Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Economics

Bachelor Thesis

Creation of an optimal stock portfolio

Author: Mubina Nuriddinova

Supervisor: Ing. Petr Procházka, MSc, Ph. D.

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

BACHELOR THESIS ASSIGNMENT

Mubina Nuriddinova

Economics and Management

Thesis title

Creation of optimal stock portfolio

Objectives of thesis

In the course of the work, I will try to consider what the stock portfolio is and what their species exist. Consider the classification of risks, taking into account their risk models.
And the main part of the work will be devoted to the main methods of formation of the optimal structure of the investment portfolio: model Markowitz, Sharpe's index model and a model for valuing long-term assets. We give practical application of some models.

In thesis work, an attempt will be made to analyze the main methods of forming an optimal portfolio of securities, which are currently popular with investors and financial market analysts. The scheme of analysis of these methods, their advantages and disadvantages will be indicated, as well as the application of these schemes to the securities market

Methodology

During the report's preparation an analysis was the passive and active strategy of managing the securities portfolio within the framework of modern conditions.

The thesis also presents an analysis on the basis of back-testing of two models for assessing the return on assets: CAPM and the Fama-French model.

Goals of the analytical section are achieved by using regression analysis and various precise techniques of technical analysis of quantitative data.

The proposed extent of the thesis

40 pages

Keywords

Stock market, Portfolio investment, Investment, CAPM, Markowitz, Sharpe

---

Recommended information sources

A Simplified Model for Portfolio Analysis Author(s): William F. Sharpe Source: Management Science
Dillian, Jared, Street Freak: Money and Madness at Lehman Brothers: A Memoir, New York: Simon and Schuster
Federal reserve system – https://www.federalreserve.gov
Kotz, David M. (2015). The Rise and Fall of Neoliberal Capitalism. Harvard University Press.
Marenkov NL Investments. Series Textbooks of Moscow State University. Rostov n / a: Phoenix, 2002
Markowitz, H. M. (1952), "Portfolio selection", The Journal of Finance, March.
Rukhlov A. Principles of portfolio investment. – Finance. Securities.
Sharp U., Alexander G., Bailey J. Investments. – M .: Infra-M, 2006
Wallison, Peter, Bad History, Worse Policy (Washington, D.C.: AEI Press, 2013)
Williams, Mark (April 12, 2010). Uncontrolled Risk. McGraw-Hill Education

---

Expected date of thesis defence

2017/18 WS – FEM (February 2018)

The Bachelor Thesis Supervisor

Ing. Petr Procházka, Ph.D., MSc

Supervising department

Department of Economics

Electronic approval: 12. 3. 2018

prof. Ing. Miroslav Svatoš, CSc.

Head of department

Electronic approval: 12. 3. 2018

Ing. Martin Pelikán, Ph.D.

Dean

Prague on 15. 03. 2018

Declaration

I declare that I have worked on my bachelor thesis "**Creation of optimal stock portfolio"** by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break copyrights of any their person.

In Prague, March 15, 2018. _____

Mubina Nuriddinova

Acknowledgement

I would like to thank Dr. Petr Procházka, MSc, Ph. D. for his advice and support during my work on this thesis.

Creation of an optimal stock portfolio

Summary:

In this work, an attempt will be made toanalyse the primary methods of forming an optimal portfolio of securities, which are currently popular with investors and financial market analysts. The scheme of analysis of these methods, their advantages and disadvantages will be indicated, as well as the application of these schemes to the securities market.

In the course of the work, I will try to consider what the stock portfolio is and what their species exist. The central part of the work will be devoted to the primary methods of formation of the optimal structure of the investment portfolio: the Fama and French model, Sharpe's index model. We give practical application of some models.

Key words: stock, portfolio investment, investment, CAPM model, Fama French

Vytvoření optimálního zásobního portfolio

Souhrn:

V této práci se pokusí analyzovat primární metody tvorby optimálního portfolia cenných papírů, které jsou v současné době oblíbené u investorů a analytiků finančního trhu. Bude uvedena schéma analýzy těchto metod, jejich výhody a nevýhody, stejně jako uplatnění těchto systémů na trhu cenných papírů.

V průběhu práce se budeme snažit zvážit, jaké je akciové portfolio a jaké jsou jeho druhy. Centrální část práce bude věnována primárním metodám tvorby optimální struktury investičního portfolia: Fama French model, Sharpeův indexový model. Uvádíme praktické uplatnění některých modelů.

Klíčová slova: akcie, portfoliové investice, investice, model CAPM, Fama French

Table of Contents

Table list

Figure list

List of Abbreviation

S_i	Standard deviation
n	Number of income estimates
h_j	Bond yield
X_j	Relative shares
E	Expected value of income
D_i	Dispersion
V_f	Variation in market efficiency
E_k	Expected earnings per share
b_k	The response (sensitivity) of the expected income
O	Residual or specific risk
d	Investor's planned profitability
x_i	Share of "i" paper in the optimal portfolio
β	Beta
t	Time

CAPM	Capital Asset Pricing Model
BE	Book value of Equity
ME	Market value of Equity
MV	Market Value
HML	High Minus Low
SML	Small Minus Big
BN	Big Neutral
SN	Small Neutral
BG	Big Growth
SG	Small Growth
B/S V	Big/Small Value
MTBV	Market to Book Value
APTA	Arbitrage Pricing Theory
AEPR	Average Excess Portfolio Return
MSCI	Morgan Stanley Capital International
USA	United States of America

1. Introduction

The two most important decisions that a private investor has to take care how much money to invest and where to invest, financial consultants like to repeat. The primary factor that determines the profitability of investments is usually considered the distribution of assets in the portfolio: how much money is invested in stocks, bonds, bank deposits, as well as in real estate, precious metals, etc.

Current practice shows that a portfolio that is uniform in content does not provide a stable return to the portfolio holder. That is why the diversified portfolio, a portfolio of the most various securities is more widespread.

The current state of the financial market makes it necessary to react quickly and adequately to its changes. Therefore the role of investment portfolio management sharply increases and lies in finding the boundary between liquidity, profitability and risk that would allow choosing the optimal portfolio structure. Various strategic models serve this purpose. In this paper, an attempt will be made toanalyse the primary methods of formation of an optimal portfolio of securities, which are currently popular with investors and financial market analysts.

The scheme of analysis of these methods, their advantages and disadvantages will be indicated, as well as the application of these schemes to the securities market.

2. Objectives and Methodology

2.1. Objectives

The purpose of the courseworkis the study of theoretical problems, the specifics of the formation and development of the securities market; the definition of the primary functions and tasks, which allows solving the securities market. The topic is quite relevant for today because the developed market security and their market play a huge role in mobilising free funds for the needs of enterprises and states.

2.2. Methodology

In the course of the work, I will try to consider what the stock portfolio is and what their species exist. Consider the classification of risks, taking into account their risk models. And the main part of the work will be devoted to the main methods of formation of the optimal structure of the investment portfolio: model Markowitz, Sharpe's index model and a model for valuing long-term assets. We give practical application of some models.

In thesis work, an attempt will be made to analyze the main methods of forming an optimal portfolio of securities, which are currently popular with investors and financial market analysts. The scheme of analysis of these methods, their advantages and disadvantages will be indicated, as well as the application of these schemes to the securities market

3. Theoretical Part

3.1. Optimal portfolio

3.2. Portfolio Investing

Market conditions and the investor's opportunities determine the choice of his investment strategy. Portfolio investment has some features and advantages over other types of investments. An investment portfolio is understood as a particular aggregate of securities owned by a natural or legal person, or legal or physical persons with the rights of equity participation, acting as an integral management object. In a developed stock market, a securities portfolio is an independent product and it is its sale in whole or in parts that satisfy the need of investors when investing in the stock market. Usually, the market sells a certain investment quality with a given risk/income ratio, which in the process of portfolio management can be improved.

The basic principles of building a classic conservative (low-risk) portfolio are:

1. The principle of conservatism. The ratio between high-risk and risky shares is maintained so that income from reliable assets overwhelmingly covers the possible losses from the risky share. The investment risk, therefore, consists not in the loss of part of the principal amount, but only in the receipt of insufficiently high income. Naturally, without risk, you can not rely on any super-high income. However, practice shows that the overwhelming majority of clients are satisfied with incomes ranging from one to two deposit rates of banks of the highest reliability category, and do not want to increase revenues due to a higher degree of risk.

