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Risk Return Relationship in the Finnish Stock Market in the light of Capital Asset Pricing Model (CAPM)

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The relationship between the risk and return have always been a topic of interest to investors and academics. Capital Asset Pricing Model (hereafter, CAPM) is one of the most important theoretical foundations in the field of finance. The current study examines, first, the relationship between return and risk in the context of the Finnish market, and second, to identify if the realized return of Finnish companies highlights over/under-performance. The findings indicate that the risk-return relationship has been working in sync and the stock return of sample firms have been observed to be less volatile than the market index.
Keywords: Risk, Return, Systematic Risk, Unsystematic Risk, Portfolio Diversification, Jensen's Alpha

The relationship between risk and return has always been one of the most enthusiastically discussed topics in the field of finance due to its importance particularly when making financial decisions to invest, raise capital and assess portfolio performance. For example, one of the primary jobs of a corporate finance executive is to make decisions about whether the company should invest in new projects such as plant & machinery and product research and development. As these investment expenditures involve a whopping amount of money, therefore, it is important that corporate managers carefully evaluate them, and this process is called capital budgeting. Any investment can essentially be explained as a sequence of the periodically recurring cash flows and one standard approach followed to obtain the capital budgeting solution is the calculation of the net present value (NPV) of the project (Lo, 2019). The NPV is simply the difference between the sum total of the present value of the future expected cash inflows and the current cost of the project. The managers must choose projects carrying maximum positive NPV in order to maximize the firm value. In order to derive the present value of the expected cash flows, which are one of the essential components of NPV calculations, it is important to determine the appropriate discount rate. The academic name for the discount rate is the cost of capital. The cost of capital can be viewed as the opportunity cost of investing in the project because investors must expect to earn at least that *floor* 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 can be 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. The rate of return on debt is simply the interest on the financial (interest bearing) debt, which is often known *ex-ante* and *ex-post*. The real puzzle is to estimate the cost of equity, which is the expected rate of return to investors in the company's common stock. Similarly, the discussion pertaining to the rate of return is incomplete without the concept of risk. The relevant questions regarding risks may be: "what does risk mean?", "how many types of risk are there?", "do all risks affect the rate of return", and "how exactly do risks affect return?" One of the most widely studied model answering the above questions is the CAPM. Investors face two types of risk: systematic risk and unsystematic risk. Investors are only rewarded for systematic risk because unsystematic risk can be eliminated by diversification. Systematic risk, referred to as beta coefficient, 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 (Brealey, Myers, & Allen, 2011).

The current study examines, first, the relationship between return and risk derived by applying the CAPM model in the context of the Finnish market, and second, to identify if the realized return of Finnish companies highlights over/under-performance in the light of CAPM. The Jensen's alpha has been applied to measure over, and under-performance. The period of study is from 2012 to 2016. Data sample includes 90 stocks listed on Helsinki stock exchange.

Review of Literature

Other things being equal, an important objective of the investors is to maximize the value of their wealth in the firm, which can be measured by the holding period return (HPR). HPR is basically the sum of dividend paid and the difference between the price at the beginning, the end of holding period divided by the price paid to buy security:

