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AN EMPIRICAL ASSESSMENT OF DIFFERENT RISK MEASURES FOR STOCKS TRADED ON THE ASE

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Abstract

This paper examines three different measures of risk, the standard deviation, the correlation coefficient and the beta coefficient. The measures are compared with each other in relation to the way with which they estimate the risk, using the Spearman's rank correlation coefficient. The results show that the risk is valued differently in every case. The same rank correlation coefficient is being used to form portfolios with relative stable beta coefficients in order to minimize the variation of the associated risk. The results showed that a relationship exists to beta coefficients between stocks that can give useful information about the portfolio diversification, as it is possible for portfolios with relative constant coefficients and higher returns in relation to risk they undertake to be formed.

Keywords: *risk measures, Spearman's rank correlation, stability of beta coefficient, portfolio diversification*

JEL Classificiation*:* **G32**

1.INTRODUCTION

The concept of risk has permeated so much in the financing community that no one needs to be convinced about the necessity to include it in the analysis of investments (Blume, 1971). Most financial as well as real assets have some exposure to risk. Investments that are more risky must achieve higher returns to compensate for risk as suggested in financial theory (Damodaran, 2006). One of the basic problems of portfolio management is the right quantification of risk. The amount of money needed by a business to finance its investment plans and operations is sensitive to price fluctuations and market conditions (Siriopoulos, 1999). A risk manager needs to anticipate whether his portfolio will decline in the future and to what extent, in order to be able to determine the amount to be invested in each asset of his portfolio. The right identification and quantification of risk, especially in turmoil periods, stabilizes the financial system. The risk at these periods of time is higher and each attempt for reducing it, most of the time, becomes worthless.

There are multiple ways to measure the investment risk, but different measures produce different results leading to a different quantification of risk for the underlying asset. The standard deviation and the variance, the Value at Risk, the beta coefficient and the volatility are some of the ways with which the risk is quantified. The CAPM model developed by Sharpe (1964) and Lintner (1965) has made the beta coefficient an important variable of pricing an asset. The beta coefficient is used not only for the empirical estimation of equilibrium models such as CAPM (Capital Asset Pricing Model), APM (Arbitrgage Pricing Model) (Ross, 1976) and FFM (Fama & French 3 factor model) (Fama & French, 1996) but also to the valuation of mutual funds, portfolio optimization and the estimation of cost of capital. The basic problem of the beta coefficient is its variation over time while some other factors may also exist that affect the stock returns (Maringer, 2004).

In the current paper three different measures of risk are calculated, ie the standard deviation, the correlation coefficient, for the purpose of diversifying a portfolio and the beta coefficient. The work proceeds as follows: the next part presents the different measures of risk, part three refers the methodology and data, part four the empirical results and part five concludes the paper.

2.MEASURES OF RISK

This part of the work presents the different ways of measuring the investment risk. The portfolio selection theory developed by Markowitz (Markowitz, 1952) states that the standard deviation can be used as a measure for analyzing the risk of an asset. For example a stock or portfolio with high standard deviation is considered to contain higher risk than a stock or portfolio with a lower standard deviation, as the return can be changed fast enough to one direction or another. The standard deviation is defined as follows:

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2} \qquad (1)$$

This measure in the economics literature is criticized because it evaluates deviations from the mean symmetrically. But more often than not, investors regard the risk as a failure to catch up a target so from this point of view the standard deviation as a risk measure is questioned (Hahn et al., 2002).

The correlation coefficient is another measure. Strong positive correlation indicates that upward movements in one return series tend to be accompanied by upward movements in the other and vice versa (Alexander, 2002). For two random variables X and Y the correlation is given as follows:

$$corr(X,Y) = \mathrm{cov}(X,Y) / \sqrt{[V(X)V(Y)]} \qquad (2)$$

or

$$\rho_{xy} = \sigma_{xy} / \sigma_X \sigma_y \qquad (3)$$

Where cov(X,Y) is the covariance between the variable X and Y

V(X) and V(Y) is the variance of X and Y respectively

The coefficient varies between –1 and +1. High absolute values mean that the two random variables are strongly connected. However the correlation is a limited measure of dependency in financial markets if the two variables are not stationary over time (i.e. the mean, variance and covariance depend on time t) (Hamilton, 1994) due to the existence of non- linearity between asset returns.

