

Optimizing Long-term Incentive Plans

Public document

**Master Thesis Business
Mathematics and Informatics**

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September 2008



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Preface

In the final phase of my study Business Mathematics and Informatics (BMI) a six month internship is obligatory. The internship provides the opportunity to gain experience in professional life and apply the knowledge I obtained during my study. The internship should integrate the three disciplines of the study, business management, mathematics, and computer science.

My work at Watson Wyatt mainly consisted of researching the long-term bonus and developing models that were able to overcome the actual problem of this long-term bonus. An additional objective, and not unimportant, was developing a tool that is able to receive and represent the financial data in an easy format. This broadly covers all three required aspects of BMI.

I am glad that Watson Wyatt in Amstelveen gave me the opportunity to conduct my internship. First I would like to thank my supervisors Stephan van de Groep and Sven Slavenburg for their efforts and valuable guidance during my internship. I also like to thank my supervisors at the Vrije Universiteit, Dennis Roubos and Sandjai Bhulai for their help and guidance during the internship. Furthermore, I would like to express my gratitude to all members of the HCG practice: Charonne Min, Frank Robbe, Mary Cloosterman, Monique Driessen, Evert Jan Arends. Finally, I would like to thank my parents for their support during all these years.

Vincent van Elk
September 2008

Executive summary

The long-term bonus is the largest component of the executive directors' reward that is provided through a long-term incentive plan designed to improve executive directors' long-term performance. The actual value of the bonus depends on certain performance conditions and/or requirements. One of these performance conditions is Total Shareholder Return, which refers to the movement in share price plus reinvestment of dividend over a performance period. After the performance period the position of the company within the ordered sequence of the peer group determines its reward. The main problem with this performance condition is that it depends too much on the starting time of the long-term incentive plan. Therefore the main goal of the research conducted in this thesis is to develop a model that is able to overcome the time dependent problem of the long-term incentive plans.

The retrieval of historical data was quite hard, even with the program that was written in Visual Basic. Therefore this analysis was only done for one company. If there is a good financial data provider available, this could be easily extended with other companies.

The simulation program, which was made in Matlab, is easy to use and without any effort additional graphs or models can be added. The downside is its running time; it can take up to one hour until the program is finished with its simulation.

*[***Classified***]*

After some experiments we can conclude that model 1 and model 3 do not produce a more time independent relative TSR. Model 2 produces better results, but is still not really impressive. Model 4 added to model 2 produces really good results, but the use of ranking boundaries is not really realistic. A more realistic approach is model 4 added to model 3.

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1 Introduction

****Please note that this is a reduced version of a confidential report.****

Watson Wyatt's Database Directors Remuneration (DDR) shows that the average CEO's remuneration consists for 25% of base salary, 27% of annual bonus and 48% of long-term bonus. The DDR also shows that over 70% of the AEX companies use the creation of shareholder value as the performance measure for the long-term bonus. This implies that the value of the companies, represented by its share price, must be as high as possible. So we can say that the current remuneration structure is fairly well aligned to the long-term goals of the companies. Because of the high value of long-term bonuses, one can expect that the plan design behind this incites executives in the best way towards long-term company performance. Unfortunately this is not always the case, and there is still need to improve the performance measure for the long-term bonus.

1.1 Watson Wyatt, Human Capital Group

Watson Wyatt is a global consulting firm focused on human capital and financial management. They are specialized in four areas: employee benefits, human capital strategies, technology solutions, and insurance and financial services. Their focus is to provide human resource advice and business based solutions that support shareholder value creation. Watson Wyatt can be divided into seven practices: Benefits Group, Investment Consulting, Benefits Administration Solutions, Insurance and Financial Services, Human Capital Group, International and Business Services. They have more than 6000 associates in 30 countries and have global revenues of approximately \$1.5 billion of which 12% are attributable to the Human Capital Group (HCG).

The aim of the HCG within Watson Wyatt is to provide a full advisory and implementation service in executive compensation. The HCG in the Netherlands has done some big projects in the past for: Sony, Miele, Lyreco, TomTom and ELQ. HCG has following particular service lines of consulting excellence:

- Remuneration survey.
- Salary systems.
- Global Grading System.
- Performance management.
- Executive compensation.
- Conditions of employment à la carte.
- Pension communication.

Especially executive compensation is 'hot news' these days¹, it is fast changing and driven by market developments, economics, legislation and shareholder activism. The HCG in the United Kingdom is already strong in this particular service line and has

¹ Moberg received 7 million euro for his resignation:
http://www.volkskrant.nl/economie/article512804.ece/Moberg_kreeg_7_miljoen_bij_vertrek_bij_Ahold.html

many clients. The HCG in the Netherlands just started a profound executive reward survey where information is gathered for the remuneration of top managers and the executive board. The HCG practice expects to grow especially in this specific area.

The internship takes place at the HCG practice and is related to the service line executive compensation. For more detail about the HCG organisation chart in the Netherlands see Appendix 1.

1.2 Motivation

We have already seen above that one of the service lines of the HCG is executive compensation. A specific component of the compensation of an executive is the long-term bonus. There is an actual problem with a specific plan design of the long-term bonus (see 2.2), hence this topic has already been researched in the past at the HCG. During this research a more suitable method was created for rewarding the executive directors' long-term bonus. It has already been verified, during a foregoing analysis, that the results can be improved. Thus the HCG of Watson Wyatt has welcomed this internship to analyze and improve the method mentioned above.

1.3 Delineation

During the internship we required the historical daily closing prices and dividend data of different companies. In the past this financial data was collected from the financial market data provider Reuters, but during the internship Watson Wyatt Amstelveen stepped over to the financial market data provider Bloomberg. It took a while before Bloomberg was up and running, and on top of that it was still only accessible on one computer. Finally the decision was made to build a program in Visual Basic that reads the required financial data directly from the Yahoo! Finance site. Independent financial data providers are supplying the Yahoo! Finance site from quotes and other information, for instance, the Amsterdam Stock Exchange data is supplied by Telekurs².

1.4 Objectives

The researched plan design (see 2.2) of the long-term bonus has a disadvantage; the plan design depends too much on its starting time. The main objective of this thesis is to overcome this time dependent problem. During the internship we encountered also two other objectives, which are linked closely together. We can distinguish the following three objectives:

- Before we can work on the main objective, we first need to know what the peer group (comparable companies) is of the Dutch companies listed on the stock

² <http://www.telekurs-financial.com/>

market. Not all Dutch companies have a peer group, because not every company is using the same plan design for the long-term bonus. This information can be found in the annual reports of these companies. Besides the peer group we have also collected the remuneration of the Chief Executive Officer, the Chief Financial Officer, and other Executive Directors. This information is put into the DDR, which has the purpose in providing a consulting and analyzing tool to investigate the remuneration levels of company directors. In this matter the salary scales³ are always filled with up to date market data. Thus the first objective is reading the annual reports of the specific companies and retrieving the necessary information from it. Appendix 5 shows a list of all companies with a peer group that were retrieved during the internship.

- Once we have collected the peer group of each company it is time to receive and represent all the financial data clearly in Excel. The task, in receiving and representing the financial data, is really a time-consuming procedure. There are just too many manual operations needed to perform this task. So the second objective is constructing a program that can receive and represent the financial data in an easy and respectively good format that is directly available. Further on during this thesis we will call this program the Yahoo! program.
- During an earlier analysis of the long-term bonus a program was built with Visual Basic. This program should be able to overcome the actual problem as described in 2.2. The main, and third, objective of the research conducted in this thesis is to analyse the program and improve it.

1.5 Organisation

In chapter 2 we give a more detailed description of the Yahoo! program and the main problem. Chapter 3 describes the structure of all models that were developed and researched during the internship. Thereafter, in chapter 4, we will explain the results of the experiments of every single model. Finally, some conclusions are drawn in chapter 5 and after the last chapter the reader finds some topics that can be interesting for further research, the references, and appendices.

³ Salary scales are the basis of the salary systems (see 1.11.1 Watson Wyatt, Human Capital Group).

2 Description of the objectives

The Yahoo! program will be explained in the first part of this chapter and further on a more detailed description of the main objective of this internship will be given. After reading this it will be clear how the specific plan design of the long-term bonus works and what the actual problems are with this plan design.

2.1 Retrieving historical data

The second objective is the collection and presentation of historical data. The essential historical data consists of historical daily closing prices and historical dividend data of specific companies. The closing prices are defined by the price of the last transaction for a given security at the end of a given trading session [22]. For many market centres, including the Amsterdam Stock Exchange, regular trading sessions runs from 9.30 a.m. to 4.00 p.m. Eastern Time. The dividend data is defined by the taxable payment declared by a company's board of directors and given to its shareholders out of the company's current or retained earnings [23]. Before we can receive the historical daily closing prices and dividend data of a specific company, we first need to know what the ticker is of this company. The ticker represents a specific company: the first part of the ticker is an abbreviation of the name of the company and the second part represents the specific stock exchange. For example the ticker AGN.AS; AGN stands for Aegon and the suffix AS represents the Amsterdam Stock Exchange⁴. With the use of this ticker we can receive historical daily closing prices and dividend data directly into Excel.

We have used Visual Basic to construct a program that receives the required data and processes these data to be presented in a clear way in Excel. Once the requested data are received, we encountered one main problem: how do we handle the missing data? We can distinguish the following 3 situations:

- A few missing data points between the starting date and the end date.
- A big part of the requested data is missing. For example, requesting the data between 2000 and 2003 results only in data between 2002 and 2003.
- The company does not exist in the Yahoo! database.

If there are only a few data points missing then we set the closing price equal to the closing price of the previous day. In this way the return between these two days equals one. The return on a specific day t is defined by the ratio between the closing price plus dividend and the closing price of the previous day [24]:

$$return_t = \frac{closingprice_t + dividend_t}{closingprice_{t-1}}. \quad (1)$$

⁴ The specific suffix of a country can be found at: <http://finance.yahoo.com/exchanges>

In the second situation it is wise to try another financial market data provider first⁵. If this does not result in a better data set, then all missing data points are set to the same value. This way the company will not correlate very well with the comparable companies. It is arguable to remove a company which contains a lot of missing data. The people who have to decide if it is a good plan might think it is strange when one of the companies is missing. On the other hand, if the returns are all equal to one the company will have a very small contribution in solving the main objective (2.2). If from one or more companies no financial data can be received, then the financial data should be received from another financial market data provider. It is just not plausible that there is not any available financial data for a specific company. For further details about the Yahoo! programme see Appendix 6, there is a small tutorial on how to work with this Excel program. In Appendix 7 we can find the Visual Basic code behind this program.

2.2 Time dependent relative Total Shareholder Return

The remuneration of executive directors of Dutch companies consists of a basic salary, an annual bonus, a long-term bonus and a pension. The long-term bonus is the largest component of the executive directors' reward that is provided through the Long Term Incentive Plan (LTIP). The LTIP is a reward system designed to improve executive directors' long-term performance. The reward helps the company to attract, motivate and retain highly qualified executive directors. The executive directors of a company has a direct influence on the day-to-day running, direction and profitability of the company, thus the long-term performance of a company depends on the performance of the executives in this period. In a typical LTIP, the executive director must fulfil various conditions and/or requirements that prove that he or she has contributed to increasing shareholder value. A company creates value for its shareholders when the shareholder return exceeds the required return to equity. In other words, a company creates value in a specific year when it outperforms expectations. The Supervisory Board decides what the actual value of the long-term bonus will be under certain conditions and/or requirements. For example, an LTIP participant is provided with free shares after three years, subject to the condition that he remains in employment throughout the period and the company meets certain performance conditions. The shares that are provided to the participant will be held in trust and on paper allocated to the participant. If the attached conditions to the award are met, the trustees release or transfer the shares to the participant.

70 percent of the AEX companies use the Total Shareholder Return (TSR) as long term incentive performance condition. This means that a lot of focus is placed on the creation of shareholder value. The TSR refers to the movement in share price plus reinvestment of dividend over a performance period expressed as a percentage of the initial investment. The performance period is usually three years or more but varies by market and other factors. TSR can be easily compared from company to company without having to worry with size bias; this is because the TSR is measured in terms of

⁵ <http://moneycentral.msn.com>, <http://www.belegger.nl>, <http://www.euroinvestor.nl>

percentage. TSR⁶ for a company, with n trading days, is the multiplication of the returns during this period [18]:

$$TSR_{1,n} = \left[\prod_{t=1}^n return_t \right] - 1 = \left[\prod_{t=1}^n \frac{(closingPrice_t + dividend_t)}{closingPrice_{t-1}} \right] - 1, \quad (2)$$

where $closingPrice_0$ is given.

Relative TSR is the ranking of one company's TSR against the TSR of the peer group. Relative TSR has become the predominant form of long-term performance measure since 1999. The second most popular measure of long-term performance is Earnings Per Share (EPS). The performance share plan of ING can be seen in Figure 1. The LTIP of ING will provide a share bases reward after a three year performance period. If, after the performance period, ING has a rank between one and three 200% of shares will be granted. The initial grant will increase or decrease (on a linear basis) on the basis of ING's ranking after the three year performance period.

Number of shares awarded after each three-year performance period related to peer group	
ING ranking	Number of shares
1 – 3	200%
4 – 8	Between 200% and 100%
9 – 11	100%
12 – 17	Between 100% and 0%
18 – 20	0%

Figure 1 performance share plan of ING [10].

The supervisory board considers relative TSR to be an appropriate measure, as it objectively measures the company's financial performance and appraise its long-term value creation compared to companies in the sector. Relative TSR has many advantages:

- Transparent.
- Easily understood.
- Directly related to shareholder interests.
- Readily measurable at any time for regular and frequent feedback.
- Externally assessable and objective.

Unfortunately relative TSR has also a big disadvantage: if a LTIP is started, the rank of the company will be quite different when, for instance, the LTIP is started one day later. Thus if a plan is only started one day later, then the value of the long-term bonus will be quite different. This is not really pleasant: when the relative TSR measures the long-term performance of a company it should not be affected by a small time shift. Thus it would be more appropriate if it becomes less time dependent.

⁶ This is the case in the simulation models, described in section 3. If the first closing price uses the subscript zero, then it gets less confusing in the latter part of this thesis.

3 The simulation models

This chapter discusses the different simulation models. Paragraph 3.1 describes the model that was developed during a former research. The paragraphs 3.2, 3.3 and 3.4 will give more detail about the models that were developed as part of the current research. In the analyses of the different models we have used the target company Aegon and its peer group (consisting of twelve companies) as a test case over the performance period 28th April 2003 until 25th April 2006. In the remaining part of this thesis we will use the word target company as the company of interest.

We have already seen in objective description 2.2 that the rank of a company depends for a great part on the starting time of the plan. The main idea behind the following models is to create an optimized peer group, which is a weighted sum of each company in the peer group. If a company in the peer group has a strong relationship with the target company, then the value of its weight will be large. To the contrary, if a company in the peer group has a weak relationship with the target company, then the value of the weight will be small. Thus, we assume that there is a linear relationship between the target company and its peer group. This way we are creating an optimized peer group that has a strong relationship with the target company. With the use of this optimized peer group, we aim at establishing a relative TSR that is less time dependent than the actual relative TSR. How this is done can be read in the remaining of this chapter.

3.1 Model 1

This paragraph describes model 1 that was developed during a former research. The structure of this model is very similar to the new models that were constructed during the current research.

****Classified****

3.1.1 Risk-neutral measure

****Classified****

3.1.2 Optimization

Multiple linear regression is a statistical technique that predicts values of one (dependent) variable on the basis of two or more (independent) variables. The dependent variable in the regression equation is modelled as a function of the independent variables, corresponding parameters, and an error term. The error term is treated as a random variable, which represents the unexplained variation in the dependent variable. The Pearson correlation coefficient measures the strength and direction of a linear relationship between two variables. Thus, during the optimization part, the parameters are estimated such that the Pearson product-moment correlation between predicted and observed values $r_{\hat{y},y}$ has its maximum value. The general form of

the multivariate linear regression equation with m observations and n independent variables is as follows [3]:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_n X_{in} + \varepsilon_i \quad i = 1, \dots, m \quad j = 1, \dots, n$$

Y_i is the dependent variable of observation i .

β_0 is the Y intercept, the value of Y if all X are zero.

X_{ij} is the independent variable of observation i of variable j .

β_j is the coefficient assigned to the independent variable j during regression, this is the parameter we like to estimate.

ε_i is the error term of observation i , which models the unsystematic error of the Y_i term from the predicted \hat{Y}_i term. It is also known as random noise ($\varepsilon_i = Y_i - \hat{Y}_i$).

The predicted equation looks like:

$$\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 X_{i1} + \hat{\beta}_2 X_{i2} + \dots + \hat{\beta}_n X_{in} \quad i = 1, \dots, m \quad j = 1, \dots, n$$

\hat{Y}_i is the predicted (optimized) value of observation i .

$\hat{\beta}_j$ is the predicted parameter of the independent variable j .

