2,093220
Bank/Consum	Index of production	1,623207	0,644432	2,518817
	Lending to enterprises	-1,040332	0,386357	-2,692668
Bank/Pharma	Return Bank Index	-6,849941	3,055575	-2,241784
	Inflation	-0,025861	0,012225	-2,115375
Bank/Retail	Return Bank Index	-5,668421	2,239509	-2,531100
Bank/Technology	Index of production	2,134944	0,488280	4,372374
	Inflation	-0,033207	0,012608	-2,633837
	Order Income	-1,138001	0,454180	-2,505620
Bank/Transport	Return Bank Index	-7,658296	2,691739	-2,845110

	Index of production	1,582747	0,602134	2,628563
	Lending to enterprises	-1,504780	0,432002	-3,483266
Bank/Utilities	Index of production	2,038093	0,862980	2,361691
	Inflation	-0,038371	0,010524	-3,646052
	Lending to enterprises	-1,587404	0,641037	-2,476306
Chemical/Consum	Return Chemical Index	-6,841115	2,884903	-2,371350
	Inflation	-0,051751	0,018177	-2,847010
Chemical/Pharma	Inflation	-0,043002	0,015375	-2,796781
	Interest rate	0,303030	0,097306	3,114184
Chemical/Retail	Index of production	1,880881	0,607442	3,096397
	Lending to enterprises	-0,676732	0,332621	-2,034544
Chemical/Technology	Index of production	2,035580	0,707589	2,876784
	Lending to enterprises	-1,654615	0,433591	-3,816072
	Unemployed	0,877434	0,393257	2,231200
Chemical/Transport	Index of production	1,511811	0,738649	2,046725
	Inflation	-0,033435	0,007981	-4,189413
	Lending to enterprises	-1,647449	0,500562	-3,291195
	Unemployed	1,225640	0,477665	2,565897
Consum/Pharma	Index of production	1,815218	0,754522	2,405787
	Inflation	-0,045710	0,018465	-2,475423
Consum/Retail	Return Retail Index	-5,566350	2,357261	-2,361363
	Index of production	2,157149	0,743216	2,902452
	Inflation	-0,045778	0,018428	-2,484177
	Order Income	-1,505748	0,548678	-2,744321
Consum/Technology	Index of production	1,623476	0,653724	2,483428
Consum/Transport	Index of production	1,857374	0,652800	2,845244
	Inflation	-0,040299	0,010407	-3,872442
	Lending to enterprises	-1,494425	0,667021	-2,240448
Consum/Utilities	Index of production	1,769320	0,710769	2,489303
Pharma/Retail	Order Income	-2,199503	1,051460	-2,091856
Pharma/Technology	Balance of trade	0,018316	0,006361	2,879208
	Index of production	1,275648	0,640431	1,991858
	Interest rate	0,212931	0,102683	2,073678
	Lending to enterprises	-1,012087	0,355717	-2,845203
	Unemployed	0,632924	0,316964	1,996833
Pharma/Transport	Index of production	2,111724	0,687843	3,070067
	Inflation	-0,040820	0,011473	-3,557971
	Lending to enterprises	-1,185530	0,554767	-2,136988
Pharma/Utilities	Return Pharma Index	-7,774962	2,880817	-2,698874
	Inflation	-0,036543	0,015847	-2,306017
	Interest rate	0,229083	0,104137	2,199822
Retail/Technology	Balance of trade	0,027906	0,013372	2,086869
	Index of production	2,315077	0,612700	3,778481
	Lending to enterprises	-1,128272	0,446316	-2,527967
Retail/Transport	Lending to enterprises	-1,414404	0,406355	-3,480705
	Unemployed	1,143729	0,389394	2,937201
Retail/Utilities	Index of production	1,825832	0,525536	3,474229
	Order Income	-1,781924	0,401959	-4,433099
Technology/Transport	Return Technology Index	-4,509364	1,949102	-2,313560
	Inflation	-0,028763	0,009542	-3,014323
	Lending to enterprises	-1,651483	0,490243	-3,368701
	Order Income	1,267208	0,478138	2,650298