The beta coefficient is another useful statistical measure, which designates the risk of a stock or portfolio according to a benchmark index. The measurement of the non-diversifiable or the systematic risk plays a critical role in the theories of capital asset pricing. A similar model to CAPM is the Market Model in case that the single factor is the market without considering the risk free rate that is taken into account in the CAPM. While the CAPM is expressed in terms of expected relationship between risk and return the Market Model represents a return generating process. The model is estimated using OLS with the dependent variable being the return on a security and as the explanatory variable the return of the market index. A stock with a beta equal to one shows that its return coincides with the benchmark index. Stocks with beta higher than one are considered ‘aggressive’ while stocks with beta lower than one as ‘defensive’. Thus for periods where the market moves upward a good choice is to select ‘aggressive’ stocks while the ‘defensive’ stocks must be preferred for turmoil periods where the overall market moves downward. In order to evaluate the beta coefficient the market model is used, which is a statistical model not considered to be based on a financial theory (Gibbons, 1982). The model has the following form:

$$R_i = a_0 + b_1 R_m + e_i \qquad (4)$$

where: : R_{it} is the return of stock i at time t

R_{mt} is the return of the benchmark index at time t

e_{it} is a random variable with $E(e_i)=0, E(e_i^2)=0, \mathrm{E}(e_i e_k)=0, i \neq k$

and the beta coefficient is given from $b_i = \frac{Cov(R_{it}R_{mt})}{Var(R_{mt})}$ where the numerator is the covariance between the security i and the benchmark index while the denominator is the variance of the benchmark index. The expected return of security i is a combination of the specific return component represented from a_0 at the first term of equation (4) and the market return represented from $b_1E(R_m)$ at the second term of equation (4).

3. METHODOLOGY AND DATA

In order to evaluate how the different risk measures capture the risk of securities, the Spearman correlation will be used (Hahn et al., 2002). The Spearman correlation is a non-parametric measure without making any assumption about the linear relationship between the variables, nor does it require the variables to be measured on interval scales. The Spearman correlation is given as follows:

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)} \qquad (5)$$

where: di is the difference between each rank of corresponding values of X and Y and

n is the number of pairs of values.

The data concern 10 stocks of high cap traded on the Athens Stock Exchange (henceforth ASE), representing almost 60% of its total capitalization. The chosen period for analysis is from February 2000 until July 2007 concerning monthly returns. The total observations count to 90 while for the estimation of beta coefficient a five-year period is used, as this is the best period for estimating more reliably the systematic risk (Dimson and Marsh, 1983). Stocks lacking sufficient observations were excluded from the sample, while the monthly returns were estimated as:

$$r_i = (P_t - P_{t-1}) / P_{t-1}$$

where P_t is the price of security i at time t and P_{t-1} is the price of security i at time t-1. From the estimation of returns dividends were omitted as their inclusion would add little to the overall variability and time series structure of the data given that dividends are generally reported only annually or semi-annually (Lo and MacKinlay, 1988).

