TESTING CAPITAL ASSET PRICING MODEL FOR ROMANIAN CAPITAL MARKET

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ABSTRACT: The purpose of this article is the empirical testing of Capital Asset Pricing Model (CAPM) for the Romanian capital market, both for individual assets and for portfolios, using a sample of daily data for 24 companies listed on Bucharest Stock Exchange, during the period 06.01.2003 - 31.07.2009, following the interpretation of results and usefulness of the model estimates. My intention is to find if the relationship between expected return and risk is linear, if beta is a complete measure of the risk and if a higher risk is compensated by a higher expected return. The results confirm that the intercept is statistically insignificant, upholding theory, for both individual assets and portfolios. The tests do not necessarily provide evidence against CAPM, however other simulations can be built, more close to reality, improving the model and offering an alternative which also takes into account the specific conditions of local capital market and the global financial crisis consequences.

Key words: Capital Asset Pricing Model (CAPM), beta, risk free rate, risk premium, expected return

JEL codes: G12

Introduction

The universe and the reality we live in are governed, apart from one side thought to be constant or predictable, sometimes called perfect or with efficient estimations, also by uncertainty, no pattern, extreme behavior, chaos, fractal geometry.

There are voices who say that these rare events, difficult to predict, have a substantial impact, inverting some assumptions of the „classic" models.

Anchored at present, it is difficult to look in the past and understand how it was the financial world before portfolio theory, how conceptual elements such as risk and return, fundamental to any today course of Finance, were then a novelty and were regarded with reservations.

The alert, continuous and impressive activity of the capital markets in the middle of economic, financial and politic reality, their sensitivity to a big number of factors and changes are fascinating and intriguing in the same time.

The research of this expansive and attractive field, the theories and models developed over time and events, innovating ideas, tested and proved, moments of crisis, failures, new papers and debates create the premises for a generous documentation and analysis for the investors' behavior in the capital markets.

Literature review

It took until the 1940s and 1950s for compelling theories on the investors' risk preference and on the decision-making in a changeable environment to come forth (von Neumann şi Morgenstern, 1944; Savage, 1954). The portfolio theory, which proposes that investors can create portfolios with an optimum rate between risk and return, was developed in the 1950s by Harry Markowitz (1952, 1959) and Roy (1952). The measuring of standard deviations has emerged in the

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academic literature through the works of Fisher and Lorie (1968), whereas the carefully elaborated estimations of the risk premium on the basis of the analysis of the return rates on long term were published by Ibbotson and Sinquefield (1968).

The model of portfolio selection developed by Harry Markowitz is based on the selection of risky assets, which uses and links for the first time in the portfolio analysis concepts such as mean, variance, covariance. The model also advocates the opportunity of diversification.

Tobin's *„Liquidity preference as behavior towards risk"* (1958) expanded on Markowitz's model by introducing the concept of risk-free asset and found that the efficient set of combinations risk-return is a line, thus simplifying the process of portfolio selection and demonstrating that the same portfolio of risky assets suit all investors. What differs are the values selected to be assigned to risky assets or to risk-free assets. Each investor may limit their investment by selecting two mutual funds: a fund which only invests in risk-free assets (such as the treasury bonds) and one which invests in a „magic" portfolio governed by the risk σ_M and the $\overline{R}_M$ return. The difficulty in calculating and estimating the costs occurs precisely in determining this magic portfolio, of the market M, of the assets and of the values invested in these assets.

The next step which simplified this selection was the market model or the unifactorial model drawn up by William Sharpe based on the supposition that the return of each asset is a linear function in relation to a single market index. The model proposed by Sharpe had an empirical underpinning: most of the assets move together most of the time, thus only one factor or a limited number of factors determine the variations in the return of the assets. This linear relation can be easily estimated using the least squares method; the coefficients thus estimated can be used to build covariances and then optimum portfolios. Sharpe's approach has reduced the dimension of the portfolio problem and made it easier to establish efficient portfolios.

Subsequently, Sharpe focused on the theory of capital market equilibrium. Until then, the portfolio theory was a theory of individual behavior: how can an investor select from a range of available assets.