	Unemployed	1,131202	0,500915	2,258269
Technology/Utilities	Return Technology Index	1,495463	6,844099	2,185040
	Return Utilities Index	-9,536235	3,732771	-2,554734
	Index of production	1,640209	0,671528	2,442504
	Lending to enterprises	-1,496601	0,409017	-3,659021
	Unemployed	0,888025	0,444547	1,997595
Transport/Utilities	Index of production	2,263240	0,740771	3,055251
	Lending to enterprises	-1,487728	0,373817	-3,979830
	Unemployed	1,094449	0,385538	2,838759

Time series correlation

Significant explanatory variables for sample 1991 - 1999

Correlation	Significant variables	Coefficient	standard error	t-statistic
Automotive/Bank	Index of Production	2,772750	1,246763	2,223958
	Lending to enterprises	-3,536611	1,286716	-2,748556
	Order income	-2,033407	0,889972	-2,284798
	Unemployed	2,851573	1,019394	2,797322
Automotive/Chemical				
Automotive/Consum				
Automotive/Pharma				
Automotive/Retail	Index of Production	2,296545	0,877986	2,615695
	Lending to enterprises	-1,963657	0,781400	-2,512997
	Order income	-2,066981	0,743954	-2,778374
	Unemployed	1,790921	0,614294	2,915415
Automotive/Technology				
Automotive/Transport				
Automotive/Utilities	Return Utilities Index	-6,907369	2,699208	-2,559035
	Business Expectations	-1,809766	0,842039	-2,149267
Bank/Chemical	Lending to enterprises	-1,052360	0,438072	-2,402252
	Unemployed	0,853960	0,350862	2,433894
Bank/Consum	Lending to enterprises	-2,458324	0,880307	-2,792576
	Unemployed	1,828039	0,694457	2,632327
Bank/Pharma				
Bank/Retail	Return Retail Index	9,259556	4,634571	1,997932
Bank/Technology	Index of Production	2,236411	0,891530	2,508510
	Lending to enterprises	-2,003430	0,788240	-2,541651
	Order income	-1,877639	0,748973	-2,506950
	Unemployed	1,882853	0,619159	3,040985
Bank/Transport	Index of Production	2,178953	0,796549	2,735492
	Lending to enterprises	-3,216119	0,723671	-4,444175
	Unemployed	2,581847	0,564105	4,576890
Bank/Utilities	Unemployed	2,058476	0,909637	2,262964
Chemical/Consum				
Chemical/Pharma				
Chemical/Retail				
Chemical/Technology	Return Chemical Index	1,219092	6,103701	1,997299
	Lending to enterprises	-1,666423	0,666694	-2,499532
	Unemployed	1,385212	0,522402	2,651620
Chemical/Transport				
Consum/Pharma				

Consum/Retail				
Consum/Technology				
Consum/Transport	Lending to enterprises	-2,403921	1,208090	-1,989852
Consum/Utilities				
Pharma/Retail				
Pharma/Technology	Interest rate	0,582265	0,200247	2,907735
	Lending to enterprises	-1,874334	0,864127	-2,169049
	Unemployed	1,428949	0,678580	2,105792
Pharma/Transport	Interest rate	0,585593	0,264709	2,212213
Pharma/Utilities				
Retail/Technology	Lending to enterprises	-2,110818	0,797368	-2,647232
	Order income	-2,782710	0,757313	-3,674452
	Unemployed	2,376154	0,624489	3,804956
Retail/Transport				
Retail/Utilities				
Technology/Transport	Unemployed	1,801639	0,859350	2,096513
Technology/Utilities	Index of Production	1,809556	0,834467	2,168518
	Lending to enterprises	-2,607624	0,773969	-3,369160
	Order income	-2,010339	0,717482	-2,801937
	Unemployed	2,365166	0,581395	4,068086
Transport/Utilities				

