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Study of CAPM on Finnish stock market

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Description

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Description

Capital asset pricing model (CAPM) is one of the most important pillars of finance. It has been widely studied and applied for its powerful implication in risk return tradeoff and performance analysis of stocks. The objectives of the study are (a) to do an analysis of Finnish stocks according to CAPM (b) to examine the relationship between return and risk measure derived from the model.

A quantitative approach is chosen in order to answer research questions. Secondary data on stock prices is collected. In total, there are 90 stocks listed on Helsinki stock exchange included in this study. Time horizon of the study is from 2012 to 2016. The method of analysis is called second pass regression which was introduced by Lintner. The first pass regression is time series regression run on each stock to estimates parameters of CAPM. Then, second pass regression is done to examine the causal relationship between risk and return.

The research results indicate that there are more overperforming stocks than underperforming stocks given the level of risk. The degree of deviation from CAPM is moderate. Portfolio including 90 stocks is less volatile than the market index. In addition, market risk increases from 2013 to 2014 and stay stable throughout the period. Both two types of risk are found to affect rate of return positively.

Keywords (subjects)

Capital asset pricing model, asset pricing, risk return trade off, market risk, Jensen alpha.

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1 Introduction

1.1 Background

The relation between risk and return have always been one of the most enthusiastically discussed in the financial economics because of its great impact on many related areas. For example, one of the primary jobs of a corporate financial officer is to make decision whether the company should invest in new projects which could be new machinery, new plant, a new product research and development projects…etc. Because these expenditures and investments often require a large amount of money, it is important for managers to carefully evaluate them. The whole planning process of doing this is called capital budgeting. Given the fact that any investments can essentially be reduced to a sequence of cash flows, one standard approach to capital budgeting is by calculating the net present value (NPV) of the project (Andrew Lo, 2008). NPV is simply the difference between present value of cash inflows and cash outflows. Then, managers have to make decision on allocation of budget among projects with positive net present value while taking into account company's strategy. By doing this, managers increase the value of the company according to the value additivity principle. NPV calculation consists of two essential components: future cashflows and discount rate. The fact that investment's cashflow is generated in the future makes the problem more complicated because there is always a certain degree of uncertainty in them. Hence, the core issue of NPV method is finding the appropriate discount rate to adjust for the riskiness of projects. The academic name for this discount rate is cost of capital. Cost of capital can be viewed as the opportunity cost of investing in the project because investors expected to earn at least the same rate of return for funding the projects as for investing on company's stock under the assumption that the investment on the project has the same riskiness as the company's overall business. The company cost of capital is quantitatively estimated as the weighted-average cost of capital, which is the average rate of return demanded by investors in the company's debt and equity. Rate of return of debt is simply the interest on the debt which is known in many cases. The puzzle is figuring out the cost of equity to which expected rate of return to investors in the company's common stock is used as proxy. (Brealey, Myers, and Allen 2011, 241).

It is common knowledge that rate of return is determined by the level of risk. Then, the questions should be asked are: "what specifically risk means?", "how many types of risk are there?", "Does all of them affect rate of return", and "how exactly does risk determine return?". One of most widely studied model answering these questions is capital asset pricing model. According to the model, there are two types of risk: systematic risk and unsystematic risk. But investors are only rewarded for systematic risk because unsystematic risk can be eliminated by diversification. Systematic risk is referred to as beta. It is the type of risk that is common to the entire economic system. It is also called by economists as business cycle risk. It measures the sensitivity of a stock to general market movement. Ever since being introduced by Treynor, William Sharpe, and John Lintner, CAPM has been widely applied and studied because of its simplicity and usefulness. Most of these studies are conducted using US stock market data. Therefore, the authors believe it is worthwhile to do a thesis about CAPM on Finnish Stock market.

1.2 Research questions

The main purpose of this thesis is to examine the Finnish stock market under the scope of CAPM. The time frame of study is from 2012 to 2016. Data sample includes 90 stocks listed on Helsinki stock exchange.

1. **Is there a change in systematic risk on year to year basis in Finnish stocks?**
2. **To what extend Finnish stocks overperform or underperform on annual basis?**

A metric derived from CAPM called Jensen alpha would be used to answer this question.

3. **What is the relationship between risk and return?**

This question will be examined both theoretically and empirically with Finnish stock data. Uncovering the structure of risk return relationship would be greatly beneficial for financial officials and investors.

1.3 Structure of thesis

The remainder of this thesis consists of 4 main parts. The first part is literature review in which the key concepts concerning the research would be explained in detail. This part also presents the empirical research of previous studies on the topic. Next, "methodology" part will discuss the research approach and data analysis method. After that, quantitative results and findings would be presented in "result" part. In the last part "discussion", the author will summarize the result. Also included in this part is a presentation of the implication, limitations, validity of the findings and suggestion for further researches.

2 Theoretical background

2.1 Risk and return

RATE OF RETURN

One of the ultimate purposes of every investor is to make profit. Profit in investment world is called return. Rate of return is a key measure of an investment's performance. Thus, it is important to determine the definition of return and how it is quantitatively measured.

The general quantified measurement of return is holding period return (HPR). HPR is basically the sum of dividend paid and the difference between price at the beginning and price at the end of holding period divided by the price paid to buy security:

$$HPR\ (\%) = \frac{devidend + ending\ price - beginning\ price}{beginning\ price} 100\%$$

Another interpretation of the equation is the number of euros earned during the holding interval for each euro invested under the assumption that dividend is earned at the end of holding period. In the case of dividend paid before the security is sold, this equation ignores the reinvestment of dividend for the sake of simplicity (Bodie, Kane, & Marcus 2004, 132).

According to Mayo (2007, 146), there are three types of return often referred to by academics: expected return, realized return and required return. Expected return is the estimated return in the future investors would earn for an investment. This is the expected value of HPR. Expected return is not the measure for the actual pay off investor have received. The return investor actually gains from an investment is called realized return. Realized return is calculated from historical data. Realized return sometimes is called as actual return by other academics. Required return is the minimum return investor require to accept the risk associated with an investment. Required return could be understood as the opportunity cost of an investment, the return investor could have earned for a different project with similar risk in the market. This is often used as benchmark to help investors make decision. In the context of capital budgeting mentioned in the introduction part, required return is the cost of capital. Expected return earned on a company's stock is often used as proxy to cost of equity in computing cost of capital.

DEFINITION OF RISK FREE, RISK PREMIUM, AND RISK

Because risk is a qualitatively vague notion, the author would like to define risk indirectly by defining more specific concepts including risk-free, risk premium first. ***Risk free assets*** are the kinds of investments that guarantee a certain return at the end of holding period. Government bond is often considered to be risk free because the government can always print money to pay back the par value of bond. Therefore, investor can safely assume that investments in bonds will give an amount of money known in advance. Of course, if inflation is taken into account, return on bonds may not be certain anymore because the money received from bond is only nominal, in spite of that government bonds still can be used as a proxy to risk-free asset because it is the safest investment available in the market in terms of known nominal income. Return on risk free assets is called ***risk free rate***. Bodie, Kane, and Marcus (2004) measures reward of an investment by subtracting risk-free rate from rate of return and call it ***risk premium***.

Risk is concerned with the uncertainty that realized return turns out to be different from the expected return. Higher risk means that the spread between realized return and expected return gets wider. In this sense, it is interesting to note that risk works both on the upside and downside. Taking more risks increases chance of great losses and possibilities of big wins at the same time. In fact, the term “speculation” is used to indicate potentially high return investments but are very risky. But in the long term, speculation is not necessarily a good investment. Remember that what induces investors to take risk is the risk premium, therefore, a risky asset but have small risk premium selling at a high price is a bad investment (Drobny 2010, 87). Mathematical function provided later will demonstrate this point.

STANDARD DEVIATION: A MEASURE OF RISK

When considering whether to buy a stock, investors need to think of possible scenarios could possibly happen and the HPR of the stock in each scenario. Then, he needs to estimate the probability for each scenario. This process is called scenario analysis and a list results from this analysis is called a probability distribution of HRPs (Bodie, Kane, Marcus 2004, 136). An illustrating example with s numbers of scenarios is presented in the following table.

Table 1 Probability for each scenario corresponding to certain rate of return

Scenario	Probability, denoted p(s)	HPR, denoted r
1	p1	r1
2	p2	r2
3	p2	r3
…….	…….	……..
s	p(s)	r(s)

Statistical measurement for expected return, and risk is derived from the above probability distribution. The mean value of the above distribution of HPRs equals to the expected return on the investment. Basic statistical theory defines mean value of probability distribution as the weighted average of returns with weight equals to the probability corresponding to each scenario:

$$E(Rs) = RsPs$$

Note that R(s) is the realized return in each scenario. As risk is defined as the difference between realized return and expected return, a statistical parameter called “variance” is the measure of risk:

$$Var(r) = \sum_{s=1}^{S} p(s)(R(s) - \mu)^2$$

Variance is a measure of the volatility of realized return around expected return. It is the appropriate measure of risk because it captures the uncertainty of return. Since variance has the squared attribute to avoid negative value between Rs and E(R), standard deviation (denoted σ) is computed by taking the squared root of variance in order that the measure of risk has the same dimension as the expected return.

$$\sigma = \sqrt{Var(r)}$$

Expected return and standard deviation are the two most important parameters when evaluating a performance of a stock. The greater value of σ is, the riskier the stock is and hence the less attractive it is to investors.