2. The principle of diversification is the fundamental principle of portfolio investment. The idea of this principle is well manifested in the old English saying: do not put all the eggs in one basket - "do not put all the eggs in one basket." As applied to our situation, this may sound like do not put all the money in one paper, however profitable this investment may seem to you. Only such restraint will avoid catastrophic damage in the event of an error. Diversification reduces the risk becausehigh incomes for other

securities will compensate possible low returns on one security. Minimization of risk is achieved by including a wide range of industries in the securities portfolio that are not closely related to each other, to avoid synchronisation of cyclical fluctuations in their business activity. The optimal value is from 8 to 20 different types of securities. Spraying attachments occur both between the active segments, and inside them. For short-term government bonds and treasury bills, it is a question of diversification between securities of various series, for corporate securities - between shares of different issuers. Simplified diversification consists in merely dividing funds between several securities without serious analysis.

Sufficient funds in the portfolio make it possible to take the next step - to carry out so-called sectoral and regional diversification. The principle of sectoral diversification is to prevent portfolio distortions in the direction of securities of enterprises in one industry. The fact is that the cataclysm can comprehend the industry as a whole. For example, drop-in oil prices on the world market may lead to a simultaneous drop in the prices of shares of all oil refineries, and the fact that your investments will be distributed among various enterprises of this sector will not help you. The same applies to businesses in the same region. Simultaneous decline in stock prices may occur due to political instability, strikes, natural disasters, the introduction of new transport routes, the anterior region, etc.

3. The principle of sufficient liquidity is to maintain a share of quick assets in a portfolio that is not below the level sufficient for unexpectedly turning high-yield transactions and meeting the customers' cash needs. Practice shows that it is more profitable to keep a particular part of the funds in more liquid (albeit less profitable) securities but to be able to react quickly to changes in market conditions and specific beneficial offers. Also, contracts with many customers naturally oblige to keep some of their funds in liquid form.

Management means the application to a set of different types of securities of specific methods and technological capabilities that allow: to preserve the invested initially funds, to achieve the maximum level of income, to ensure the investment orientation of the portfolio. In other words, the management process is aimed at preserving the essential investment quality of the portfolio and those properties that would correspond to the interests of its holder.(Ruhl. A. 2005) (Kotz, David M. (2015).

3.3. Basics of forming a securities portfolio

Managing capital, a professional investor faces many complex problems in the formation and evaluation of the portfolio. This raises many questions:

1. What to focus on: the risk of the entire portfolio or individual assets included in it?

2. How to measure the risk of a portfolio Is it possible to reduce the risk of the portfolio by changing the weights of the assets in it?

3. If so, how to achieve a risk reduction, ensuring the return on the portfolio, comparable to the yield of its constituent assets?

When formulating an investment portfolio, the following considerations should be guided:

- investment safety (investment invulnerability from shocks in the investment capital market)

- stability of income generation

- liquidity of investments, that is, their ability to participate in the immediate acquisition of goods (works, services), or quickly and without loss of price to turn into cash.(Ruhlov. A. 2005)

The main problem that needs to be addressed in the formation of the securities portfolio is the problem of distributing a certain amount of money by the investor for various alternative investments (for example, shares, bonds, cash, etc.) in such a way as to best achieve their goals. First of all, the investor aspires to receive the maximum income due to: again from a favourable change in the share price; dividends; receipt of solid interest, etc. On the other hand, any capital investment is associated not only with the expectation of income generation, but also with the constant danger of losing, and therefore, in the optimisation tasks of choosing a portfolio of securities, risk must be taken into account. In principle, to create a portfolio of securities, it is sufficient to invest money in any one

type of financial assets. However, modern economic practice shows that such a homogeneous portfolio (or non-diversified) is very rare. A much more common form is the so-called diversified portfolio, i.e. a portfolio with a wide variety of securities.

Here is a classic example of why the diversified portfolio has become predominant. Suppose there are two firms: the first produces sunglasses, the second - umbrellas. The investor invests half of the money in shares "Points", and the other half - in the shares of "Umbrellas". The result of the operation is shown in Table 1.

The use of a diversified portfolio eliminates the spread in the rates of return on various financial assets. In other words, the portfolio, consisting of shares of such diverse companies, ensures the stability of obtaining a positive result.

Weather conditions	Rate of return on shares of "sunglasses",%	Rate of return on shares of "Umbrellas",%	Portfolio income ratio
Rainy	0	20	10
Normal	10	10	10
Sunny	20	0	10

Table 1The results of the diversification of the securities portfolio. Source: own work

3.4. Models of choosing the optimal portfolio of securities

The current state of the financial market makes it necessary to react quickly and adequately to its changes. Therefore the role of investment portfolio management sharply increases and lies in finding the boundary between liquidity, profitability and risk that would allow choosing the optimal portfolio structure. This purpose is served by various models of choosing the optimal portfolio.(V.A. Galanova, A.I. Basova., 2004)

Let's consider some of the known models of choosing the optimal portfolio of securities.

3.5. The Markovitz Model

The beginning of the theory of investments was laid in 1952. the publication of an article by Harry Markovitz entitled "Portfolio Conclusion: Effective Diversification."

G. Markovitz developed a mathematical model for the formation of the optimal portfolio, for which he was awarded the Nobel Prize in Economics in 1990, and methods of building portfolios under specific criteria. Markowitz's approach begins with the assumption that the investor currently has a specific amount of money for investment. This money will be invested for a specifiedperiod - the period of ownership. If you set the desired level of portfolio return for the investor, you can put the task of choosing a portfolio structure that, with a given level of profitability, would lead to a minimum risk. The complexity of practical implementation of this model is due to the fact that at that time the use of probability theory in financial theory was not perceived by economist theorists and practitioners. At the same time, the difficulty of introducing Markovitz's model was due to the underdevelopment of computer technology and the complexity of the calculation algorithms.

The main idea of the Markovitz model is to statistically consider the future income brought by the financial instrument as a random variable, i.e. The incomes for individual investment objects randomly vary within certain limits. Then, if you determine in some way for each investment object certain probability of occurrence, you can get the distribution of the probabilities of obtaining income for each alternative investment of funds. To simplify the model, Markovitz believes that the income from investment alternatives is normally distributed.
(Yankovsky K.P. Investments 2006), (Sharp U., Alexander G., Bailey J. I., 2006), (Kolesnikova, V.S. Torkanovsky., 2002), (Markowitz, H. M. (1952)) (Markowitz, H. M. (1956))

According to the Markovitz model, the indicators characterising the investment object and the risk are determined, which makes it possible to compare various alternatives to investing regarding goals and thereby create a scale for evaluating various combinations.
(V.A. Galanova, A.I. Basova., 2004)

3.5.1. The optimal portfolio method for Markowitz solves the following questions:

1. It gives an answer to the question whether the investment portfolio of the organisation is optimal.
2. Calculates an effective boundary for comparing multiple portfolio distributions.
3. Allows you to define a portfolio that provides the most appropriate combination of risk and return for the organisation.
4. It monitors the current portfolio, which makes it possible to adjust its composition regardingoptimising risk and profitability.
5. Allows you to select assets for short sales, distributing the funds received optimally among the remaining assets. (www.franklin-grant.ru)

As the scale of the expected income from some possible incomes, in practice, the most probable value is used, which in the case of a normal distribution coincides with the mathematical expectation.

Let the portfolio of n securities be formed. The expected value of income for the i-th security (Ei) is calculated as the arithmetic means of the possible individual incomes Ri with weights Pij, attributed to them by the probabilities of the offensive:

n

Ei = SRi * Pij

j = 1

where the sum ;

Pij = 1

n - specifies the number of income estimates for each security.