[***Classified***]

$$r_{xy} = \sum_{j=1}^n \beta_j \frac{\text{cov}(Y, X_j)}{(\text{var}(Y)\text{var}(X_j))^{0.5}} = \sum_{j=1}^n \beta_j \frac{\text{cov}(Y, X_j)}{\sigma_Y \sigma_{X_j}}.$$

Unfortunately the companies of the peer group are also inter-correlated, thus we also have to take their relationships into account [12]:

$$\text{var}\left(\sum_{j=1}^n \beta_j X_j\right) = \text{cov}\left(\sum_{j=1}^n \beta_j X_j, \sum_{i=1}^n \beta_i X_i\right) = \sum_{i=1}^n \sum_{j=1}^n \beta_i \beta_j \text{cov}(X_i, X_j).$$

So the formula for the multiple correlation coefficient with inter-correlated variables is as follows:

$$R_{xy} = \frac{\sum_{j=1}^n \beta_j \text{cov}(Y, X_j)}{\left(\text{var}(Y) \sum_{i=1}^n \sum_{j=1}^n \beta_i \beta_j \text{cov}(X_i, X_j)\right)^{0.5}}. \quad (4)$$

Note that the maximum coefficient of multiple correlation criterion will be of no help in picking the β_0 value. This does not affect our results, because adding or subtracting of a value β_0 will not change the value of the correlation. So, to find the maximum of this

function we have to find the values where the first derivative of this function approximates zero. The first derivative to parameter l is:

$$\frac{\partial R}{\partial \beta_l} = \frac{\text{cov}(Y, X_l)}{\left(\text{var}(Y) \sum_{j=1}^n \sum_{k=1}^n \beta_j \beta_k \text{cov}(X_j, X_k) \right)^{0.5}} - \frac{\sum_{j=1}^n \beta_j \text{cov}(Y, X_j) \left[\text{var}(Y) \sum_{j=1}^n \beta_j \text{cov}(X_j, X_l) \right]}{\left(\text{var}(Y) \sum_{j=1}^n \sum_{k=1}^n \beta_j \beta_k \text{cov}(X_j, X_k) \right)^{1.5}}.$$

We also like to know if it is a maximum or a minimum, thus also the second derivative is calculated. The second derivative to parameter m :

$$\begin{aligned} \frac{\partial R}{\partial \beta_m} \left(\frac{\partial R}{\partial \beta_l} \right) &= \frac{-\text{cov}(Y, X_l) \text{var}(Y) \sum_{j=1}^n \beta_j \text{cov}(X_j, X_o)}{\left(\text{var}(Y) \sum_{j=1}^n \sum_{k=1}^n \beta_j \beta_k \text{cov}(X_j, X_k) \right)^{1.5}} \\ &- \frac{\text{cov}(Y, X_o) \text{var}(Y) \sum_{j=1}^n \beta_j \text{cov}(X_j, X_l) + \sum_{j=1}^n \beta_j \text{cov}(Y, X_j) \text{var}(Y) \text{cov}(X_o, X_l)}{\left(\text{var}(Y) \sum_{j=1}^n \sum_{k=1}^n \beta_j \beta_k \text{cov}(X_j, X_k) \right)^{1.5}} \\ &+ \frac{3 \sum_{j=1}^n \beta_j \text{cov}(Y, X_j) \text{var}(Y) \sum_{j=1}^n \beta_j \text{cov}(X_j, X_l) \text{var}(Y) \sum_{j=1}^n \beta_j \text{cov}(X_j, X_o)}{\left(\text{var}(Y) \sum_{j=1}^n \sum_{k=1}^n \beta_j \beta_k \text{cov}(X_j, X_k) \right)^{2.5}}. \end{aligned}$$

Details are provided in Appendix 2.

The Newton-Raphson (or just Newton's) method is used for finding the (local) maxima of Equation 4 [20]. Newton's method is a well-know algorithm for finding the local maxima or local minima of functions. We are seeking for $\ell(x^*) \geq \ell(x)$ for all x close to x^* . Newton's method requires the computation of the gradient vector and Hessian matrix:

$$\nabla \ell(x) = \begin{pmatrix} \frac{\partial}{\partial_1} \ell(x) \\ \frac{\partial}{\partial_2} \ell(x) \\ \vdots \\ \frac{\partial}{\partial_m} \ell(x) \end{pmatrix} \quad \nabla^2 \ell(x) = \begin{pmatrix} \frac{\partial}{\partial_{11}} \ell(x) & \cdots & \cdots & \cdots & \frac{\partial}{\partial_{1m}} \ell(x) \\ \frac{\partial}{\partial_{12}} \ell(x) & \ddots & & & \vdots \\ \vdots & & \ddots & & \vdots \\ \vdots & & & \ddots & \vdots \\ \frac{\partial}{\partial_{m1}} \ell(x) & \cdots & \cdots & \cdots & \frac{\partial}{\partial_{mm}} \ell(x) \end{pmatrix}$$

The Taylor expansion of $\ell(x_k)$:

$$q_k(s_k) = \ell(x_k) + \nabla \ell(x_k)^T s_k + \frac{1}{2} s^T \nabla^2 \ell(x_k) s_k.$$

attains its optimized value when ∇x_k solves the linear equation:

$$\nabla \ell(x_k) + \nabla^2 \ell(x_k) s_k = 0 \Rightarrow s_k = -\nabla \ell(x_k) (\nabla^2 \ell(x_k))^{-1}.$$

We can distinguish the following steps in finding the maximum of Equation 4⁷:

0. Give the start value x_0 .
1. $s_k = -\nabla \ell(x_k) [\nabla^2 \ell(x_k)]^{-1}$. If $s_k = 0$, then stop.
2. Choose the step size $\alpha_k = 1$
3. Set $x_{k+1} = x_k + \alpha_k s_k$, and $k=k+1$. Go to step 1

[***Classified***]

The Lagrange multiplier method is used to find extreme values of a function whose domain is restricted and lies within a particular subset of the domain. The Lagrange multiplier method [9]:

$$\max R(x) \text{ Such that } g_i(x) = 0, i = 1, \dots, n.$$

The gradient must satisfy the following equation:

$$\nabla R(x) = \sum_{i=1}^n \lambda_i \nabla g_i.$$

The restrictions are said to be independent if all the gradients of each restriction are linearly independent, that is $\{\nabla g_1(x), \dots, \nabla g_n(x)\}$ is a set of linearly independent vectors on all points where the restrictions are verified. This is equivalent in solving the following problem without any restrictions:

⁷ The method assumes that the Hessian matrix is non-singular. Step 2 can be augmented with a line search to find an optimal value of the step size parameter. Convergence is only guaranteed if the starting point is sufficiently close to a local maximum x^* at which the Hessian is negative definite.

$$\max R(x) - \sum_{i=1}^n \lambda_i (g_i(x))$$

Thus we are maximizing the following equation:

$$R_{xy} = \frac{\sum_{j=1}^n \beta_j \text{cov}(Y, X_j)}{\left(\text{var}(Y) \sum_{i=1}^n \sum_{j=1}^n \beta_i \beta_j \text{cov}(X_i, X_j) \right)^{0.5}} - \lambda \left(\sum_{j=1}^n \beta_j - 1 \right).$$

The first derivative of this function is:

$$\frac{\partial R}{\partial \beta_l} = \frac{\text{cov}(Y, X_l)}{\left(\text{var}(Y) \sum_{j=1}^n \sum_{k=1}^n \beta_j \beta_k \text{cov}(X_j, X_k) \right)^{0.5}} - \frac{\sum_{j=1}^n \beta_j \text{cov}(Y, X_j) \left[\text{var}(Y) \sum_{j=1}^n \beta_j \text{cov}(X_j, X_l) \right]}{\left(\text{var}(Y) \sum_{j=1}^n \sum_{k=1}^n \beta_j \beta_k \text{cov}(X_j, X_k) \right)^{1.5}} - \lambda.$$

[***Classified***]

3.1.3 Classification

[***Classified***]

3.2 Model 2

During the analysis of the previous model we encountered some problems (see section 4). Therefore model 2 was developed to overcome these problems. The main idea behind model 2 is the same as model 1, but the separated parts are executed in a different sequence.

[***Classified***]

3.2.1 Optimization

[***Classified***]

3.2.2 Adjusted coefficients

[***Classified***]

3.2.3 Classification

[***Classified***]

3.3 Model 3

[***Classified***]

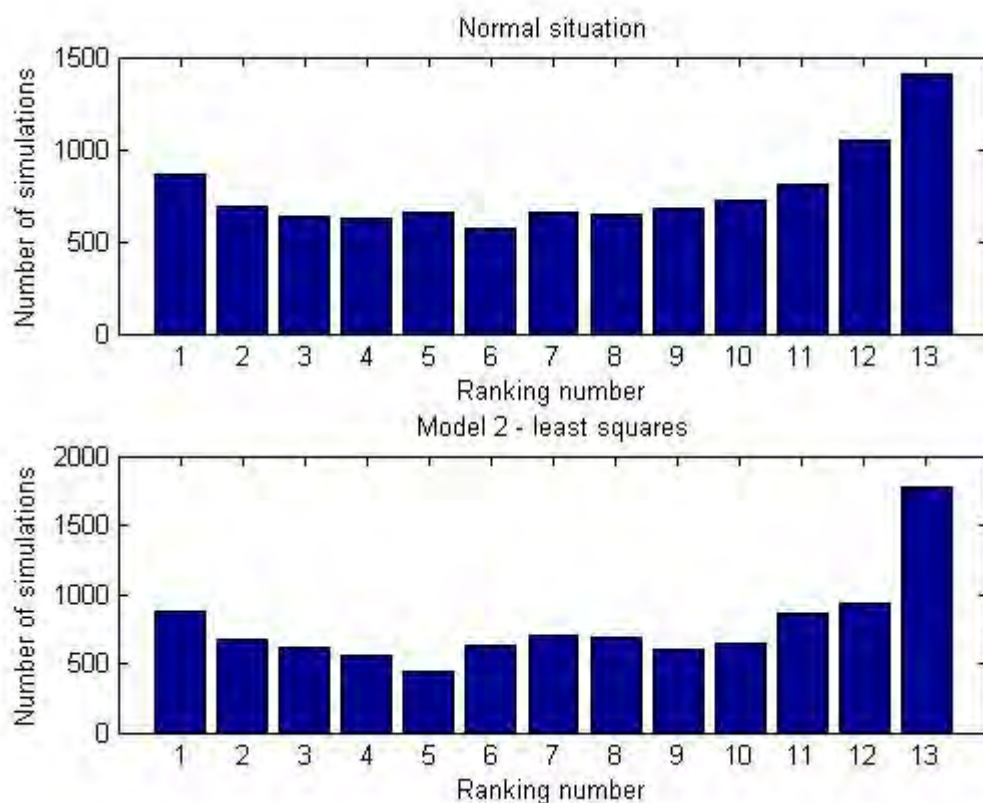


Figure 8 Distribution of the ranking numbers after 10.000 simulations. Ranking number 13 increases with 30 percent.

[***Classified***]

3.4 Model 4

[***Classified***]

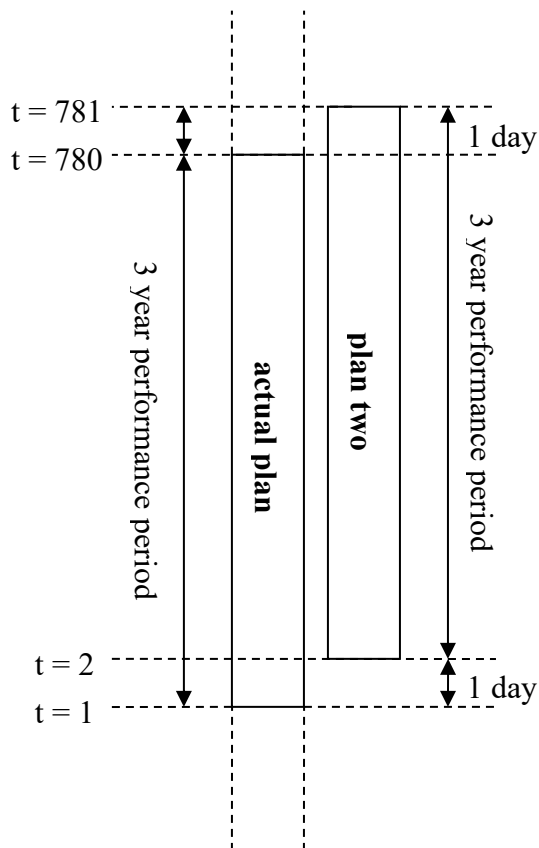


Figure 9 Plan one and plan two of a specific company. Plan two starts one day later compared to plan one.

[***Classified***]

4 Experiments

In the following sections the word ‘TSR’ must actually be ‘adjusted TSR’, but it becomes confusing if we repeat this all the time. First we will discuss the experiments of the optimization part, because this is in all models exactly the same. Thereafter we will continue with the experiments of all four models.

4.1 Optimization

This paragraph describes the experiments that were carried out during the analysis of the optimization part. First a few assumptions are studied to justify the linear model described in paragraph 3.1.2. Further on we estimate the coefficient under the two different criteria described in paragraph 3.1.2 and 3.2.1. Once again we are using the company Aegon and its peer group to analyse the different models. The peer group consist of the following twelve companies: Allianz, Aviva, AXA, Fortis, Generali, ING, Hartford FS, Prudential Financial, Lincoln National, Metlife, Nationwide, and Prudential PLC.

4.1.1 Testing the assumption of multiple linear regression

One of the first things we have done is the verification of the four principal assumptions which justify the use of a linear regression model. These four assumptions are [8]:

1. Linearity of the relationship between dependent and independent variables.
2. Independence of the errors.
3. Homoscedasticity of the errors
4. normality of the error distribution

The first assumption of multiple linear regression can never be virtually checked, due to the higher dimensions. However the results are not greatly affected with minor variation from this assumption. Therefore it is enough to look at bivariate scatter plots between the dependent variable and the independent variables. In Appendix 4.1 we can see all the bivariate scatter plots between the dependent variable and independent variables. In these plots it is shown that all the points are symmetrically distributed around the diagonal line (linear least squares). Consequently we verify the first assumption of linearity.

If the errors are not independent, then you could predict one error from the others and thus improve the prediction of the dependent variable. With the use of autocorrelation we can find repeating patterns, such as the presence of periodic signal, or harmonic frequencies. Appendix 4.2 shows the plots of the sample autocorrelation function with respectively 30 and 700 number of lags. The 95% confidence bounds are also given in the figures. We can see that the residual auto-correlation stays approximately between the confidence bounds. Thus we can conclude there is no repeating pattern in the errors.

Homoscedasticity means that the variance around the regression line is constant. Serious violation in homoscedasticity results in underemphasizing the Pearson correlation coefficient. Because of the independence of the error term on the independent variable, we can conclude that homoscedasticity of the error simultaneous means homoscedasticity of the predicted variables. Thus we can check for homoscedasticity if the plots of error versus time or error versus predicted values are not getting any larger. If this does happen we call it heteroscedasticity (see Figure 10). In Appendix 4.3 we can see that there is no heteroscedasticity between error versus time and predicted values.

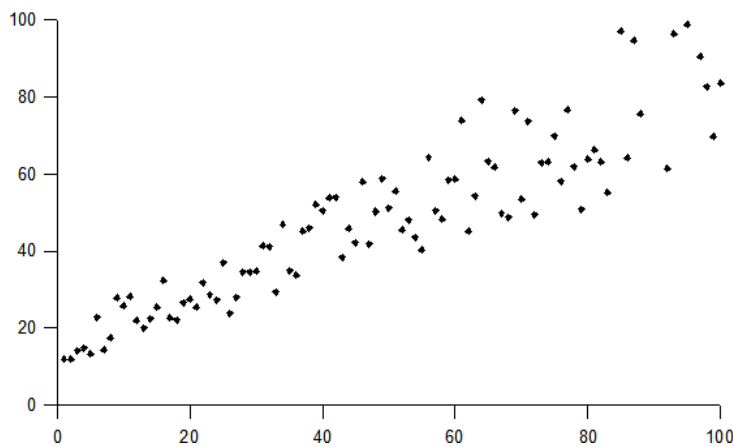


Figure 10 Heteroscedasticity; variable variance

Any evidence of no randomness of the error term casts serious doubt on the adequacy of a linear regression equation. Thus the error terms must be independent of each other, will have a mean of zero, and will have a normal distribution. We can check the normality assumption with the two-sample Kolmogorov-Smirnov test, or plot the error distribution against a normal distribution with the same mean and variance, or we can just watch the probability density function of the error. Appendix 4.4 shows the probability density function of the error. The normal distribution can be recognized quite clearly from the figure.

4.1.2 Optimization with and without restrictions

[***Classified***]

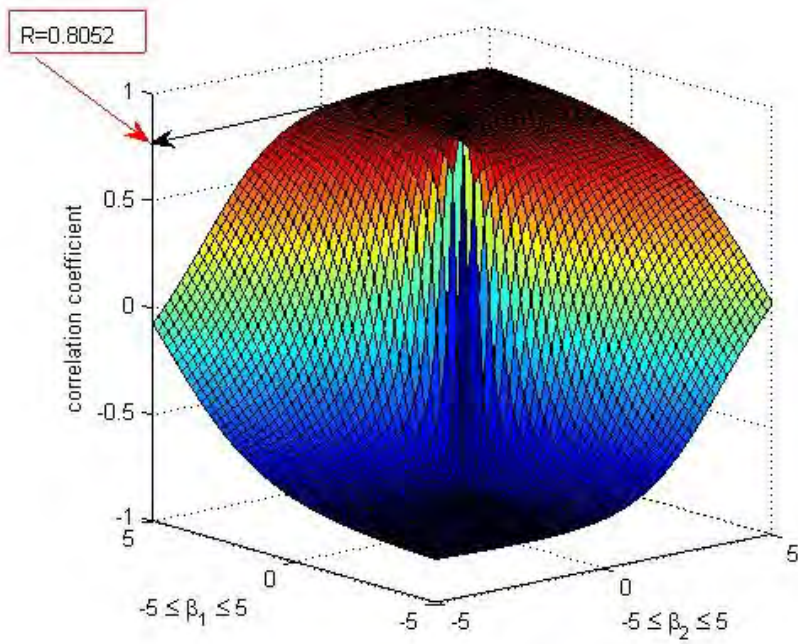


Figure 11 The correlation coefficient versus the predicted parameters of Allianz and ING.