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

An interpretation of the above equation is that it shows the number of euros earned during the holding interval for each euro invested under the assumption that dividend is earned at the end of the holding period. However, one limitation of the above equation is that it ignores the dividend paid before the security is sold, therefore, this equation ignores the reinvestment of dividend (Bodie, Kane, & Marcus, 2004). Mayor (2008) mentions three types of return, which are generally used in the academic literature: expected return, realized return and required return. The expected return is the estimated return of the HPR that the investors estimate to earn in the future. Realized return, also known as the actual return, is calculated from historical data. On the other hand, the required return is the minimum return that an investor requires to accept the risk associated with an investment. Therefore, the required return is also referred to as the opportunity cost of an investment, the return investor can earn for a different project with a similar risk profile in the market. Thus, the required return serves as a benchmark to help investors make investment decisions. In the context of capital budgeting mentioned in the introduction part, the required return is the cost of capital. The expected return and required return are often used as synonyms when computing the cost of equity in order to obtain the cost of capital. Like 'return', the concept of 'risk' is also a complex phenomenon. Before we discuss 'risk', it is interesting to explore what is 'risk-free'. 'Risk-free assets' guarantee a certain return at the end of holding period and the government bond is a financial asset, which is considered to be risk-free as the probability of the issuer, that is the government, getting bankrupt is nearly zero. Moreover, even in the financial emergency, the bond issuing government can print money to pay back the par value of the bond. Nonetheless, there are several counter-arguments to the notion of 'risk-free' assets. For example, if inflation is taken into account, return on bonds may not be certain anymore because the money received from the bond is often nominal. However, in spite of such counter-arguments, government bonds are still used as a proxy to risk-free asset. Return on risk-free assets is known as 'risk-free rate' (Bodie, Kane, & Marcus, 2004). '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 as 'upside potential' and 'downside risk'. Taking more risks increases the chance of great losses and possibilities of big wins at the same time.

If R(s) is the realized return and p(s) is probability in each of the given scenario 's', then the risk can be defined as the difference between realized return and expected return (μ), a statistical parameter called 'variance' is used to measure such 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 an 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 square root of variance in order to measure the risk in the same dimension that of the expected return.

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

The expected return and standard deviation are the two most important parameters when evaluating the performance of a stock. Higher the value of σ is, riskier the stock is and hence it may be less attractive to risk-averse investors having the lower risk appetite. The modern portfolio theory, propounded by Harry Markowitz in 1952, provides a systematic approach to investment allocation. One of the revolutionary ideas of the theory is that investors can reduce risks by holding a diversified portfolio. Since holding one single stock can be relatively risky, investors always put their money in a portfolio comprising of various assets. A portfolio is simply a combination of securities, which may include stocks, bonds, cash, or any other financial instruments.

Given that a portfolio may include different assets, the fraction of investment in each security is represented by portfolio weight (denoted w), as below:

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

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

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

Covariance is an important statistical concept when calculating the variance of a portfolio. Covariance between two assets is defined as the expected product of their deviations from their individual expected values. 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 the correlation coefficient has the same conceptual meaning as covariance, it is applied to have more standardized comparisons across different assets (Fabozzi & Markowitz, 2002). A positive value of covariance or correlation 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 implies that the prices of two assets move exactly by the same magnitude and in the same direction. In this case, the standard deviation of portfolio combining these two assets is the weighted average of each asset's standard deviation. The covariance matrix is the commonly used tool to calculate portfolio variance.

Table 1. Variance Co-variance Matrix

	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

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) becomes 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 covariance. For that reason, the covariance between risky assets contributes more to the portfolio risk than variances of individual assets do (Lo, 2019). The special case of a portfolio consists of 'n' equally weighted risky assets is used to depict how diversification reduces the overall portfolio risk (Brealey, Myers, & Allen, 2011). In this case where wi=1/n for all assets, the variance of the 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, the portfolio's variance steadily reaches the average covariance. In other words, in a well-diversified portfolio, an individual security's contribution to the overall portfolio's risk depends on its covariance with other securities in the portfolio rather than its variance (Bodie, Kane, & Marcus, 2014). For this reason, as long as stocks are not perfectly correlated, the 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. However, in reality, stock prices always move together to a certain degree because of the impact of general market factors on all the stocks. In such case, there is a limit at which diversification stop reducing portfolio risk. In other words, there is a part of the total risk that cannot be *diversified away*. For this reason, this type of risk is called 'market risk', which is also known as 'systematic risk' and 'undiversifiable risk'. On the other hand, the type of risk, which can be eliminated by diversification is called 'specific risk' or 'idiosyncratic risk' because it is peculiar to the individual stocks only (Brealey, Myers, & Allen, 2011). Figure 1 illustrates how diversification can reduce portfolio risk. The vertical axis shows the variance of the portfolio return. The number of securities included in the portfolio is represented on the horizontal axis. 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, some empirical studies have shown that portfolio consists of about 20 stocks of randomly chosen companies will have only systematic risk and the unsystematic risk gets eliminated (Fabozzi & Markowitz, 2002).