Time series correlation

Significant explanatory variables for sample 2000 - 2009

Correlation	Significant variables	Coefficient	standard error	t-statistic
Automotive/Bank	Return Bank Index	-8,969198	3,649458	-2,457679
Automotive/Chemical				
Automotive/Consum	Return Consum Index	-1,844195	5,229891	-3,526259
	Interest rate	-0,507422	0,180080	-2,817762
	Lending to enterprises	2,0356350	0,715566	2,844789
	Order income	2,262084	1,019932	2,217877
	Unemployed	-1,922492	0,583720	-3,293516
Automotive/Pharma				
Automotive/Retail				
Automotive/Technology				
Automotive/Transport	Interest rate	-0,469745	0,211789	-2,217992
Automotive/Utilities	Balance of trade	-0,649083	0,184331	-3,521289
Bank/Chemical	Return Chemical Index	-17,226180	6,216100	-2,771219
	Business expectations	1,589398	0,769867	2,064508
Bank/Consum	Return Bank Index	-10,119860	4,640887	-2,180589
	Lending to enterprises	1,960776	0,803370	2,440688
	Unemployed	-1,691951	0,661711	-2,556933
Bank/Pharma	Return Bank Index	-9,658440	3,848367	-2,509750
	Business expectations	-2,149767	0,988596	-2,174565
	Lending to enterprises	0,983534	0,442544	2,222453
	Unemployed	-0,930414	0,411256	-2,262372
Bank/Retail	Unemployed	-1,113886	0,518325	-2,149010
Bank/Technology	Return Technology Index	-15,165110	6,469589	-2,344061
	Balance of trade	0,520366	0,239737	2,170571
	Lending to enterprises	1,210871	0,525916	2,302404

	Unemployed	-1,268991	0,459904	-2,759249
Bank/Transport	Return Transport Index	-16,719270	5,656868	-2,955570
	Unemployed	-1,428327	0,569654	-2,507359
Bank/Utilities	Interest rate	-0,719177	0,266756	-2,696008
Chemical/Consum	Unemployed	-1,884711	0,645307	-2,920642
Chemical/Pharma	Inflation	-0,041888	0,017445	-2,401236
Chemical/Retail	Return Chemical Index	-12,334920	5,799884	-2,126754
Chemical/Technology				
Chemical/Transport	Return Chemical Index	1,749517	6,028433	2,902109
	Return Transport Index	-11,459380	3,989461	-2,872414
	Balance of trade	0,623553	0,219559	2,840024
	Business expectations	-2,306878	0,983111	-2,346509
	Inflation	-0,039741	0,017976	-2,210784
	Interest rate	-0,408553	0,190953	-2,139548
Chemical/Utilities	Return Chemical Index	-13,513970	6,088108	-2,219733
Consum/Pharma	Return Consum Index	-16,620530	7,061085	-2,353822
	Interest rate	-0,439236	0,217367	-2,020711
	Lending to enterprises	2,257190	0,818055	2,759214
	Unemployed	-2,136176	0,685421	-3,116590
Consum/Retail				
Consum/Technology	Return Consum Index	-26,508380	6,665428	-3,976996
	Interest rate	-0,783878	0,287040	-2,730899
	Lending to enterprises	2,716347	0,749677	3,623357
	Unemployed	-2,522597	0,608969	-4,142405
Consum/Transport	Return Transport Index	-8,488975	3,822873	-2,220575
	Balance of trade	0,683719	0,246641	2,772120
	Business expectations	-2,421148	1,048569	-2,309002
Consum/Utilities	Return Consum Index	-22,728830	6,769605	-3,357482
	Balance of trade	-0,473959	0,212033	-2,235304
	Interest rate	-0,600618	0,208620	-2,878999
	Lending to enterprises	2,917527	0,753562	3,871650
	Order income	2,189847	1,084352	2,019499
	Unemployed	-2,621475	0,613260	-4,274655
Pharma/Retail	Return Pharma Index	-15,075160	5,325354	-2,830828
	Index of production	2,439195	1,164226	2,095121
	Order income	-2,314790	1,156441	-2,001649
Pharma/Technology				
Pharma/Transport	Return Transport Index	-8,606081	3,764532	-2,286096
	Balance of trade	0,581732	0,242526	2,398635
Pharma/Utilities	Return Pharma Index	-15,479340	5,755226	-2,689614
Retail/Technology	Unemployed	-1,223973	0,543410	-2,252392
Retail/Transport	Return Retail Index	8,688757	4,303865	2,018827
	Return Transport Index	-13,266270	5,098835	-2,601825
	Balance of trade	0,566981	0,273889	2,070110
Retail/Utilities				,
Technology/Transport	Return Transport Index	-11,610600	3,323784	-3,493186
	Balance of trade	0,621936	0,233050	2,668677
Technology/Utilities	Return Technology Index	-2,217403	5,568455	-3,982080
	Return Utilities Index	2,462905	1,132244	2,175241
Transport/Utilities	Return Transport Index	-9,063065	4,026674	-2,250757
	Return Utilities Index	21,852260	9,606107	2,274830