2.2 Modern portfolio theory

Harry Markowitz devised portfolio theory in 1952 to provide a systematic approach to investment allocation. One of the revolutionary idea of the theory is that investors can reduce risks by holding a diversified portfolio. Because holding one single stock is too much risky, investors always put their money in a portfolio. A portfolio is simply a combination of securities which could include stocks, bonds, cash, or any others financial instruments.

MEAN VARIANCE ANALYSIS

Given portfolio including different risky assets, the fraction of investment in each security is represented by portfolio weight (denoted w), it is obvious that:

$$w1 + w2 + w3 + \cdots + wn = 1$$

The expected return of portfolio including n risky assets is the weighted average of the expected return of each asset:

$$Ep = w1E(R1) + w2E(R2) + \cdots + wnE(Rn)$$

Covariance is an important statistical concept when calculating variance of portfolio. Covariance between two assets is defined as expected product of their deviation from their individual expected value. The equation for covariance between asset i and j is:

$$Cov(Ri, Rj) = E\big((Ri - E(Ri)) \times (Rj - E(Rj))\big) = \sigma ij = \sigma i \sigma j \rho ij$$

Where ρij is defined as the correlation coefficient between two assets.

Covariance between two assets can also be defined as the product of their individual standard deviation and correlation coefficient between them. Both covariance and coefficient measure the degree to which returns of two assets vary together. While correlation coefficient has the same conceptual meaning as covariance, it can also be used to compare across different assets because it was standardized by dividing covariance by the product of standard deviation; as a result, being corrected for differences in standard deviations Fabozzi (2002, 27). A positive value of covariance or coefficient means assets' returns change in the same direction, while a negative value means assets' returns move inversely. The value of ρij ranges from -1 to 1. When ρij equals 1, it means prices of two assets moves exactly in lockstep. In this case, the standard deviation of portfolio combining these two assets is the weighted average of each asset's standard deviation. In any other cases, combining different risky assets has the benefit of reducing risk. Markowitz demonstrated this in 1952.

Covariance matrix is the commonly used tool to calculate portfolio variance, portfolio variance is the sum of the products of weights and entries.

	w1	w2	…	wn
w1	$\sigma 1^2$	Cov(R1, R2)	…	Cov(R1, Rn)
w2	Cov(R2,R1)	$\sigma 2^2$	…	Cov(R2, Rn)
…	…	…	…	…
wn	Cov(Rn, R1)	Cov(Rn, R2)	…	σn^2

Or the formula for variance of portfolio return can be written as:

$$Var(Rp) = \sum_{i,j=1}^{n} wiwjCov(Ri, Rj) = \sum_{i,j=1}^{n} wiwj\sigma i\sigma j\rho ij$$

Note that when i=j, Cov(Ri, Rj) is the variance of i or j. It can be seen from the matrix that while there are n values of variances, there are (n^2-n) values of covariances. For that reason, covariances between risky assets contribute more to the portfolio risk than variances of individual assets do (Lo, 2008).

HOW DIVERSIFICATION REDUCES RISK

The special case of a portfolio consists of n equally weighted risky assets was used to illustrate how diversification reduce overall risk of portfolio (Brealey, Myers and Allen 2011, 173). In this case where wi=1/n for all assets, the variance of portfolio is:

$$Var(Rp) = \sum_{i=1}^{n} \frac{\sigma i^2}{n^2} + \frac{1}{n^2} \sum_{i \neq j} cov(Ri, Rj)$$

$$= \frac{1}{n} \times average\ variance + \frac{n-1}{n} \times average\ covariance$$

Consequently, as the number of securities in the portfolio grows, portfolio’s variance steadily reaches the average covariance. In other words, in a well-diversified portfolio, an individual security’s contribution to portfolio’s risk depends on its covariances with other securities in the portfolio rather than its variance (Bodie, Kane, & Marcus 2013, 228). For this reason, as long as stocks are not perfectly correlated, standard deviation of portfolio is smaller than the weighted average of standard deviations of individual risky assets in the portfolio. Especially, when stocks are completely uncorrelated, which means correlation coefficient among stocks equals zero, portfolio variance is reduced to zero. But in the reality, stock prices always move together to a certain degree because of the impact of general market on all stocks. In this case, there is a limit at which diversification stop reducing portfolio risk. In other words, there is a part of total risk that cannot be diversified away. For this reason, this type of risk is called **market risk, systematic risk, or undiversifiable risk**. On the other hand, the type of risk can be eliminated by diversification is called **specific risk or idiosyncratic risk** because it is peculiar to individual stocks (Brealey, Myers, & Allen 2011, 174). Figure 1 illustrates how diversification reduces portfolio risk. The vertical axis shows the variance of portfolio return. The number of securities included in the portfolio is represented on the horizontal axis. As can be seen, as the number of risky assets increases, aggregated specific risk is almost eliminated. The appropriate number of securities in a portfolio to be considered well diversified depends on the type of security. For example, for common stock, studies have shown that portfolio consists of about 20 stocks of randomly chosen companies will have only systematic risk (Fabozzi 2002, 76).

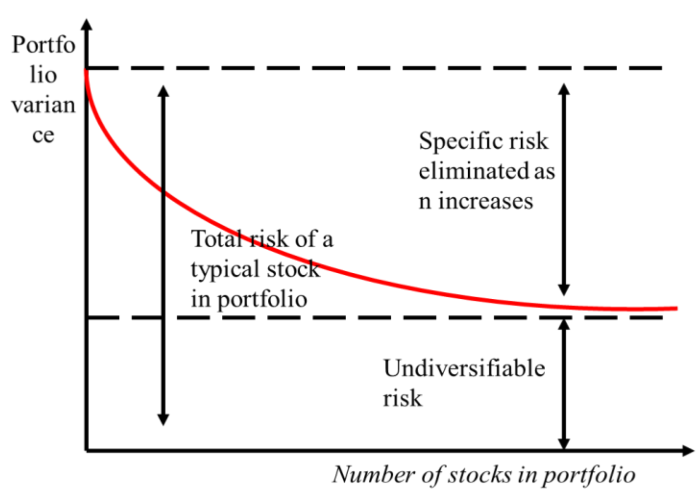

Figure 1 Effect of diversification (Lo 2008)

EFFICIENT FRONTIER

Efficient frontier includes all combinations of risky assets that provide the best rate of return for a degree of risk. Figure 2 illustrates this point. This figure can be drawn by running a simulation in which all possible values of risky assets' weights are simulated in mean variance analysis. The vertical axis measures the expected return of portfolio. Portfolio risk represented by standard deviation is shown in the horizontal axis. All feasible combinations of risky assets in the portfolio lie within the variance minimum boundary. A portfolio is referred to as efficient if it provides the highest rate of return for a given level of risk. Therefore, it is obvious that all efficient portfolios available must lie on the upper part of the variance minimum frontier. In other words, efficient frontier represents all best possible risk return trade-offs from combining risky assets. Every rational investor wants to hold portfolios on that line. Holding which specific portfolio depends on investor's preference. It is worth emphasizing that this analysis was made without regard to risk-free rate, the next section will show what could happen in the presence of risk-free rate.

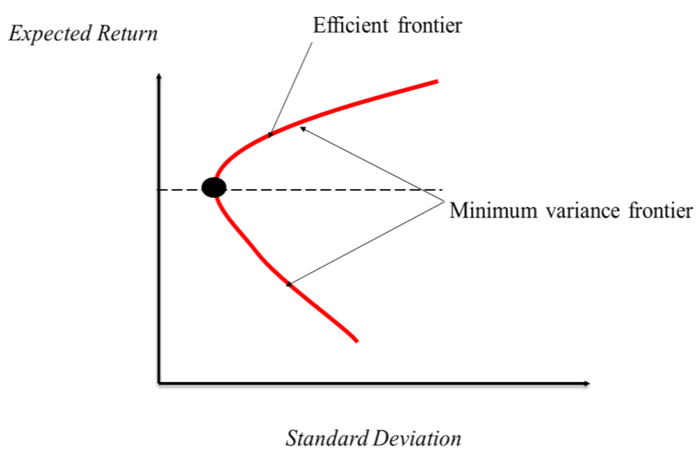

Figure 2 The minimum variance frontier of risky assets (Bodie, Kane, Marcus, & 2013, 220).

