USING THE MARKET MODEL ON ROMANIAN STOCK EXCHANGE

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Abstract

One of the concerns in portfolio management is to anticipate market evolution, generally given by a stock index. The market value of a stock is connected to the trends of the index; each security follows, more or less, the index trend line. This relationship between the return on a financial security and the return on a market index outlines the concept of market model.

Key words: market model, systematic risk (market risk), unsystematic risk (idiosyncratic risk), volatility, correlation coefficient, etc.

Clasificare JEL: G11

The relationship between the return on a security and the return on the market portfolio generated widespread concern among financial specialists and one of the results of their studies was *W. Sharpe's* market model, that came public in 1970. The model describes the link between the return of an asset and the return of the market using a regression and due to its simplicity and coherence, it became very popular, framing at the same time an important starting point for the future research in stock market.

The market model explains the linear relationship between the return on a stock, on one hand, and the rate of return for the market index, in the same period of time, on the other hand. We mean by market model the regression:

$$R_i = \alpha_i + \beta_i R_M + \varepsilon_i \qquad (1)$$

One of the basic assumptions for this model is the one that says the return of a security is described mostly by a single macroeconomic factor, the market's return, respectively. Consequently, the securities' variability (risk) can be explained by the variability of the market's return, to a great extent, and this gives the quantification of the systematic risk (non-diversifiable, market risk. This type of risk is linked to the swings in macroeconomic indicators like: gross domestic product, inflation rate, average interest rate, exchange rate, etc. The amount of risk that cannot be explained by variability in the market's return is the idiosyncratic risk, diversifiable, and refers to the firm-specific risk factors and the economic sector to which the company belongs:

$$\sigma_i^2 = \beta_i^2 \sigma_M^2 + \sigma_{\varepsilon i}^2 \quad (2)$$

The diversifiable risk for each security is given by the variance of the residuals, $\sigma_{\varepsilon i}^2$. This risk can be virtually eliminated from a portfolio through diversification.

$$\sigma_{\varepsilon i}^2 = \left(1 - \rho_{i,M}^2\right)\sigma_i^2 = \sigma_i^2 - \beta_i^2 \sigma_M^2 \quad (3)$$

The systematic risk is measured by beta.

Beta (β_i = the slope of the regression line) is an elasticity coefficient of a security return (R_i) with respect to index return (R_M). In other words, it measures the percentage change β_i% in the return R_i when the return R_M is increased or decreased by 1% (statistically speaking).

$$\beta_i = \frac{\sigma_{iM}}{\sigma_M^2} \quad \text{where:} \quad (4)$$

$$\sigma_{iM} = \frac{\sum_{t=1}^{T}\left(R_{it} - \overline{R}_i\right)\left(R_{Mt} - \overline{R}_M\right)}{T-1} \quad (5)$$

$$\sigma_M^2 = \frac{\sum_{t=1}^{T}\left(R_{Mt} - \overline{R}_M\right)^2}{T-1} \quad (6)$$

The size of β_i compared to market beta β_M (which, by default, is equal to one: $\beta_M = 1$) classifies the securities by their systematic risk in:

- more volatile securities(with $\beta_i > 1$);
- volatile securities (with $\beta_i = 1$)
- less volatile securities (with $\beta_i < 1$).

The securities with $\beta_i = 0$ are an exception to the rule of market model, meaning that their return is completely independent of R_M. The securities with $\beta_i < 0$ are not very common, in negative correlation with the stock market. The knowledge of β_i size is useful in estimating the expected return of the securities [$E(R_i)$] and in active portfolio management (buying volatile stocks when the market is in expansion or less volatile stocks when the market is in contraction).