To measure the risk, scatter indicators are used, so the higher the variance in the magnitude

of the possible revenues, the higher the risk that the expected income will not be received. Thus, the risk is expressed by the deviation (and lower) of the values of the proceeds from the most probable value. The measure of dispersion is the root-mean-square deviation si, the more significant this value, the higher the risk:

n

Ei=Ö(SPij(Rij– Ei)2)

In Markovitz's model, instead of the standard deviation, the dispersion Di is used to measure risk, which is equal to the square of si, since this indicator has advantages in the technique of calculations j=1

An investor wishing to invest in an optimal way is interested not so much in comparing individual types of securities with each other as in comparing all kinds of portfolios, as this makes it possible to use the effect of risk dispersion, i.e. The expected value of income and the variance of the portfolio are determined. The expected value of income E of the securities portfolio is defined as the sum of the most probable income Ei of various securities n. At the same time, incomes are weighed with relative shares

Xj (i = 1 ... n)

corresponding to capital investments in each bond or share:

n

E = SXi * Ei

i = 1

For variance, this amount appliesto certain restrictions, since the change in the stock price in the market is not isolated from each other, but covers the entire market as a whole. Therefore, the dispersion depends not only on the degree of dispersion of individual securities but also on how all securities in the aggregate are simultaneously falling or rising

at the rate, i.e. From the correlation between changes in the rates of individual securities. With the rest of the correlation between the individual rates (i.e., if all shares are simultaneously raised or lowered), the risk from deposits in various securities can neither be reduced nor increased. If the stock prices do not correlate with each other, but in the extreme case (the portfolio contains an infinite number of shares), the risk could be eliminated, since the fluctuations of the exchange rates would on the average be zero. In practice, the number of securities in the portfolio is always finite, and therefore the distribution of investments in different securities can only reduce the risk, but it is impossible to exclude it completely.

So, when determining the risk of a particular portfolio of securities, one must take into account the correlation (one-sidedness) of stock prices. As an indicator of correlation, Markovitz uses the covariance between the changes in the rates of individual securities.

Thus, the variance of the whole portfolio is calculated by the following formula:

n n

V = SSXi * Xk * Ci

i = 1 k = 1

By definition, for i = k$C_{ik}$is equal to the variance of the share. This means that the variance, and therefore the risk of this portfolio, depends on the risk of this stock, the covariance between individual stocks (i.e., the systematic market risk), and the share of Xj of individual securities in the portfolio as a whole.

Considering theoretically the limiting case in which an infinite number of securities can be included in the portfolio, the variance will asymptotically approach the average value of covariance C.

Graphically, this can be represented as follows (Figure 1):

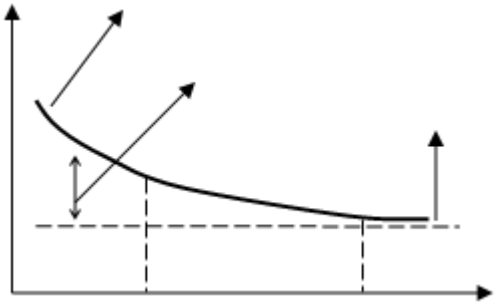

Figure 1 The Markovitz Model source: own work

Number of securities in the portfolio

(Marenkov NL. 2002), (Markowitz, H. M. (1952)), ((Markowitz, H. M. (1952))

3.5.2. The possibility of reducing the risk by managing a portfolio of securities

So, Markovitz developed a very important for the modern theory of the securities portfolio, which says: the aggregate risk of the portfolio can be decomposed into two components. On the one hand, this is the so-called systematic risk, which can not be ruled out and to which all securities are exposed in thealmost equal measure. On the other hand, there is a specific risk for each particular security that can be avoided by managing a portfolio of securities. At the same time, the sum of the combined funds for all objects should be equal to the total volume of investment investments (for example, part of the funds in the bank account is introduced into the model as an investment with zero risks), i.e. The sum of the relative shares of Xj in the total volume must be equal to one:

n

SXi = 1

i = 1

The problem is the numerical determination of the relative shares and bonds in the portfolio (Xj values) that are most beneficial to the owner. Markovitz limits the solution of the model to the fact that out of the whole set of "admissible portfolios", i.e., To satisfy the constraints, it is necessary to identify those that are riskier than others. These are

portfolios that hold a higher risk (variance) than others for the same income or portfolios that generate lower returns at the same level of risk.

Using the method of critical lines developed by Markovitz, it is possible to identify unpromising portfolios that do not satisfy the constraints. Thus, only efficient portfolios remain, i. Portfolios are containing a minimum risk for a given income or bringing the maximum possible income at a given maximum level of risk that an investor can go to.

This fact is of great importance in the modern theory of securities portfolios. The portfolios selected in this way are combined into a list containing information on the percentage of the portfolio from individual securities, as well as on the income and risk of portfolios. The choice of a specific portfolio depends on the maximum risk that the investor is willing to invest in.

In Fig. 2 unacceptable, acceptable and useful portfolios are presented. The portfolio is sufficient if it satisfies the constraints, and, in addition, for a given income, for example, E1, contains a lower risk of R1 compared to other portfolios that generate the same income E1, or at a certain risk R^2 brings a higher E2 income than other combinations with R^2

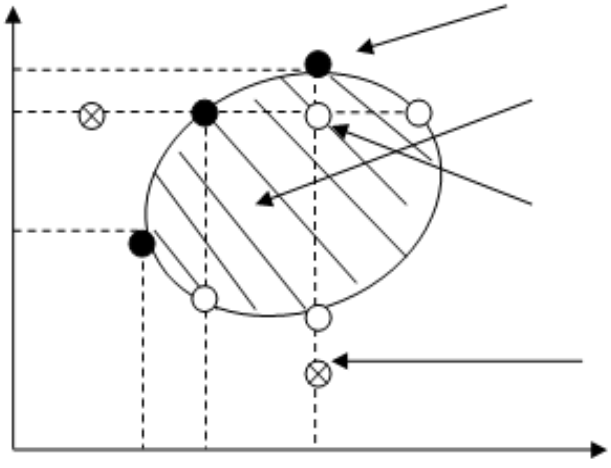

Figure 2 The Markovitz Model source: (V.A. Galanova, A.I. Basova 2004),

. (V.A. Galanova, A.I. Basova 2004), (Markowitz, H. M. (1956))

3.6. Inadmissible, admissible and effective portfolios

Separation of risk into independent components gives an investor an opportunity to analyse securities from all sides and determine their strengths and weaknesses in the formation of the portfolio. From the methodological point of view, the Markovitz model can be defined as practically normative, which, of course, does not mean imposing a particular style of behavior on the securities market to the investor. The task of the model is to show how the goals set are achievable in practice.
("Textbooks of Moscow State University". 2002) (V.A. Galanova, A.I. Basova. 2004)

A negative feature of the Markovitz model can be called the fact that a significant amount of data on the securities market accumulated over many years and meeting the conditions of representativeness is required to solve the problem of Markovitz. In practice, especially on the Russian stock market, which was only recently formed, it is challenging to obtain such data, and sometimes it is impossible.
(V.S. Torkanovsky, 2002)

3.7. Three-factor model of Fama-French

The multifactor model gives investors more information about the
the degree of manifestation of risk and the market premium for this risk than the one-factor model or CAPM.
Fama and French (1993) proposed a three-factor model, which became a standard tool for assessing profitability in foreign practice.
Factors such as company size and price/book value were added to the market premium to more accurately explain the return on assets.
SMB is the difference between the returns of small and large companies. HML is the difference between the returns of companies with high and low price/book value ratios.
There are also other interpretations of two additional factors, according to which, and the calculation is not taken by individual companies with different sizes and ratios, but by portfolios of shares of such companies.
The SMB factor is necessary to cover the risk of firm size, while HML is designed to share the risk of "growth" (a company with a low price/book value) and a "state"
risk (a company with a high ratio).

(Fama, E. F., & French, K. R. (2004). The capital asset pricing model: theory and evidence. *Journal of Economic Perspectives)*

These two factors are motivated by the observations made by Fama and French that the average return on shares of small companies and shares of companies with a high price/book value ratio historically have a higher yield than that predicted by the CAPM. These observations lead to the conclusion that the size or the ratio of price and balance value have a significant effect on the systematic component of risk and, accordingly, on the level of profitability and security.

Fama and French found that SMB and HML portfolios explain the strategies based on alternative price parameters (price/earnings, book value/market price), five-year sales growth and trends of five-year yields to a decrease with accuracy. All these strategies cannot be described and defined by the CAPM model and the Beta coefficient.

However, the positive results of the tests of the three-factor model of Fama-French have both good and bad consequences. On the one hand, additional sources of risk have been found that give a better estimate of the expected yield. On the other hand, this may mean that there are still unknown sources of risk, which gives way to new factors and complicating existing models.

For both CAPM and Fama French models, it is assumed that simple techniques are used to estimate the return on an asset, in particular, about the necessary information on prices.