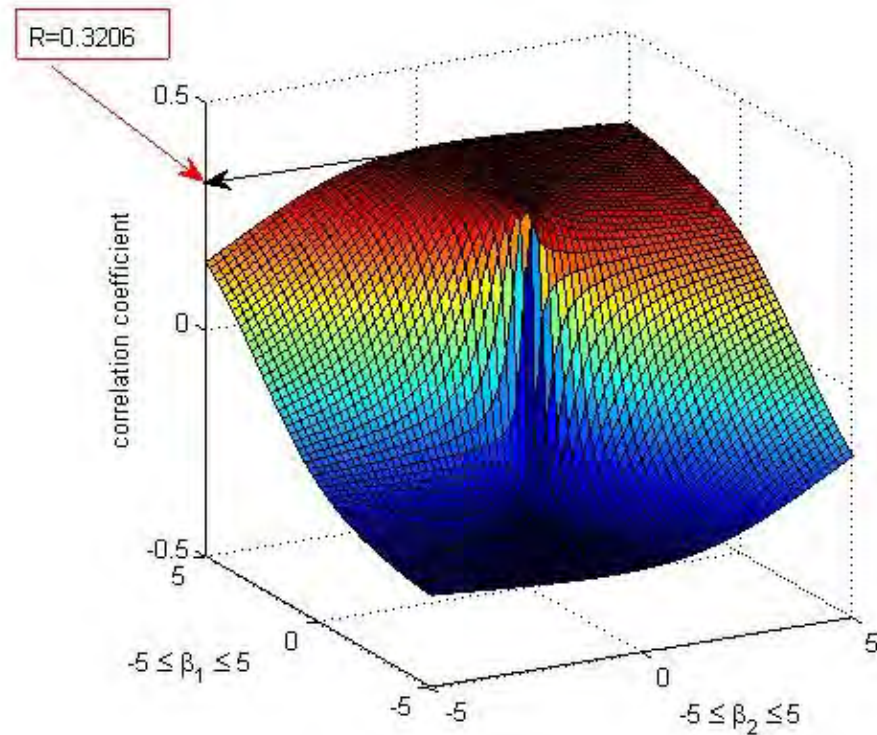


Figure 12 The correlation coefficient versus the predicted parameters of Prudential Financial and Lincoln National.

[***Classified***]

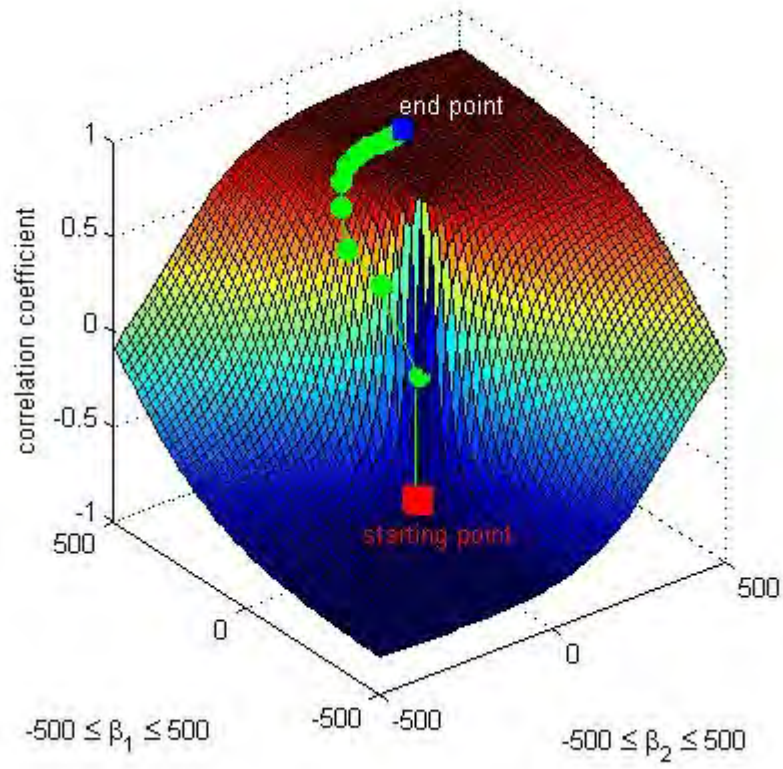


Figure 13 The optimization trail of Allianz and ING from starting point to end (optimized) point without gradient or Hessian matrix.

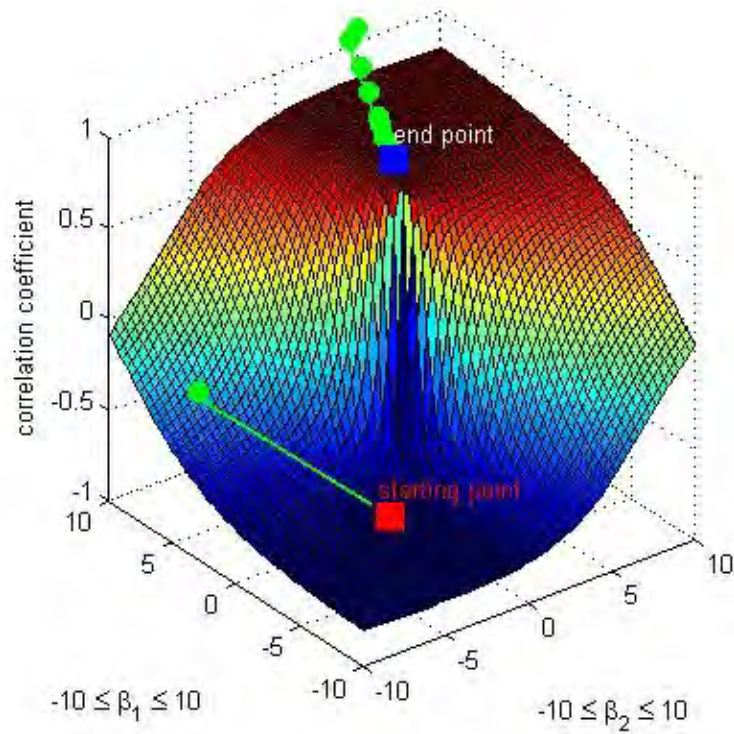


Figure 14 The optimization trail of Allianz and ING from starting point to end (optimized) point with the specification of the gradient.

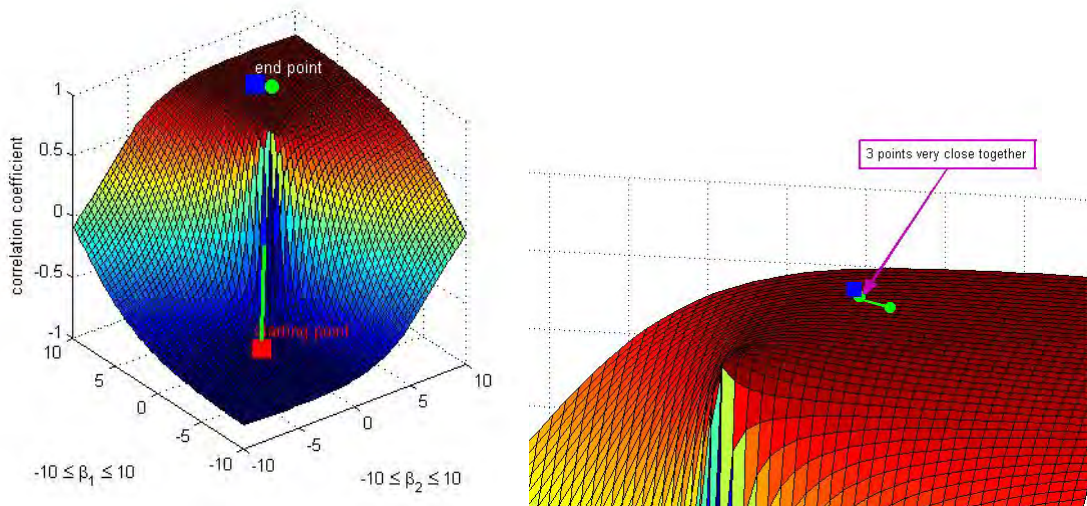


Figure 15 The optimization trail Allianz and ING from starting point to end (optimized) point with the specification of the gradient and the Hessian matrix (left). Last few points during the optimization are very close to each other (right).

[***Classified***]

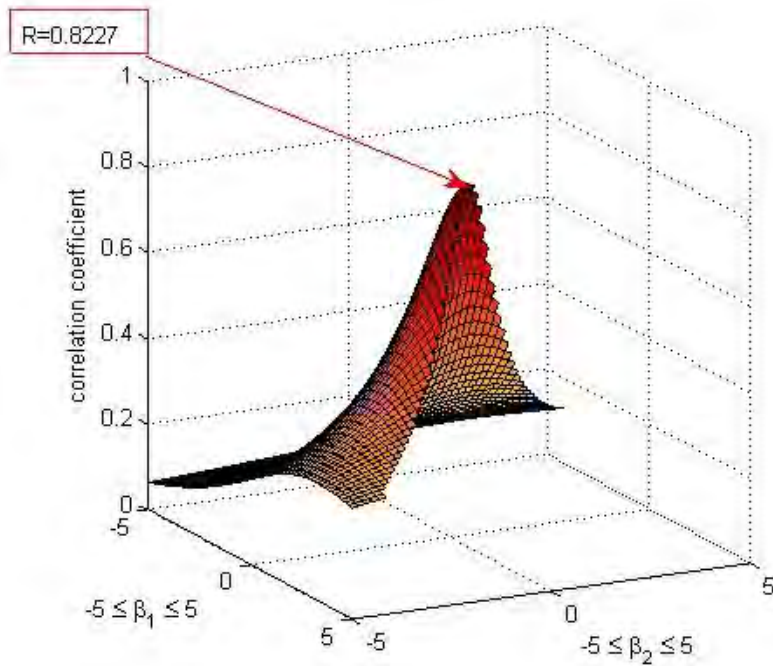


Figure 16 The correlation coefficient versus the predicted parameters of AXA, Allianz and ING with the first restriction on the parameters added.

[***Classified***]

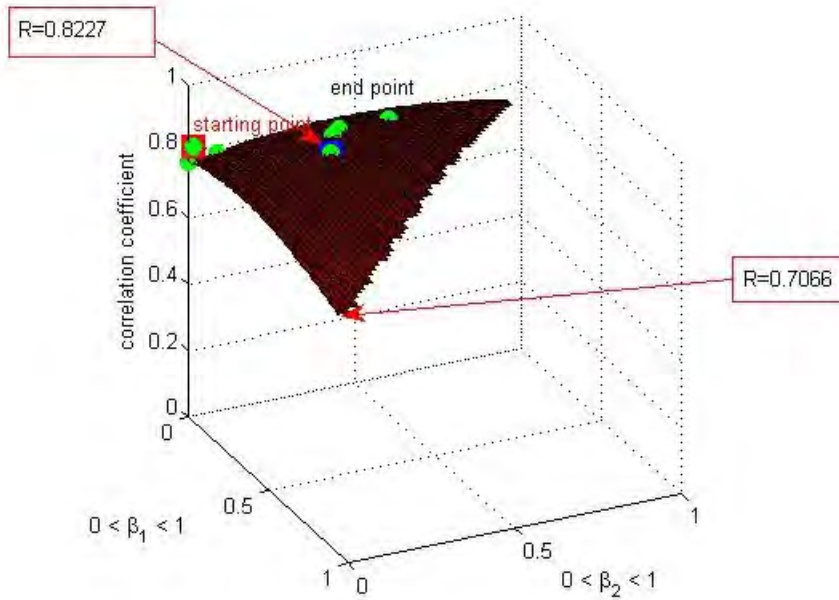


Figure 17 The correlation coefficient versus the predicted parameters of AXA, Allianz and ING with both restriction on the parameters added.

[***Classified***]

4.1.3 Least squares versus maximum correlation coefficient

[***Classified***]

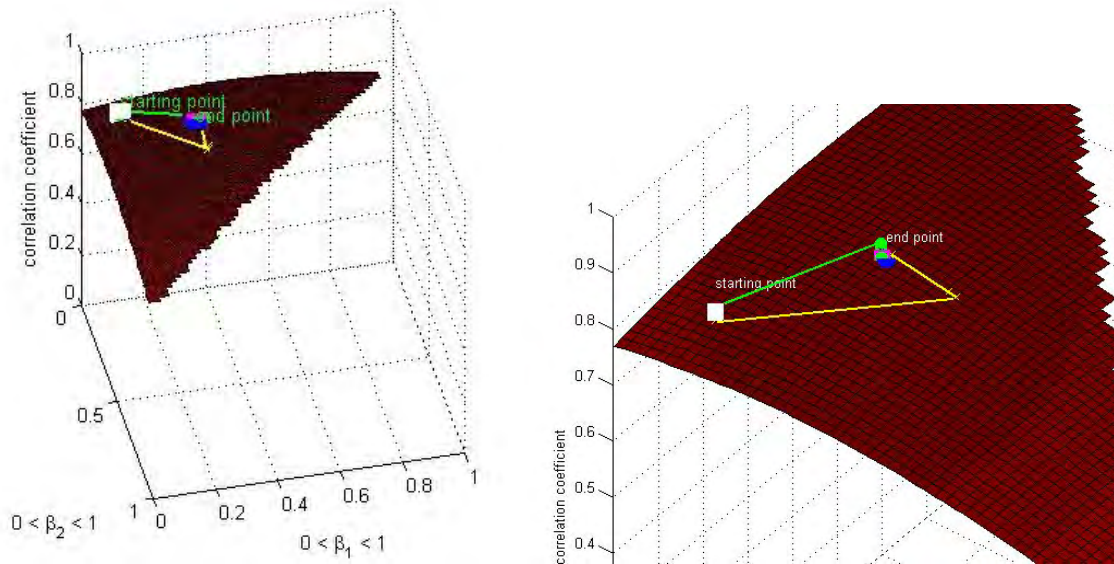


Figure 18 The optimization trial of AXA, Allianz and ING with the least squares criterion (yellow) and the maximum correlation coefficient criterion (green).

[***Classified***]

4.2 Analysis of model 1

This section discusses the main problems of model 1. We have already seen in 2.2 that the TSR is expressed in terms of percentage, this way the TSR can be easily compared from company to company without having to worry with size bias. [***Classified***]

4.2.1 Optimization of the input

[***Classified***]

4.2.2 Classification

[***Classified***]

4.2.3 Risk free rate

[***Classified***]

4.3 Analysis of model 2

The main idea of model 2 is to use the optimized peer group to predict the TSR value of the target company. This way we can estimate the TSR values of a plan that starts at a later date in comparison to the actual plan. In this model we are using the returns instead of the returns in terms of percentage. The previous paragraph already showed that the returns in terms of percentages gave some problems during the optimization.

4.3.1 Prediction of the future

[***Classified***]

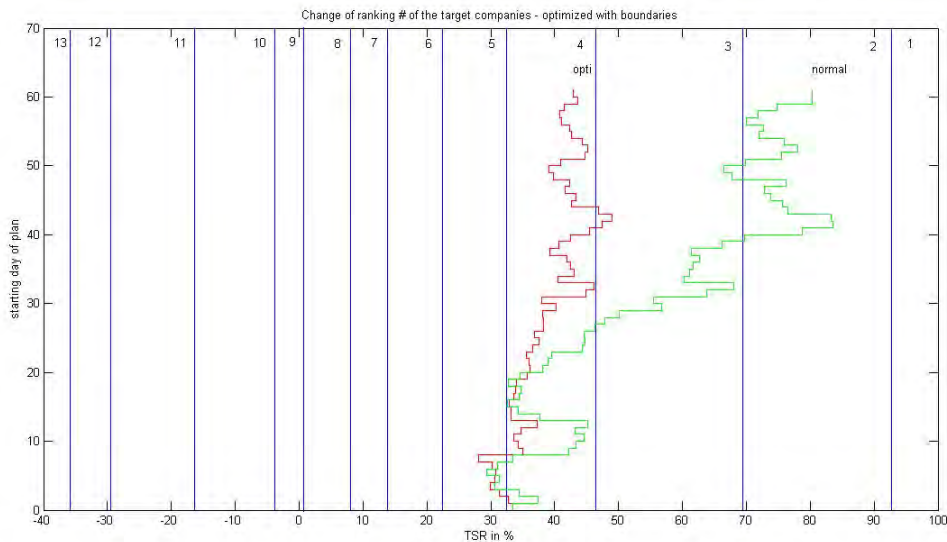


Figure 22 Change in ranking of target company and optimized target company, when the starting date of the plan changes. This is only one simulation run of model 2.

A graphical view of one simulation is nice, but we can say more about the model if we look at the average and average deviation of these plans. We can see in Figure 22 the average optimized target company (red) with its average deviation (blue) and the average target company (green) with its average deviation (yellow). The average of the optimized target company and the target company are almost the same. This is not really surprising, because the expected value of each separate plan after its performance period is the same. This does not change with optimization. We can also notice a reduction in the average deviation of the optimized target company compared to the target company. Thus we can conclude that the chance in a shift of ranking number, if a plan is started at a later date, is smaller in the optimized situation compared to the normal situation.