The correlation coefficient (ρ_{iM}) between R_i and R_M measures the strength of the linear dependence between R_i and R_M. Its significance is complementary to β_i because:

$$\rho_{iM} = \beta_i \frac{\sigma_M}{\sigma_i} \text{ or: } \beta_i = \rho_{iM} \frac{\sigma_i}{\sigma_M} \quad (7)$$

Consequently,

- a coefficient $\beta_i > 1$ will be accompanied by a significant correlation coefficient $0,5 \le \rho_{iM} < 1$;
- a $\beta_i < 1$ will have a ρ_{iM} which emphasizes a low intensity correlation $\widetilde{R}_i \sim \widetilde{R}_M$ $(0 \le \rho_{iM} < 0,5)$.

The fraction of the variance in Ri that is explained by R_M in a linear regression analysis is synthesized by the **coefficient of determination R^2**, which is the square of the correlation coefficient: $R^2 = \rho^2$.

The intercept α_i for the linear regression is the difference between the average $\overline{R}_i$ and the average return explained by the average market return $\overline{R}_M$:

$$\alpha_i = \overline{R}_i - \beta_i \overline{R}_M \qquad (8)$$

This symbolizes the return R_i when the retun R_M is zero. The intercept α_i can vary between positive and negative values, depending on the stock market instability.

Study case

In the table below we gave an exemple of the correlation that exists between each security and the market portfolio using the least squares method. For the market portfolio we used BET index, as it is a free float weighted capitalization index of the most liquid 10 companies listed on the BVB (Bucharest Stock Exchange) regulated market.

Table 1. *Components of market model for 13 stocks*

	σ_{iM}	β_i	α_i	σ_i^2	$\beta_i^2 \times \sigma_M^2$	$\sigma_{\varepsilon i}^2$	ρ_{iM}	R_i^2
ALU	0,000240	0,654777	0,000312	0,000838	0,000157	0,000681	0,433222	0,187682
ALR	0,000263	0,717088	0,001719	0,001202	0,000189	0,001013	0,396189	0,156966
ATB	0,000241	0,655560	-0,000435	0,000629	0,000158	0,000472	0,500539	0,250539
AZO	0,000304	0,827473	0,001200	0,001156	0,000251	0,000905	0,466112	0,217261
BRD	0,000032	0,088422	0,003115	0,000661	0,000003	0,000658	0,065883	0,004341
TEL	0,000110	0,299607	0,002306	0,002281	0,000033	0,002249	0,120154	0,014437
TUFE	0,000245	0,668877	-0,000105	0,000804	0,000164	0,000640	0,451773	0,204099
RRC	0,000348	0,947452	0,000716	0,000905	0,000329	0,000575	0,603343	0,364023
SIF3	0,000418	1,137997	-0,000100	0,001043	0,000475	0,000568	0,674992	0,455614
SNP	0,000397	1,080940	-0,000332	0,000668	0,000429	0,000239	0,801303	0,642087
SOCP	0,000167	0,455653	0,000313	0,001020	0,000076	0,000944	0,273268	0,074676
TLV	0,000378	1,030670	-0,000286	0,000688	0,000390	0,000298	0,752837	0,566764
TRP	0,000145	0,396491	0,001447	0,000848	0,000058	0,000791	0,260744	0,067987
BET	0,000367	1	0	0,000367	0,000367	0	1	1

In the table above we notice that the most volatile stocks are SIF 3, SNP and TLV, all the others being less volatile, with a $\beta_i < 1$. Among the least volatile stocks we can mention BRD, SRT and TRP. For SIF3, SNP and TLV with beta greater than one, the correlation coefficient has the following values 0.67, 0.8, 0.75, respectively.

Next we will give an exemple for the market model using SNP. For this purpose, we had the regression:

$$R_{iSNP}=\alpha_{iSNP} + \beta_{iSNP} * R_{iM} + \varepsilon_i \quad (9)$$

Using the least squares estimation, we got the results:

Table 2. *Statistical results*

Dependent Variable: SNP Method: Least Squares				
Variables	Coefficient	Std. Error	t-Statistic	Prob.
Intercept (α)	-0.000332	0.000996	-0.332896	0.0395
BET	1.080940	0.051351	21.05021	0.0000
R-squared	0.642087	Mean dependent var		0.003017
Adjusted R-squared	0.640638	S.D. dependent var		0.025892
S.E. of regression	0.015522	Akaike info criterion		-5.485167
Sum squared resid	0.059507	Schwarz criterion		-5.456914
Log likelihood	684.9032	F-statistic		443.1113
Durbin-Watson stat	2.226704	Prob(F-statistic)		0.000000

The coefficient for the BET's return has the value β_{SNP} = 1.08094.