Cross sectional correlation				
Significant explanatory variables for sample 1991 - 2009				
Correlation	Significant variables	Coefficient	standard error	t-statistic
Automotive/Bank				
Automotive/Chemical				
Automotive/Consum				
Automotive/Pharma				
Automotive/Retail				
Automotive/Technology	Unemployed	0,922540	0,429607	2,147402
Automotive/Transport				
Automotive/Utilities	Interest rate	0,283406	0,125207	2,263503
Bank/Chemical	Unemployed	0,878397	0,445077	1,973584
Bank/Consum	Interest rate	0,305963	0,135177	2,263419
Bank/Pharma	Return Bank Index	-8,540114	3,451018	-2,474665
	Return Pharma Index	1,319241	4,401324	2,997373
	Unemployed	1,119356	0,441646	2,534508
Bank/Retail	Unemployed	0,983559	0,470434	2,090748
Bank/Technology	Unemployed	1,594199	0,611013	2,609109
Bank/Transport	Business expectations	-2,272895	0,932489	-2,437449
	Interest rate	0,309145	0,140669	2,197677
	Lending to enterprises	-1,031043	0,449429	-2,294118
	Unemployed	1,478680	0,463094	3,193042
Bank/Utilities	Return Bank Index	-13,215380	3,778158	-3,497837
	Return Utilities Index	15,037860	5,606801	2,682076
	Business expectations	-2,562114	0,797722	-3,211790
	Interest rate	0,488447	0,133341	3,663138
	Unemployed	1,055409	0,393669	2,680959
Chemical/Consum	Interest rate	0,241976	0,119080	2,032050
Chemical/Pharma	Return Chemical Index	-8,864474	3,744196	-2,367524
	Return Pharma Index	12,941680	3,830370	3,378702
Chemical/Retail				
Chemical/Technology	Return Chemical Index	-18,235940	7,288496	-2,502017
	Return Technology Index	10,799700	4,592153	2,351771
	Unemployed	0,928284	0,467721	1,984696
Chemical/Transport				
Chemical/Utilities	Interest rate	0,406189	0,173707	2,338351
Consum/Pharma	Return Consum Index	-23,137890	6,528867	-3,543937
	Return Pharma Index	19,788670	4,848340	4,081536
Consum/Retail	Return Consum Index	-13,140380	6,550277	-2,006080
Consum/Technology	Return Consum Index	-17,903420	7,890664	-2,268937
Consum/Transport	Interest rate	0,415694	0,185866	2,236527
Consum/Utilities	Inflation	-0,038975	0,012525	-3,111726
	Interest rate	0,514080	0,167203	3,074581
Pharma/Retail	Return Retail Index	-8,333388	3,289779	-2,533115
	Order income	-1,353518	0,605428	-2,235638
Pharma/Technology		11,414150	4,322244	2,640793
Pharma/Transport	Return Pharma Index	-5,317175	2,508634	-2,119550
	Return Transport Index	0,798535	0,373930	2,135518
	Unemployed	-0,042590	0,014327	-2,972719

Pharma/Utilities	Inflation	-0,042590	0,014327	-2,972719
Retail/Technology				
Retail/Transport				
Retail/Utilities	Business expectations	-1,527543	0,733606	-2,082239
	Inflation	-0,040569	0,014589	-2,780787
Technology/Transport	Unemployed	0,913884	0,436888	2,091803
Technology/Utilities	Unemployed	0,915693	0,430378	2,127648
Transport/Utilities	Business expectations	-2,530415	1,056622	-2,394817
	Inflation	-0,051206	0,012240	-4,183318
	Interest rate	0,444490	0,170889	2,601052
	Order income	1,511141	0,743627	2,032122
	Unemployed	1,138129	0,552704	2,059202