However, the three-factor model, using additional parameters, cover a larger volume of news related to the state of the economy. At the level of testing, the three-factor model of Fama-French has significant advantages in comparison with the CAPM. Nevertheless, the returns inherent in the SMB and HML portfolio are unstable and therefore, like the single-factor CAPM, the three-factor model explains the relationship between risk and returns with considerable error.

(French, Craig W. (2003). The Treynor Capital Asset Pricing Model. *Journal ofInvestment Management*)

Thus, despite the fact that risk and profitability are probably related, none of the models describes this ratio with sufficient accuracy, and, accordingly, can not be used as a tool for risk assessment and investment management.

3.8. The Sharpe, index model

As follows from the Markovitz model, it is not necessary to specify the distribution of the incomes of individual securities. It is sufficient to determine only the quantities characterising this distribution: the mathematical expectation of E_1, the variance D_1 and the covariance C_{ik} between the incomes of individual securities. This should be analysed before the portfolio is drawn up. In practice, for a comparatively small number of securities, it is possible to make such calculations to determine the expected income and variance. When determining the correlation coefficient, the labour intensity is very high. For example, in the analysis of 100 shares, about 500 covariances will be required.
(V.A. Galanova, A.I. Basova. 2004), (Kolesnikova, V.S. Torkanovsky. 2002)

To avoid such a high complexity, Sharpe proposed an index model (or a model for assessing financial assets of Capital Asset Pricing Model- CAPM), which is the relationship between the effectiveness of a particular security and the efficiency of a market portfolio. Moreover, he did not develop a new method for compiling a portfolio but simplified the problem in such a way that an approximate solution can be found with much less effort. Sharpe introduced the so-called B-factor, which plays a unique role in modern portfolio theory.

Sharp's index model uses a tight (and in itself undesirable due to the decrease in the effect of risk dispersion) the correlation between changes in the rates of individual stocks. It is assumed that the necessary input data can be approximately determinedby just one underlying factor and the relationships that link it to the change in the rates of individual stocks. Assuming the existence of a linear relationship between the stock price and a particular index, you can use the forecast estimate of the index value to determine the expected stock price. Also, it is possible to calculate the cumulative risk of each share in the form of aggregate variance.
(Rukhlov A. 2005)

In the CAPM model, it is assumed that the effectiveness of a security X_j depends linearly on some leading factor F describing the efficiency of the market as a whole, and at the same time, specific factors that are random variables e_j affect each price paper.

Then Xj = aj + bj * F + ej where a_j and b_j are some deterministic values, and the coefficient bj reflects the dependence of paper efficiency on the market situation, if $b_j > 0$, then the paper effect is similar to the market effect, if $b_j < 0$, then the paper efficiency increases when the market efficiency decreases

To characterise a particular security, other parameters are used. Since the variation in the effectiveness of each security consists of "own" and "market", the value

Rj2 = (bj * VF) / Vej

where V_F is the variation of market efficiency;

V_{ej} - avariation of the "own" component of paper efficiency

Willcharacterise the share of the risk of each contribution introduced by the uncertainty of the market as a whole. This expression shows that the larger R^2, the smaller the share of the "own" risk of the paper V_{ej}, therefore, it is preferable, with all other conditions being equal, of paper with large values of R^2.

If we measure the efficiency of investments in securities from the effectiveness of the risk-free contribution r_0, then the parameter

aj = aj-bj * r0

Represents an excess of the effectiveness of security over risk-free efficiency (it can be consideredan absolute risk premium). If aj <0, then the market price for this paper is overstated, and shortly it may go down; If aj> 0, then the market price is understated, and

in the future, it is likely to increase. Consequently, all other things being equal, paper with aj> 0 is more preferable.

In the Western markets, the values of a, b and R^2 are regularly calculated for all securities and published together with the indices. Using this information, an investor can form his own securities portfolio. In the Russian market, professionals are also gradually starting to use a-, b- and R^2-analysis. Individual investment institutions calculate a, b and R^2.
(William F. Sharpe Jan., 1963), (Kolesnikova, V.S. Torkanovsky. Finance and Statistics, 2002) ((A Simplified Model for Portfolio Analysis Author(s): William F. Sharpe Source: Management Science)

3.9. CAPM: Basic Principles and Functions

CAPM belongs to one of the most important achievements of the theory in the field of finance. It shows the importance of mutual dependence between investment profitability and risk, additionally adds profit opportunities without any risks, and is also easier to apply in practice than the Magkovitsa model. CAPM grew by the Markowiza model, transferring the idea of optimal, verified portfolios to the whole market and also estimating specific values. It means that this approach can be used both in a macro context where CAPM stands for the relationship between profitability and the risk of the whole portfolio, and in the context of micro, concerningcertain securities.
Typical parameters of each portfolio in the capital market are: risk and expected are turn on investment. To measure risk, the CAPM model uses the beta coefficient, which means that the CAPM model only considers the systematic risk of shares or a portfolio of shares. This parameter has in time become the main characteristic of the risk of shares and is currently widely used on stock exchanges. The basis of the CAPM model is such conditions as:

a. lack of transaction costs,
b. the ideal separation of financial instruments,
c. the absence of taxes on individual income,
d. Transactions of a particular investor can not influence the price of a financial instrument,
e. when making decisions, investors only consider the expected return on investment and the risk of financial instruments,

f. is a short sale of shares,
g. there is an unlimited opportunity to issue and receive a loan with a risk-free return,
h. All investors decide in one period, and. All investors have the same expectations about the characteristics of financial instruments (return on investment, risk, the coefficient of mutual dependence), is called the homogeneity of investors expectations.
i. All tools can be bought or sold on the market without any obstacles.

3.9.1. The basis of the CAPM are two functions:

- Capital Market Line (CML), which represents the relationship between risk and return on the portfolio,
- The securities market line or the Security Mar-ket Line (SML), shows the relationship between the beta parameters and the return on investment.

(www.investopedia.com)

3.10. The model of the aligned price (Arbitrage Price - Theory - Modell APT)

The purpose of arbitrage strategies is to use differences in the price of securities of one or related type in different markets or segments of markets for profit (usually without risk). Thus, through arbitrage, it is possible to avoid imbalances in the cash markets and the relations between cash markets and futures markets. So, arbitrage is an equalising element for the formation of the most efficient capital markets.

As the necessary data in the model, common risk factors are used, for example, indicators: economic development, inflation, etc. Individual studies are conducted: how the course of a particular action in the past reacted to the change of such risk factors. Using the relations obtained, it is assumed that it is possible to calculate the behaviour of shares in the future. Naturally, predictions of risk factors are used for this. If the rate thus calculated is higher than the present stock price, this indicates the profitability of the purchase of the share.

In this model, the expected return of a share depends not only on one factor (B-factor), as in the previous model, but is determined by a variety of factors. Instead of income

throughout the market, the share for each factor is calculated separately. The starting point is that the average sensitivity of the corresponding factor is 1.0. Depending on the susceptibility of each share to various factors, the corresponding shares of income change. Together they determine the total income of the stock. According to the model, in the conditions of equilibrium provided by arbitrage strategies, the expected income, for example, Ei, is composed of interest on the deposit without the risk of l0 and a certain number of (not less than three) factors affecting the whole market with corresponding risk premiums (l1 ... k) that have a sensitivity (b1 ... k) with respect to different securities:

Ei = l0 + l1 * bi1 + l2 * bi2 + ... + lk * bik

The stronger the reaction reacts to the change in a particular factor, the more profit can be in the affirmative case.

4. Practical Part

I will apply the two asset-pricing models to the Dutch stock market and see if there exists a preferred dominant model in explaining stock returns. Clearly, the two factor do not give clear insight in risk and return variables since its factors are merely a proxy of the true state variables. Testing the models will mainly serve to evaluate which model is most consistent and reliable in explaining returns on the Dutch stock market.
Findings on each model will be presented in later chapters. For comparison sake I have tested the models for a ten-year period from 2004 to 2014 with monthly observations. Monthly data is used since it accounts for speed in arbitrage adjustments. Moreover, it is able to mitigate potential drawbacks of microstructure issues related to price formation and price discovery, transaction and timing cost, information and disclosure, and market maker and investor behavior. A total of 120 observations are used to construct portfolios, with model specific technicalities taken into account. The sample period contains cyclical economic movements with epochs of fluctuating market volatility.
All required data for the analysis is obtained from the DATASTREAM database. The data relevant for the empirical research are the active primary-quoted stocks on the Euronext. The latter consists of 126 currently active stocks. However, to omit the exposure to sample selection bias, I have eliminated all stocks with insufficient market data. Moreover, only

stocks that trade continuously over the ten-year period are included. Finally, I did not use stocks with negative (BE/ME) to prevent distortion of the results. After this process 78 stocks remain eligible for analysis. To compute stock returns the monthly price adjusted-default stock returns (RI) for every firm during 120 months are collected.