2.3 Capital asset pricing model

Based on Markowitz's model, Capital asset model pricing (CAPM) was developed by three economists William F. Sharpe, John Lintner, and Jan Mossin. This model is an extension of Markowitz's model for that it introduced the addition of risk-free asset to the efficient portfolio and evaluation of individual securities (Mayo 2007, 172).

CAPITAL MARKET LINE

The three economists proved that it was possible to identify a portfolio of risky assets that any investor would hold if lending and borrowing at risk-free rate were possible. That portfolio is called tangency portfolio because it is the tangent point between the line originating from risk-free return and the efficient frontier of risky assets. This line includes all the optimal investment possibilities because it provides the highest risk return trade-off measured by Sharpe ratio. Therefore, all efficient portfolios now must be on this tangency line.

$$Sharpe\ ratio = \frac{E(Rp) - r_f}{\sigma_p}$$

Figure 3 shows how lending and borrowing extend the possibilities range of investment possibilities. The left part of the line can be achieved by spending a portion of investment on risk free asset, which also means lending money because government bond is used as proxy to risk free asset. Likewise, by short selling at risk-free rate and then using that money to invest in tangency portfolio, investors expected to earn a higher rate of return at the expense of greater risk.

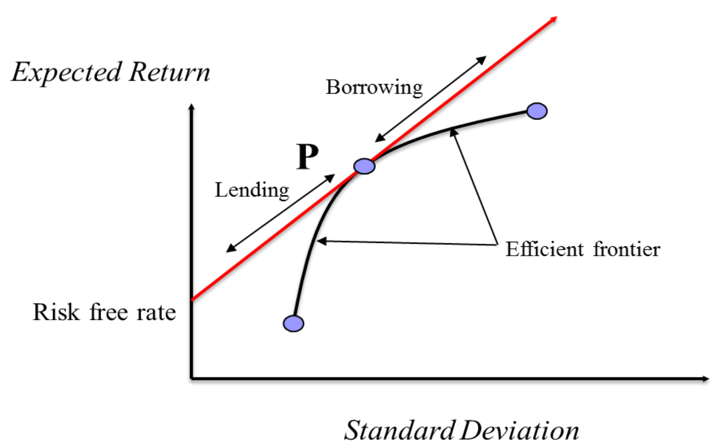

Figure 3 The efficient frontier of risky assets with optimal capital allocation line

They went on to argue that if all investors had the same information, faced the same risk-free rate, and did the same analysis, they would obviously arrive at the same tangency portfolio P. It means that all investors would choose a portfolio that includes the same risky assets with the same weights for each asset. In equilibrium, this portfolio must comprise all risky assets in the market at the weight of each asset equals its proportion of market value to the total market value of all risky assets. This portfolio is called **market portfolio**. The optimal capital allocation lines comprised from all investors' expectation will become one single **capital market line** (Elton, Gruber, Brown, & Goetzmann 2014, 293).

Rate of return of efficient portfolios on the capital market line is presented by the following linear equation:

$$E(Rp) = Rf + (E(Rm) - Rf)\frac{\sigma p}{\sigma m}$$

Where p denotes efficient portfolio and m denotes market portfolio. (ibid., 294.)

In words, the above equation states that return on an efficient portfolio is the sum of return achieved from risk-free and market risk premium which depends on the portfolio's standard deviation relative to market portfolio's standard deviation (Mayo 2007, 173). The equation captures the relationship between risk and return of efficient portfolios. If investors increase their portfolio risks (σp) by borrowing risk free securities to hold more of market portfolio, they will expect to earn a higher rate of return because the $\sigma p/\sigma m$ ratio becomes larger. Reversely, buying more risk-free asset will lead to decrease in portfolio risk and portfolio return as well.

EXPECTED RETURN ON INDIVIDUAL SECURITIES

The revolutionary idea of CAPM is showing how to estimate expected return of any individual asset and inefficient portfolios which is not on the capital market line.

As concluded earlier in the portfolio theory section, well diversified portfolio's variance depends on covariances of individual securities. Therefore, an individual risky asset risk must be examined in terms of its covariances with other securities in the portfolio. In CAPM model, beta is used to measure a stock's contribution to the variance of market portfolio. In this sense, beta is the measure of systematic risk of individual securities. For any arbitrary portfolio, its market risk is calculated by taking the weighted average of individual securities' betas. The mathematical equation of beta for a single asset i is:

$$\beta i = \frac{Cov(Ri, Rm)}{\sigma m^2} = \rho_{im}\frac{\sigma i}{\sigma m}$$

The ratio between stock standard deviation and market's measures how volatile the stock is relative to market volatility. It is obvious that greater the ratio, the higher risk associated with the stock. The correlation coefficient between the stock return and market return indicates how consequential this ratio is. A risky asset with beta equals 1 means that its return's changes match market return's. If the stock has beta greater than 1, it is considered to be riskier than the market portfolio and expected to have greater rate of return. The greater value of beta is, the more systematic risk associated with the stock, therefore, the more sensitive its price to market changes. For example, a 20% change in return of market portfolio will lead to 40% change in return of stock with β=2 and 10% change of stock with β=0,5. In other words, risk premium of a stock is proportional to the market risk premium. The proportion is stock's beta, or:

$E(Ri) - Rf = \beta i(E(Rm) - Rf)$ or $E(Ri) = Rf + \beta i(E(Rm) - Rf)$

The above equation is the traditional form of CAPM. The equation captures the risk return relationship for individual securities or any portfolios in the market. It shows that risk return relationship is linear. Investors are compensated only for taking market risk because they don't have to bare specific risk, which can be diversified away in a portfolio. In other words, in the context of portfolio, beta is the right measure of risk rather than stock's standard deviation. Only in the case of efficient portfolios when portfolios' risks are totally composed of market risk (because unique risks of individual stocks have been eliminated), beta and standard deviation are the same. The relationship between expected return and beta is graphically illustrated by security market line as in figure 4.

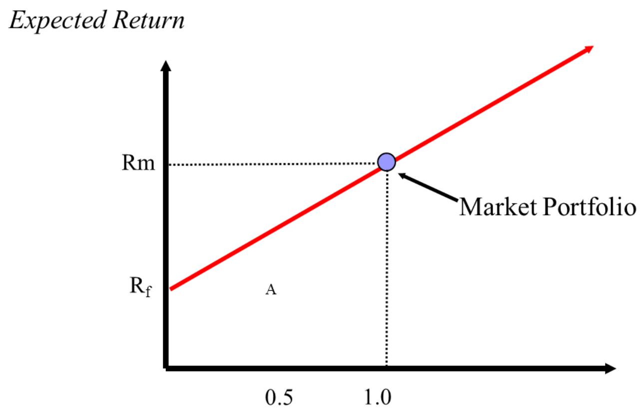

Figure 4 Security Market line

The vertical axis shows the expected return, while the horizontal axis shows market risk. CAPM states that every security must be on the security market line in equilibrium. Stocks under the line will fall in price while prices of stocks above the line will increase quickly so that they will reach the line. For example, the price of a hypothetical stock A in the figure with β=0.5 under the line will fall quickly because investors can easily earn a higher return for the same level of risk by investing half in risk-free asset and half in market portfolio. Similarly, if there exists a stock above the line, every investor will be eager to buy it and consequently drive its risk premium down to the security market line (Brealey, Myers, Allen 2011, 195).

The application of security market line does not limit to stocks. It can also be applied to calculate the appropriate rate of return for projects. For example, if financial manager wants to calculate the required rate of return for an oil drilling project. He can calculate beta of oil drilling stock, and then apply the model to calculate the expected rate of return of the stock. The result should be the appropriate discounted rate for the project (Lo, 2008).

JENSEN ALPHA

One of the applications of CAPM is to evaluate the performance of portfolios or individual securities. An investment is perceived to overperform the market if its realized return is higher than the expected rate of return stipulated by CAPM. Similarly, underperformed stocks provide an actual return lower than the expected return according to CAPM. The difference between the actual return and expected return is called Jensen alpha, denoted α. Jensen alpha is the appropriate measure to evaluate stock's performance because it takes into account only the market risk of stocks. Stock overperforms the market when it has positive alpha, negative alpha implies that the stock underperforms the market (Lo, 2008).

2.4 Previous empirical studies on CAPM

Empirical literature review is an important step in the study for several reasons. First, it raises the awareness of the topic by showing the knowledge gap, based on which the hypothesis is formed. Hypothesis brings the objectivity and focus to the research process. Second, it provides some insights into how to conduct a similar study on the topic. This would be very helpful in choosing the methodology of the research that ensure the validity and credibility.

Ever since the CAPM was introduced, Academics have been showing varying results on the validity of CAPM. While there are many papers supporting CAPM, there are also works dispute it. This section will discuss both views. In general, most of them focus on three main conclusions from the model. First, beta alone explains the rate of return, and their relationship is linear. Second, the market portfolio always gives higher expected return than riskless assets do. Third, assets have betas equal zero must have expected rate of returns equal risk-free rate (Fama, & French 2004, 26).