A fundamental issue in finance is the way the risk of an investment affects the expected return. Capital Asset Pricing Model (CAPM) offered for the first time a coherent framework for the understanding of this issue. CAPM was developed in the beginning of the 1960s by William Sharpe (1964), Jack Treynor (1962), John Lintner (1965) and Jan Mossin (1966) and is based on the idea that not all the risks influence the prices of the assets and that a risk can be diversified and reduced by introducing the asset in a portfolio.

Even though the capital markets were organized in such a way as to undertake and share the risks, CAPM has come about at a time when the theory of decision-making in a changeable environment was relatively new and the main concepts of risk and return were not yet known on the capital market.

CAPM - improvements and alternatives

Further research has loosened up the general requirements of CAPM in order to adapt to the complexity of real world and has confirmed the empirical observations of the model.

CAPM can be formulated in either discrete-time or in continuous-time. Sharpe (1964) and Lintner (1965) describe a model for a single period of time where returns are distributed normally. The hypothesis of normal distribution of returns can be relaxed. Merton (1973) expands the CAPM model advanced by Sharpe and Lintner.

Levy and Samuelson (1992) group the reviewing of CAPM in four different cases, three with different holding periods and one in which all investors have the same holding period, and in all four cases the distribution of returns and the rate of the risk-free asset may vary from time period to time period.

By relaxing initial conditions or by adding other hypotheses, CAPM has been expanded in various directions. Some of the best known improvements to the model allow the comprisal of heterogeneous expectations (Lintner, 1969; Merton, 1987), the exclusion of risk-free asset (Black, 1972) – also known as the two factors model, the inclusion of several periods of time and of investment opportunities that can change from time period to time period (Merton, 1973; Breeden, 1979), the expansion to international investments (Solnik, 1974; Stulz, 1981; Adler and Dumas, 1983), the alternative of a multifactorial model based on arbitrage reasoning (Ross, 1976).

It is intensely debated whether the original CAPM model or one of its extensions such as the multifactorial model is the correct approach to valuation of assets. Initial tests on CAPM run by Black, Jensen and Scholes (1972), Fama and MacBeth (1973) confirmed that high beta assets have higher returns then low beta assets. The relation between beta and the expected return is not as abrupt as the theoretical relation described by SML (Security Market Line).

Data selection

The case study applies the CAPM model on the Bucharest Stock Exchange data with the aim of interpreting and considering the utility of the estimations of the model.

The research on the CAPM model was conducted on a sample of 24 companies listed on the Bucharest Stock Exchange. Series of daily data were used for the econometric analysis. Since the frequency of the series of data was irregular, a new series of time grouping all available days was created. The research has been conducted in the period 06.01.2003 - 31.07.2009. The database of the Bucharest Stock Exchange served as information source on the closing prices for each company: Daily market report, the number of observations for each company is 1627.

CAPM does not specify a time interval for the data selection of the series and the time series can be selected having different frequencies (daily, monthly, yearly) and the values of the beta coefficient are sensitive to their choice.

BET-C composite index has been used as proxy for the market portfolio. BET-C reflects the 24 companies selected for the purpose of this research.

The rate of return of the risk-free asset was calculated as average of the interest rates of government bonds, on the basis of the available data on the Bucharest Stock Exchange website.

Research methodology

The Capital Asset Pricing Model (CAPM) regression equation can be written as follows:

$$E(R_i) = R_f + \beta_i \cdot (E(R_M) - R_f) + \varepsilon_i, \; i = \overline{1,N} \quad (1)$$

where:

$E(R_i) =$ the expected return on security *i*;

$R_f =$ the risk-free rate calculated as average of the interest rates of government bonds: $R_f = 7{,}61\%$;

$\beta_i =$ the volatility of the asset *i* compared to the market portfolio M;

$R_M =$ the expected return on market portfolio, M;

$\varepsilon_i =$ the error term, a random variable, summing the action of other factors besides market, not taken into account over the asset *i*;

$E(R_M) - R_f =$ the excess return over the risk-free rate return, the risk premium for bearing one unit of beta risk;

$N = 24$.