Table-1:Descriptive Statistics of Risk Measures

Stocks	Risk Measures	mean	st.dev.	min	max	skew	kurt	J-B
ALPHA	correlation	0.821	0.021	0.788	0.864	0.57	2.4	3.5
	st.dev.	0.106	0.0057	0.1	0.118	0.79	2.23	2.49
	beta	1.329	0.093	1.208	1.483	0.32	1.6	3.68
COCA-COLA	correlation	0.633	0.02	0.591	0.664	-0.25	1.9	1.88
	st.dev.	0.074	0.008	0.066	0.088	0.52	1.73	3.49
	beta	0.716	0.028	0.658	0.776	0.06	2.54	0.28
ELPE	correlation	0.592	0.063	0.478	0.68	-0.51	1.65	3.68
	st.dev.	0.091	0.006	0.085	0.101	0.53	1.56	4.09
	beta	0.824	0.088	0.717	0.977	0.45	1.69	3.25
EMPORIKI	correlation	0.786	0.034	0.72	0.824	-0.72	2.01	3.99
	st.dev.	0.133	0.006	0.122	0.141	-0.7	2.01	3.81
	beta	1.598	0.078	1.428	1.704	-0.76	2.5	3.34
ETHNIKI	correlation	0.86	0.006	0.841	0.871	-0.7	3.4	2.74
	st.dev.	0.116	0.008	0.104	0.133	0.27	2.39	0.85
	beta	1.526	0.059	1.425	1.629	-0.01	2.02	1.21
EUROBANK	correlation	0.808	0.021	0.761	0.845	-0.64	2.47	2.49
	st.dev.	0.087	0.006	0.081	0.098	0.54	1.35	3.68
	beta	1.079	0.073	0.971	1.192	0.05	1.35	3.5
OTE	correlation	0.712	0.027	0.643	0.748	-0.5	2.49	1.63
	st.dev.	0.078	0.005	0.074	0.096	1.41	4.82	**14.6**
	beta	0.853	0.088	0.717	1.003	0.47	1.68	3.4
PEIREOS	correlation	0.824	0.036	0.767	0.869	-0.4	1.45	3.92
	st.dev.	0.096	0.007	0.084	0.104	-0.65	1.74	4.26
	beta	1.205	0.056	1.116	1.286	0.12	1.49	2.98
TITAN	correlation	0.635	0.059	0.549	0.707	-0.38	1.42	3.99
	st.dev.	0.059	0.001	0.057	0.063	-0.16	1.92	1.61

Stocks	Risk Measures	mean	st.dev.	min	max	skew	kurt	J-B
	beta	0.576	0.03	0.531	0.635	0.37	2.13	1.67
	correlation	0.744	0.01	0.704	0.777	-0.35	2.78	0.72
VIOHALKO	st.dev.	0.121	0.004	0.111	0.127	-1.67	4.75	**18.3**
	beta	1.389	0.156	1.174	1.604	-0.1	1.47	3.07

Table 1 presents the descriptive statistics of the different measures of risk for the selected securities. Evaluating each measure for a 5-year period and making rolling estimation for the acquisition of beta coefficient we took 30 observations of risk measures for each one of the stocks. From the table it is clear that the correlation of the stocks with that of the General Index of the ASE, that have been used as the benchmark Index, varies between 0.664 and 0.871. The standard deviation varies from 5.7% to 14.1% and the beta coefficient from 0.531 to 1.704. Table 1 also depicts the normality test of Jarque-Bera, which follows the x squared distribution, while the null hypothesis is rejected for high values of J-B (5.99 c.v.,5% c.l.)(Groenewold and Fraser, 1997). Only 2 stocks seem to violate the normality assumption and they appear with bold letters at table 1.

4.EMPIRICAL RESULTS

4.1 The rank similarity of risk measures

The values of the three risk measures (correlation, st. deviation and beta coefficient) for the selected stocks have been calculated first. Table 2 shows some cases where the risk measures gave different results in relation to the associated risk of the specific dates. From the same table it seems that the correlation coefficient at March of 2005 (first sample) gave an increased value in relation to February of 2005 while for the same month the values of standard deviation and beta coefficient were decreased relative to the previous month (February 2005). Also in the case of the second example, the October 2006 month appears less risky than September 2006 for the security according to the correlation coefficient and the standard deviation while it is not the case for the beta coefficient that seems to be increased. The last example gives the same result, ie the correlation and standard deviation remain stable while a rise to the value of beta is observed. Thus the risk measures deliver different rankings assessing the risk in a different way.