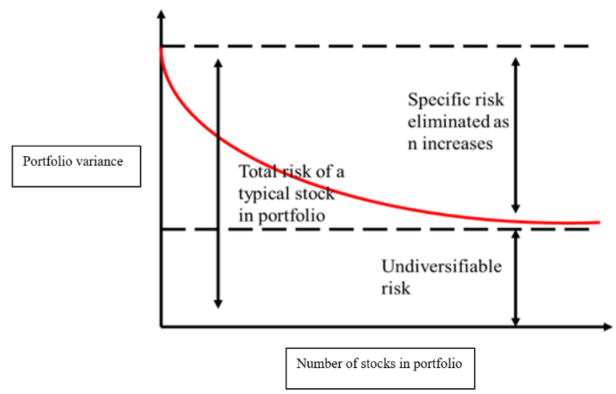

Figure 1 Effect of diversification (Lo 2019)

In a similar vein, 'Efficient Frontier' includes all combinations of risky assets that provide the best rate of return for a given degree of risk. Figure 2 illustrates this point. The vertical axis measures the expected return of the portfolio. The portfolio risk represented by the standard deviation is shown on 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 rest on the upper part of the variance minimum frontier. Every rational investor must endeavor to hold the asset portfolios on the efficient frontier.

Based on Markowitz's model, 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 (Mayor, 2008). The three economists proved that it was possible to identify a portfolio of risky assets that any investor can hold if lending and borrowing at the risk-free rate were possible. Such portfolio is called *tangency* *portfolio* as 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 the Sharpe ratio. Therefore, all efficient portfolios must position themselves on this tangency line.

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

E(Rp) is the expected portfolio return and r_f is the risk free rate of return.

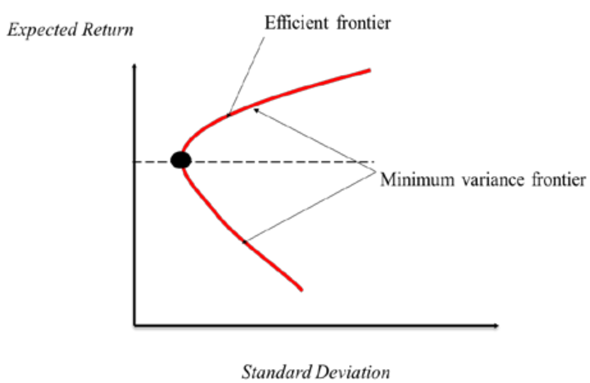

Figure 2 The minimum variance frontier of risky assets (Bodie, Kane, & Marcus, 2014).

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

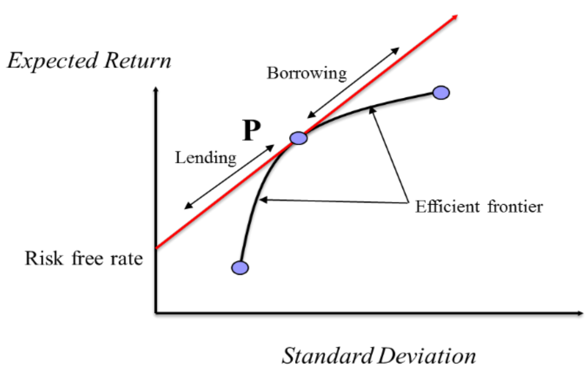

Figure 3 The efficient frontier of risky assets with optimal capital allocation line