According to Levy (2012, 192), Lintner is one of the first to test CAPM empirically. He uses 301 stock data from 1954-1963. His method includes two stages of regression. This thesis employs the same method as Lintner's. In the first stage, he runs 301 time-series regressions of stock return on market return for each stock to obtain 301 corresponding betas. Using these 301 pairs of return and beta, he runs one cross sectional regression in the second stage to test the validity of beta. The form of this regression is: $r_i=a_0+a_1\times b_i+\varepsilon_i$. Where r_i and b_i are stock return and beta estimate.

For the equation of CAPM to hold true, a_0 must be not significantly different from risk-free rate and a_1 must not be significantly different from market risk premium. To put this in words, CAPM version of Sharpe stated that the intercept of the security market line (figure 4) had to be equal to risk-free rate, and the coefficient on beta (the slope of security market line) is the difference between market return and risk-free rate (market excess return). While the result does show evidence of a significant correlation between return and beta, it is not supportive of CAPM in this respect. The intercept is found to be greater than risk-free rate, for which one-month treasury bill is used as proxy, the market excess return was greater than the coefficient on beta.

Miller and Scholes (1972) use the method as Lintner did with larger data sample. They also add variance of the residual term in the second regression as an explanatory variable. The results are that both beta and residual variance are significantly explaining variation in return. The coefficient of determination (r squared) of this regression with two explanatory variables is 0.33. This is higher than r squared of regressions with beta and residual variance used separately as the explanatory variable. This finding contradicts the hypothesis of CAPM which is beta is the only variable explaining variation in return. Levy (2012, 196).

Levy (1978) finds similar results with data sample size of 101 stocks for twenty-year period 1948-1968. The first pass regression is done the same as previous studies. But he runs three times of second pass regression. The first cross sectional regression with beta as independent variable give the r squared = 0.21 which indicates beta is a good predictor of return. But the interesting results is that r squared increases to 0.38 when stock's variance used as the independent variable which indicates stock's variance does better in explain return than beta does. Levy (2012, 202).

Fama and MacBeth (1973) also find out results supporting the relationship between return and beta with a different method. They work with portfolios instead of individual stocks as earlier tests. The number of portfolios in their study is 20. The market portfolio used in this regression includes all stocks listed on New York stock exchange at their equal weighted value. After estimating beta for each portfolio, they run cross sectional regressions for each month. Besides beta and residual variance, they also beta squared as the third independent variable in cross sectional regression to test if the relationship between return and beta is non-linear. For each month they get a different coefficient of regression on independent variables. The critical part of the study is to calculate the mean of each coefficient across all months and use t test to test if these averages are significantly different from zero. The results are that only beta is the significant variable explaining variation in return, the coefficient of residual variance and beta squared is not significantly different from zero. This result contrasts with previous studies and has been the most supportive test of the central hypothesis of CAPM which is beta is the only factor explaining return. But the fact that this test uses portfolios make the results cannot be generalized to individual risky stocks. Levy (2012, 200).

Even though some of the above studies suggest that stock's variance and residual variance, which is specific risk, also explain rate of return which is not aligned with CAPM, all of them confirm the hypothesis of CAPM that there is a linear relationship between return and beta. Following studies disregard the role of beta the role of beta in explain return.

Banz (1981) uses all stocks listed on the New York Stock Exchange during 1926-1975 period to study the relationship between return, beta, and market size. The novelty in his study is that he adds market size as an independent variable in the cross-sectional regression. His analysis shows that smaller stocks tend to have higher return than large size stock. This phenomenon is obtained after controlling for beta. Therefore, he concludes that beta is not a risk factor explaining return. Reinganum (1981) also reports similar phenomenon. Levy (2012, 204).

The firm size effect is most elaborative in Fama's and French's paper in 1992. In this paper, the authors use the same method of monthly as in Fama's and Macbeth's study. The research covers the period from 1963 to 1990. Besides beta, the explanatory variables are market size and book to market ratio. Their estimate of the coefficient on beta indicates that there is not a significant correlation between return and beta. By contrast, market size and book to market ratio are found to be powerful factors in explaining return.

3 Methodology

According to Saunders, Lewis, and Thornhill (2009, 595), research methodology is simply put as how the research is carried out. It's not only a depiction of how the data is collected and analyzed, but also the theoretical concepts justifying for the employed method. It is important that research methodology is appropriate to the purpose of research.

3.1 Research approach

Saunders et al. (2009) use the research "onion" framework to depict the main issues in the research process. The first layer is research philosophy (ibid., 105). Creswell (2014) uses a slightly different terminology to imply research philosophy. He states that philosophical worldview is important because it has great influence on choices of detailed research design. In other words, it is the researcher's basic beliefs about the nature of doing research that underpin the direction of research. The philosophy in this thesis is positivism because it matches the thesis's purpose. Positivism implies that the researcher must carefully observe the objective reality. Accordingly, the theory is continuously tested and sharpened by data driven method until it can be generalized to similar circumstances.

It is implicit in the choice of the philosophical worldview that quantitative approach is used in this thesis. Creswell (2014) defines quantitative approach as a systematic examination of a phenomenon using statistical techniques. One of its application is to test a theory about the relationship between two variables which can be expressed by a number. An important advantage of the quantitative approach is that it provides descriptive data which could be compared and derived the tendency of variables. This strength is essential in answering the research questions in this thesis. Another strength of the quantitative approach is that it allows reducing a complex problem to limited variables. There may be many different factors affecting stock performance, some of which could be qualitative for example the psychological attitude of investors toward the company. Analyzing this kind of qualitative data requires much more effort in interpreting the meaning of data, not to mention the possibility of acquiring data for such a great number of companies in the first place. In other words, the quantitative approach helps streamline the process while still ensure a systematic validity for the thesis.

According to Saunders et al. (2009, 138), the purpose of research can be classified into three types: explanatory, exploratory, and descriptive. This thesis is descriptive as it seeks to provide a clear description of 90 stock from 2012-2016. At the same time, it is also explanatory in the sense that it examines the relationship between return and risk measures.

Another important choice in research design is whether the logical reasoning method is deductive or inductive. Trochim (2006) refers to deductive reasoning as “top down” because it starts with a theory and then developing a hypothesis. After that, the researcher collects observation to address that hypothesis. Finally, the hypothesis will be tested according to the observation, which confirms or disconfirms the original theory. This process matches the objective of this thesis; therefore, the thesis is deductive.

3.2 Data collection

The period of study is from 2012 to 2016. All data used in this thesis is secondary data. Secondary data means data originally meant to serve other purposes by different researchers. The main strength of secondary data is that it provides a large amount of data over time with high precision, especially in the case of quantitative data (Saunders et al. 2009, 256).

The theoretical background is based on various books and articles regarding investment and corporate finance, in which portfolio theory and CAPM is studied at the uttermost effort. This part is particularly important in this thesis because it not only familiarizes the author with the main concepts in the field but also plays a vital role in setting up the research problem and conducting the research. Empirical research is meant to provide some perspectives on the question of the empirical results of CAPM. It also gives valuable suggestions on research approach. This part is based on articles and journals about the empirical studies of CAPM.

Data on stock price is taken from Nasdaq OMX Nordics website for the period of 2012-2016. 90 stocks listed on Helsinki stocks exchanged are chosen. This is the number of stocks that have available data during the period and are actively traded. Information on 90 stocks included in this thesis can be found from appendix 2. This thesis uses 12-month Euribor rate as proxy for risk-free rate. This is the interest rate at which European banks lend or borrow loans which have maturity of 12 months. This information is retrieved from Euribor rate website. The proxy for market portfolio is OMX Helsinki_GI which includes 131 stocks listed on Helsinki exchange. Index price is also accessed from Nasdaq OMX Nordics website.

3.3 Data analysis

There are 2 main stages in data analysis. The first step is to run time series regressions for 90 stocks to estimates betas, Jensen alphas, and specific risks. In the second step, cross sectional regressions are run for each testing period to examine the relationship between risk factors (total risk, beta, and specific risk) and return.

1. Time series regression.

First, daily return is computed from daily price data as holding period return mentioned in section 2.1. In order to smoothen computation process, dividend is disregarded from the computation. Next, the daily return is converted to annual return. One common approach is to apply the same method as computing daily return with prices at the first and last day of the year. As a consequent, the result of this method depends on the randomness of prices at those days and may not be representative for variation of daily prices for the whole year. Therefore, the author decides to compute the average value of daily returns of the year, this average value is then converted to annual return by the following formula:

$$Rannual = \left((1 + average\ of daily\ return)^{number\ of\ trading\ days} - 1\right) \times 100\%.$$

Having computed stocks' return and market index's return, the author runs 90 time-series regressions to estimate betas and Jensen alphas of every stock for each period. In these regressions, the independent variable is daily index's excess return and the dependent variable is stocks' daily excess return. The regression model is:

$$y_{it} = \alpha_i + \beta_i \times x_{mt} + \varepsilon_i \qquad \text{(model 1)}$$

Where:

y_{it}: stock's excess returns (stock return minus risk free rate).