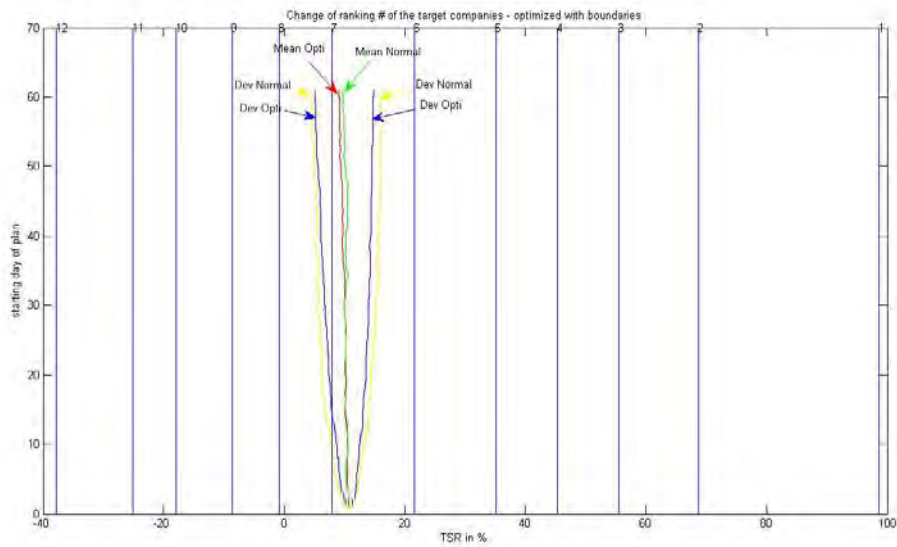


Figure 22 The average change in ranking number of the target company and the optimized target company. Notice the reduction of the average deviation of the optimized target company (blue) compared to the average deviation of the target company (yellow).

4.3.2 Ranking excess

Figure 24 confirms how good the optimized target company works in comparison to the target company. Especially the plan that starts sixty days later shows a significant reduction of the shifts of ranking numbers. The reduction in excess ranking numbers is

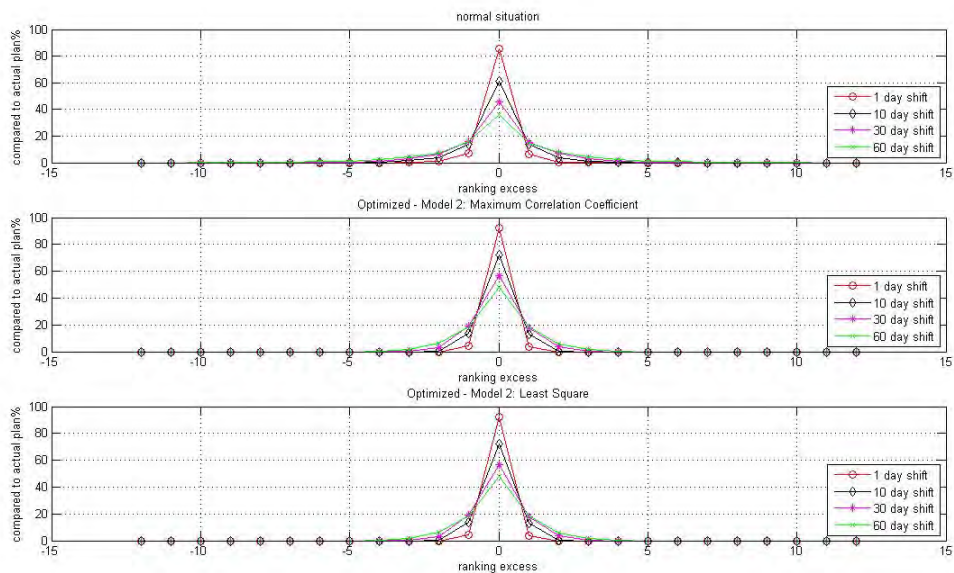


Figure 24 Percentage that stays the same compared to the actual plan versus excess ranking. The upper figure is the normal situation, the middle is with the use of an optimized (maximum correlation coefficient) peer group, and the lower is with the use of an optimized (least square) peer group.

[***Classified***]

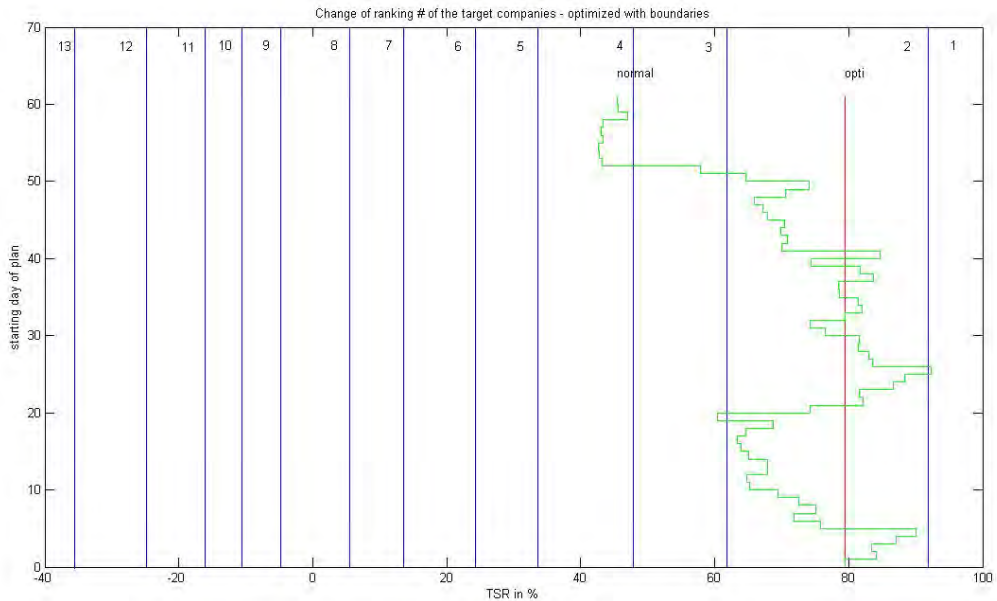


Figure 25 Change in ranking of target company and optimized target company, when the starting date of the plan changes. The optimized peer group and the target company have a correlation of one.

4.4 Analysis of model 3

The idea behind model 3 is to optimize the target company and all the companies within the peer group. [***Classified***]

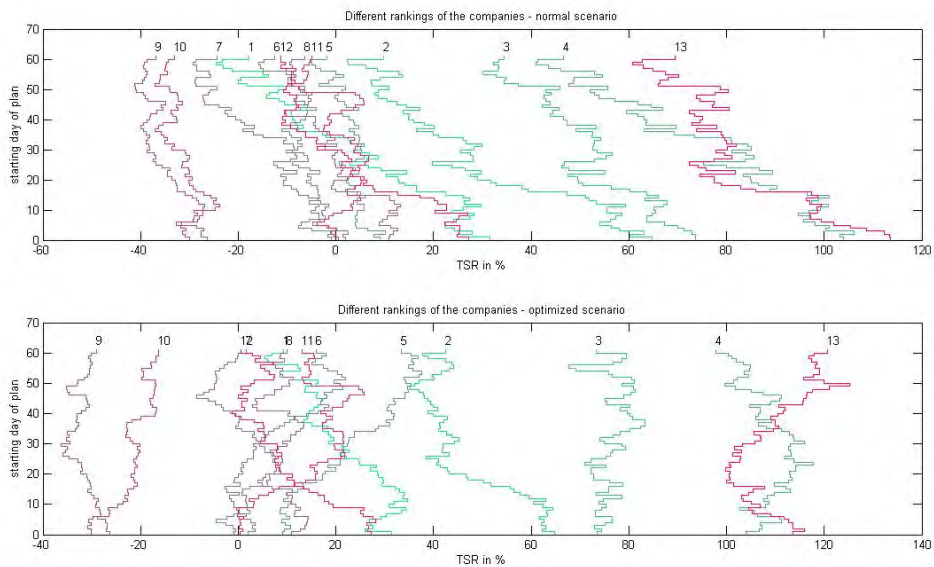


Figure 26 Change in ranking of all companies, when the starting dates of the plan changes. This is only one simulation run of model 3.

Figure 27 shows the average over all simulations of final TSR values of all companies and the respective deviations. Notice that the average TSR values of the companies are closely positioned to each other. In spite of the chaotic picture it is still noticeable that the average deviation of the optimized companies is less compared to the normal situation. This model does not produce good results. This is caused by the close positions of each other, despite of the reduction in average deviation.

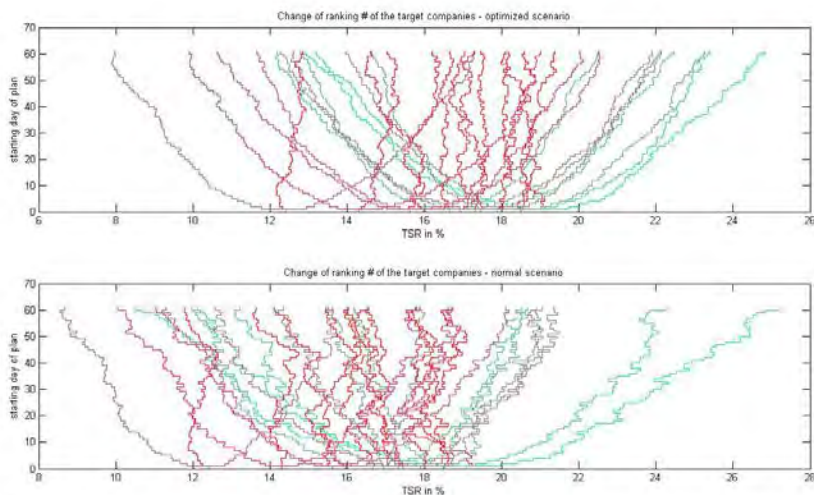


Figure 27 Change in ranking of all companies, when the starting dates of the plan changes. Notice the average TSR values (red) and the average deviations of all companies. Every average deviation of a specific company has its own colour. The first graph is the optimized scenario and the lower graph is the normal situation.

[***Classified***]

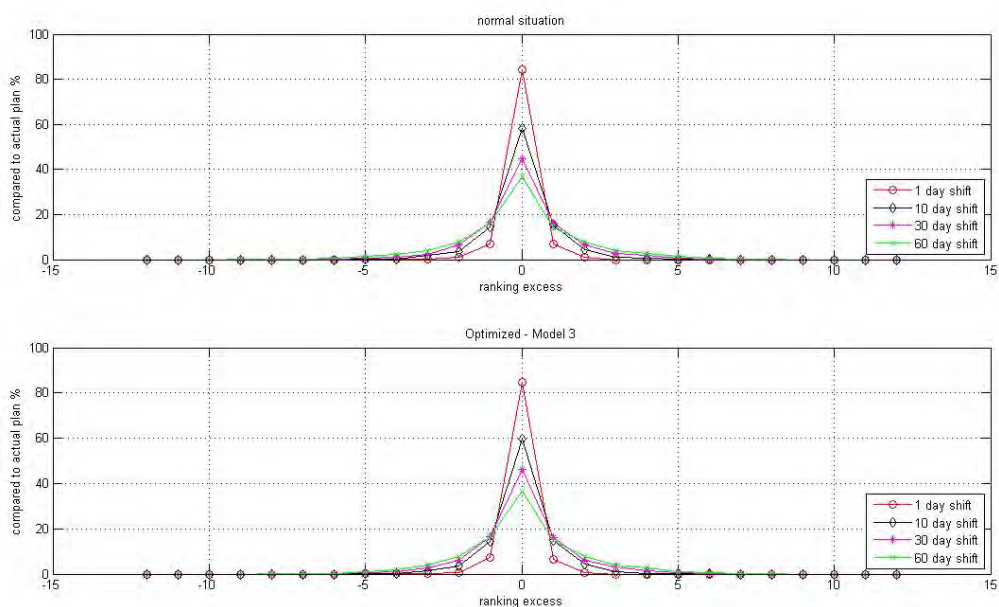


Figure 28 Percentage that stays the same compared to the actual plan versus excess ranking. The upper figure is the normal situation and in the lower all companies were optimized.

4.5 Analysis of model 4

Figure 29 shows the results with and without the integration of model 4. The results can also be found in Table 8, and it illustrates very clear that model 2, which also uses model 4, produces really good results. If model 4 is also included in model 3, then the results increase approximately with ten percent (see Figure 30). This increase can be counted due the decrease of the standard deviations of the final TSR values of all companies (see Figure 31). Hence we can conclude that model 4 is of great help in reducing the time dependency of the TSR values.

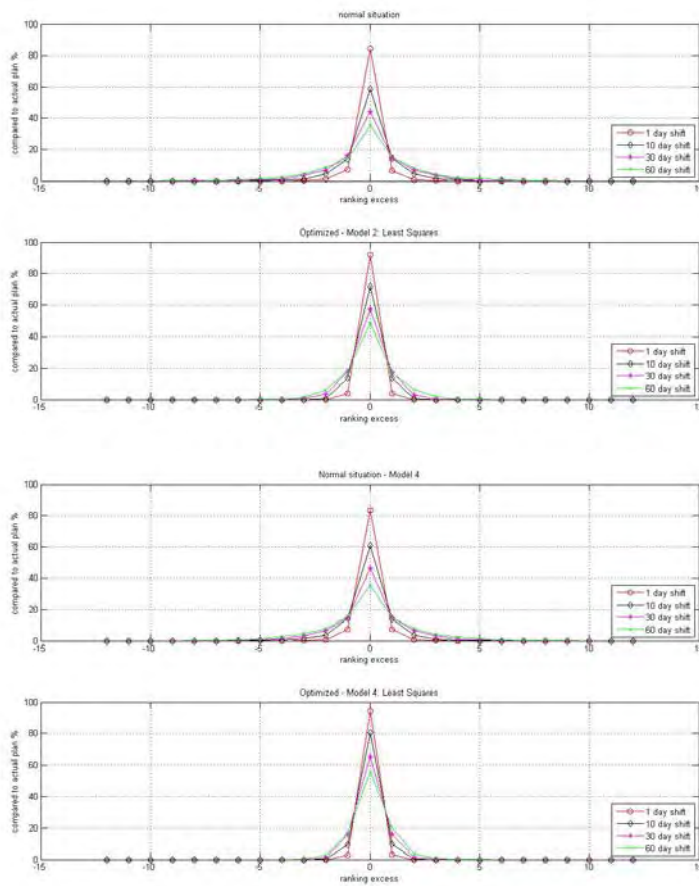


Figure 29 Percentage that stays the same compared to the actual plan versus excess ranking. The upper two figures is the normal situation and model 2 without model 4 and on the lower two is the normal situation and model 2 with the use of model 4.

Table 8 No change in ranking number compared to actual plan in %

starting date	normal situation	model 2 - least squares	model 4 - normal situation	model 4 + model 2 - least squares	model 3 - least squares	model 4 + model 3 - least squares
1	84.32	91.76	88.24	94.20	83.29	85.31
10	58.52	71.92	67.92	80.44	58.29	70.40
30	44.32	57.36	54.00	66.20	45.86	55.00
60	35.60	48.56	46.00	56.80	35.70	46.86

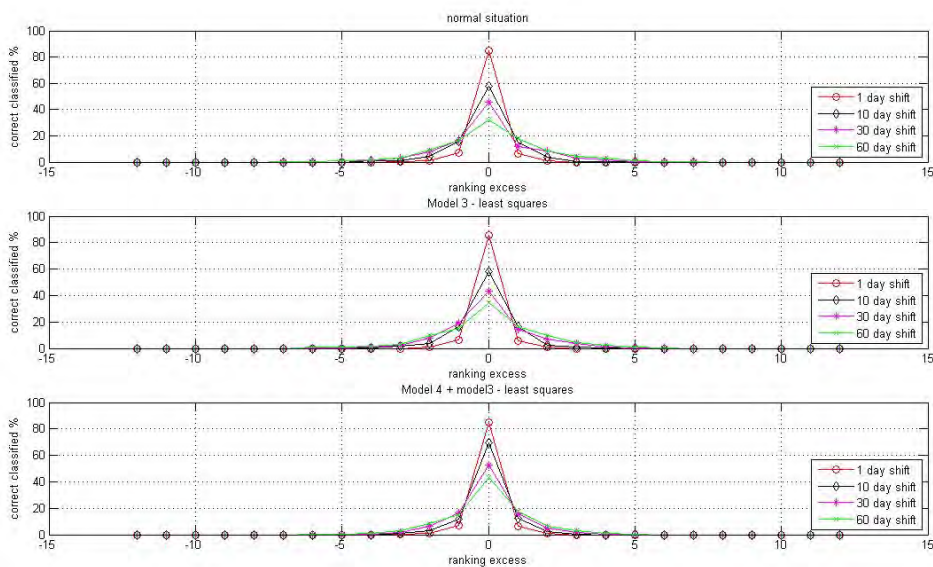


Figure 30 Percentage that stays the same compared to the actual plan versus excess ranking. The upper is the normal situation, the middle figure uses model 3, and the lower uses model 3 with model 4.