William F. Sharpe, John Lintner and Jan Mossin went on to argue that if all investors are having the same information and facing the same risk-free rate, they obviously will be arriving at the same tangency portfolio P. It means that each investor can 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 available in the market and 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 of aggregated expectations of all investors' and becomes one single 'capital market line' (Elton, Gruber, & Goetzmann, 2014). The 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 Rp denotes return on the efficient portfolio and Rm denotes the return on market portfolio (Elton, Gruber, & Goetzmann, 2014). The above equation states that return on an efficient portfolio is the sum of return achieved from the risk-free rate of return and market risk premium, which depends on the portfolio's standard deviation relative to market portfolio's standard deviation (Mayor, 2008). The equation captures the relationship between risk and return of efficient portfolios. If investors increase their portfolio risks (σ_p) by borrowing risk free securities to hold more of the market portfolio, they will expect to earn a higher rate of return because the σ_p/σ_m ratio becomes larger. Conversely, buying more risk-free asset may lead to a decrease in both portfolio risk and portfolio return. In CAPM, the beta is used as a measure of a stock's contribution to the variance of the 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 that of market's measures how volatile the stock is relative to market volatility. Obviously greater the ratio higher will be risk associated with the stock. The higher value of beta represents a more systematic risk associated with the stock. For example, a 20% change in return of market portfolio leading to 40% (10%) change in return of stock will have $\beta=2$ (0.5). In other words, the risk premium of a stock is proportional to the market risk premium:

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

The above equation is the traditional form of CAPM. The relationship between expected return and beta is graphically illustrated by security market line as in Figure 4.

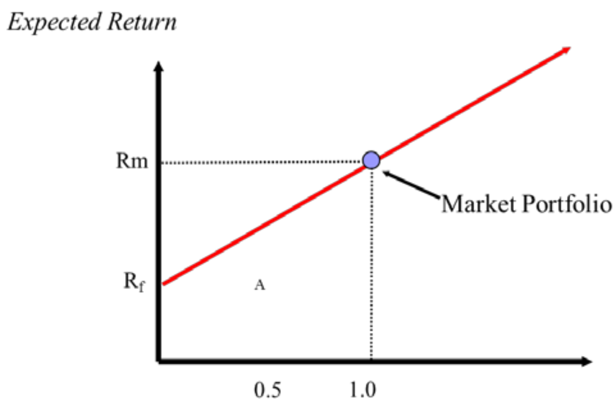

Figure 4 Security Market line (Brealey, Myers, & Allen, 2011)

The application of the 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 the financial manager wants to calculate the required rate of return for an oil-drilling project then he/she can calculate beta of oil drilling stock, and subsequently apply the model to calculate the expected rate of return of investment in the project. The expected rate of return of investment in the project result can serve as the appropriate discount rate for the project cash flows (Lo, 2019). One of the applications of CAPM is to evaluate the performance of portfolios or individual securities. An investment is perceived to over-perform 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 known as Jensen's alpha, which is an important analysis tool used by academics and investors to check over/under-performance of individual stocks/portfolio (Lo, 2019). Fama & French (2004) argue that most of the empirical studies related to CAPM focus on three main conclusions- first, beta alone explains the rate of return, and their relationship is linear; second, the market portfolio always gives a higher expected return than riskless assets do; and third, assets have betas equal zero must have expected rate of returns equal risk-free rate.

According to Levy (2011), the intercept of the security market line (Figure 4) must be equal to the risk-free rate, and the coefficient on beta (the slope of security market line) is the difference between market return and risk-free rate, known as the market excess return. The empirical evidence shows that there is a significant correlation between return and beta; however, it is not supportive of the CAPM in this respect. The intercept is found to be greater than the risk-free rate, for which one-month treasury bill is used as a proxy. Miller and Scholes (1972) find that both beta and residual variance (RV) are significantly explaining variation in the rate of return. The coefficient of determination (R^2) of the regression model, which is simply the square of two explanatory variables, is higher than R^2 of regressions with beta and RV used separately as the explanatory variable. This finding contradicts the hypothesis of CAPM that beta is the only variable explaining variation in stock return (Levy, 2011).

The following hypotheses have been tested in the current study-

H_1: CAPM explains the relationship between return and risk,

H_2: CAPM explains the difference between realized and expected returns and therefore highlights over/under-performance.