α_i: regression intercept.

β_i: coefficient on index's excess return.

x_{mt}: index's excess returns (index's return minus risk free rate).

ε_i: random error term.

Compare the regression model to formula of CAPM: $E(Ri) - Rf = \beta i(E(Rm) - Rf)$, It is obvious that α_i is the abnormal return of stock (deviation of actual return from expected return according to CAPM) or Jensen alpha, and β_i is stock's beta.

The next step is to decompose systematic risk and specific risk from the total risk. According to Hotvedt and Tedder (1978), the coefficient of determination r squared in the above regression model represents the portion of total risk which is the total variance of stocks explained by changes in the explanatory variable which is index's excess return. Thus, it can be used to measure the percentage of systematic risk in total risk. Therefore, specific risk can be measured by the following equation:

Specific risk $= Variance\ of\ stock\ return - \beta_i^2 \times variance\ of\ market\ return.$

Because the above equation measures the residual variance from the model 1, specific risk will be denoted as RV in the result section.

2. Cross sectional regression.

This step is to examine the relationships between return and risk measures. The risk measures are total risk, RV, and beta. These three measures will be used as explanatory variables in the following model:

$$r_i = a_0 + a_1 \times x_i + \varepsilon_i \qquad \text{(model 2)}$$

Where:

R_i- returns of 90 stocks over the testing period

a_0-regression intercept

a_1- regression coefficient on explanatory variable

x_i-explanatory variable.

Three regressions are run for each year from 2012 to 2016 and for the total 5-year period. This thesis focuses on the strength and significance of the relationship. Pearson correlation coefficient measures the strength and direction of the linear relationship between two variables. P value of regression coefficient is to test the null hypothesis that there is no linear relationship between two variables or a_1= 0. The smaller p value is the more unlikely the observed data is assuming the null hypothesis is true.

4 Results

4.1 Descriptive statistics

RETURN:

Table 2 shows descriptive statistics on stocks' returns in each research year and total research period. The mean value of 90 stocks' returns stays positive throughout the period with the smallest annual return is 2.1% in 2014. Annual return reaches the highest value at 34.9% in 2015. 5-year period return is nearly 140%. The coefficient of variations (the ratios of standard deviation to the mean) stays around 2 in every period. 2014 is the year when the ratio has the highest value of 4.47. High coefficients of variation mean that there are large deviations of stocks' returns relative to their means. As expected, wide ranges between the highest return and lowest return exist. The difference is 24.69 for the 5-year total period.

Table 2 Descriptive statistics and normality test on return

Panel A: Descriptive Statistics						
	2012	2013	2014	2015	2016	2012-2016
Mean	0.135	0.314	0.021	0.349	0.288	1.399
Standard Error	0.039	0.076	0.031	0.077	0.065	0.286
Median	0.127	0.186	0.020	0.224	0.149	0.933
Coefficient of variation	2.76	2.30	4.47	2.09	2.15	1.937
Standard Deviation	0.373	0.725	0.094	0.730	0.620	2.711
Sample Variance	0.139	0.525	0.008	0.533	0.384	7.347
Kurtosis	14.062	14.960	-0.065	54.363	13.702	53.302
Skewness	2.501	3.545	0.405	6.661	3.382	6.585
Range	2.846	4.502	1.381	6.737	3.902	24.697
Maximum	2.397	4.049	0.828	6.416	3.334	23.809
Minimum	-0.449	-0.452	-0.553	-0.321	-0.568	-0.888
Count	90	90	90	90	90	90
IQR	0.402	0.453	0.429	0.393	0.416	1.415
Panel B: Shapiro-Wilk Test						
	2012	2013	2014	2015	2016	2012-2016
W	0.829	0.615	0.978	0.449	0.642	0.4509
p-value	8.28E-09	5.38E-14	0.13578	1.1E-16	1.77E-13	1.11E-16
alpha	0.05	0.05	0.05	0.05	0.05	0.05
normal	no	no	yes	no	no	no

It is important to examine the distributions of returns because one of the primary assumptions of CAPM is that returns are normally distributed. Panel B shows the results of Shapiro-Wilk Test for the null hypothesis that distribution of returns is normal. Distribution of return is normal only in 2014. Specifically, almost all distributions have high positive degrees of skewness. This means return distributions are right skewed.

High degrees of kurtosis indicate that distributions have heavy tails or outliers. Figure 5 illustrates graphically returns' distributions. As can be seen from the graph, except for 2014 distribution, all have positive outliers (presented by blue dots outside box plots) but there is no negative outlier in any distribution.

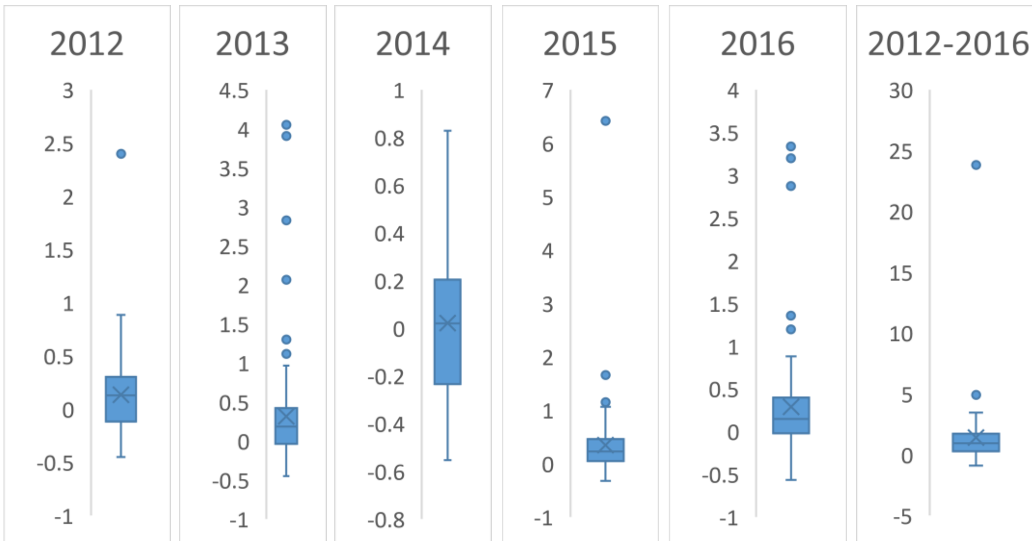

Figure 5 Box plots visualizing return distributions in each study period

COMPONENTS OF RISK:

Table 3 shows the summary statistics of three different measures of risks for the total period. The estimates have been annualized. Stocks' variance which is the total risk (n=90) averages 0.137 with a standard deviation of 0.178. Specific risk has the mean of 0.119 and standard deviation of 0.179 while the mean of beta is 0.640 and its standard deviation is 0.358. The standard deviation of beta is 55,9% to the means while the measures for variance and specific risk are 130% and 150% consecutively. This means that beta variable is less dispersed from the mean than variance and specific risk. All three measures have wide spreads in 90 stocks' data with differences between the min and max value are 1.435, 1.455, and 1.666 for total risk, specific risk, and beta consecutively. Similar calculation result for each year sub period is included in appendix 1. Besides, it can also be found in Appendix 1 that specific risk constitutes around 82% in total risk while the portion of market risk is about 18%.

Table 3 Summary statistics of measures of risks for the 5-year period

	Variance	*Specific risk*	*Beta*
Mean	0.137	0.119	0.640
Standard Error	0.019	0.019	0.038
Median	0.093	0.074	0.554
Mode	0.050	0.036	0.671
Standard Deviation	0.178	0.179	0.358
Coefficient of variation	1.305	1.501	0.559
Sample Variance	0.032	0.032	0.128
Range	1.435	1.455	1.666
Maximum	1.476	1.472	1.772
Minimum	0.041	0.017	0.107

Paired sample t test is used to answer the question if beta changes on yearly basis. The test procedure is run as follow. First, the author calculates the differences in betas of each 90 stocks in each two-consecutive year from 2012 to 2016. Denote Di as the difference, the null hypothesis of the test is the true mean of Di is zero which means that beta does not change between these two years. The test is run four times for each two-consecutive year. Table 4 presents the results of the tests. The table includes mean of difference, standard deviation, standard error, t stat of the test to compare with the critical value to check for the null hypothesis and the significance of Di mean. The null hypothesis is rejected when the absolute value of t stat is greater than the critical value. As can be seen, the null hypothesis is rejected only for the test between 2014 and 2013 which has t stat of 3.377. The mean of 90 stocks' betas increases by 0.110 from 2013 to 2014 and is significant at 1% level. This means these stocks on average become more sensitive to market movement from 2013 to 2014.