Cross sectional correlation

Significant explanatory variables for sample 1991 - 1999

Correlation	Significant variables	Coefficient	standard error	t-statistic
Automotive/Bank	Index of production	3,893532	1,512744	2,573821
	Lending to enterprises	-4,175167	1,331810	-3,134958
	Order income	-3,192465	1,274504	-2,504868
	Unemployed	3,445778	1,054417	3,267947
Automotive/Chemical	Index of production	2,964395	1,481309	2,001199
	Lending to enterprises	-3,463945	1,303144	-2,658144
	Unemployed	2,972526	1,030633	2,884173
Automotive/Consum	Index of production	3,866287	1,424793	2,713577
	Lending to enterprises	-4,255989	1,260393	-3,376715
	Order income	-3,513637	1,217130	-2,886822
	Unemployed	3,522096	0,994388	3,541974
Automotive/Pharma	Index of production	3,982412	1,515059	2,628553
	Lending to enterprises	-3,387409	1,355281	-2,499414
	Order income	-3,263467	1,275484	-2,558611
	Unemployed	2,896774	1,066181	2,716962
Automotive/Retail	Index of production	3,242318	1,291316	2,510863
	Inflation	-0,459547	0,179633	-2,558261
	Lending to enterprises	-3,601088	1,149260	-3,133397
	Order income	-2,960707	1,094185	-2,705856
	Unemployed	2,785354	0,903485	3,082901
Automotive/Technology				
Automotive/Transport	Index of production	3,356178	1,370949	2,448068
	Lending to enterprises	-4,057418	1,221304	-3,322201
	Order income	-2,691309	1,160096	-2,319903
	Unemployed	3,429596	0,967130	3,546158
Automotive/Utilities	Lending to enterprises	-3,119532	1,203897	-2,591195
	Unemployed	2,861898	0,945436	3,027066
Bank/Chemical	Return Chemical Index	-16,882910	7,767301	-2,173588
	Business Expectations	3,882833	1,494870	2,597439
	Inflation	-0,461685	0,223168	-2,068777
	Lending to enterprises	-3,675200	1,261785	-2,912699
	Unemployed	2,224998	1,010591	2,201679
Bank/Consum	Business Expectations	3,743600	1,448418	2,584612
	Index of production	4,489624	1,480438	3,032631

	Lending to enterprises	-6,258845	1,296583	-4,827183
	Order income	-4,237782	1,251828	-3,385276
	Unemployed	4,796813	1,022850	4,689654
Bank/Pharma	Inflation	-0,647243	0,239069	-2,707350
	Lending to enterprises	-4,001674	1,447189	-2,765137
	Order income	-3,369241	1,323601	-2,545510
	Unemployed	3,021554	1,097306	2,753612
Bank/Retail	Business Expectations	4,917410	1,430854	3,436696
	Index of production	3,028519	1,393653	2,173079
	Inflation	-0,995086	0,206967	-4,807953
	Lending to enterprises	-4,860765	1,264793	-3,843132
	Order income	-3,151493	1,186763	-2,655537
	Unemployed	3,213511	0,976348	3,291358
Bank/Technology	Balance of trade	0,041234	0,015702	2,626045
	Business Expectations	5,785966	2,025811	2,856124
	Inflation	-0,823020	0,289663	-2,841296
	Lending to enterprises	-5,249468	1,655746	-3,170456
	Unemployed	3,276344	1,320064	2,481959
Bank/Transport	Business Expectations	3,370051	1,417600	2,377294
	Index of production	3,794019	1,406809	2,696898
	Lending to enterprises	-6,899568	1,278096	-5,398316
	Order income	-2,432027	1,191139	-2,041766
	Unemployed	5,215928	0,996283	5,235389
Bank/Utilities	Inflation	-0,546354	0,199750	-2,735195
	Lending to enterprises	-3,270784	1,219896	-2,681199
	Unemployed	2,711446	0,927553	2,923224
Chemical/Consum	Lending to enterprises	-4,962677	1,762720	-2,815352
	Unemployed	3,657765	1,435613	2,547877
Chemical/Pharma				
Chemical/Retail	Business Expectations	4,457551	1,971345	2,261173
	Inflation	-0,624330	0,218692	-2,854837
Chemical/Technology	Business Expectations	4,424874	1,564195	2,828851
	Inflation	-0,442984	0,220670	-2,007452
	Lending to enterprises	-3,179066	1,392003	-2,283806
Chemical/Transport	Lending to enterprises	-5,432914	1,388428	-3,912997
	Unemployed	3,878774	1,132573	3,424745
Chemical/Utilities	Lending to enterprises	-2,382510	1,096616	-2,172601
	Unemployed	1,842558	0,920699	2,001258
Consum/Pharma	Unemployed	2,002009	0,982894	2,036851
Consum/Retail	Return Retail Index	-18,177950	8,012027	-2,268833
	Business Expectations	5,560730	2,106340	2,639997
	Index of production	4,423497	1,660899	2,663315
	Lending to enterprises	-6,325599	1,610748	-3,927119
	Order income	-4,061393	1,477972	-2,747949
	Unemployed	4,247726	1,303505	3,258696
Consum/Technology	Balance of trade	0,031720	0,010335	3,069012
	Unemployed	1,859797	0,911834	2,039622
Consum/Transport	Lending to enterprises	-3,917861	1,424394	-2,750547
	Unemployed	3,152784	1,003603	3,141466
Consum/Utilities	Lending to enterprises	-4,223741	1,426476	-2,960963
	Unemployed	3,636953	1,247687	2,914957
Pharma/Retail	Business Expectations	4,080433	1,598436	2,552765