4.1. The methodology of Model Research

The same methodology Fama and French (1993) used in their research paper to construct distinct portfolios is applied in this thesis. Although for every model a more detailed explanation will be given in later chapters, a brief introduction to the generalized method is presented in this paragraph.

The CAPM model require a different approach to the construction of portfolios. The relevant variable in the CAPM model is the corresponding beta of every one portfolio at time t. In the Fama and French model however, the monthly return on stocks are regressed on return to a market portfolio of stocks and mimicking portfolios for size and book-to-market ratio.

4.2. CAPM model

4.2.1. Portfolio formation

To run the two-pass technique regressions, a set of nine portfolios must be constructed as the intersection of the size dimension and beta coefficient for every firm in the sample period. The latter procedure serves to prevent distortions in the results and error-in-variable problems. To obtain company specific beta, a regression is run for every firm at every time t, where the dependent variable is the excess return on the firm stock and the independent variable is the excess return on the market as a whole. The size dimension for the portfolio formation process merely is arranged on a continuum ranging from small-capitalization firms to large capitalisation firms. A total of 78 firms for which there is consistent and sufficient data are included in the nine portfolios. In table 2 the characteristics of the nine distinct portfolios are presented. Every one portfolio is the result of the intersection of firms that overlap on any two dimensions, beta and size. For this process, I have used a ‘Venn diagram’ to alleviate

sorting issues. Alternatively, the sorting can be done manually. Quite arguably, however, this sorting method is prone to mistakes and therefore not recommended.

Somewhat intuitively, we find that relatively large firms, in general, have a lower standard deviation. This observation is a result of the straightforward assumption that, given their nature, small firms tend to be riskier and hence more volatile. At the same time, we find that the standard deviation of average returns of high beta firms is relatively high. Conversely, the contrary holds for firms for which the beta is low. Lastly, we find that the average return of portfolios is highest among large firms. For the sake of clarity, the definition of beta is shortly described,and a brief explanation is given on the interpretation of beta estimates.
The beta of the market portfolio is always equal to 1. The beta of a security or a portfolio compares the volatility of its returns to the volatility of the market returns.

β= 1.0 - the security has the same volatility as the market as a whole
β> 1.0 - the security has more volatility than the market as a whole
β< 1.0 - the security has less volatility than the market as a whole

Note that the values above relate to absolute values and not to exact values (where positive and negative numbers are distinguished) and could therefore also be denoted asβ= |1.0|, β> |1.0| and β< |1.0| respectively.

Characteristic		HIGH BETA	MEDIUM BETA	LOW BETA
AVERAGE	**LARGE SIZE**	0,49%	0,72%	0,50%
STANDARD DEVIATION		10,05%	7,06%	6,51%
AVERAGE	**MEDIUMSIZE**	0,10%	0,66%	0,37%
STANDARD DEVIATION		12,52%	9,80%	7,45%
AVERAGE	**SMALL SIZE**	-1,37%	-0,17%	0,41%
STANDARD		15,07%	10,08%	7,48%

Table 2 Nine portfolios sorted on beta and size with its corresponding average return and standard deviation. Source: DATASTREAM database

The average returns are excess returns for every one portfolio during the sample period (2004-2014)

4.2.2. First-pass regression

As previously mentioned, the first step in the two-pass technique is the time-series regression. In this time-series estimation, the security returns are regressed against a market index. For every portfolio *I*and every month *t* the following regression is run:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i (r_{m,t} - r_{f,t}) + e_{i,t}$$

Where:

$r_{it} - r_{ft}$	is the excess return of portfolio *i* for month *t*
$r_{Mt} - r_{ft}$	is the market risk premium for month *t*

The results are drawn with a rearranged version of the CAPM model and yield beta estimates for every one portfolio that was constructed previously. An overview of this can be found in table 3. This information can be used in the second step of the two-pass technique, the cross-sectional regression. As we can see, the obtained beta estimates are the coefficients of the market risk premium in the model above.

Naturally, we find that high beta stocks result in high beta estimates. The results show no clear evidence of a positive relation between beta and firm size. One would expect small size firms to have a beta estimate equal or larger than large firms due to their riskier nature. This is however only the case in the middle segment of the beta ordering. For the high and low beta estimates it appears that large firms have a higher beta. In fact, medium size firms are affected most by high beta estimates across all three beta-portfolio-categorisations. For every portfolio also the alpha estimate is included. These alpha estimates are all very close to zero.

COEFFICIENT		HIGH BETA	MEDIUM BETA	LOW BETA
b (beta)	**LARGE SIZE**	1,3567	0,8015	0,5223
alpha		0,01866	0,01441	-0,0149
b (beta)	**MEDIUM SIZE**	1,4422	0,8780	0,5954
alpha		0,03802	-0,02967	0,01513
b (beta)	**SMALL SIZE**	1,2354	0,8763	0,3178
alpha		0,01444	0,01421	-0,00506

Table 3 Beta coefficients for the nine different portfolios in the time-series regression, source: DATASTREAM database

This implies that the CAPM does well in explaining stock returns. In the subsequent paragraphs, we will run alternative analysis to see if the above conclusion based on time-series regression holds.

4.2.3. Second-pass regression

The second step in the two-pass technique is the cross-sectional regression. In cross-sectional estimation, the estimated CAPM-beta from the first pass is related to average return. The dependent variable remains unchanged and is the excess portfolio return. The regression of the second step regression denotes:

$$r_{!"} - r_{!"} = \lambda_{!!} + \lambda_{!!}\beta_{!} + e_{!"}$$

Where:

$r_{pt}-r_{ft}$ is the excess return on portfolio *I* for month *t*

$\hat{\beta}_{!}$ Is the beta estimate obtained earlier

Running the above regression for each month consists of nine pairs of beta coefficients that relate to the number of portfolios.

(Fama, E. F. and French, K. R. (1992), The Cross-Section of Expected Stock Returns. *The Journal of Finance)*

To conclude from the findings in table 4, the following hypothesis is used:
Hypothesis 1: $\lambda_0 = 0$. If true, no other factors than the beta affect the CAPM.
Hypothesis 2: $\lambda_1 > 0$. If true, there is a positive linear relationship between systematic risk and expected return.

Hence, if the CAPM is correct, then λ_0 must be zero. In my estimate, λ_0 is larger than zero. The above, however, must hold for the CAPM to be correct since it accounts for the assumption that solely beta explains stock returns. The CAPM is not able to explain returns fully. Moreover, if the CAPM is correct a predictor, then λ_1 must be more significant than zero. Again, this does not hold in the empirical testing on the Dutch stock market. A summary of the results is found below in table 4. In figure 3 the finding that $\lambda_1 < 0$ is confirmed. In other words, there exists a negative relationship between systematic risk and expected return for the sample period.

(Fama, E. F., & MacBeth, J. D. (1973). Risk, return, and equilibrium: Empirical tests. *The Journal of Political Economy)*

Statistic (January 2004 - January 2014)	*A0*	*A1*
Average	0,81776	-0,6618
t-statistic of average	1,50294	-1,17198
p-value of average	0,17656	0,27954

Table 4 Cross-sectional regression statistics of the total sample period, Source DATASTREAM database.

As mentioned previously, it is expected that when average excess returns are plotted against beta, a positive linear relationship can be found. This implies systematic risk is compensated with an excess return in the market. If the actual excess return of the stock is different from the value calculated by CAPM, there will be an intercept, which implies that the fundamentals of the CAPM will be violated. Figure 3 serves to confirm the findings in the cross-sectional regression: the CAPM is not able to prove that it can provide results that could validate its use. The main reason is likely that the assumption of risk-return trade-off found by Fama and MacBeth (1973) is not found for the sample period on the Dutch stock market. Therefore the results are likely to be erroneous.

Clearly a negative relation is found, contrary to what the CAPM.