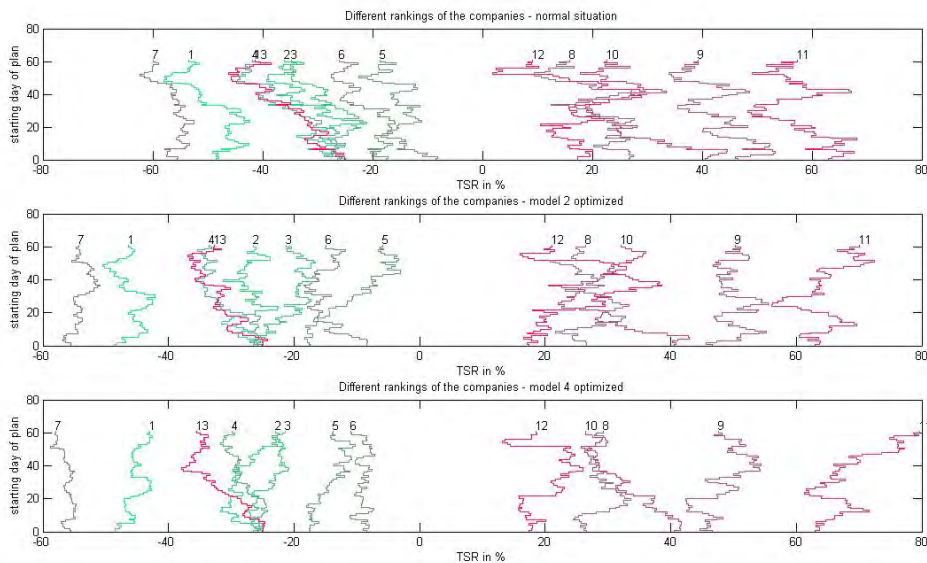


Figure 31 Change in ranking of all companies, when the starting dates of the plan changes. Upper figure is the normal situation, in the middle is model 3 used, and the lower uses model 3 integrated with model 4. This is just one simulation.

Figure 32 shows the average over all simulations of final TSR values of all companies and the respective deviations. Notice that the average TSR values of the companies are closely positioned to each other. The first graph shows model 4 added to model 3, the second graph shows model 3, and the last graph shows the normal situation. In spite of the chaotic picture it is still noticeable that the average deviation of the optimized

companies (first two graphs) is less compared to the normal situation, especially if we add model 4 to model 3. If we just use model 4, without model 3 added, then the results are the same as with model 3 added to model 4 (see Table 8). This is, once again, caused by the close positions of each company, despite of the reduction in average deviation.

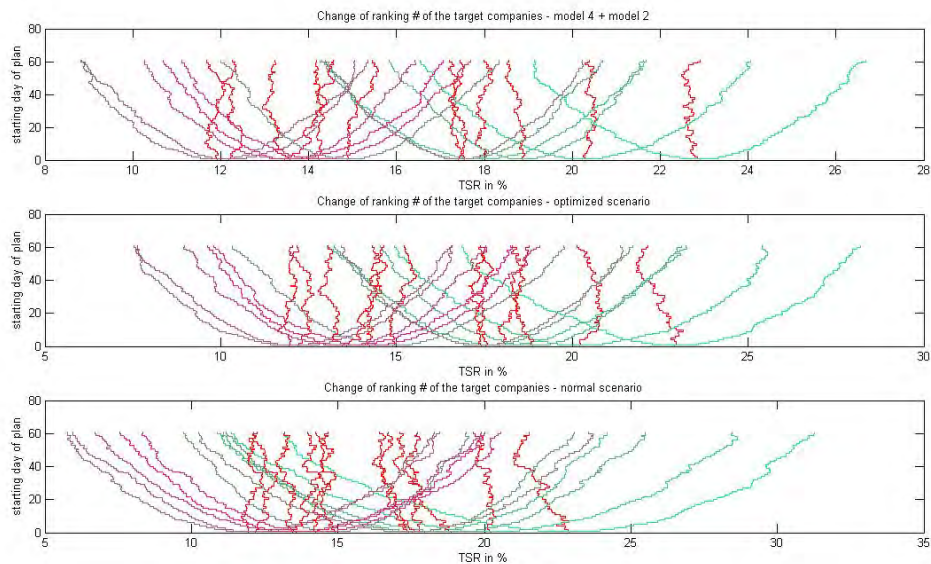


Figure 32 Change in ranking of all companies, when the starting dates of the plan changes. Notice the average TSR values (red) and the average deviations of all companies. Every average deviation of a specific company has its own colour. The first graph is model 4 added to model 3, the middle one is model 3 and the lower graph is the normal situation.

4.6 Simulation and reality

[***Classified***]

5 Conclusion

There are a number of things that became clear during the research, but the most important conclusion is that the simulation models can be very useful for executive directors. With the use of a simulation model, the executive directors get more insight of his likelihood to receive a reward. These simulation models can only be used to give a probability of a specific reward. If we like to use the optimization in practice, then we have to adjust some properties of the LTIP, such as the performance period.

The Yahoo program that was build to receive and present the financial data works very well, but it was really hard to find the right ticker of a specific company. Besides the ticker, also the financial data was sometimes incomplete. Therefore it is encourages to use another financial data provider like Bloomberg to receive the needed data.

*[***Classified***]*

*[***Classified***]*

Further research

The research conducted in this thesis only analyzed the target company Aegon and its peer group. We have seen in paragraph 2.1 that also a program is written to receive the needed historical data from Yahoo finance. We still had trouble receiving the data, because it was hard to find the right tickers for each individual company. There were already some tests done on different target companies with an incomplete peer group, which resulted in a low correlation coefficient. Thus we believe that you must be 'lucky' to obtain a peer group which correlated well with the target company. We have also seen in paragraph 4.4 that the optimization of some companies within the peer group of Aegon results in low correlation coefficients. This also implies that a high correlation coefficient is not really common. Unfortunately there was no other, easy accessible, financial data provider available.

There are also some tests done, during the internship, on non-linear models. We used, for example, a neural network (feed-forward back-propagation network) and it already showed some better correlation coefficients compared to the linear model. The central idea of neural networks is that parameters can be adjusted, so that the network exhibits some desired or interesting behaviour. Thus, you can train the network to do a particular job by adjusting the weight, or perhaps the network itself will adjust these parameters to achieve some desired end. We encountered the problem that we could not add the necessary restrictions (Equation **Error! Reference source not found.**) to the model.

The maximum correlation coefficient is an important issue in all models. It is therefore also possible to use this program to compose a peer group for a specific target company, which has the most optimal correlation coefficient possible.

References

1. T.F. Coleman and Y. Li (1996). *A Reflective Newton Method for Minimizing a Quadratic Function Subject to Bounds on Som of the Variables*. SIAM Journal on Optimization.
2. R. Fletcher (1987). *Practical Methods of Optimization*. John Wiley and Sons.
3. M.C.M. de Gunst (2005). *Statistical Models*. Vrije Universtiteit, Amsterdam.
4. W. Härdle, L. Simar (2007). *Applied Multivariate Statistical Analysis*, second edition. Springer, Berlin.
5. R. J. Harris (2001). *A Primer of Multivariate Statistics*, Third Edition. Lawrence Erlbaum Associates, London.
6. S. Holzner (1998). *Visual Basic 6 Black Book*. The Coriolis Group, USA.
7. H. Hawhee (1999). *MSCD Training Guide: Visual Basic 6*. New Riders Publishing, USA.
8. N. Hunt (2001). *Linearity Assumptions*.
<http://www.coventry.ac.uk/ec/~nhunt/regress/ass2.html>
9. S. Jensen (2004). *Lagrange multiplier*.
<http://www.slimy.com/~steuard/teaching/tutorials/Lagrange.html>
10. B. Lochtenberg (2008). <http://company.info/id/33231073>
11. D. I. Schneider (1999). *Computer Programming, Concepts and Visual Basic*. Pearson Custom Publishing, New Jersey.
12. E.W. Weissterin (2008). *Variance*.
<http://mathworld.wolfram.com/Variance.html>
13. E.W. Weisstein (2008). *Least Square Fitting*.
<http://mathworld.wolfram.com/LeastSquaresFitting.html>
14. (2005). *Visual Basic wereld*. <http://www.vbwereld.nl/>
15. (2008). *Visual Basic for Applications*.
<http://www.helpmij.nl/forum/forumdisplay.php?f=348>
16. Microsoft (2008). *MSDN library*. <http://msdn.microsoft.com/en-us/library/default.aspx>
17. (2008). *Monte Carlo method*.
http://en.wikipedia.org/wiki/Monte_Carlo_method
18. (2008). *TSR*. http://www.valuebasedmanagement.net/methods_tsr.html
19. (2008). *Correlation*. http://en.wikipedia.org/wiki/Correlation_coefficient
20. (2008). *Newton Raphson*. <http://nl.wikipedia.org/wiki/Newton-Raphson>
21. (28 March 1996) . *Quasi-Newton methods*. <http://www-fp.mcs.anl.gov/OTC/Guide/OptWeb/continuous/unconstrained/quasi.html>
22. (2008). *Closing price definition*.
http://www.investorwords.com/907/closing_price.html
23. (2008). *Dividend definition*. <http://www.investorwords.com/1509/dividend.html>
24. (2008). *Business Resources*.
<http://college.cengage.com/business/resources/casestudies/students/financial.htm>

Appendices

1 HCG organisation chart

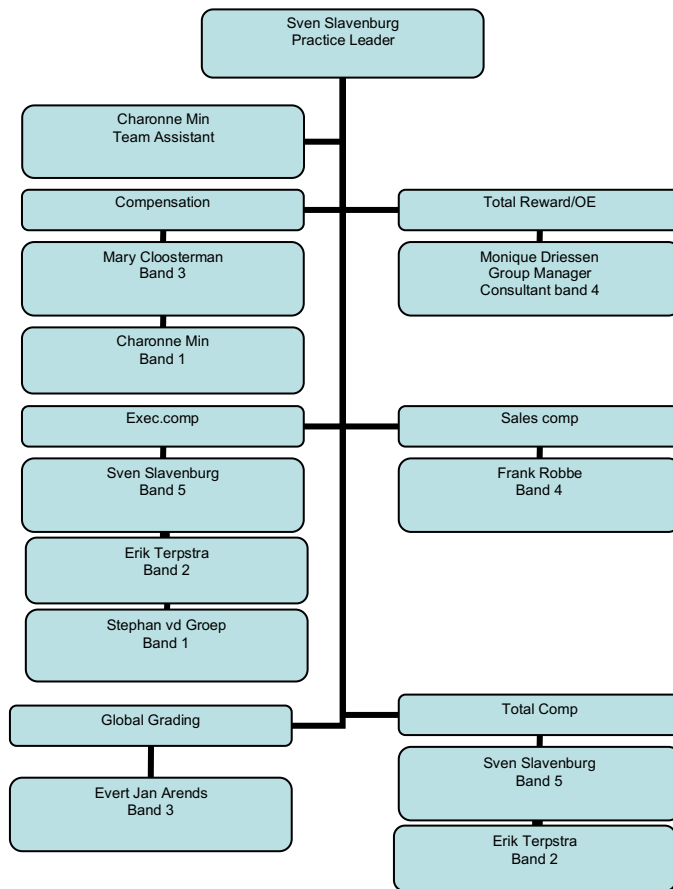


Figure 34 Organogram of HCG Watson Wyatt.

2 More details of the first and second derivative of the multivariate correlation coefficient.

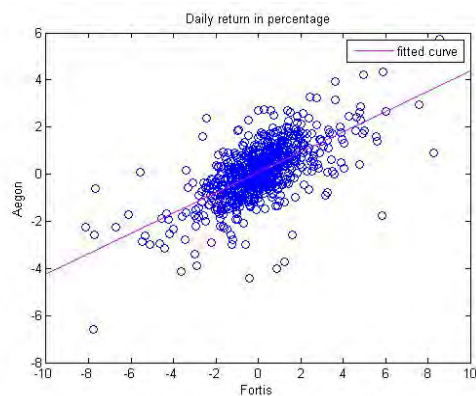
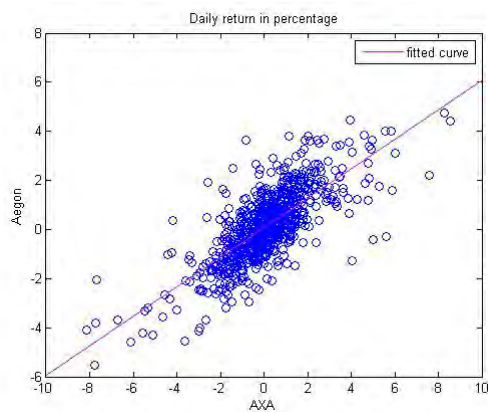
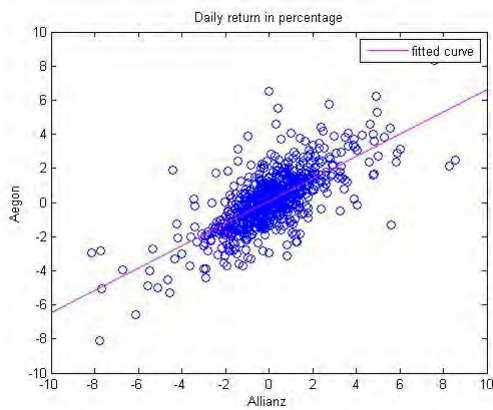
[***Classified***]

3 More details of the ordinary least squares

[***Classified***]

4 Multiple linear regression assumptions

4.1 Bivariate scatter plots



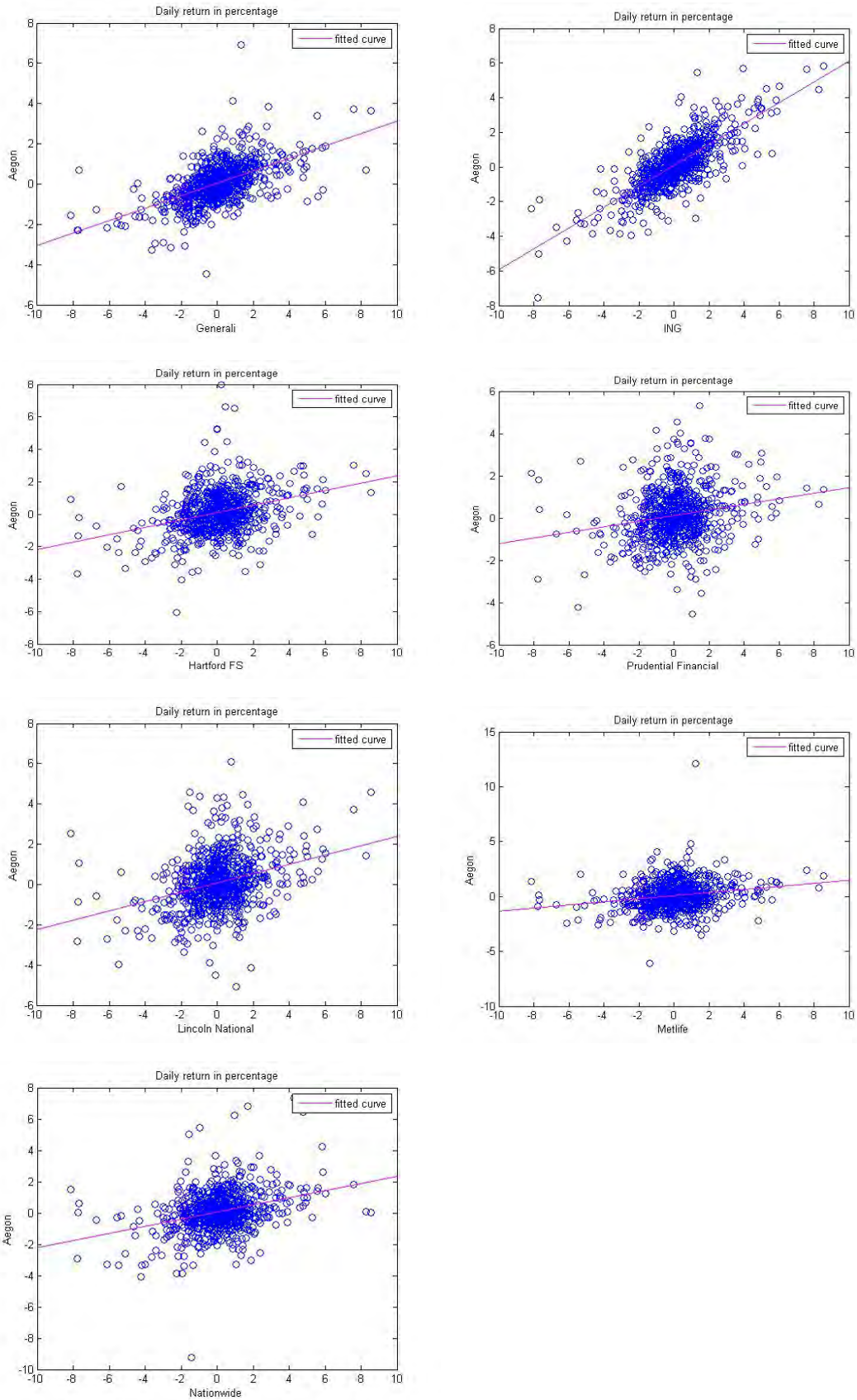
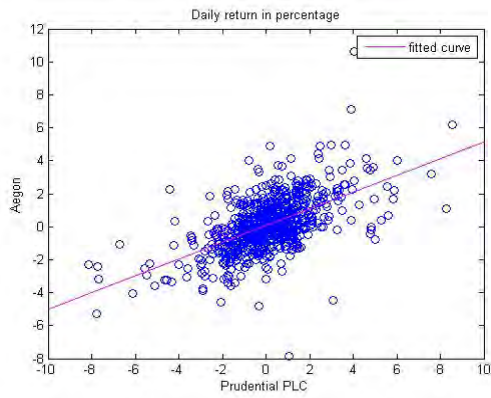


Figure 35 Scatter plots of all companies against Aegon.