Table 4 Paired samples tests for differences in betas

	Mean	Std. Deviation	Std. Error	t stat	Critical value	sig. (2-tailed)
β2013-β2012	-0.006	0.260	0.027	-0.229	1.987	0.819
β2014-β2013	0.110	0.308	0.032	3.377	1.987	0.001
β2015-β2014	-0.012	0.192	0.020	-0.611	1.987	0.543
β2016-β2015	-0.019	0.165	0.017	-1.073	1.987	0.286

JENSEN'S ALPHA:

Table 5 summarizes some descriptive statistics on Jensen alphas for each year and the total period. The mean is positive in almost each year except for the year 2014 when the mean is -0.064. The year 2012 has the lowest positive mean with 0.047 while the mean reaches its highest value at 0.222 in 2015. The average values are 0.128 and 0.182 for 2013 and 2016 respectively. The mean for the 5-year period is 0.306. Concerning the spread of data, the difference between highest alpha and lowest alpha ranges from 1.348 to 6.322 throughout the period. The lowest range is in 2014 while the highest spread falls in 2015. The range for the 5-year period is 4.436. The lowest bound is closer to zero than the highest bound in almost all datasets except for the year 2014. Similarly to return, almost all datasets of alpha have positive skewness and a high degree of kurtosis, which indicates that highly positive outliers exist.

Table 5 Descriptive statistics on Jensen alpha

	2012	2013	2014	2015	2016	2012-2016
Mean	0.047	0.128	-0.062	0.222	0.182	0.306
Standard Error	0.037	0.066	0.028	0.071	0.059	0.084
Median	0.004	0.032	-0.067	0.082	0.032	0.121
Mode	0.273	0.122	0.065	0.084	0.032	0.268
Standard Deviation	0.355	0.626	0.270	0.678	0.561	0.793
Coefficient of variation	7.497	4.897	4.377	3.057	3.082	2.595
Variance	0.126	0.392	0.073	0.460	0.315	0.629
Kurtosis	17.526	15.269	0.169	54.040	15.246	2.684
Skewness	2.955	3.652	0.445	6.638	3.519	1.407
Range	2.787	3.878	1.348	6.322	3.707	4.436
Minimum	-0.479	-0.652	-0.614	-0.478	-0.600	-0.923
Maximum	2.308	3.226	0.735	5.844	3.107	3.513
Count	90	90	90	90	90	90

Figure 6 shows the frequency distributions of 90 alphas for each year and 5-year period. On the horizontal axis are intervals of 0.1 (equivalent to 10%) width. The numbers above the bins show number of stocks with alphas within the intervals. For the total period, there are 37 stocks for which negative alphas and 53 stocks for which positive alpha.

During the same period, there are 18 stocks with alphas greater than 1 of which 3 stocks having alphas greater than 2 at 2.32, 2.67, and 3.51. In 2012, the number of negative and positive alphas is divided evenly with 45 stocks for each half. 2014 is the only year which has more negative alphas (67 stocks) than positive alphas (23 stocks). There are 37, 31, and 38 negative alpha stocks in 2013, 2015, and 2016 respectively. Numbers of positive alpha stocks in 2013, 2015, and 2016 are 53, 59, and 51 respectively.

(Figure is shown on next page)

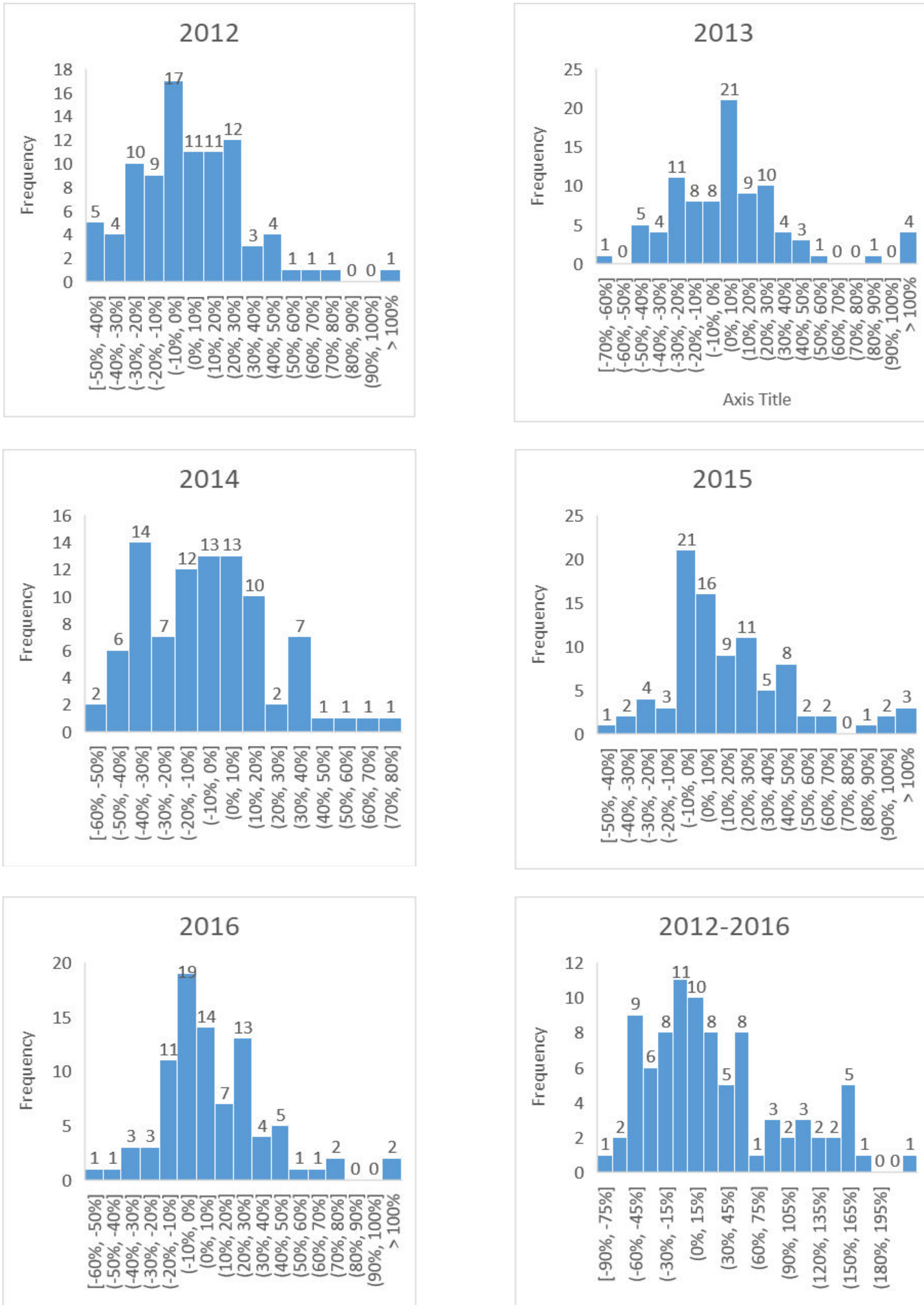

Figure 6 Frequency distributions of Jensen alpha of 90 stocks for each year and total period from 2012-2016

4.2 Relationship between return and risk measures

This section summarizes the results cross sectional regression. As observed from the descriptive part of returns in section 4.1, there are outliers in return data which makes return distribution is not normal. One of the assumptions of CAPM is that return has normal distribution. Therefore, regression of return on each risk measure is run twice in each testing period. The first time uses all 90-stock data. In the second time, stocks with outliers are excluded from regression inputs.

Results of the cross-sectional regression using stock data with return outliers are summarized in table 6 and table 7. Table 6 shows Pearson correlation coefficient between return and risk measure, table 7 includes slope estimates and corresponding p values. Pearson correlation coefficient between return and beta ranges from -0.07 to 0.17 in 5 one-year periods and is only -0.04 for the total period indicating a weak relationship between two variables. Except for the year 2014, return and total risk shows higher correlation than beta and return. Correlation between return and specific risk is slightly weaker than the correlation between return and total risk but remains much significantly higher than the correlation between return and beta. The highest correlation between return and variance is detected in 2015 at 0.84, in the same year specific risk is most correlated with return at r = 0.72. As for the significance of the relationship, the most significant relationship between return and beta is detected in 2014 at 10% level. By contrast, the relationship between return and total risk is insignificant only in 2014. The relationship between return and total risk is significant at 10% level in 2012 and 2013, at 1% level in other testing periods. The similar phenomenon is found in the relationship between return vs specific risk.