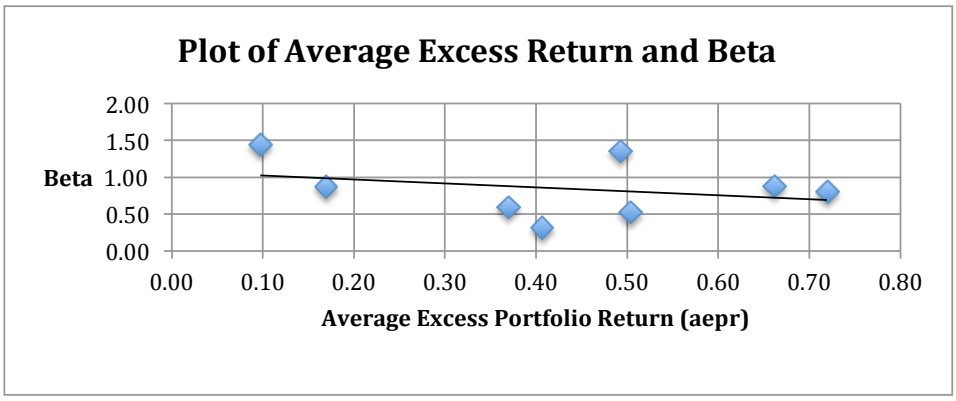

Figure 3 Plot of average excess portfolio returns on beta., Source: ecxel output.

4.2.4. Alternative testing of the CAPM

Fama and French (1993) conducted an alternative testing procedure in which they constructed portfolios for the CAPM according to size and value, as opposed to sorting portfolios on beta and size. One of their findings is that the alpha (intercept) of low (BE/ME) firms is lower than firms with a high (BE/ME). Moreover, they argued that the t-statistic increases in the same pattern. That is, growth firms tend to have more significant absolute t-statistics compared to value firms. The most important takeaway

from their findings is that if they appear to hold, it serves to prove that the CAPM does not do so well. The alternative testing of the CAPM confirms the limitations of the model found in previous paragraphs. In table 5 the data is summarised.

	VALUE	NEUTRAL	GROWTH	VALUE	NEUTRAL	GROWTH
CAPM						
ALPHA	0,2988	-0,4736	-0,7902	-0,2140	0,1587	-0,2788
Standard Error	0,3768	0,3273	0,4055	0,3635	0,1832	0,1962
T Statistic	0,7929	-1,4470	-1,9485	-0,5887	0,8664	-1,4210

Table 5 Data on six value-weighted portfolios to measure CAPM validity, Source Shaikh, S. A. Testing Capital Asset Pricing Model on KSE Stocks. Journal of Managerial Sciences Volume VII

The Fama and French Three-Factor Model prove to be slightly better in predicting results compared to the CAPM. We can see that the explanatory variables SMB and HML that have been added to the CAPM can do a better job in explaining the excess stock returns. The intercepts of the Three-Factor model are lower and thus, adding Size and Value as an extension to the CAPM does better explain effects on average excess stock returns in the sample period.

(Shaikh, S. A. Testing Capital Asset Pricing Model on KSE Stocks. *Journal of Managerial Sciences* Volume VII)

4.3. Fama-French Three Factor Model

4.3.1. Portfolio formation

The portfolio formation procedure for the Fama and French Three Factor model is somewhat different from the one that is used for the CAPM. It involves two additional factors Fama and French found to be, at least partially - yet significantly - explaining security returns. These factors are SMB, which denotes the return of **S**mall-**M**inus-**B**ig firms, and HML, which denotes the return of **H**igh-**M**inus-**L**ow firms. Six portfolios are constructed through the intersection of both Size (SMB) and Value (HML). The result is the following set of portfolios: Small Value, Small Neutral, Small Growth, Big Value, Big Neutral and Big Growth. Again, a Venn diagram is used to alleviate sorting issues.

To calculate the SMB and HML factor for each period t in the sample period, the following method is applied:

a. Categorize all stocks included in the sample in order of size. The 50% largest firms are labelled BIG, and the 50% smallest firms are labelled SMALL.
b. Categorize all stocks included in the sample based on the book-to-market equity ratio (BE/ME). Rank the stocks in three groups.

The most substantial 30% is labelled Value, the middle 40% is labelled Neutral, and the remaining 30% is labelled Growth.

c. For each year, the following six portfolios are constructed: Big Growth (BG), Big Neutral (BN), Big Value(BV), Small Growth(SG), Small Neutral(SN) and Small Value(SV). These are a product of the intersection of any two factors size and value.
d. For each time t in the sample period, the factor SMB t is computed:
   ⅓ (SV + SN + SG) -⅓ (BV + BN + BG)

Similarly, the factor HML t is computed as follows: ½ (SV + BV) - ½ (SG +BG)

(Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of financial economics)*

In table 6, the number of companies in portfolios formed on Size and Value issummarised. A noteworthy observation is that small size firms on average tend to have a more substantial number of high (BE/ME) firms, whereas large size firms on average tend to include more neutral to low (BE/ME) firms. As expected, the number of small stock portfolios is similar in size to the number of significant stock portfolios. Indeed, the division point is the median.

On average, there is an equal number of portfolios across small and large firms sorted on (BE/ME). However, a negative relationship seems to hold for Value and Growth portfolios across Size, where the SV portfolio holds an average of 13 firms, whereas the BV portfolio holds an average of 10 portfolios. On the contrary, the SG portfolio holds an average of only nine firms, whereas the BG portfolio holds an average of 14 firms. When we assume that high book-to-market equity ratios signal an elevated risk of financial distress, the above results indicate that small size firms tend to be more in distress. Alternatively, the relatively large number of firms in the SV may indicate that, indeed, small firms are more undervalued than their larger counterparts.

YEAR	SV	SN	SG	BV	BN	BG
2013-2014	17	15	7	6	17	16
2012-2013	15	14	10	8	18	13
2011-2012	15	15	9	8	17	14
2010-2011	14	15	10	9	17	13
2009-2010	11	15	13	12	17	10
2008-2009	12	18	9	11	14	14
2007-2008	11	19	9	12	13	14
2006-2007	12	17	10	11	15	13
2005-2006	12	18	9	11	14	14
2004-2005	15	16	8	8	16	15
AVERAGE	**13**	**16**	**9**	**10**	**16**	**14**

Table 6 Number of Companies in portfolios sorted on Size and Value, Source DATASTREAM database.

Fama and French offer an extensive database for different portfolio dimensions and characteristics, including all factors required to compute multifactor model output. (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html)

Unfortunately, there is no Dutch database available on their website. Since the factors are market specific, I had to manually compute all two factors for every month *t* across the portfolios. That sums to a total of 240-factor variables.

Table 7 presents further insights into the actual magnitude of the book-to-market ratio and the size of the firms represented in each one portfolio. As can be observed, the average market capitalisation of small firms is around € 200 million. The dispersion is relatively minor, as opposed to the dispersion across big firms. Here we can see that the dispersion is relatively large. Furthermore, it is clear that significant firms with a low (BE/ME) ratio have the lowest average firm size. The firms included in BV portfolios have an above average (BE/ME) ratio, whereas the firms included in the BG portfolios have a meager (BE/ME) ratio.

			BOOK TO MARKET EQUITY			
SIZE	**VALUE**	**NEUTRAL**	**GROWTH**	**VALUE**	**NEUTRAL**	**GROWTH**
	AVERAGE FIRM SIZE (MILLION €)			*AVERAGE (BE/ME)*		
SMALL	189,9172	212,8694	199,8040	1,6325	0,8504	0,3183
BIG	9771,7898	11934,4001	7274,2338	1,4953	0,7289	0,3654

Table 7Average firm size in millions of euros and average book-to-market ratio across the six different portfolios for the

sample period. Source: own work

The mean monthly excess returns of the six different portfolios are presented in table 8. Note that only three out of six portfolios yield positive excess returns during the sample period.

Arguably, the reason is the economic downturn from 2007 to 2011 that is incorporated entirely in the computation of the sample period excess returns.

Except the BV portfolio, large firms massively outperform small firms during the sample period. This finding is inconsistent with the findings of Fama and French (1993) who argue that small firms are riskier thus yield higher expected excess returns. There is no notable difference in the standard deviations across portfolios. This implies that big firms offer a higher return at equal volatility. This particular finding concludes that there is no clear risk/return trade-off or implies irrationality in investing behaviour. In the last row of the table, the finding of the significant firm effect is confirmed. Indeed, BN and BG firms do better than their small counterparts. Interestingly, the standard deviations of BV and BN firms are more extensive than their small counterparts.