Table-2: Selected Values of the Risk Measures

Stock	Date	Correlation	St. Deviation	Beta Coefficient
TITAN	25/2/2005	0.679	0.061	0.542
	30/3/2005	0.693	0.06	0.536
VIOHALKO	29/9/2006	0.756	0.124	1.555
	31/10/2006	0.749	0.123	1.56
EUROBANK	29/6/2007	0.777	0.084	1.149
	31/7/2007	0.77	0.084	1.158

For this reason the Spearman correlation coefficient was chosen for a better evaluation of the rank similarity among the selected measures. If the coefficient is close to +1 it shows that there is a strong positive relation between the two measures of risk. If it is close to -1 shows a negative relation, while if it is close to 0 does not give any useful information for the correlation of two variables. Using Student's t distribution with two degrees of freedom, the critical value for the correlation coefficient is 0.35 in absolute prices. Table 3 depicts the rank correlation coefficient for the three measures of risk.

Table-3 :Spearman's rank correlation

	ALPHA	σ	b		**EUROBANK**	σ	b
ALPHA	cor	-0.233	-0.082	**EUROBANK**	cor	-0.3	0.296
	σ		-0.193		σ		**-0.36**
	COCA COLA	σ	b		**OTE**	σ	b
COCA COLA	cor	**0.494**	0.296	**OTE**	cor	-0.193	**0.851**
	σ		**0.412**		σ		-0.134
	ELPE	σ	b		**PEIREOS**	σ	b
ELPE	cor	0.341	0.21	**PEIREOS**	cor	**0.607**	0.123
	σ		**0.877**		σ		0.276
	EMPORIKI	σ	b		**TITAN**	σ	b
EMPORIKI	cor	**0.876**	-0.058	**TITAN**	cor	**0.594**	0.237
	σ		-0.056		σ		**0.674**
	ETHNIKI	σ	b		**VIOHALKO**	σ	b
ETHNIKI	cor	**0.587**	**-0.472**	**VIOHALKO**	cor	0.21	0.069
	σ		**-0.862**		σ		0.179

Table 3 shows that there are 12 out of 30 cases with statistically significant coefficient meaning a strong relation of measuring the risk. However, from the 12 cases there are three that gave negative sign of the correlation showing an opposite way of capturing the risk of security. Having cases where a risk measure was increasing while at the same time the other measure was decreasing requires further investigation. The rank coefficient concerning the standard deviation with the other measures of risk varies from -0.862 to 0.877 and that of correlation between -0.472 and 0.851. So it is clear that the specific risk measures do not capture the risk with the same way and it is imposed for investors and portfolio managers to be very careful for choosing a risk measure.

4.2 The stability of beta

The estimation of beta coefficients that help portfolio formation is often associated with some practical problems such as the instability over time and the violation of CAPM assumptions. The reason is that asset returns may not be stationary in practice (Groenewold & Fraser, 1999). The market model allows for time varying estimates, however the instability of beta coefficient would have consequences to the right estimation of portfolio risk and how it changes over time.

Using again the Spearman's rank correlation we have tried to form portfolios with stable coefficient in order to minimize the variation portfolio risk. Portfolios are constituted from two stocks and table 4 presents Spearman's rank correlation for the beta coefficient within the stocks. There are 24 cases with statistically significant coefficients while 6 of them have negative coefficient, which allows the portfolio formation with a better risk return relationship.

Table 5 shows that as the rank correlation increased the same happen to standard deviation of beta coefficient. Figure 1 depicts the results as well as an increasing trend line figuring out the relation between the rank correlation of beta coefficients and their standard deviation. Thus, finding out at the first stage the Spearman's rank correlation coefficients among the stocks, it is possible to form portfolios at which the beta coefficient can remain constant during the time giving the investors a better knowledge about the risk they undertake for a given level of beta coefficient.