(Table is shown on next page)

Table 6 Pearson correlation coefficients between return and risk measures using data including outliers

	Time period					
	Total Period	Subperiods				
	2012-2016	2012	2013	2014	2015	2016
r(Ri, β)	-0.04	0.09	0.12	0.12	-0.07	0.17
r(Ri, Var)	0.61	0.20	0.54	0.02	0.84	0.46
r(Ri, RV)	0.53	0.16	0.32	0.01	0.72	0.38

Table 7 Regression coefficients and p values from model 2 using data including outliers

Explanatory variable		Time period					
		Total Period	Subperiods				
		2012-2016	2012	2013	2014	2015	2016
Beta	x_1	-0.44	0.07	0.20	0.02	-0.15	0.31
	p value	*0.733*	*0.425*	*0.252*	*0.062*	*0.500*	*0.103*
Variance	x_1	2.95	0.58	0.54	0.04	1.53	1.74
	p value	*1.39E-10*	*0.055*	*0.051*	*0.901*	*1E-25*	*0.0001*
Specific risk	x_1	2.86	0.56	0.53	0.09	1.54	1.56
	p value	*1.18E-10*	*0.067*	*0.054*	*0.997*	*2.22E-26*	*0.0006*

The regression results using data without outliers are summarized in table 8 and table 9. The strength and significance of the relationship between return and beta increase significantly in this regression. Pearson correlation is 0.23 for the 5-year period and ranges from 0.12 to 0.31 throughout sub periods. It becomes significant at 5% level for the total period and in 2012 and 2016. In other sub periods, the relationship is significant at 10% level. This time, the correlation between return and total risk becomes much weaker. The statistic for the 5-year period is 0.02 Pearson correlation. 2013 is a strange year when there are moderate correlations between return and all three risk measures. The relationships are also significant in this year at 5%, 1% and % level for return vs beta, return vs total risk and return vs specific risk respectively. In all other sub periods, the relationship between return and beta is stronger and more significant than the relationship between return vs total risk and return vs specific risk.

Table 8 Pearson correlation coefficients between return and risk measures using data with outliers excluded

	Time period					
	Total Period	Subperiods				
	2012-2016	2012	2013	2014	2015	2016
r(Ri, β)	0.23	0.21	0.31	0.12	0.27	0.21
r(Ri, Var)	0.02	0.05	0.24	0.02	0.08	0.08
r(Ri, RV)	0.03	0.09	0.25	0.01	0.07	0.08

Table 9 Regression coefficients and p values from model 2 using data with outliers excluded

Explanatory variable		Time period					
		Total Period	Subperiods				
		2012-2016	2012	2013	2014	2015	2016
Beta	x_1	0.78	0.12	0.21	0.02	0.20	0.20
	p value	*0.028*	*0.059*	*0.027*	*0.062*	*0.083*	*0.049*
Variance	x_1	0.11	0.13	0.27	0.04	0.21	0.23
	p value	*0.869*	*0.597*	*0.003*	*0.901*	*0.425*	*0.418*
Specific risk	x_1	0.23	0.21	0.29	0.09	0.17	0.24
	p value	*0.740*	*0.392*	*0.019*	*0.997*	*0.521*	*0.420*

5 Discussion

This chapter aims to answer the research question by summarizing and explaining the results of the analysis. The next section is to shows the basis for the reliability of the research. Then, the limitation of the research in terms of data collection and data analysis is presented. Finally, suggestion for further research is drawn from the limitation.

5.1 Summary of the key findings

The main objectives of this thesis are to a) study the relationship between return and risk measures and b) make a general analysis of Finnish stock market based on CAPM. The research questions are:

1. **What is the structure of systematic risk of Finnish stocks on year to year basis?**
2. **To what extend Finnish stocks overperform or underperform on annual basis?**
3. **What is the relationship between risk and return?**

The first objective is focused on the first two questions about systematic risk and Jensen alpha. It is clear from the result section that average beta of 90 stocks over the 5-year period is 0.640. This indicates that in general, the hypothetical portfolio including 90 stocks is less volatile than the market. Particularly, when the market index (which in this case is the OMX Helsinki-GI including all stocks listed on Helsinki stock exchange) changes by 10%, the hypothetical portfolio changes by 6.4% in the same direction. During 2012-2016 period, the average beta of these stocks increases by 0.110 from 2013 to 2014. This is the only significant change in beta is observe. Note that even though this conclusion is made for the 90 stocks as a whole, it cannot be generalized to individual stocks because the analysis of betas shows large standard deviation to the mean and large range between smallest and biggest beta.

Analysis of Jensen alpha clearly answers the second question about the performance of the stocks. In general, there are more stocks overperform the market than stocks underperform the market. Mean of 90 stocks' alpha for the 5-year period is 0.306 implies these stocks on average earn about 30.6% more than they should have given their level of market risk. One may feel tempted to make exceedingly positive conclusion about the performance of all 90 stocks when reading this result. But it is worth noticing the distribution of Jensen alpha is not normal. High degree of kurtosis and skewness of distribution can lead to distorted view about the sample when looking at the mean. Indeed, in no period is the median of Jensen alpha bigger than 10%. Median of alpha for the 5-year period is significantly lower than the mean at 0.121. Even though this still signals a positive performance level, the degree of overperforming is not as high as judging from the mean.

The theoretical background provided the author with a framework to answer the third question both theoretically and empirically. Theoretically, CAPM divides total risk into two types of risk which are systematic and unsystematic risk. Because diversification can eliminate unsystematic risk, which is unique to individual firms, systematic risk represented by beta should be the only factor explaining return in an efficient market. The assumption of efficient market index is important in CAPM because it assumes all investors follow the same method of choosing stocks which is mean variance analysis described in the theoretical background section. It also assumes that there is no asymmetric information among investors. Because these assumptions may not always hold true, academics have been reporting results not supportive of CAPM. As shown in section of previous studies on CAPM, several empirical researches by Lintner (1965), Miller and Scholes (1972), Fama and MacBeth (1974) show that specific risk is also an explanatory factor of return. The properties of security market line do not match with the results of these studies. The studies result in a flatter line, which has smaller slope and greater intercept. Nevertheless, the main conclusion of CAPM which is beta explains return in a linear way is confirmed by most of the studies. The most famous study rejecting this conclusion belongs to Fama and French (1992), they show stock size and book to market ratio have much higher explanatory power of return than beta.

This study employs the same analysis method called two-pass regression to examine the relationship between return and risk measures. The first pass includes time series regressions to estimate betas and Jensen alphas. In the second pass, cross sectional regressions are run to examine relationships between types of risk (total risk, beta, and specific risk) and return. First cross-sectional regressions including all 90 stocks show results not align with CAPM. High P value of coefficient on beta and small Pearson correlation indicates there is no linear relationship between return and beta. By contrast, strong and significant relationships between total risk, specific risk and return are observed. Doubting that outliers in return affect the result, the author runs the second pass regression the second time for each pair. This time, the relationships between return and total risk, return and specific risk are found to be weak and insignificant, whereas a statistically significant relationship between return and beta is observed. Another interesting finding is that the relationship between specific risk and return and relationship between total risk and return tend to be close to each other and in contrast to the relationship between beta and return. The reason for this is that specific risk constitutes around 80 percent of total risk (Appendix 1).

In sum, it can be concluded that both specific risk and beta does have effect on return. A possible explanation for this is that Finnish stock market is still a small market; therefore, it is not always efficient. Occasionally, there are some stocks highly deviating from security market line (extremely high Jensen alpha). Thus, when these stocks are included in the cross-sectional regression, the relationship between return and beta is distorted. However, one cannot disregard the effect of these outliers because the number of them is not negligible. Thus, conclusion on Finnish market is less informative if they are totally ignored.

5.2 Reliability and validity

According to Saunders, Lewis, and Thornhill (2009, 156), reliability is defined as the consistency of the results given the data analysis method and datasets used in the research. There are four common threats to the reliability of the research: subject error (e.g. errors in data collection; for example, wrong data sources), subject bias, observer error (e.g. errors in analyzing or recording data), and observer bias (e.g. bias in making interpretation of the data). As for this research, the reliability is ensured for following reasons. Firstly, the research follows the two-pass regression method which was proposed by Lintner in 1965 is the framework for doing similar research and has been applied by academics for many years in different markets. Secondly, the research covers as many stocks as possible on the criteria that the stock is frequently traded and has available data for the 2012-2016 period. This is to avoid possible personal preference of the researcher about irrelevant factors in CAPM such as industry or revenue. Finally, all the data is retrieved from reliable sources. Prices on stock data and risk-free rate are retrieved from official websites.