			BOOK TO MARKET EQUITY			
SIZE	VALUE	NEUTRAL	GROWTH	VALUE	NEUTRAL	GROWTH
		MEANS			STANDARD DEVIATIONS	
SMALL	0,46%	-0,31%	-0,60%	5,73%	5,58%	6,47%
BIG	0,01%	0,37%	-0,10%	6,97%	5,81%	5,14%
δ (S-B)	0,44%	-0,68%	-0,51%	-1,23%	-0,23%	1,33%

Table 8Average excess portfolio returns and the corresponding standard deviations for the sample period for all six portfolios.sSource: own work

In the last row the difference between small and big size portfolios is represented.

If we look at table 9, we see that the SMB factor, which measures the significantsize effect, is harmful. This is inconsistent with findings on the U.S. stock market where it was found that small firms outperformed big firms. Furthermore, the value of the mean excess market return is quite low. The economic turmoil in Europe and across the globe is most likely to be the primary cause. The value effect shown by the HML factor is consistent with findings of Fama and French (1993). They found that high book-to-market ratio firms have higher returns compared to their lower counterparts. The reason can be attributed to the riskiness inhibited by the former firms.

Name	Mean	Std.
RM-RF	0,22	5,50
SMB	-0,25	2,96
HML	0,58	3,78

Table 9 Mean and Standard Deviation for the three factors for the sample period, source own work

Summarizing, the above implies the following for the Dutch stock market during the sample period: Risk-loving investors, who seek additional risk, should invest in big firms. Similarly, risk-averse investors should opt to invest in big firms as well. Interestingly, the significant firm effect is present, which contrasts to Fama and French, who argue that small firms offset higher risk with higher returns. This is undoubtedly not the case for the sample period. The value effect found does align with findings of Fama and French and is consistent with the assumption of the Value premium found on the U.S. stock market. (www.federalreserve.gov)

Lastly, table 10 consists of the tests of the correlations coefficients of all three factors for the entire sample period. This test is done to compare against the correlation effects found by Fama and French. The correlation structure of the explanatory variables indicates that the risk factors SMB and HML affect market betas. Fama and French find the same results.

	RM-RF	SMB	HML
RM-RF	1,00	-	-
SMB	0,32	1,00	-
HML	0,05	0,16	1,00

Table 10 Correlation coefficients of the Market, Size and Value factor for the sample period. source own work

4.3.2. Regression analysis

The purpose of running the regression is to obtain the estimate coefficients on alpha, RM-RF, SMB and HML. These estimates tell us something about the exposure to the various dimensions. The regression is denoted as:

$$r_{!"} - r_{!"} = \alpha_! + \beta_! (r_{!"} - r_{!"}) + s_! SMB_! + h_! HML_! + e_{!"}$$

Where

$r_{it} - r_{ft}$ is the excess return on portfolio *i* for month *t*

r_{Mt}-r_{ft} is the market risk premium for month *t*

SMB_t is the SMB factor for each month *t*

HML_t is the HML factor for each month *t*

SIZE	VALUE	NEUTRAL	GROWTH	VALUE	NEUTRAL	GROWTH
		α			**P-Value**	
SMALL	0,08121	-0,3086	-0,36615	0,65174	0,23432	0,196
BIG	-0,58748	0,13408	-0,14013	0,05217	0,47327	0,42249
		b			**P-Value**	
SMALL	0,8757	0,9196	1,0354	0,E+0	0,E+0	0,E+0
BIG	0,9982	0,9939	0,8385	0,E+0	0,E+0	0,E+0
		s			**P-Value**	
SMALL	0,9923	0,8109	0,9574	0,E+0	1,587E-14	3,330E-16
BIG	-0,1459	0,0174	-0,111	0,17535	0,79414	0,07703
		h			**P-Value**	
SMALL	0,7389	0,0095	-0,386	0,E+0	0,88944	0,E+0
BIG	0,5943	0,049	-0,2809	1,486E-11	0,32275	0,E+0
		Adj. R^2				
SMALL	0,88565	0,7501	0,77867			
BIG	0,78434	0,87999	0,86586			

Table 11 Sample statistics for the six weighted portfolios, source: own work.

Sample statistics for the six weighted portfolios for the entire sample period. For each coefficient estimate a corresponding p-value is denoted. In the bottom part of the table the adjusted R^2 is summarized.

The results of this regression are summarised in table 11. We can find that the alpha estimates differ from zero. This does not necessarily imply that the robustness of the model can be refuted. Note that if the factors would correctly explain excess returns, the alpha coefficient will be indistinguishable from zero. When we include all three factors in the regression, we can see that most of the intercepts are no more significant than 0,59 and relatively close to zero. The intercept is particularly useful as a benchmark to compare against other models.

When we look at the beta estimate of excess market returns, it becomes clear that these coefficients are positive and close to one. If we look at the p-values, we find statistical significance at the 5% level. Further down the line, we find the coefficient estimates for the SMB factor. Four out of six take positive values. Interestingly, all three small size portfolios take positive values. The estimates for big size portfolios are either

negative or zero. Fama and French had shown that small firms load positively and big firms load negatively on SMB. Thus, this finding is consistent with their research. Moreover, the small size portfolios show statistical significance for the s coefficient at the 5% level. Lastly, the coefficient estimates for the HML factor. Here we find statistical significance for all but two portfolios. SN and BN portfolios have a factor loading on the HML factor that is insignificant at the 5% level. This finding corresponds to prior findings of Fama and French who show that high book-to-market ratio firms load positively and low book-to-market firms load negatively on HML. Further support of the robustness of the model is found in the R^2 statistic. This will give some information about the goodness of fit of a model. In regression, the R^2 coefficient of determination is a statistical measure of how well the regression line approximates the real data points. An R^2 of 1.0 indicates that the regression line perfectly fits the data. The adjusted R^2, which is used as a tool for measurement in this thesis, is merely a slight modification of R^2 that adjusts for the number of descriptive terms in the model. The adjusted R^2 in the regression analysis is anywhere in the range of 0,75 to 0,89. This implies that, on average, the model explains approximately 83% of the variation.

To better understand the actual validity of the regression analysis, every one portfolio is regressed on the three factors. That is, the excess returns for the whole period for every portfolio are the dependent variable. The factors MKT-RF, SMB and HML serve as independent variables in the analysis. Also, regressions are carried out for three sub-periods of the sample period.

FF3FM (total)	SV	SN	SG	BV	BN	BG
ALPHA	0,081	-0,309	-0,366	-0,587	0,134	-0,140
Standard Error	0,179	0,258	0,282	0,299	0,186	0,174
T Statistic	0,453	-1,196	-1,301	-1,962	0,720	-0,805

Table 12 sub-period regressions of excess returns source: own work

Whole period and sub-period regressions of excess returns on factors with their corresponding standard error and tstatistic.

FF3FM SP	SV	SN	SG	BV	BN	BG
(SUBPERIODS FF3FM)						
Jan 2004 - April 2007						
ALPHA	-0,283	0,713	-0,093	0,260	0,006	0,070
Standard Error	0,297	0,362	0,491	0,465	0,384	0,297
T Statistic	-0,953	1,973	-0,190	0,560	0,016	0,236
May 2007 – Au 2010						
ALPHA	0,189	-0,588	-0,972	-1,361	0,189	-0,199
Standard Error	0,398	0,571	0,514	0,626	0,384	0,368
T Statistic	0,476	-1,029	-1,893	-2,174	0,492	-0,541
Sep 2010 - Dec 2013						
ALPHA	-0,215	-0,665	-0,319	-0,702	0,102	-0,598
Standard Error	0,305	0,422	0,534	0,476	0,313	0,300
T Statistic	-0,705	-1,573	-0,597	-1,474	0,325	-1,992

Table 13 T-statistic, source: own work

In the table above we find that the t-statistics for all but one portfolio regression are smaller than two. Indeed, Fama and French argue that there not be many portfolios for which the t- statistic is more significant than 2 when using the Fama and French Three Factor Model compared to the CAPM. In fact, all but one t-statistic is significantly smaller for the Three Factor Model compared to the CAPM.

The Fama and French Three-Factor Model prove to be slightly better in predicting results compared to the CAPM. We can see that the explanatory variables SMB and HML that have been added to the CAPM can do a better job in explaining the excess stock returns. The intercepts of the Three-Factor model are lower and thus, adding Size and Value as an extension to the CAPM does better explain effects on average excess stock returns in the sample period.