	Inflation	-0,797857	0,261419	-3,052019
	Order income	-3,439089	1,365723	-2,518146
Pharma/Technology	Business Expectations	4,749055	1,694299	2,802962
	Inflation	-0,691141	0,256093	-2,698788
	Lending to enterprises	-4,126413	1,837457	-2,245720
Pharma/Transport	Index of production	3,953094	1,839510	2,148993
	Lending to enterprises	-5,459774	1,514603	-3,604757
	Unemployed	4,232525	1,237843	3,419274
Pharma/Utilities	Inflation	-0,698306	0,234991	-2,971632
	Interest Rate	0,848148	0,327715	2,588068
	Lending to enterprises	-3,720302	1,661791	-2,238730
	Order income	-2,265009	1,101586	-2,056135
	Unemployed	2,729299	1,277550	2,136353
Retail/Technology	Balance of trade	0,035548	0,015570	2,283172
	Business Expectations	6,322865	1,837864	3,440333
	Inflation	-0,962340	0,238708	-4,031454
	Lending to enterprises	-5,022276	1,376228	-3,649305
	Unemployed	2,982486	1,064031	2,803008
Retail/Transport	Business Expectations	4,919101	1,791520	2,745770
	Index of production	3,733758	1,446094	2,581961
	Inflation	-0,754398	0,328485	-2,296599
	Lending to enterprises	-5,859488	1,264461	-4,633981
	Order income	-3,285203	1,389753	-2,363875
	Unemployed	3,995216	1,053130	3,793659
Retail/Utilities	Inflation	-0,838461	0,202949	-4,131383
	Lending to enterprises	-3,660490	1,332009	-2,748098
	Unemployed	2,604658	1,062631	2,451139
Technology/Transport	Balance of trade	0,034757	0,015091	2,303203
	Business Expectations	5,913367	1,832432	3,227060
	Index of production	3,451462	1,579521	2,185132
	Inflation	-0,647234	0,311538	-2,077545
	Lending to enterprises	-6,946643	1,394805	-4,980369
	Unemployed	4,561557	1,070171	4,262454
Technology/Utilities	Balance of trade	0,036687	0,012532	2,927429
	Business Expectations	3,510944	1,404573	2,499652
	Inflation	-0,720642	0,210270	-3,427220
	Lending to enterprises	-4,096154	1,281625	-3,196062
	Unemployed	2,642837	0,958100	2,758414
Transport/Utilities	Balance of trade	0,026564	0,011533	2,303415
	Lending to enterprises	-5,076202	1,072300	-4,733940
	Unemployed	4,065574	0,912654	4,454672

Cross sectional correlation				
Significant explanatory variables for sample 2000 - 2009				
Correlation	Significant variables	Coefficient	standard error	t-statistic
Automotive/Bank				
Automotive/Chemical				
Automotive/Consum				
Automotive/Pharma	Return Auto Index	4,327156	1,848182	2,341304
	Return Pharma Index	19,881000	5,572064	3,567978