Starting from the closing prices have resulted daily returns, as follows:

$R_t = \ln \frac{P_t}{P_{t-1}} = \ln P_t - \ln P_{t-1}$, *using the approximation* $\ln(1+x) \approx x$, *when* $x \to 0$.

In order to form portfolios, all 24 stocks were grouped according to their market capitalization, obtaining 4 portfolios with the following structure:

Portfolio 1 = 0.58127355·SNP + 0.285494719·BRD + 0.061894087·TLV + 0.047190736·ALR + 0.012731153·ATB + 0.011415756·SCD
Portfolio 2 = 0.218187182·ART + 0.204623875·MPN + 0.191200258·AZO + 0.149163759·OLT + 0.130163517·PTR + 0.10666141·EFO
Portfolio 3 = 0.236159124·IMP + 0.188088283·SNO + 0.178974536·ARS + 0.154510391·CMP + 0.141226748·EPT + 0.101040917·APC
Portfolio 4 = 0.31414852·TBM + 0.287855·AMO + 0.212141918·STZ + 0.071997395·ARM + 0.0676204·PEI + 0.046236767·ECT

Estimating the model

Stationarity

In order to test the stationarity of the series, the presence of unit roots is tested using ADF (Augmented Dickey-Fuller) test and PP (Phillips-Perron) test to determine the integrability order.

The initial data series (the closing prices for all 24 companies and for BET-C index) were $I(1)$ and by first difference (determining returns as a difference of natural logarithms) they become $I(0)$.

Empirical test of the model

Following the estimation of the CAPM regression equation, the values for alfa and beta coefficients and for other statistics are presented in the table below:

Table no. 1

CAPM - Estimated Coefficients and Statistics

Symbol		Coefficient	Std. Error[*3]	t-statistic[*4]	Prob.	R2	Adjusted R2
ALR	alfa	0.062671	0.003267	19.181243	0.000000	0,192081	0,191584
	beta	0.828145	0.042133	19.655551	0.000000		
AMO	alfa	0.073416	0.004339	16.919095	0.000000	0,155019	0,154499
	beta	0.966143	0.055956	17.266181	0.000000		
APC	alfa	0.034882	0.004031	8.652706	0.000000	0,04405	0,043462
	beta	0.449842	0.051985	8.653297	0.000000		
ARM	alfa	0.031467	0.004281	7.349746	0.000000	0,034382	0,033788
	beta	0.419964	0.055210	7.606593	0.000000		
ARS	alfa	0.023834	0.005701	4.181025	0.000031	0,012056	0,011448
	beta	0.327348	0.073510	4.453103	0.000009		
ART	alfa	0.059623	0.004315	13.816859	0.000000	0,10961	0,109062
	beta	0.787041	0.055646	14.143641	0.000000		
ATB	alfa	0.071323	0.002298	31.032580	0.000000	0,378933	0,37855
	beta	0.933216	0.029638	31.487507	0.000000		
AZO	alfa	0.077788	0.004406	17.655767	0.000000	0,167573	0,16706
	beta	1.027578	0.056815	18.086514	0.000000		
BRD	alfa	0.086740	0.002928	29.622517	0.000000	0,357598	0,357203
	beta	1.135664	0.037760	30.076074	0.000000		