5. Conclusion

In the course of the work, the main portfolio theories were analyzed and evaluated within the framework of existing economic conditions. Using the provisions of the Markowitz theories, diversified and optimal portfolios dramatically improves the quality of the portfolio. Thus, the inclusion in the portfolio of assets with the lowest correlation reduces the overall portfolio risk, as well as diversification by sectors of the economy, investing in more assets.

The result of the research is also an analysis of the process of formation and management of the securities portfolio in practice. The advantages and disadvantages of the principal investment strategies in the formation of the portfolio were identified. However, the choice of the most suitable for the market in the post-crisis period remains a debatable issue.

In this thesis was the assessment of the reliability of the CAPM, the Fama and French Model. The sample covers 120 monthly observations for the sample period January 2004 to January 2014. In this study it is found that, contrary to what Fama and French (1993) found, big firms outperform small firms. In other words, investors holding large cap stocks seem to enjoy higher returns than investors holding small cap stocks.

As the results showed, in neither of the long-term periods (economic decline and recovery), neither CAPM nor Fama-French showed close to real results. The coefficient of the Alpha coefficient in all cases was significantly above zero.
Furthermore, there appears to be a positive value effect. Firms with a high (BE/ME) perform better than firms with a low (BE/ME).

The findings about the risk premium appear to suggest that there is time-period bias or a data-fishing bias in the data. Data-fishing may be caused by the use of multiple factors in the model. A possibility is that there is no true causal relation in the series, which makes the regression illegitimate. Moreover, the big market effect contradicts previous literature, which implies that on average, small firms do better. The above contradictions and inverse risk-return relationship seem to distort the robustness of the models in explaining excess stock returns. Therefore, further testing in different sub periods is necessary. It is also recommended to use a larger sample size in order to prevent time-period bias. Lastly, it is worth mentioning that these models were tested on the U.S. stock market, which is significantly larger. The relative small size of the Dutch stock market in terms of firms compared to the U.S. stock market is also likely to distort the results.

The Fama and French Three-Factor model does slightly a better job in explaining the excess stock returns than the CAPM does. The intercept estimates across all portfolios are

lower than those found using the CAPM. Furthermore, Fama and French argue there are not many portfolios for which the t-statistic is larger than when using the Fama model compared to the CAPM.

The distortion of results is mainly caused by the inverse relationship of firm size and excess stock returns.

6. Reference

Literature

Marenkov NL Investments. Series Textbooks of Moscow State University. Rostov n / a: Phoenix, 2002
ISBN 5-222-03964-1

Rukhlov A. Principles of portfolio investment. - Finance. Securities. – 2005
ISBN 5–98118–181–8

The securities market: Textbook / Ed. V.A. Galanova, A.I. Basova. - Moscow: Finance and Statistics, 2004
ISBN 5-279-02170-9

Securities: A Textbook / Ed. IN AND. Kolesnikova, V.S. Torkanovsky. -2 th ed., Pererab. and additional. - Moscow: Finance and Statistics, 2002
*ISBN*5-279-02096-6

Sharp U., Alexander G., Bailey J. Investments. - M .: Infra-M, 2006
ISBN 5-16-002595-2

Yankovsky K.P. Investments. - St. Petersburg: Peter, 2006. - (Series "Short Course")
*ISBN*978-5-388-00165-8

Kotz, David M. (2015). The Rise and Fall of Neoliberal Capitalism. Harvard University Press.
ISBN 9780674725652

Markowitz, H. M. (1952), “Portfolio selection”, The Journal of Finance,March.
ISBN 978-1-55786-108-5

Markowitz, H. M. (1956), “The optimization of a quadratic function subject

to linear constraints", Naval Research Logistics Quarterly, 3.*ISBN*: 978-80-7349-307-3 A Simplified Model for Portfolio Analysis Author(s): William F. Sharpe Source: Management Science, Vol. 9, No. 2 (Jan., 1963),
ISBN-10: 9814329959

Wallison, Peter, *Bad History, Worse Policy* (Washington, D.C.: AEI Press, 2013) ISBN *978-0-8447-7238-7.*

Kotz, David M. (2015). *The Rise and Fall of Neoliberal Capitalism*. Harvard University Press. *ISBN 9780674725652.*

Periodic literature:

Fama, E. F., & MacBeth, J. D. (1973). Risk, return, and equilibrium: Empirical tests. *The Journal of Political Economy*. 607-636.

Fama, E. F., & French, K. R. (2004). The capital asset pricing model: theory and evidence. *Journal of Economic Perspectives.* 25-46.

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of financial economics.* 33(1), 3-56.

Fama, E. F. and French, K. R. (1992), The Cross-Section of Expected Stock Returns. *The Journal of Finance.* 47: 427–465.

French, Craig W. (2003). The Treynor Capital Asset Pricing Model. *Journal of Investment Management*. *1 (2)*, 60–72.

Shaikh, S. A. Testing Capital Asset Pricing Model on KSE Stocks. *Journal of Managerial Sciences* Volume VII Number. 2, 282.

Online Sources

www.franklin-grant.ru

www.libguides.vu.nl

www.investopedia.com

www.federalreserve.gov

www.mba.tuck.dartmouth.edu

7. Appendix

Firms	
AALBERTS INDUSTRIES	HES - BEHEER
ACCELL GROUP	HOLLAND COLOURS
AEGON	HYDRATEC INDUSTRIES
AFC AJAX	ICT AUTOMATISERING
AHOLD KON.	ING GROEP
AIR FRANCE-KLM	KARDAN N V
AKZO NOBEL	KAS BANK
AMSTERDAM COMMODITIES	KENDRION
AND INTL.PUBLISHERS	KPN KON
ARCADIS	LAVIDE HOLDING
ASM INTERNATIONAL	MACINTOSH RETAIL
ASML HOLDING	MTY HOLDINGS
BALLAST NEDAM	NEDAP
BAM GROEP KON.	NEDSENSE ENTERPRISES
BATENBURG TECHNIEK	NEWAYS ELEC.INTL.
BE SEMICONDUCTOR	NIEUWE STEEN INV.
BETER BED HOLDING	NUTRECO
BEVER HOLDING	ORDINA
BINCKBANK	PHILIPS ELTN.KONINKLIJKE
BOSKALIS WESTMINSTER	PORCELEYNE FLES
BRILL (KON.)	RANDSTAD HOLDING
BRUNEL INTL.	REED ELSEVIER (AMS)
CORBION	ROODMICROTEC
CORIO	ROYAL DUTCH SHELL A
CROWN VAN GELDER	ROYAL IMTECH
CTAC NM	SAINT GOBAIN
DOCDATA	SBM OFFSHORE
DPA GROUP	SLIGRO FOOD GROUP
DSM KONINKLIJKE	TELEGRAAF MEDIA GROEP
EUROCOMMERCIAL	TEN CATE
EXACT HOLDING	TKH GROUP
FUGRO	UNIBAIL-RODAMCO
GEMALTO	UNILEVER CERTS.
GRONTMIJ	UNIT 4
GROOTHANDELSGEB.	USG PEOPLE
HAL TRUST	VASTNED RETAIL
HEIJMANS	VOPAK
HEINEKEN	WERELDHAVE
HEINEKEN HLDG.	WOLTERS KLUWER

COEFFICIENT		VALUE	NEUTRAL	GROWTH
b(MKT-RF)	BIG	0,9982	0,9939	0,8385
s(SMB)		-0,1459	0,0174	-0,111
h(HML)		0,5943	0,049	-0,2809
b(MKT-RF)	SMALL	0,8757	0,9196	1,0354
s(SMB)		0,9923	0,8109	0,9574
h(HML)		0,7389	0,0095	-0,386

COEFFICIENT		VALUE	NEUTRAL	GROWTH
b(MKT-RF)	BIG	0,97916	0,96137	0,83602
s(SMB)		-0,16184	-0,00982	-0,11309
h(HML)		0,56456	-0,00167	-0,28479
m(MOM)		-0,06811	-0,11634	-0,00903
b(MKT-RF)	SMALL	0,86885	0,8957	1,012
s(SMB)		0,98655	0,79092	0,93779
h(HML)		0,7282	-0,02765	-0,42245
m(MOM)		-0,02454	-0,08531	-0,08363