4.2 Independency

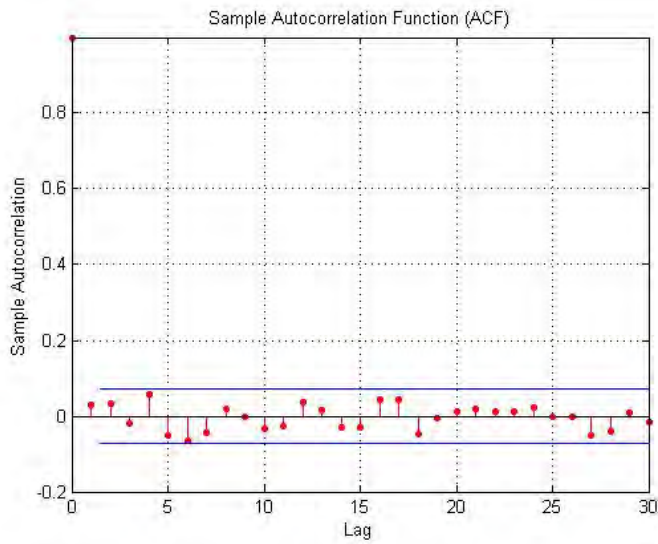


Figure 36 Autocorrelation plot.

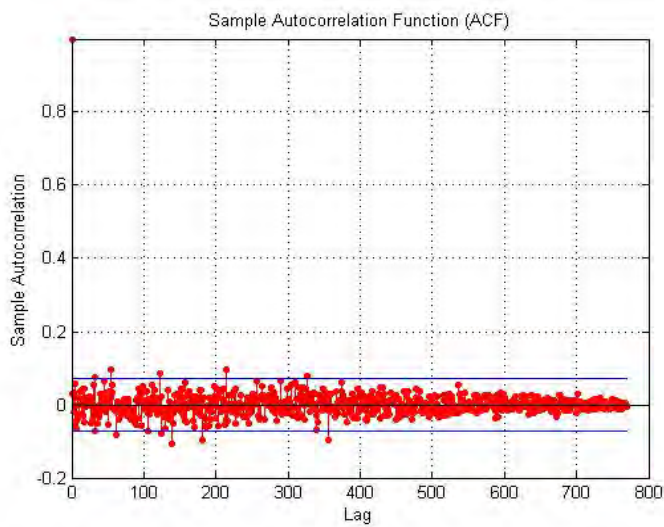


Figure 37 Autocorrelation plot.

4.3 Homoscedasticity

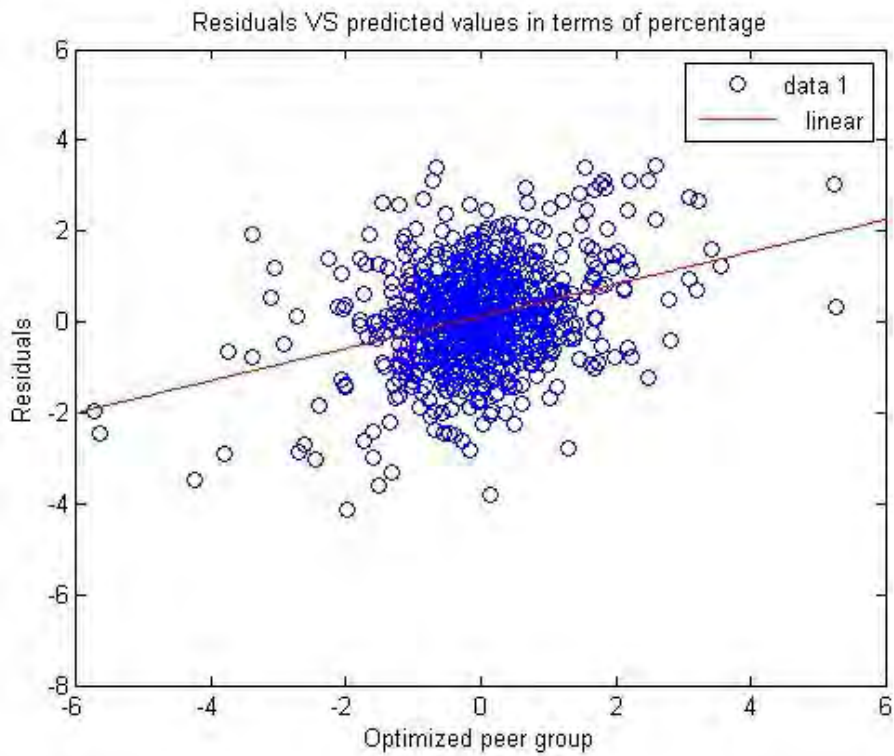


Figure 38 Plot of residuals versus optimized peer group.

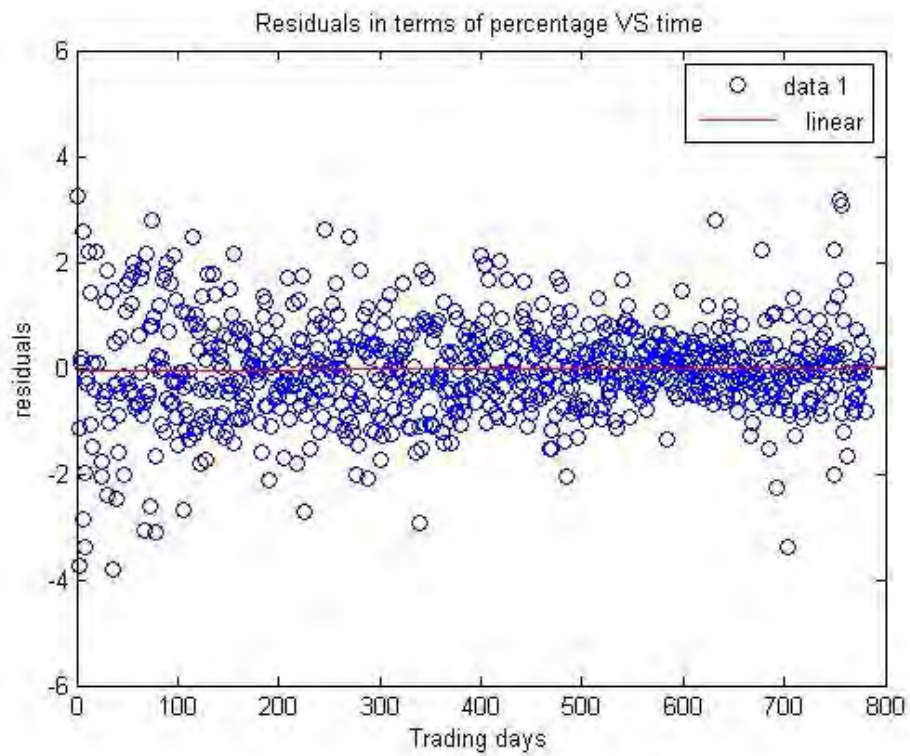


Figure 39 Plot of residuals versus trading days.

4.4 Normality check

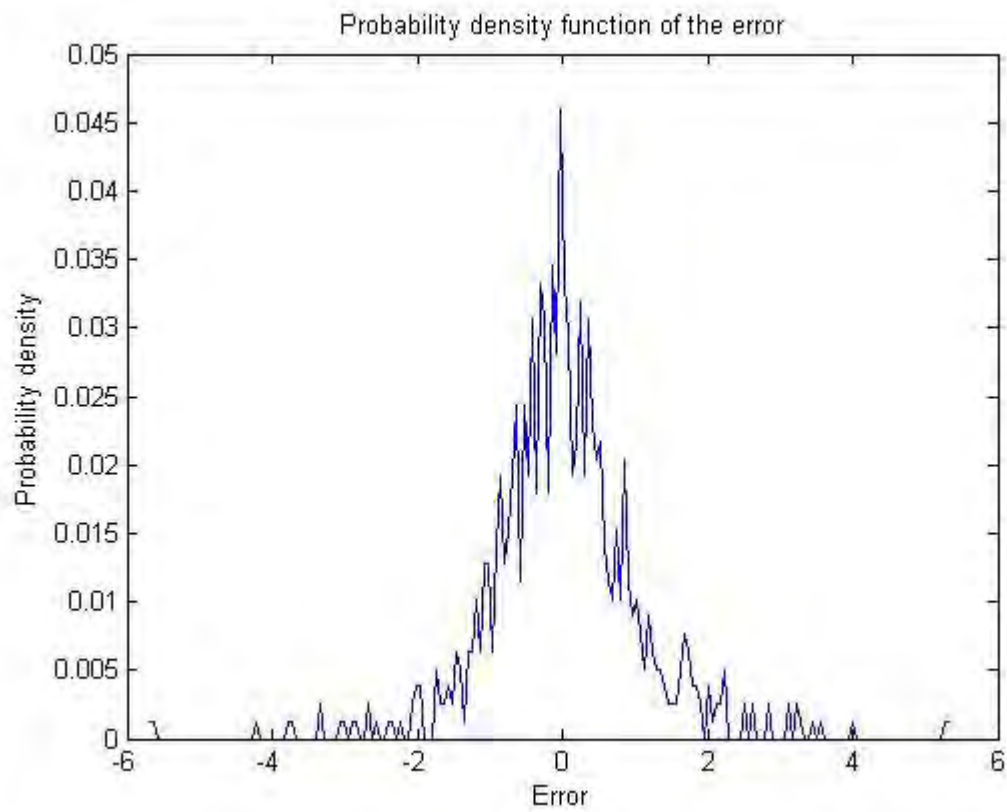


Figure 40 Probability distribution of the residuals.

5 Peer groups gathered during the analysis of the annual reports

AEX:

	National peer group		International peer group			
dsm	philips	tnt	tnt		Randstad holding nv	KPN
basf	Electrolux	Unilever	Carrefour SA	Geodis SA	Adecco S.A.	Belgacom
Akzo Nobel	Emerson Electric	Heineken	National Express Group Plc	Atlantia SPA	Manpower Inc.	BT Group Plc
Ciba	General Electric	Corporate Express	Oesterreichische Post AG	Tesco PLC	Volt Information Sciences.	Deutsche Telekom
Clariant	Hitachi	Numico	Deutsche Post AG	Tui AG	Kelly Services Inc.	France Télécom
danisco	Honeywell International	Ahold	Sainsbury PLC	PPR SA	True Blue Inc. (Labor Ready Inc.)	Hellenic Telecom
solvay	Johnson & Johnson	DSM	Deutsche Lufthansa	Kuehne Nagel	Robert Half International Inc.	Portugal Telecom SA
Ems chemie holding	Matsushita	Hagemeyer	British Airways Plc	G4S Plc	Spherion Corporation	Swisscom
lanxess	Schneider	SBM offshore	SA AB	Firstgroup Plc	USG People N.V.	Telecom Italia Spa
lonza group	Siemens	Philips Electronics	Bunzl Plc	Serco Group Plc	Vedior N.V.	Telefónica S.A.
novozymes	Toshiba	Randstad	Woolworths Group Plc	BT Group PLC		Telekom Austria
rhodia	3M	Wolters Kluwer	Rentokil Initial Plc	Adecco SA		Telenor
		Akzo Nobel	Metro AG	Scottish and Southern		TeliaSonera AB
		Reed Elsevier	Air France-KLM	Swisscom AG		Vodafone Group Plc
		ASML Holding	Delhaize SA	Belgacom SA		
		KPN	Marks and Spencer Plc	De Samensluttede A/S		
		Vedior	Securitas AB			
			Alitalia SPA			

	Ahold	tomtom	Corporate express	ING Group
Wal-Mart Stores Inc.	AEGON	TELE ATLAS	Bunzl PLC	Citigroup
Carrefour S.A.	AHOLD	TNT	Genuine Parts Company	Fortis
Metro A.G.	AKZO NOBEL	UNIBAIL-RODAMCO	Office Depot Inc.	Lloyds TSB
Tesco PLC	ARCELORMITTAL	UNILEVER	Randstad Holding NV	ABN AMRO
Target Corporation	ASML HOLDING	VEDIOR	United Stationers Inc.	Credit Suisse
The Kroger Co.	CORIO	WOLTERS KLUWER	Hagemeyer N.V.	Bank of America
Staples Inc.	CORPORATE EXPRESS		Manutan International S.A.	Deutsche Bank
Costco Wholesale Corporation	DSM		OfficeMax Inc.	HSBC
SuperValu Inc.	FORTIS		Staples Inc.	BNP Paribas
Delhaize Brothers and Co. (Delhaize Group)	HEINEKEN		Wesco International Inc.	Banco Santander

Safeway Inc.	ING GROEP	W.W. Grainger Inc.	Aegon
	KPN	Premier Farnell plc	Munich Re
	PHILIPS	Electrocomponents plc	AXA
	RANDSTAD		Prudential UK
	REED ELSEVIER		Hartford Financial Services
	ROYAL DUTCH SHELLA		AIG
	SBM OFFSHORE		Allianz
			Aviva
			Invesco

Reed Elsevier		heineken	unilever		AKZONOBEL	Wolters Kluwer
The Thomson Corporation	Informa	Anheuser-Busch Inc.	Kraft	Colgate	Arkema group	Arnoldo Mondadori
United Business Media	Taylor Nelson	Carlsberg A/S	Lion	Danone	BASF	Emap
McGraw Hill		InBev S.A.	L'Oréal	Heinz	Ciba Specialty Chemicals	Reed Elsevier
Fair Isaac		SABMiller plc	Nestlé	Kao	Dow Chemical Company	McClatchy.
Reuters Group		Scottish & Newcastle plc	Orkla	Kimberly-Clark	DuPont	Axel Springer
John Wiley & Sons		Henkel KGaA	PepsiCo		Hercules	Grupo PRISA
Pearson		L'Oréal S.A.	Procter & Gamble		Kansai Paint	Reuters
DMGT		LVMH S.A.	Reckitt Benckiser		Kemira OYJ	Dun & Bradstreet
Wolters Kluwer		Diageo Plc.	Sara Lee		PPG Industries	John Wiley & Sons
Lagardere		Nestlé S.A.	Shiseido		RPM Industrial	T&F Informa
ChoicePoint		Unilever N.V.	Avon		Sherwin-Williams	Lagardère
Dun & Bradstreet			Beiersdorf		Valspar Corporation	Thomson
Dow Jones			Cadbury Schweppes			McGraw-Hill
EMAP			Clorox			United Business Media
WPP			Coca-Cola			Pearson

AMX :

	international	national				
Stork	SNS	sns	oce	Imtech	CSM	DrakaHolding
AALBERTS INDUSTRI	CNP Assurance	AALBERTS INDUSTRI	Agfa Heidelberg Druck	ABB	ABF	Andrew Corp
AMG	Nordea Bank	AMG		Getronics	Südzucker	Belden CDT
ARCADIS ASM INTERNATIONAL	Storebrand	ARCADIS ASM INTERNATIONAL	DSM	Berger	Tate & Lyle	Commscope
BAM GROEP KON	Northern Rock		Akzo Nobel	AMEC	Wessanen.	Daetwyler
BINCKBANK BOSKALIS WESTMIN	Unipol	BAM GROEP KON	Infineon	Stork	ADM	Fugro
	Swiss Life	BINCKBANK BOSKALIS WESTMIN	ASMI	BAM	Danisco	Fujikura
	Fortis		Philips	Suez	Ebro Puleva	Hagemeyer General Cable Corp
CRUCCELL	Irish Life & Permanent	CRUCCELL	ASML	Vinci	General Mills	
CSM	ING	CSM	Stork	Siemens	IAWS Group	Leoni

DRAKA HOLDING	Brandford & Bingley.	DRAKA HOLDING	Bilfinger	Kerry Group	Nexans
EUROCOMM. PROP CD	Den Norske Bank	EUROCOMM. PROP CD			SBM Offshore
FUGRO	Grupo Catalan Occidente.	FUGRO			Stork
HEIJMANS		HEIJMANS			Superior Essex
IMTECH		IMTECH			
LOGICA		LOGICA			
NUTRECO		NUTRECO			
OCE		OCE			
ORDINA		ORDINA			
SNS REAAL		USG PEOPLE			
USG PEOPLE		VASTNED RETAIL			
VASTNED RETAIL		VOPAK			
VOPAK		WAVIN			
WAVIN		WERELDHAVE			
WERELDHAVE		WESSANEN KON			
WESSANEN KON					

Nutreco		LogicaCMG		Wessanen		Arcadis	
AEGON	TNT	HEIJMANS	GRONTMIJ	Indra Sistemas	SunOpta Inc.	URS (U.S.)	
AHOLD	TOMTOM	IMTECH	HUNTER DOUGLAS	iSOFT	Nestlé	TRC (U.S.)	
AKZO NOBEL	UNIBAIL-RODAMCO	LOGICA	INNOCONCEPTS	Misys	Unilever	WSP (U.K.)	
ARCELORMITTAL	UNILEVER	OCE	KARDAN	Ordina	CSM	Grontmij (NL)	
ASML HOLDING	VEDIOR	ORDINA	MACINTOSH RETAIL	Sage	Hain Celestial Group	Atkins (U.K.)	
CORIO	WOLTERS KLUWER	SNS REAAL	NIEUWE STEEN INV	SAP	Kraft	Sweco (S)	
CORPORATE EXPRESS	AALBERTS INDUSTR	USG PEOPLE	OPG GROEP	Sopra Group	Heinz	Alten (Fr)	
DSM	AMG	VASTNED RETAIL	PHARMING GROUP	TietoEnator	Danone	Pöyry (Fin)	
FORTIS	ARCADIS	VOPAK	QURIUS AMD	Xansa	United Natural Foods Inc.	Tetra Tech (U.S.)	
HEINEKEN	ASM INTERNATIONAL	WAVIN	SLIGRO FOOD GROUP	Atos Origin			
ING GROEP	BAM GROEP KON	WERELDHAVE	SMIT INTERNATIONAL	Capgemini			
KPN	BINCKBANK	WESSANEN KON	SUPER DE BOER	CGI Group			
PHILIPS	BOSKALIS WESTMIN	ANTONOV	TELEGRAAF MEDIA GR	Computer Sciences Corp.			
RANDSTAD	CRUCCELL	BALLAST NEDAM	TEN CATE	Dassault Systems			
REED ELSEVIER	CSM	BETER BED	TKH GROUP	Electronic Data Systems (EDS)			
ROYAL DUTCH SHELLA	DRAKA HOLDING	BRUNEL INTERNAT	UNIT 4 AGRESSO	Getronics			
SBM OFFSHORE	EUROCOMM. PROP CD	ERIKS GROEP	VAN DER MOOLEN	Groupe Steria			
TELE ATLAS	FUGRO	EXACT HOLDING	VAN LANDSCHOOT	IBM			
			VASTNED OFF/IND				

6 Yahoo financial data receiver program

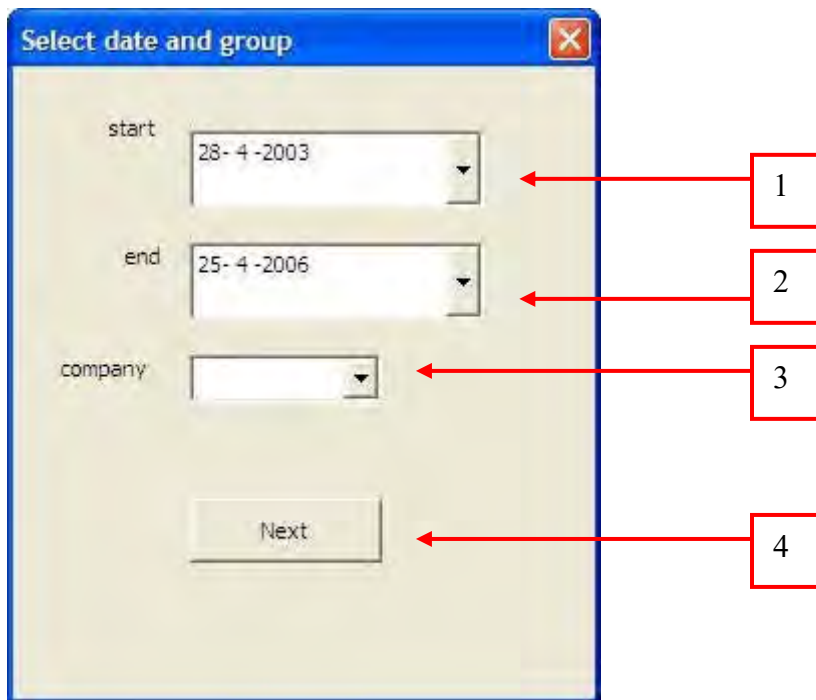


Figure 41 - Yahoo data sheet 1.