Data and Methodology

The study analyzes secondary data only for the period 2012-2016. The sample includes as many as 90 stocks listed on Helsinki stocks exchange. This 12-month Euribor rate has been used as a proxy for the risk-free rate. This is the interest rate at which European banks lend or borrow loans having the maturity of 12 months. This information is retrieved from https://www.euribor-rates.eu/. The data of the stock prices, market portfolio and indexes have been taken from http://www.nasdaqomxnordic.com/shares/. The proxy for the market portfolio is OMX Helsinki_GI, which includes 131 stocks. The data analysis involves running 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. First, in the time series regression, the daily return is computed from daily price data as holding period return. In order to smoothen the computation process, dividend is disregarded from the computation. Next, the daily return is converted to the 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, in the current study, the median value of daily returns of a given year have been computed, which is then annualized according to the following formula:

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

Having computed stocks' return and market index's return, 90 time-series regressions are run to estimate betas and Jensen's 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 cross sectional regression model is:

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

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 values derived by the regression model 1 to those derived by the CAPM formulation i.e. $E(R_i) - R_f = \beta_i(E(R_m) - R_f)$, therefore, α_i represents the abnormal return of stock (deviation of actual return from expected return according to CAPM) also known as Jensen's alpha, and β_i is stock's beta. The next step is to decompose the total risk into systematic risk and specific risk. The specific risk can be measured by the following equation:

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

The risk measures are total risk, RV, and beta, which are used as explanatory variables in the model 1. Three regressions are run for each year from 2012 to 2016 and for the total 5-year period. The Pearson correlation coefficient measures the degree and direction of the linear relationship between two variables.

Empirical Findings

Table 2 shows descriptive statistics on stocks' returns for each research year and full period of analysis. The mean value of 90 stocks' returns stays positive throughout the period with the smallest annual return is 2% in 2014. Annual return reaches the highest value at 35% in 2015. The 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 except for the year 2014 when the ratio has the highest value of 4.47. The high coefficients of variation mean that there are large deviations of stocks' returns relative to their means.

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 normally distributed only in 2014. Specifically, almost all distributions have high positive degrees of skewness. This means return distributions are right skewed. High degree of kurtosis indicates that distributions have heavy tails or outliers.

Table 3 shows the decomposition of total risk into systematic (market) risk and unsystematic (firm specific) risk. The year-to-year comparison reveals that substantially larger share of risk faced by the firms has been unsystematic risk, which has varied from 79.21% to 87.93%. The finding implying that firm specific risk has been more prolific than the risk sourced by the market fluctuations. The result for the full period also follow the same trend.

Paired sample t test is used to answer the question if beta changes on yearly basis. First, the differences in betas of each of the 90 stocks are calculated in each of the two-consecutive year from 2012 to 2016. Denoted as 'Di' referring to the difference in beta coefficients of the two consecutive years, 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 of the two-consecutive year. Table 4 presents the results of the tests. 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 3.37. The mean of 90 stocks' betas increases by 0.11 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 2 Descriptive statistics and normality test on return

Panel A: Descriptive Statistics						
	2012	2013	2014	2015	2016	2012-2016
Mean	0.14	0.31	0.02	0.35	0.29	1.40
Standard Error	0.04	0.08	0.03	0.08	0.07	0.29
Median	0.13	0.19	0.02	0.22	0.15	0.93
Coefficient of variation	2.76	2.30	4.47	2.09	2.15	1.94
Standard Deviation	0.37	0.72	0.09	0.73	0.62	2.71
Sample Variance	0.14	0.52	0.01	0.53	0.38	7.35
Kurtosis	14.06	14.96	-0.06	54.36	13.70	53.30
Skewness	2.50	3.54	0.41	6.66	3.38	6.59
Range	2.85	4.50	1.38	6.74	3.90	24.69
Maximum	2.39	4.05	0.83	6.42	3.33	23.81
Minimum	-0.45	-0.45	-0.55	-0.32	-0.57	-0.89
IQR	0.40	0.45	0.43	0.39	0.42	1.42
Firms	90	90	90	90	90	90
Panel B: Shapiro-Wilk Test						
	2012	2013	2014	2015	2016	2012-2016
W	0.82	0.61	0.97	0.44	0.64	0.45
p-value	0.00	0.00	0.14	0.00	0.00	0.00
alpha	0.05	0.05	0.05	0.05	0.05	0.05