The intercept's α_{SNP} value is α_{SNP} = -0.000332, significant with a confidence level of 95%.

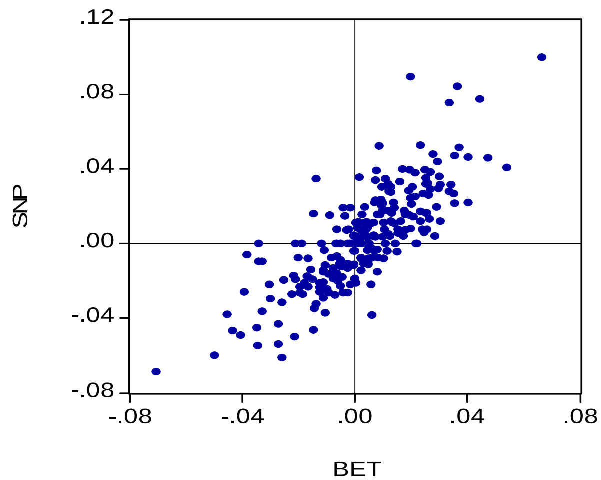
The estimation is:

R_{SNP} = -0,000332 + 1,080940*R_M

Considering the value of the coefficient β_{SNP} (1.080940) > 1, we can say that SNP is very volatile, which means that a +/- 1% change in the market index will generate changes greater than +/- 1%, and those changes consist of +1.080940% in the return of SNP.

The coefficient β also gives the slope for the scatter plot:

Graph 1. **Correlation SNP against BET**



The global risk of the security, by its components, will be:

$$\sigma^2_{SNP} = \beta^2_{SNP} * \sigma^2_{SNP} + \sigma^2_{\varepsilon SNP} \quad (10)$$

and can be described as: Global risk$_{SNP}$ = Market risk + Firm-specific risk

$$\sigma^2_{SNP} = 0{,}00067 = \begin{cases} \beta^2_{SNP} * \sigma^2_{BET} = 0{,}00043 \text{ market risk} \\ + \\ \sigma^2_{\varepsilon} = 0{,}00024 \text{ firm - specific risk} \end{cases}$$

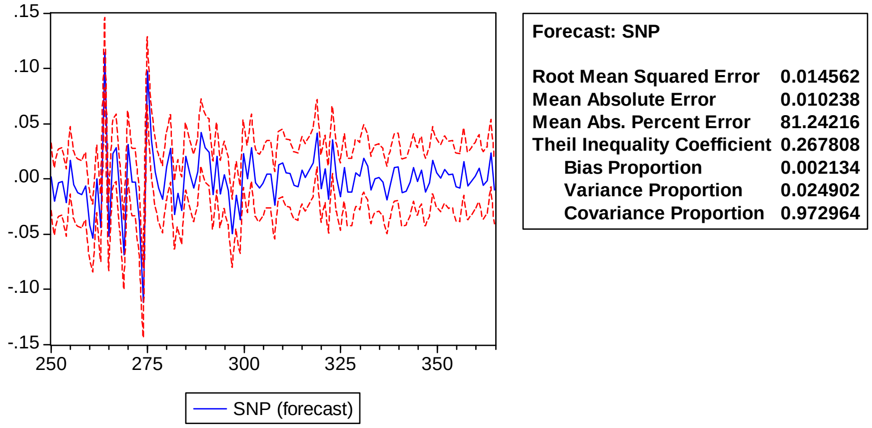
This decomposition outlines that the market risk is greater than the firm – specific risk, the explanation consisting of the high level volatility of the security sensitive to the market swings.