To create an organized presentation of the date in Excel, we need to perform the following steps in the Yahoo historical data receiver program:

1. Select the starting date of the historical data you like to receive.
2. Select the end date of the historical data you like to receive. If the interval between these data is not available in Yahoo, then it will take the largest interval of the target company which is available in Yahoo.
3. Over here we can fill in our target company, we can also use the drop-down list box to select a predefined target company.
4. Once the data and company are filled-in we can go to the next screen by pushing the "Next" button. While doing this there will be a check if there really is a target company selected and if the end date isn't smaller than the starting date.

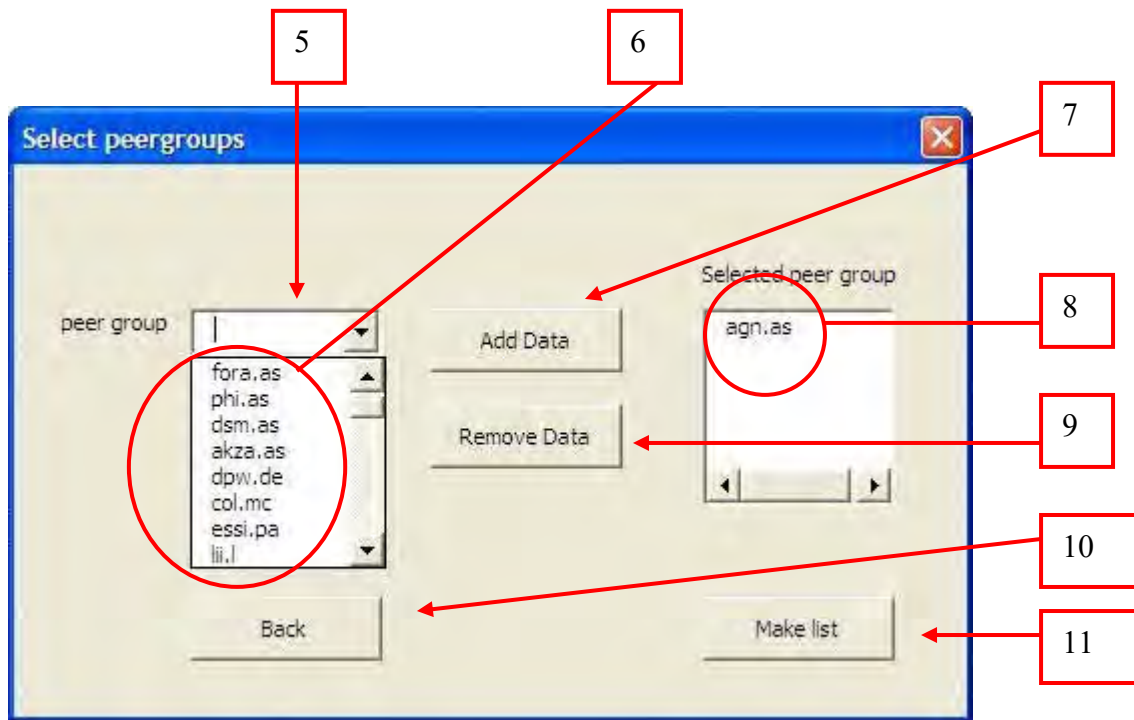


Figure 42 - Yahoo data sheet 2.

5. It is now time to select the peer group. We can type each peer group manually in the textbox or we can select one from the drop-down box (6).
7. The peer group can now be added to the list, we can do this by pressing the “Add data” button. If we aren’t satisfied with the added peer group we can always remove it with the “Remove Data” button (9).
8. In this list we can see the whole peer group and the up most one is the target company itself.
10. If we decide to use another company we can always go back to the previous page by selecting the “Back” button.
11. When everything is filled in correctly it is time to create the list in excel by pushing the “Make list” button

Once the list is constructed, there will be a clear presentation of the daily share price and dividend of the selected companies. The third part of the project is done in Matlab, hence there is also a sheet “Matlab data” where you can copy paste the requested data directly into Matlab (see Figure 43).

Microsoft Excel - getYahooHistory.xls

File Edit View Insert Format Tools Data Window Help

100%

Arial

	A	B	C	D	E	F	G	H	I	J	K
4	Date	Close	Dividends		Date	Close	Dividends		Date	Close	Dividends
5	28-4-2003	9.5	0		28-4-2003	14.77	0		28-4-2003	16.72	0
6	29-4-2003	9.08	0		29-4-2003	14.56	0		29-4-2003	16.68	0
7	30-4-2003	9.11	0		30-4-2003	14.55	0		30-4-2003	16.67	0
8	1-5-2003	9.11	0		1-5-2003	14.55	0		1-5-2003	16.67	0
9	2-5-2003	9.08	0		2-5-2003	14.1	0		2-5-2003	16.82	0
10	5-5-2003	9.52	0		5-5-2003	14.6	0		5-5-2003	17.25	0
11	6-5-2003	9.56	0		6-5-2003	15.19	0		6-5-2003	17.18	0
12	7-5-2003	9.16	0		7-5-2003	15.17	0		7-5-2003	17.16	0
13	8-5-2003	8.6	0		8-5-2003	14.52	0		8-5-2003	16.65	0
14	9-5-2003	8.62	0		9-5-2003	14.48	0		9-5-2003	16.75	0
15	12-5-2003	8.66	0		12-5-2003	14.45	0		12-5-2003	16.66	0
16	13-5-2003	8.8	0		13-5-2003	14.45	0		13-5-2003	16.56	0
17	14-5-2003	8.92	0		14-5-2003	14.35	0		14-5-2003	16.3	0
18	15-5-2003	8.88	0		15-5-2003	14.34	0		15-5-2003	16.32	0
19	16-5-2003	8.99	0		16-5-2003	14.54	0		16-5-2003	16.52	0
20	19-5-2003	8.29	0		19-5-2003	13.44	0		19-5-2003	15.37	0
21	20-5-2003	8.17	0		20-5-2003	13.28	0		20-5-2003	15.16	0
22	21-5-2003	7.54	0		21-5-2003	12.61	0		21-5-2003	14.75	0
23	22-5-2003	7.94	0		22-5-2003	13.18	0		22-5-2003	15.18	0
24	23-5-2003	7.33	0		23-5-2003	12.93	0		23-5-2003	14.97	0
25	26-5-2003	7.34	0		26-5-2003	12.81	0		26-5-2003	14.85	0
26	27-5-2003	7.69	0		27-5-2003	12.9	0		27-5-2003	15.15	0
27	28-5-2003	8.14	0		28-5-2003	13.4	0		28-5-2003	16	0
28	29-5-2003	8.11	0		29-5-2003	13.65	0		29-5-2003	16.11	0
29	30-5-2003	8.03	0		30-5-2003	13.7	0		30-5-2003	16.61	0
30	2-6-2003	8.25	0		2-6-2003	14.14	0		2-6-2003	17.23	0
31	3-6-2003	8.14	0		3-6-2003	14.15	0		3-6-2003	17	0
32	4-6-2003	8.39	0		4-6-2003	14.64	0		4-6-2003	17.28	0
33	5-6-2003	8.3	0		5-6-2003	14.64	0		5-6-2003	17.45	0
34	6-6-2003	8.7	0		6-6-2003	15.21	0		6-6-2003	18.21	0
35	9-6-2003	8.33	0		9-6-2003	14.84	0		9-6-2003	17.5	0
36	10-6-2003	8.33	0		10-6-2003	14.7	0		10-6-2003	17.77	0
37	11-6-2003	8.82	0		11-6-2003	15.17	0		11-6-2003	17.82	0
38	12-6-2003	9.55	0		12-6-2003	15.85	0		12-6-2003	17.88	0
39	13-6-2003	8.91	0		13-6-2003	15.3	0		13-6-2003	16.91	0
40	16-6-2003	9.29	0		16-6-2003	15.78	0		16-6-2003	17.25	0
41	17-6-2003	9.37	0		17-6-2003	15.9	0		17-6-2003	17.23	0
42	18-6-2003	9.5	0		18-6-2003	16.21	0		18-6-2003	17.53	0
43	19-6-2003	8.98	0		19-6-2003	15.78	0		19-6-2003	17.2	0
44	20-6-2003	8.98	0		20-6-2003	15.7	0		20-6-2003	17.16	0
45	23-6-2003	8.57	0		23-6-2003	15.2	0		23-6-2003	16.78	0
46	24-6-2003	8.5	0		24-6-2003	14.98	0		24-6-2003	16.52	0
47	25-6-2003	8.6	0		25-6-2003	15.4	0		25-6-2003	16.73	0
48	26-6-2003	8.55	0		26-6-2003	15.32	0		26-6-2003	16.4	0
49	27-6-2003	9.03	0		27-6-2003	15.44	0		27-6-2003	17.1	0
50	30-6-2003	8.72	0		30-6-2003	15.13	0		30-6-2003	16.56	0
51	1-7-2003	8.46	0		1-7-2003	14.65	0		1-7-2003	16.06	0

Matlab data \ Closing prices and dividends/

Figure 43 Output of the Yahoo program.

7 Visual Basic code Yahoo! program

Modules:

```
Public linesGroup() As Integer
Public endDateGroup() As Date
Public beginDateGroup() As Date

Sub start()
' removes all data when the program
is started
addCodes ("")
Worksheets("Closing prices and
dividends").Activate
ActiveSheet.Cells(2,
3).ClearContents
ActiveSheet.Cells(2,
4).ClearContents
ActiveSheet.Range("a2",
ActiveSheet.Range("iv2").End(xlToLeft)).
Select
Selection.ClearContents
ActiveSheet.Range("a4:iv4").Select

For j = 0 To Int(Selection.Count /
4) - 1
If ActiveSheet.Cells(4, 1 + (j *
4)).HasArray = True Then
ActiveSheet.Cells(4, 1 + (j
* 4)).Select

Selection.CurrentArray.ClearContents
End If
ActiveSheet.Cells(2, 2 + (j *
4)).Interior.ColorIndex = 0
ActiveSheet.Cells(2, 2 + (j *
4)).ClearContents
Next

Worksheets("Matlab data").Activate
ActiveSheet.Range("a1",
ActiveSheet.Range("iv10000")).Select
Selection.ClearContents
Worksheets("Closing prices and
dividends").Activate
ActiveSheet.Cells(1, 1).Activate
UserForm1.Show
End Sub
Sub addCodes(company As String)
' imports all data into the combo
boxes
Worksheets("Ticker").Activate
Dim rData As Range
Dim r As Range

On Error Resume Next
Set rData = ActiveSheet.Range("a1",
ActiveSheet.Range("a1000").End(xlUp))
On Error GoTo 0
If Not rData Is Nothing Then
UserForm2.combo2.Clear
UserForm1.combo1.Clear
For Each r In rData
If r.Text <> company Then
UserForm1.combo1.AddItem (r.Text &
"aap")
```

```
UserForm1.combo1.AddItem
r.Text
UserForm2.combo2.AddItem
r.Text
End If
Next
UserForm1.combo1.ListIndex = -1
UserForm2.combo2.ListIndex = -1
End If
End Sub
```

```
Public Function getYahooHistory(pTicker
As String, _
Optional
pStartYear As Integer = 0, _
Optional
pStartMonth As Integer = 0, _
Optional
pStartDay As Integer = 0, _
Optional
pEndYear As Integer = 0, _
Optional
pEndMonth As Integer = 0, _
Optional
pEndDay As Integer = 0, _
Optional k As
Integer = 0, _
Optional
adjust As Integer = 0) As Variant()
' function to download historical
quotes from Yahoo
' > Example to get daily quotes from
2000 to 2007 for Aegon:
=getYahooHistory("agn.as",2000,1,1,2007,
12,31,,)

ReDim Preserve Module1.linesGroup(k
+ 1)
Dim sURL As String
Dim dURL As String
On Error GoTo ErrorExit

' Null Return Item
If pTicker = "None" Or pTicker = ""
Then
ReDim vData(1 To 1, 1 To 1) As
Variant
vData(1, 1) = "None"
getYahooHistory = vData
Exit Function
End If

' checks dimensie, dim1=aantalDagen,
dim2=aantalKolommen/peergroup
cellCount = Application.Caller.Count
On Error GoTo ErrorExit
If cellCount = 0 Then
dim1 = 0
```

```

        dim2 = 0
    Else
        If cellCount = 1 Then dim1 = 1
    Else dim1 =
    UBound(Application.Caller.Formula)
        dim2 = cellCount / dim1
    End If

    ' Initialize return array
    ReDim vData(1 To dim1, 1 To dim2) As
Variant
    For i1 = 1 To dim1
        For i2 = 1 To dim2
            vData(i1, i2) = ""
        Next i2
    Next i1

    ' Checks if the parameters are out
of range
    If pStartYear = 0 And _
        pStartMonth = 0 And _
        pStartDay = 0 And _
        pEndYear = 0 And _
        pEndMonth = 0 And _
        pEndDay = 0 Then
    Else
        If pStartYear < 1900 Or
pStartYear > 2100 Or _
        pStartMonth < 1 Or
pStartMonth > 12 Or _
        pStartDay < 1 Or pStartDay >
31 Or _
        pEndYear < 1900 Or pEndYear
> 2100 Or _
        pEndMonth < 1 Or pEndMonth >
12 Or _
        pEndDay < 1 Or pEndDay > 31
Or _
        pStartYear & Right("0" &
pStartMonth, 2) & Right("0" & pStartDay,
2) > _
        pEndYear & Right("0" &
pEndMonth, 2) & Right("0" & pEndDay, 2)
Then
            vData(1, 1) = "Something
wrong with dates -- asked for " & _
                pStartYear & "/" &
pStartMonth & "/" & pStartDay & " thru "
& _
                pEndYear & "/" & pEndMonth &
"/" & pEndDay
            GoTo ErrorExit
        End If
    End If

    ' get the data from yahoo and put it
into a string
    sURL =
"http://ichart.finance.yahoo.com/table.c
sv?s=" & pTicker & _
        IIf(pStartMonth <= 10, "&a=0" &
(pStartMonth - 1), "&a=" & (pStartMonth
- 1)) & _
        "&b=" & pStartDay & _
        "&c=" & pStartYear & _
        IIf(pEndMonth <= 10, "&d=0" &
(pEndMonth - 1), "&d=" & (pEndMonth -
1)) & _
        "&e=" & pEndDay & _
        "&f=" & pEndYear & _
        "&g=" & "d" & _
        "&ignore=.csv"

    ' Get date from site
    Dim oHTTP As New XMLHTTP