Table 3 Decomposition of total risk

Period	Unsystematic risk as % of total risk	Systematic risk as % of total risk
2012	80.40	19.60
2013	87.93	12.07
2014	83.92	16.08
2015	79.29	20.71
2016	79.21	20.79
2012-2016	82.67	17.33

Table 4 Paired samples tests for differences in betas (Di)

Beta (sub-periods)	Mean	Std. Deviation	Std. Error	t-stat	Sig. (2-tailed)
β2013-β2012	-0.01	0.26	0.03	-0.23	0.82
β2014-β2013	0.11	0.31	0.03	3.38	0.00
β2015-β2014	-0.01	0.19	0.02	-0.61	0.54
β2016-β2015	-0.02	0.17	0.02	-1.07	0.29

Table 5 Descriptive statistics on Jensen alpha

	2012	2013	2014	2015	2016	2012-2016
Mean	.05	.13	- .06	.22	.18	.31
Standard Error	0.04	0.06	0.03	0.07	0.06	0.08
Median	.01	.03	-.07	.08	.03	.12
Mode	0.27	0.12	0.07	0.08	0.03	0.27
Standard Deviation	0.36	0.63	0.27	0.68	0.56	0.79
Coefficient of variation	7.49	4.89	4.37	3.06	3.08	2.59
Variance	0.13	0.39	0.07	0.46	0.32	0.63
Kurtosis	17.53	15.27	0.17	54.04	15.25	2.68
Skewness	2.96	3.65	0.45	6.64	3.52	1.41
Range	2.79	3.88	1.35	6.32	3.71	4.44
Minimum	-0.47	-0.65	-0.6	-0.48	-0.60	-0.9
Maximum	2.31	3.23	0.74	5.84	3.11	3.51
Firms	90	90	90	90	90	90

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 -0.06. The year 2012 has the lowest positive mean with 0.05 while the mean reaches its highest value at 0.22 in 2015. The average values are 0.13 and 0.18 for 2013 and 2016 respectively. The mean for the 5-year period is 0.31. Concerning the spread of data, the difference between highest alpha and lowest alpha ranges from 1.35 to 6.32 throughout the period. The lowest range is in 2014 while the highest spread falls in 2015.

Figure 5 shows the frequency distributions of 90 alphas for each year and over the 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. The 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.

The relationship between return and risk measures has been discussed based on the cross section regression model 1. 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 analysis using stock data with return outliers are summarized in table 6 and table 7. Table 6 shows Pearson correlation coefficient between return and risk, table 7 includes slope estimates and corresponding p values. Pearson correlation coefficient between return and beta ranges from -0.07 to 0.17 in the five sub-periods of one-year each and is only -0.04 for the total period, therefore, 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 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 profound 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.

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. In 2013 is a year when there is higher correlations between return and all three risk measures. The relationships are also significant in this year 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.