For measuring the intensity of the relationship between the two returns, we computed the correlation coefficient $\rho_{SNP,M} = \frac{\sigma_{SNP,M}}{\sigma_{SNP} * \sigma_M} = 0.8$ and its value indicates a directly proportional and highly correlated dependence between SNP andi BET.

$R^2 = \rho^2_{SNP,M}$, having a value of $R^2 = 0.64$, that says that 64% of the changes in SNP's return is caused by the market changes.

The stability of the coefficients obtained from the estimation was analysed with a forecast for the return on SNP using the market model:

***Graph 2.** Return on SNP forecast using market model*



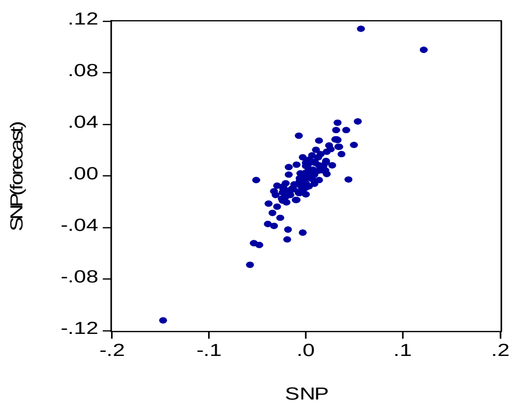
One of the dorecast evaluators is the Mean Absolute Percent Error, and indicates the average percentage deviations of the forecast from the actual, with the formula:

$$MAPE = \frac{1}{T-p}\sum_{t=p+1}^{T}\frac{|y_t - y'_t|}{y_t}\cdot 100\,, \qquad (11)$$

where: T = total number of observations;
p = number of observations used for modelling;
p+1 = indicator for the first forecast value (16.04.2010).

According to the forecast results, the forecast returns on SNP differ 81% by the actual returns.

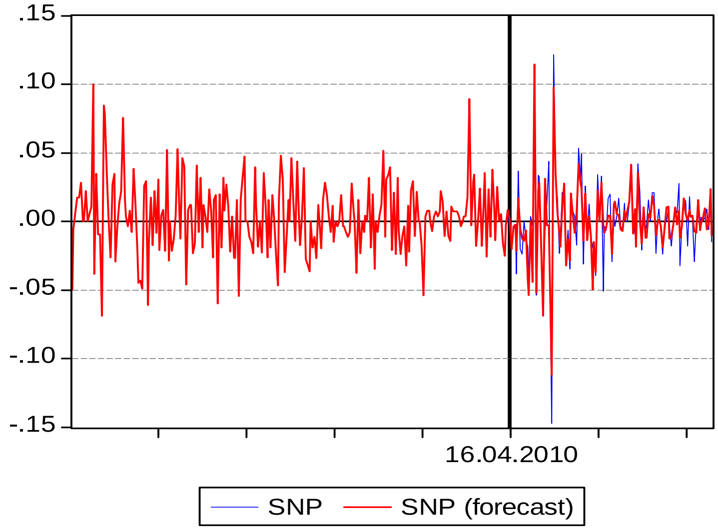
Graph 3. Correlation actual against forecast returns on SNP



Theil's coefficient is a forecast evaluator with values in the interval (0,1); the closer to 0 the value is, the better the adjustment is. In our case, the value for this coefficient is pretty low, around 0.26.

Next we created a line chart using the actual return on SNP series and the forecast series for the following period of time:

Graph 4. Actual and forecast return on SNP



Conclusion

As a result of using the market model for 13 securities on the Romanian stock market, we noticed that the idiosyncratic risk is greater than the systematic risk, with two exceptions (SNP and TLV), risk that can be diversified away to smaller levels in a portfolio.

Having picked BET index as the whole capital market for Sharpe's market model leads to 64% reliability on the model (according to the coefficient of determination R^2), in the case of SNP, but for the other securities the numbers lead to the conclusion that the market return is not given by the BET index.

Applying the market model for SNP using BET index shows out its efficiency in forecasting expected returns, but it still has his boundaries given by the stability of α and β.

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