Table-4:Spearman's Rank Correlation for the Beta coefficient

	ALPHA	COCA COLA	ELPE	EMPORIKI	ETHNIKI	EUROBANK	OTE	PEIREOS	TITAN
ALPHA									
COCA COLA	-0.149								
ELPE	-0.147	-0.217							
EMPORIKI	0.272	-0.288	**0.726**						
ETHNIKI	**0.811**	**-0.385**	0.047	**0.495**					
EUROBANK	**0.881**	-0.223	-0.288	0.213	**0.752**				
OTE	**0.6**	0.153	**-0.392**	-0.091	**0.538**	**0.5**			
PEIREOS	-0.026	**-0.379**	**0.867**	**0.665**	0.181	-0.159	**-0.447**		
TITAN	-0.16	0.134	**0.672**	**0.403**	-0.14	**-0.358**	**-0.445**	**0.683**	
VIOHALKO	**0.831**	-0.299	0.081	**0.563**	**0.917**	**0.822**	**0.509**	0.164	-0.1

Table-5:Portfolios formed according to Spearman's rank correlation

Name of Portfolio	Spearman Correlation	Average beta	st.dev.of beta	Average Sharpe Ratio	St.Dev. S.R.
OTE-PEIREOS	-0.447	1.03	4.00%	0.71%	0.68%
OTE-TITAN	-0.445	0.715	3.90%	0.92%	0.60%
ELPE-OTE	-0.392	0.84	4.60%	0.56%	0.65%
ETHNIKI-COCA COLA	-0.385	1.123	2.70%	0.76%	0.45%
COCA COLA-PEIREOS	-0.379	0.961	2.60%	1.19%	0.66%
EUROBANK-TITAN	-0.358	0.828	3.50%	1.16%	0.58%
EMPORIKI-TITAN	0.403	1.087	4.90%	0.58%	0.40%
EMPORIKI-ETHNIKI	0.495	1.562	6.00%	0.26%	0.39%
EUROBANK-OTE	0.5	0.967	7.30%	0.55%	0.54%
OTE-VIOHALKO	0.509	1.122	11.20%	0.18%	0.54%
ETHNIKI-OTE	0.538	1.191	6.80%	0.37%	0.50%
EMPORIKI-VIOHALKO	0.563	1.494	10.80%	0.12%	0.42%
ALPHA-OTE	0.6	1.092	8.60%	0.20%	0.54%
EMPORIKI-PEIREOS	0.665	1.402	6.20%	0.51%	0.52%
ELPE-TITAN	0.672	0.701	5.70%	1.30%	0.72%
PEIREOS-TITAN	0.683	0.891	4.10%	1.32%	0.77%
ELPE-EMPORIKI	0.726	1.212	7.60%	0.37%	0.45%
ETHNIKI-EUROBANK	0.752	1.303	6.40%	0.57%	0.49%
ALPHA-ETHNIKI	0.811	1.428	7.30%	0.30%	0.50%
EUROBANK-VIOHALKO	0.822	1.234	11.20%	0.41%	0.54%
ALPHA-VIOHALKO	0.831	1.359	12.10%	0.14%	0.54%
ELPE-PEIREOS	0.867	1.015	7.10%	0.98%	0.79%
ALPHA-EUROBANK	0.881	1.221	11.60%	0.43%	0.53%
ETHNIKI-VIOHALKO	0.917	1.461	10.60%	0.28%	0.50%