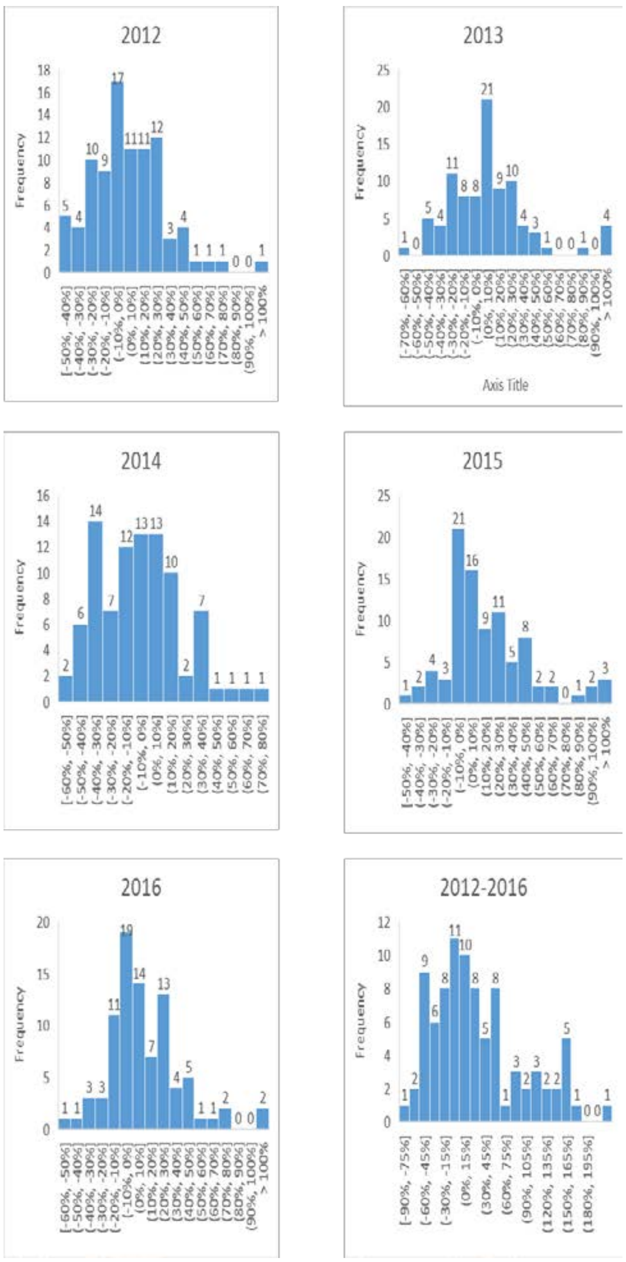

Figure 5 Frequency distributions of Jensen alpha of 90 stocks for each year and total period from 2012-2016

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

	Time period					
	Total Period 2012-2016	Sub-periods				
		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 1 using data including outliers

Explanatory variable		Time period					
		Total Period 2012-2016	Sub-periods				
			2012	2013	2014	2015	2016
Beta	x_1	-0.44	0.07	0.20	0.02	-0.15	0.31
	p value	0.73	0.43	0.25	0.06	0.50	0.10
Variance	x_1	2.95	0.58	0.54	0.04	1.53	1.74
	p value	0.00	0.05	0.05	0.90	0.00	0.00
Specific risk	x_1	2.86	0.56	0.53	0.09	1.54	1.56
	p value	0.00	0.07	0.05	0.99	0.00	0.00

Table 8 Pearson correlation coefficients between return and risk measures using data without outliers

	Time period					
	Total Period 2012-2016	Sub-periods				
		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 1 using data without outliers

Explanatory variable		Time period: Total Period 2012-2016	Sub-periods: 2012	2013	2014	2015	2016
Beta	x_1	.78	.12	.21	.02	.20	.20
	p value	.03	.06	.03	.06	.08	.05
Variance	x_1	.11	.13	.27	.04	.21	.23
	p value	.87	.59	.00	.90	.43	.42
Specific risk	x_1	.23	.21	.29	.09	.17	.24
	p value	.74	.39	.02	.99	.52	.42

Discussion and Conclusions

It is clear from the result section that average beta of 90 stocks over the 5-year period is 0.64. 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 0.11 from 2013 to 2014. This is the only significant change in beta to observe.

Analysis of Jensen alpha clearly answers the question about the performance of the stocks. In general, there are more stocks over-performing the market than the underperforming ones. The mean of 90 stocks' alpha for the 5-year period is 0.31, which implies that 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. However, 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 0.12. Even though this still signals a positive performance level, the degree of over-performing is not as high as judging from the mean.

The strong and significant relationships between total risk, specific risk and return are worth observing. Similarly, 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. A possible reason for this phenomenon is that the specific risk constitutes around 80 percent of total risk.

Overall, it can be concluded that both specific risk and market risk do affect stock return, albeit in significantly different proportions. Similarly, the Finnish stock market is still a small market, therefore, one must not expect it always functioning efficiently. Occasionally, there are some stocks highly deviating from security market line (substantially 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 their number is not negligible.

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