```

```

    ' we are using the get protocol,
sURL is location of the page, no data
transfer in the background
    oHTTP.Open "GET", sURL, False
    'carrying out the request
    oHTTP.Send
    ' check if the status of the
connection is good, negative then the
amount of lines is set to zero
    If oHTTP.Status <> "200" Then
        Module1.linesGroup(k + 1) = 0
    End If
    ' check if the status of the
connection is good, negative then exit
    If oHTTP.Status <> "200" Then GoTo
ErrorExit
    ' the response entity body is in
stringformat
    If (oHTTP.readyState = 4) Then
        sData = oHTTP.responseText
    Else
        Application.StatusBar = "Loading
please wait"
    End If

    '
http://ichart.finance.yahoo.com/table.cs
v?s=LNC&a=09&b=5&c=1984&d=01&e=22&f=2008
&g=v&ignore=.csv
    dURL =
"http://ichart.finance.yahoo.com/table.c
sv?s=" & pTicker & _
        IIf(pStartMonth <= 10, "&a=0" &
(pStartMonth - 1), "&a=" & (pStartMonth
- 1)) & _
        "&b=" & pStartDay & _
        "&c=" & pStartYear & _
        IIf(pEndMonth <= 10, "&d=0"
& (pEndMonth - 1), "&d=" & (pEndMonth -
1)) & _
        "&e=" & pEndDay & _
        "&f=" & pEndYear & _
        "&g=" & "v" & _
        "&ignore=.csv"

    ' Get date from site
    Dim dHTTP As New XMLHTTP
    ' we are using the GET protocol,
dURL is location of the page, no data
transfer in the background
    dHTTP.Open "GET", dURL, False
    'carrying out the request
    dHTTP.Send
    ' check if the status of the
connection is good, negative then the
amount of lines is set to zero
    If dHTTP.Status <> "200" Then
        Module1.linesGroup(k + 1) = 0
    End If
    ' check if the status of the
connection is good, negative then exit
    If dHTTP.Status <> "200" Then GoTo
ErrorExit
    ' the response entity body is in
stringformat
    If (dHTTP.readyState = 4) Then
        dData = dHTTP.responseText
    Else
        Application.StatusBar = "Loading
please wait"
    End If

    ' get all lines seperated by
character 10 (character that breaks the
line)

```

```

vLine = Split(sData, Chr(10))
dLine = Split(dData, Chr(10))
' set column numbers
idate = 1
iClos = 2
iDiv = 3
' Static nlines As Integer
dLines = UBound(dLine)
nlines = UBound(vLine)
Module1.linesGroup(k + 1) = nlines

' read the lines
dRow = 2
For iRow = 1 To nlines
' get columns out of lines,
seperated by ", "
vitem = Split(vLine(iRow - 1),
",")
Select Case iRow
' read the first lines
Case Is = 1
ditem =
Split(dLine(iRow - 1), ",")
vData(iRow, idate) =
vitem(0)
vData(iRow, iDiv) =
ditem(1)
vData(iRow, iClos) =
vitem(4)
Case Is = 2
vData(iRow, iDiv) = 0
vData(iRow, idate) =
CDate(vitem(0))
vData(iRow, iClos) =
Val(vitem(4))
ReDim Preserve
Module1.endDateGroup(k + 1)
Module1.endDateGroup(k
+ 1) = CDate(vitem(0))
Case Is = nlines
vData(iRow, iDiv) = 0
vData(iRow, idate) =
CDate(vitem(0))
vData(iRow, iClos) =
Val(vitem(4))
ReDim Preserve
Module1.beginDateGroup(k + 1)
Module1.beginDateGroup(k + 1) =
CDate(vitem(0))
Case Else
vData(iRow, iDiv) = 0
vData(iRow, idate) =
CDate(vitem(0))
vData(iRow, iClos) =
Val(vitem(4))
End Select
Next iRow

' Puts the dividend in the 3th
column
teller = 1
Do While teller <= nlines And dRow
<= dLines
ditem = Split(dLine(dRow - 1),
",")
If vData(teller, idate) =
CDate(ditem(0)) Then
vData(teller, iDiv) =
Val(ditem(1))
dRow = dRow + 1
Else
vData(teller, iDiv) = 0
End If
teller = teller + 1
Loop

```

```

' put in backorder
Dim vTemp As Variant
i1 = 2
i2 = nlines
Do While i1 < i2
For i3 = 1 To dim2
vTemp = vData(i1, i3)
vData(i1, i3) = vData(i2,
i3)
vData(i2, i3) = vTemp
Next i3
i1 = i1 + 1
i2 = i2 - 1
Loop

' fill in all the missing data, the
peroid is determined by the largest
group
If adjust = 1 Then
ReDim tempData(1 To dim1, 1 To
dim2) As Variant
For i1 = 1 To dim1
For i2 = 1 To dim2
tempData(i1, i2) = ""
Next i2
Next i1

dDatum = CDate(DatePart("d",
Cells(2, 3)) & "-" & DatePart("m",
Cells(2, 3)) & "-" & DatePart("yyyy",
Cells(2, 3)))
' set the first line with names
to tempData
tempData(1, iDiv) = vData(1,
iDiv)
tempData(1, idate) = vData(1,
idate)
tempData(1, iClos) = vData(1,
iClos)
iRow = 2
For aRow = 2 To
UserForm2.totalDaysCompany + 1
Select Case DatePart("w",
dDatum)
Case Is = 7
dDatum = dDatum + 2
Case Is = 1
dDatum = dDatum + 1
End Select
If dDatum = vData(iRow,
idate) Then
tempData(aRow, iDiv) =
vData(iRow, iDiv)
tempData(aRow, iClos) =
vData(iRow, iClos)
tempData(aRow, idate) =
dDatum
iRow = iRow + 1
Else
Select Case iRow
Case Is = 2
tempData(aRow,
idate) = dDatum
tempData(aRow, iDiv)
= 0
tempData(aRow,
iClos) = vData(iRow, iClos)
Case Else
iRow = iRow - 1
tempData(aRow,
idate) = dDatum
tempData(aRow, iDiv)
= 0
tempData(aRow,
iClos) = vData(iRow, iClos)

```

```

        iRow = iRow + 1
    End Select
End If
dDatum = dDatum + 1
Next aRow

vData(1, idate) = tempData(1,
idate)
vData(1, iDiv) = tempData(1,
iDiv)
vData(1, iClos) = tempData(1,
iClos)
For bRow = 2 To
UserForm2.totalDaysCompany + 1
    If tempData(bRow, idate) >=
Module1.beginDateGroup(1) And
tempData(bRow, idate) <=
Module1.endDateGroup(1) Then
        vData(bRow, idate) =
tempData(bRow, idate)
        vData(bRow, iDiv) =
tempData(bRow, iDiv)
        vData(bRow, iClos) =
tempData(bRow, iClos)
    End If
Next
End If

ErrorExit:
getYahooHistory = vData
End Function

```

Forms:

```

Public comp As String
Public Sub combol_AfterUpdate()
    comp = combol.Text
End Sub
Private Sub CommandButton2_Click()
    tijdWaarde = False
    startingDate = picker1.Value
    endDate = picker2.Value

    If startingDate >= endDate Then
        MsgBox ("Starting date is larger
then end date")
        picker1.SetFocus
        Exit Sub
    End If

    If Trim(comp) = "" Then
        MsgBox ("no peergroup entered")
        combol.Text = Empty
        combol.SetFocus
        Exit Sub
    End If

    ' adds the company to the combo box
Module1.addCodes (comp)
    ' adds the date to the worksheet
Worksheets("Closing prices and
dividends").Activate
    ActiveSheet.Cells(2, 3) =
startingDate
    ActiveSheet.Cells(2, 4) = endDate
    ' adds the company to the dropdown
list
    UserForm2.ListBox1.Clear
    UserForm2.ListBox1.AddItem comp
    UserForm1.Hide
    UserForm2.company = comp
    UserForm2.Show
End Sub

Dim peer(20) As String
Public company As String
Public totalDays As Integer
Public totalDaysCompany As Integer
Public beginDate2 As Date
Public endDate2 As Date
Public largestGroupNumber As Integer

Private Sub CommandButton5_Click()
    ' removes the selected company from
the list and adds it in the combo box
    If Not (ListBox1.ListIndex = -1)
Then
        ListBox1.RemoveItem
ListBox1.ListIndex

```

```

        combo2.AddItem
ListBox1.ListIndex
    End If
End Sub
Private Sub CommandButton1_Click()
    ' fill the tickers from combo to
    listBox
    If Trim(combo2.Text) = "" Then
        MsgBox ("no peergroup entered")
        combo2.Text = Empty
        combo2.SetFocus
        Exit Sub
    End If

    ' checks if the the company allready
    is in the list, if so then you get a
    message
    For peerGroup = 0 To
(ListBox1.ListCount - 1)
        If ListBox1.List(peerGroup) =
        combo2.Text Then
            MsgBox ("Peergroup allready
in list")
            combo2.Text = Empty
            combo2.SetFocus
            Exit Sub
        End If
    Next peerGroup

    ListBox1.AddItem combo2.Text
    combo2.Text = Empty
End Sub
Private Sub CommandButton3_Click()
    ' removes all printed data and show
    the pervious window
    Worksheets("Closing prices and
dividends").Activate
    ActiveSheet.Cells(2, 3).Clear
    ActiveSheet.Cells(2, 4).Clear
    ActiveSheet.Range("a4",
ActiveSheet.Range("iv4").End(xlToLeft)).
Select

    For j = 0 To Int(Selection.Count /
4)
        If ActiveSheet.Cells(4, 1 + (j *
4)).HasArray = True Then
            ActiveSheet.Cells(4, 1 + (j
* 4)).Select

Selection.CurrentArray.ClearContents
        End If
        ActiveSheet.Cells(2, 2 + (j *
4)).Interior.ColorIndex = 0
        ActiveSheet.Cells(2, 2 + (j *
4)).Clear
    Next

    Worksheets("Matlab data").Activate
    ActiveSheet.Range("a1",
ActiveSheet.Range("iv10000")).Select
    Selection.ClearContents
    Worksheets("Closing prices and
dividends").Activate
    ReDim Module1.linesGroup(0)
    Module1.addCodes ("")
    UserForm2.Hide
    UserForm1.Show
End Sub
Private Sub CommandButton4_Click()
    ' fills all the data in the sheets
    Worksheets("Matlab data").Activate
    ActiveSheet.Range("a1",
ActiveSheet.Range("iv10000")).Select
    Selection.ClearContents

```

```

    Worksheets("Closing prices and
dividends").Activate
    Dim emptyPeers(1 To 100) As Integer
    Dim emptyPeers2(0 To 100) As Integer
    numberPeers = ListBox1.ListCount
    endDate2 = ActiveSheet.Cells(2, 4)
    beginDate2 = ActiveSheet.Cells(2, 3)
    ' calculates the number of days
    totalDays = Round(((endDate2 -
beginDate2) / 7) * 5) + 0.5) + 1
    ' set the two date cells as date

ActiveSheet.Range(ActiveSheet.Cells(2,
3), ActiveSheet.Cells(2,
4)).NumberFormat = "d-m-yyyy"

    ' make the arrays of all companies
    aantald = 1
    Application.StatusBar = "Retreiving
Data"
    For k = 0 To (numberPeers - 1)
        emptyPeers2(k) = 0
        ActiveSheet.Cells(2, 2 + (k *
4)) = ListBox1.List(k)

ActiveSheet.Range(ActiveSheet.Cells(4, 1
+ (4 * k)), ActiveSheet.Cells(4 +
totalDays, 3 + (4 * k))).Select
        Selection.FormulaArray = _
            "=getYahooHistory(R[-
2]C[1],TEXT(YEAR(R[-2]C[" & 2 + (-1 * k
* 4) & "]),"0000"),TEXT(MONTH(R[-2]C["
& 2 + (-1 * k * 4) &
"]),"00"),TEXT(DAY(R[-2]C[" & 2 + (-1
* k * 4) & "]),"00"),TEXT(YEAR(R[-
2]C[" & 3 + (-1 * k * 4) &
"]),"0000"),TEXT(MONTH(R[-2]C[" & 3 +
(-1 * k * 4) & "]),"00"),TEXT(DAY(R[-
2]C[" & 3 + (-1 * k * 4) & "]),"00"),"
& k & ",0")
        ActiveSheet.Cells(4, 1 + (4 *
k)).Activate
        ActiveCell.CurrentArray.Select
        ' if the company doesnt exist in
        yahoo then the company will be removed
        from the list
        If Module1.linesGroup(k + 1) = 0
        Then
            emptyPeers(aantald) = k
            emptyPeers2(k) = aantald
            aantald = aantald + 1
            MsgBox ("The company " &
ListBox1.List(k) & " does not exist and
will be removed from the list.")
            Cells(4, 1 + (k * 4)).Select

Selection.CurrentArray.ClearContents
            Cells(2, 2 + (k * 4)) =
Clear
        End If
    Next

    ' removes the empty company from the
    list
    For k = 1 To aantald - 1
        ListBox1.RemoveItem
        emptyPeers(k)
        If k + 1 <= aantald - 1 Then
            For j = k To aantald - 1
                emptyPeers(j + 1) =
                emptyPeers(j) - 1
            Next
        End If
    Next
    numberPeers = ListBox1.ListCount

```

```

' check largest group
largest = 0
temp = 1
For k = 0 To numberPeers - 1
    If emptyPeers2(k) = temp Then
        temp = temp + 1
    End If
    If Module1.linesGroup(k + 1) >
largest Then
        largest =
Module1.linesGroup(k + 1)
        largestGroupNumber = (k + 1)
- (temp - 1)
    End If
Next

' checks the begin date and end date
of the company
beginDateCompany =
Module1.beginDateGroup(1)
endDateCompany =
Module1.endDateGroup(1)
totalDaysCompany =
Round(((endDateCompany -
beginDateCompany) / 7) * 5) + 0.5) + 1
ActiveSheet.Cells(2, 3) =
beginDateCompany
ActiveSheet.Cells(2, 4) =
endDateCompany

' removes all arrays
ActiveSheet.Range("a4",
ActiveSheet.Range("iv4").End(xlToLeft)).
Select
    For j = 0 To Int(Selection.Count /
4)
        If ActiveSheet.Cells(4, 1 + (j *
4)).HasArray = True Then
            ActiveSheet.Cells(4, 1 + (j
* 4)).Select
Selection.CurrentArray.ClearContents
            End If
            ActiveSheet.Cells(2, 2 + (j *
4)).Interior.ColorIndex = 0
            ActiveSheet.Cells(2, 2 + (j *
4)).Clear
        Next

' adjust the ranges which are
smaller then the largest peergroup
Application.StatusBar = "Adjusting
Data"
For k = 0 To numberPeers - 1
    ActiveSheet.Cells(2, 2 + (k *
4)) = ListBox1.List(k)
' set the date columns as date
and the others as general
    ActiveSheet.Columns(1 + (k *
4)).NumberFormat = "d-m-yyyy"
    ActiveSheet.Columns(2 + (k *
4)).NumberFormat = "general"
    ActiveSheet.Columns(3 + (k *
4)).NumberFormat = "general"
    ActiveSheet.Cells(4, 1 + (4 *
k)).Select
ActiveSheet.Range(ActiveSheet.Cells(4, 1

```

```

+ (4 * k)), ActiveSheet.Cells(4 +
totalDaysCompany, 3 + (4 * k))).Select
    Selection.FormulaArray = _
        "=getYahooHistory(R[-
2]C[1],TEXT(YEAR(R[-2]C[" & 2 + (-1 * k
* 4) & "]),"0000"),TEXT(MONTH(R[-2]C["
& 2 + (-1 * k * 4) &
"]),"00"),TEXT(DAY(R[-2]C[" & 2 + (-1
* k * 4) & "]),"00"),TEXT(YEAR(R[-
2]C[" & 3 + (-1 * k * 4) &
"]),"0000"),TEXT(MONTH(R[-2]C[" & 3 +
(-1 * k * 4) & "]),"00"),TEXT(DAY(R[-
2]C[" & 3 + (-1 * k * 4) & "]),"00"),"
& k & ",1)"
Next

```

```

ActiveSheet.Range(ActiveSheet.Cells(2,
3), ActiveSheet.Cells(2,
4)).NumberFormat = "d-m-yyyy"

```

```

' fills the returns in the "Matlab
data" sheet
Worksheets("Matlab data").Select
ActiveSheet.Columns(1 +
ListBox1.ListCount - 1).NumberFormat =
"general"

```

```

For j = 0 To numberPeers - 1
    For k = 2 To totalDaysCompany -
1

```

```

        Cells(k - 1, 1 + j).Select
        ActiveCell.FormulaR1C1 = _
            "=('Closing prices and
dividends'!R[5]C[" & 2 * (j + 1) + ((j +
1) - 2) & "]"+'Closing prices and
dividends'!R[5]C[" & 2 * (j + 1) + ((j +
1) - 1) & "]"/'Closing prices and
dividends'!R[4]C[" & 2 * (j + 1) + ((j +
1) - 2) & "]"
        Next
    Next

```

```

Worksheets("Closing prices and
dividends").Activate
ActiveSheet.Cells(1, 1).Activate
Application.StatusBar = "Data
Retrieved"
End Sub

```


8 Matlab code for the simulation program

The main class of the simulation program is:

```
function  
[normalSituation,modelOne,modelTwoMaxCorr,modelTwoLeastSq] =  
simulationProg(input,numberOfSim,  
optimizationOption,simulationSequence,desiredAnnualReturn)
```

input: Consist of a $m \times n$ array of return values, with m the duration and n the number of companies. The first column must be the target company.

numberOfSim: Number of simulation runs.

optimizationOption: If this value is 2, then it optimized the returns. If the value is 1, then it optimizes the return in terms of percentage.

simulationSequence: If this option has the value 1, then it starts with the optimization and thereafter it assigns a adjusted coefficient to all companies, including the optimized peer group. If the value is 2, then it first optimize the input and thereafter it will assign the adjusted coefficients to the companies.

desiredAnnualReturn: The expected annual return the companies grow to. Normally this is set to 0.04.

****Classified****