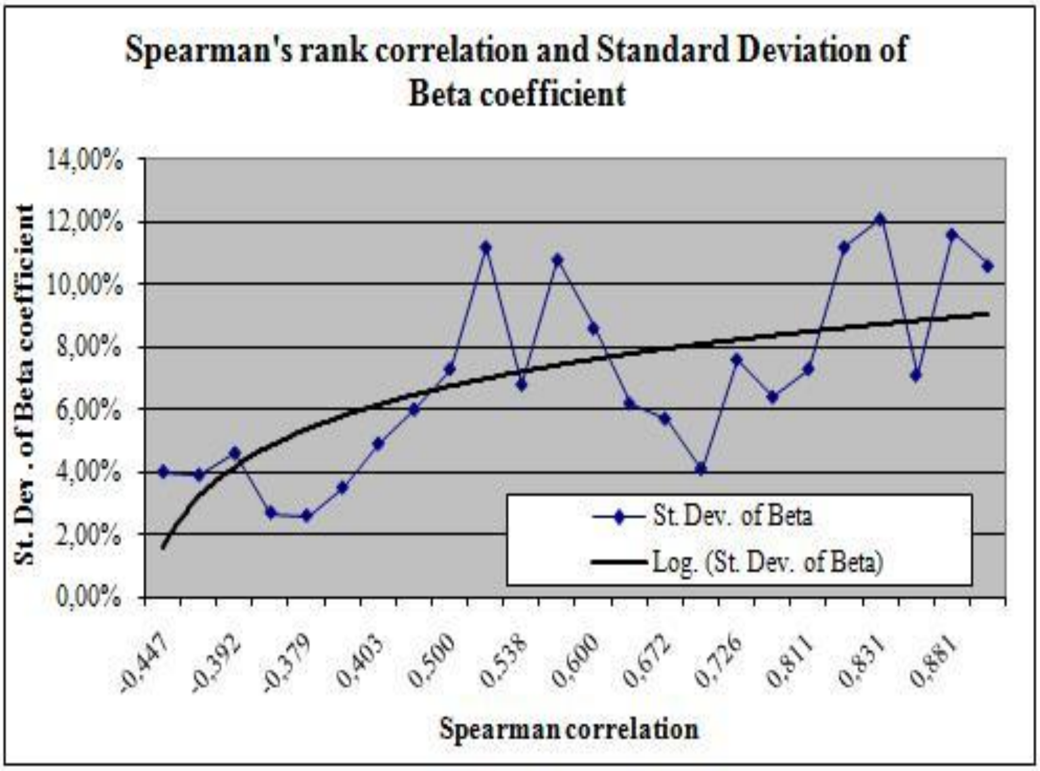

Figure-1:Standard Deviation of Beta coefficient

According to table 5, figure 2 depicts the Sharpe ratio. The ratio shows the return of a stock or portfolio per unit risk and it is clear from this figure that the line decreased as the Spearman's rank correlation increased. From this fact it seems that portfolios with negative rank correlation have higher return per unit risk. From table 8 one can conclude that if the Spearman correlation is known, selecting a portfolio with beta equal to 1.12 or 0.96, would result in quite different returns according to the risk undertaken. For example in the first case, for an investor portfolio with beta coefficient equal to 0.96 the average sharpe ratio of portfolio return would be 1.19% when the rank correlation between the stocks is –0.379 while only 0.55% when the rank correlation is 0.5. Thus, the Spearman's rank correlation can give some useful information about the behaviour of beta, resulting to portfolio formation with relative constant betas in time as well as portfolios with higher returns in relation to the risk they undertake.