	Balance of Trade	-0,534127	0,264820	-0,201695
Automotive/Retail				
Automotive/Technology	Unemployed	1,346465	0,623053	2,161077
Automotive/Transport	Interest Rate	0,538820	0,254218	2,119516
Automotive/Utilities				
Bank/Chemical	Unemployed	1,547791	0,642046	2,410716
Bank/Consum	Business expectations	-2,617934	1,288886	-2,031160
Bank/Pharma	Return Bank Index	-17,309980	6,001629	-2,884214
	Return Pharma Index	31,793620	7,152158	4,445318
	Balance of Trade	-0,724715	0,307455	-2,357139
	Lending to enterprises	-1,979007	0,726123	-2,725442
	Unemployed	1,662272	0,583014	2,851172
Bank/Retail	Business expectations	-2,846497	1,414529	-2,012328
	Lending to enterprises	-2,145188	0,829557	-2,585943
	Unemployed	2,378444	0,666469	3,568723
Bank/Technology	Business expectations	-4,081972	1,944284	-2,099473
	Lending to enterprises	-2,128147	0,894283	-2,379724
	Unemployed	2,898217	0,602557	4,809866
Bank/Transport	Business expectations	-4,155328	1,453639	-2,858569
	Unemployed	1,530669	0,734148	2,084961
Bank/Utilities	Return Bank Index	-21,995750	6,988929	-3,147228
	Return Utilities Index	38,355920	17,038430	2,251142
	Business expectations	-4,186318	1,403438	-2,982902
	Interest Rate	0,845098	0,290126	2,912860
	Unemployed	1,867619	0,711245	2,625845
Chemical/Consum	Interest Rate	0,765868	0,380662	2,011936
Chemical/Pharma	Return Pharma Index	29,411030	6,746755	4,359286
	Balance of Trade	-0,643253	0,318195	-2,021565
	Lending to enterprises	-2,088276	0,810976	-2,575014
	Unemployed	1,239774	0,517048	2,397794
Chemical/Retail	Lending to enterprises	-2,007478	0,929548	-2,159629
	Unemployed	1,931491	0,655270	2,947623
Chemical/Technology	Business expectations	-2,942832	1,459804	-2,015909
	Index of Production	3,521405	1,589320	2,215668
	Lending to enterprises	-2,105363	0,689393	-3,053939
	Unemployed	2,616795	0,626408	4,177463
Chemical/Transport				
Chemical/Utilities	Return Chemical Index	-24,244790	9,433555	-2,570058
	Return Utilities Index	33,105850	1,581938	2,092740
	Interest Rate	0,868599	0,351713	2,469624
Consum/Pharma	Return Consum Index	-30,195400	6,957204	-4,340163
	Return Pharma Index	40,767870	5,860015	6,956957
	Balance of Trade	-1,114846	0,237528	-4,693538
	Order Income	2,828845	1,174073	2,409427
Consum/Retail	Balance of Trade	-0,499658	0,244987	-2,039532
Consum/Technology				
Consum/Transport	Business expectations	-3,251701	1,351014	-2,406860
Consum/Utilities	Return Consum Index	-24,980640	9,475080	-2,636457
	Return Utilities Index	33,648370	1,570910	2,141966
Pharma/Retail	Return Pharma Index	19,735270	7,854857	2,512493
	Balance of Trade	-1,022054	0,262284	-3,896746
	Unemployed	1,702514	0,645459	2,637681

Pharma/Technology	Return Pharma Index	23,440840	6,788303	3,453122
	Lending to enterprises	-2,233140	0,681947	-3,274652
	Unemployed	1,876161	0,376112	4,988300
Pharma/Transport	Return Pharma Index	31,457330	7,140038	4,405765
	Return Transport Index	-16,873720	5,742064	-2,938615
	Inflation	-0,039617	0,018333	-2,160924
Pharma/Utilities	Balance of Trade	-0,917361	0,299602	-3,061928
Retail/Technology	Lending to enterprises	-2,927937	0,955555	-3,064123
	Unemployed	3,070054	0,656172	4,678735
Retail/Transport				
Retail/Utilities	Balance of Trade	-0,699021	0,294264	-2,375487
	Unemployed	1,783258	0,797074	2,237254
Technology/Transport	Business expectations	-4,694756	1,897936	-2,473611
	Inflation	-0,046141	0,018102	-2,548860
	Unemployed	2,715351	0,641036	4,235882
Technology/Utilities	Return Technology Index	-16,173470	7,561921	-2,138804
	Return Utilities Index	3,626398	1,219885	2,972739
	Business expectations	-2,642756	1,112160	-2,376237
	Lending to enterprises	-1,925397	0,547951	-3,513815
	Unemployed	2,108456	0,436610	4,829156
Transport/Utilities	Return Transport Index	-17,797370	5,945428	-2,993456
	Business expectations	-3,632666	1,537109	-2,363310
	Inflation	-0,052860	0,022770	-2,321488