Saunders and colleagues define validity as the accuracy of the analysis. Its major concern is the question of whether the analysis measures correctly what it supposed to measure. Validity is classified into two types: external validity and internal validity. External validity refers to the degree to which the result can be generalized to a bigger population. In this regard, this research covers all the stocks with available data on Helsinki stock exchange website during the period except for stocks with very few trades. Furthermore, the research is only concerned with Finnish stock market. Therefore, external validity is highly secured in this research. Internal validity is concerned with hidden factors that may affect the result of the study which the researcher may not be aware of. These hidden factors are often called as confounding variables. The higher internal validity of the research is, the less confounding variables there are. From this perspective, it can be guaranteed that this research has high internal validity because the 90 stocks chosen ranges across different industries, cap sizes, and stock style (growth stock vs value stock).

5.3 Limitation and recommendation

Parameters estimated from daily return may contain much disturbance changes. Clearly, the horizon of daily return is much shorter than normal investment horizon which is one year. Therefore, further research using the same method but taking a longer research period (around 10 years) can be more informative.

Another limitation of this research is that the method of working with outliers in return is simply to exclude them from the sample in the second regression. This may lead to some bias in the results. Therefore, study with a better method of dealing with outliers is recommended.

In principle, the market portfolio in CAPM does not include only common stocks but also a much wider variety of assets such as bonds, real estate, and even human capital. This is due to the difficulty in accounting for not frequently traded variable such as real estate and human capital. Therefore, the author suggests that a research which comprises of a more variety of assets to include in the market portfolio may have interesting result.

Estimates of beta from the first pass regression are the original least square (OLS) estimates. The regression gives the best-fitted line which minimizes the squared deviation from the line. Beta estimate from this regression is the best estimate when input returns follow the normal distribution. However, there are empirical works demonstrating that fat-tailed distribution (generated by outliers) is the more accurate depiction of return distribution. In this case, beta estimated from OLS method is heavily biased. Therefore, the author recommends a further research using another method which accounts for the problem of outliers in return to estimate beta and then comparing with this research to show difference between different methods. One suggestion is the robust regression used by Martin and Simin in 1999. In their paper, the authors show that beta estimated from robust regression is not as influenced by outliers as beta estimated from OLS. Another way of dealing with the problem is by grouping stocks into portfolios on the basis of beta ranking and then use the averages of individual betas as betas for portfolios. This procedure was suggested by Black, Jensen, and Scholes and has become a standard way of doing empirical study on CAPM.

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Appendix

Appendix 1 The average percent of each type of risk in total risk of 90 stocks for each period.

Period	The average percent of Specific risk in total risk	The average percent of market risk in total risk
2012	80.40403332	19.59596668
2013	87.9328197	12.0671803
2014	83.92092045	16.07907955
2015	79.29259219	20.70740781
2016	79.20419672	20.79580328
2012-2016	82.67441585	17.32558415

Appendix 2 Information of 90 stocks chosen.

Company name	Stock code	Industry	Cap size
Afarak Group Oyj	AFAGR	Basic Materials	Small cap
Affecto Oyj	AFE1V	Technology	Small cap
Aktia Bank Abp A	AKTAV	Financials	Mid cap
Alma Media Oyj	ALMA	Consumer Services	Mid cap
Amer Sports Oyj	AMEAS	Consumer Goods	Large cap
Apetit Oyj	APETIT	Consumer Goods	Small cap
Aspo Oyj	ASPO	Industrials	Mid cap
Aspocomp Group Oyj	ACG1V	Industrials	Small cap
Atria Oyj A	ATRAV	Consumer Goods	Mid cap
Basware Oyj	BAS1V	Technology	Mid cap
Biohit Oyj B	BIOBV	Health Care	Small cap
Bittium Oyj	BITTI	Technology	Mid cap
CapMan Oyj	CAPMAN	Financials	Mid cap
Cargotec Oyj	CGCBV	Industrials	Large cap
Citycon Oyj	CTY1S	Financials	Large cap
Componenta Oyj	CTH1V	Industrials	Small cap
Cramo Oyj	CRA1V	Industrials	Mid cap
Digia Oyj	DIGIA	Technology	Small cap
Digitalist Group Oyj	DIGIGR	Technology	Small cap
Dovre Group Oyj	DOV1V	Industrials	Small cap

Efore Oyj	EFO1V	Industrials	Small cap
Elisa Oyj	ELISA	Telecommunications	Large cap
eQ Oyj	EQV1V	Financials	Mid cap
Etteplan Oyj	ETTE	Industrials	Small cap
F-Secure Oyj	FSC1V	Technology	Mid cap
Finnair Oyj	FIA1S	Consumer Services	Mid cap
Fiskars Oyj Abp	FSKRS	Consumer Goods	Large cap
Fortum Oyj	FORTUM	Utilities	Large cap
HKScan Oyj A	HKSAV	Consumer Goods	Mid cap
Huhtamäki Oyj	HUH1V	Industrials	Large cap
Ilkka-Yhtymä Oyj 2	ILK2S	Consumer Services	Small cap
Kemira Oyj	KEMIRA	Basic Materials	Large cap
Kesko Oyj A	KESKOA	Consumer Services	Large cap
Kesko Oyj B	KESKOB	Consumer Services	Large cap
KONE Oyj	KNEBV	Industrials	Large cap
Lassila & Tikanoja Oyj	LAT1V	Industrials	Mid cap
Lemminkäinen Oyj	LEM1S	Industrials	Mid cap
Martela Oyj A	MARAS	Consumer Goods	Small cap
Metso Oyj	METSO	Industrials	Large cap
Metsä Board Oyj A	METSA	Basic Materials	Large cap
Metsä Board Oyj B	METSB	Basic Materials	Large cap
Neo Industrial Oyj	NEO1V	Industrials	Small cap
Neste Oyj	NESTE	Oil & Gas	Large cap
Nokia Oyj	NOKIA	Technology	Large cap
Nokian Renkaat Oyj	NRE1V	Consumer Goods	Large cap
Nordea Bank AB FDR	NDA1V	Financials	Large cap
Olvi Oyj A	OLVAS	Consumer Goods	Mid cap
Oriola Oyj A	OKDAV	Health Care	Mid cap
Oriola Oyj B	OKDBV	Health Care	Mid cap
Orion Oyj A	ORNAV	Health Care	Large cap
Orion Oyj B	ORNBV	Health Care	Large cap
Outokumpu Oyj	OUT1V	Basic Materials	Large cap
Outotec Oyj	OTE1V	Industrials	Mid cap
Panostaja Oyj	PNA1V	Financials	Small cap
PKC Group Oyj	PKC1V	Industrials	Mid cap
Ponsse Oyj 1	PON1V	Industrials	Mid cap
Pöyry Oyj	POY1V	Industrials	Mid cap
QPR Software Oyj	QPR1V	Technology	Small cap
Raisio Oyj Vaihto-osake	RAIVV	Consumer Goods	Mid cap
Ramirent Oyj	RMR1V	Industrials	Mid cap
Rapala VMC Oyj	RAP1V	Consumer Goods	Mid cap
Raute Oyj A	RAUTE	Industrials	Small cap
Revenio Group Oyj	REG1V	Health Care	Mid cap
Saga Furs Oyj C	SAGCV	Consumer Goods	Small cap
Sampo Oyj A	SAMPO	Financials	Large cap

Sanoma Oyj	SAA1V	Consumer Services	Mid cap
Sievi Capital Oyj	SIEVI	Financials	Small cap
Solteq Oyj	SOLTEQ	Technology	Small cap
Soprano Oyj	SOPRA	Technology	Small cap
Sponda Oyj	SDA1V	Financials	Large cap
SRV Yhtiöt Oyj	SRV1V	Industrials	Mid cap
SSH Communications Security	SSH1V	Technology	Small cap
Stockmann Oyj Abp A	STCAS	Consumer Services	Mid cap
Stockmann Oyj Abp B	STCBV	Consumer Services	Mid cap
Stora Enso Oyj A	STEAV	Basic Materials	Large cap
Stora Enso Oyj R	STERV	Basic Materials	Large cap
Suominen Oyj	SUY1V	Consumer Goods	Mid cap
Technopolis Oyj	TPS1V	Financials	Mid cap
Tecnotree Oyj	TEM1V	Technology	Small cap
Teleste Oyj	TLT1V	Technology	Mid cap
Telia Company	TELIA1	Telecommunications	Large cap
Tieto Oyj	TIE1V	Technology	Large cap
Tikkurila Oyj	TIK1V	Industrials	Mid cap
Tulikivi Oyj A	TULAV	Industrials	Small cap
UPM-Kymmene Oyj	UPM	Basic Materials	Large cap
Uponor Oyj	UPONOR	Industrials	Mid cap
Vaisala Oyj A	VAIAS	Industrials	Mid cap
Viking Line Abp	VIK1V	Consumer Services	Mid cap
Wärtsilä Oyj Abp	WRT1V	Industrials	Large cap
YIT Oyj	YTY1V	Industrials	Mid cap

Appendix 3 Euribor rate used as proxy for risk free rate in each period.

Period	Euribor rate (%)
2012	1.426
2013	0.745
2014	0.741
2015	0.03
2016	0.024
2012-2016	1.546333178