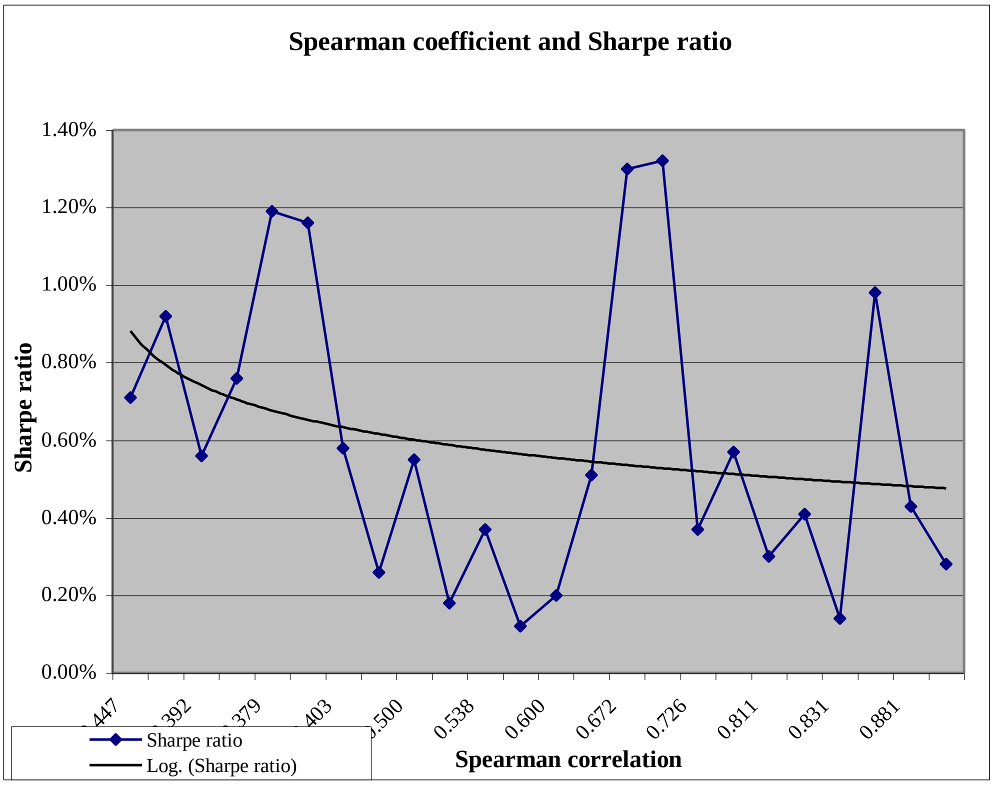

Figure-2:Sharpe ratio of selected portfolios

Table-6:Portfolios with the same beta coefficient

Portfolio	Spearman Correlation	Average beta	st.dev.of beta	Average Sharpe Ratio	St.Dev. S.R.
COCA COLA-PEIREOS	-0.379	0.961	2.60%	1.19%	0.66%
EUROBANK-OTE	0.5	0.967	7.30%	0.55%	0.54%
OTE-VIOHALKO	0.509	1.122	11.20%	0.18%	0.54%
ETHNIKI-COCA COLA	-0.385	1.123	2.70%	0.76%	0.45%

5.CONCLUSIONS

This work compares three different risk measures relative to the way with which they correspond to risk that contained to stocks and portfolios. Finding out the values for each risk measure at monthly base, we ranked the monthly periods according to their expected risk for a duration of 30 months using rolling regression. Spearman's rank correlation was used in order to compare each one of the risk measures. The results showed that the correlation coefficient, the standard deviation and the beta coefficient estimate the risk differently, a fact that might be explained by the distribution of stock returns (Ang et al., 2002). The three risk measures depict differently the asymmetry of returns. The correlation coefficient captures better the asymmetry when stock prices go downward from the conditional beta, which shows the same asymmetry both to upwards and downwards stock movements. The same stands for the standard deviation, as it evaluates symmetrically the price movements while in reality they might have asymmetry.

We also investigated several cases of portfolio formation using the Spearman's rank correlation. Knowing that beta coefficients vary during the time we formed 24 portfolios constituted of 2 stocks. The results showed that portfolios for which beta coefficients had statistically significant and negative rank coefficient gave lower standard deviation of betas in most cases with an ascending trend as the rank coefficient was increasing. Besides, portfolios with negative rank coefficient had also higher return per unit risk with the trend line of Sharpe ratio to move downward as the Spearman's rank correlation was increasing. Thus, the Spearman's rank correlation coefficient apart from the measurement of similarity among different measures of risk, can give useful information about the portfolio diversification, as it is possible to construct portfolios with relative constant coefficients and higher returns in relation to the risk undertaken.

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