CMP	alfa	0.080037	0.003498	22.883522	0.000000	0,253305	0,252845
	beta	1.058959	0.045103	23.478835	0.000000		
ECT	alfa	0.042349	0.004045	10.468487	0.000000	0,067298	0,066724
	beta	0.564867	0.052166	10.828238	0.000000		
EFO	alfa	0.033828	0.004102	8.246721	0.000000	0,041227	0,040637
	beta	0.442175	0.052897	8.359141	0.000000		
EPT	alfa	0.063635	0.005221	12.188640	0.000000	0,08713	0,086569
	beta	0.838460	0.067325	12.453948	0.000000		
IMP	alfa	0.083086	0.005510	15.079365	0.000000	0,128297	0,127761
	beta	1.098825	0.071052	15.465050	0.000000		
MPN	alfa	0.024067	0.004072	5.910373	0.000000	0,020796	0,020193
	beta	0.308472	0.052510	5.874588	0.000000		
OLT	alfa	0.068613	0.004141	16.569167	0.000000	0,147228	0,146703
	beta	0.894420	0.053399	16.749626	0.000000		
PEI	alfa	0.030263	0.003850	7.860206	0.000000	0,039325	0,038733
	beta	0.404932	0.049649	8.155878	0.000000		
PTR	alfa	0.075050	0.003932	19.085271	0.000000	0,186225	0,185725
	beta	0.977872	0.050709	19.283870	0.000000		
SCD	alfa	0.051917	0.002401	21.627067	0.000000	0,228141	0,227666
	beta	0.678426	0.030956	21.915887	0.000000		
SNO	alfa	0.051735	0.003685	14.040272	0.000000	0,111364	0,110817
	beta	0.678080	0.047516	14.270437	0.000000		
STZ	alfa	0.040580	0.004352	9.324263	0.000000	0,050871	0,050287
	beta	0.523759	0.056122	9.332562	0.000000		
TLV	alfa	0.044597	0.004613	9.668656	0.000000	0,054802	0,054221
	beta	0.577352	0.059481	9.706542	0.000000		
TBM	alfa	0.079055	0.008039	9.833808	0.000000	0,061995	0,061418
	beta	1.074341	0.103667	10.363390	0.000000		
SNP	alfa	0.093863	0.001845	50.878975	0.000000	0,623915	0,623684
	beta	1.235192	0.023790	51.921450	0.000000		
Portfolio 1	alfa	0.010442	0.001219	8.569307	0.000000	0,763031	0,762885
	beta	1.136652	0.015714	72.335515	0.000000		
Portfolio 2	alfa	-0.019682	0.001864	-10.559079	0.000000	0,367878	0,367489
	beta	0.739177	0.024036	30.752349	0.000000		
Portfolio 3	alfa	-0.017604	0.002165	-8.130753	0.000000	0,320582	0,320164
	beta	0.773109	0.027920	27.690301	0.000000		
Portfolio 4	alfa	-0.015253	0.003068	-4.972262	0.000001	0,20528	0,204791
	beta	0.810459	0.039558	20.487677	0.000000		

Testing the stability of beta coefficient

To test if beta is stable over time I have split the initial time series 06.01.2003 - 31.07.2009 into three subsamples: 06.01.2003 - 24.12.2004, 03.01.2005 - 19.12.2006 and 03.01.2007 - 31.07.2009 and then I have separately estimated CAPM for each subperiod sample, obtaining for estimated beta the following results:

Table no. 2

CAPM - Split Sample - Estimated Beta

Symbol	2003-2004	2005-2006	2007-2009	2003-2009
ALR	0.888813	0.641639	0.883568	0.828145
AMO	0.485751	0.653455	1.132392	0.966143
APC	0.508002	0.598330	0.387391	0.449842
ARM	0.229298	0.647964	0.358511	0.419964
ARS	0.213435	0.240820	0.356127	0.327348
ART	0.407263	0.836032	0.803466	0.787041
ATB	0.614548	0.858551	0.995357	0.933216
AZO	1.037372	0.776438	1.128088	1.027578
BRD	0.773358	0.954833	1.245370	1.135664
CMP	0.782185	0.870995	1.152534	1.058959
ECT	0.771282	0.656008	0.504752	0.564867
EFO	0.270172	0.315846	0.508438	0.442175
EPT	0.552200	0.648139	0.939565	0.838460
IMP	0.607309	0.721159	1.297618	1.098825
MPN	0.443404	0.146473	0.345227	0.308472
OLT	0.729334	1.005722	0.874741	0.894420
PEI	0.377327	0.390125	0.400688	0.404932
PTR	0.730382	0.678881	1.110930	0.977872
SCD	0.440130	0.479642	0.772499	0.678426
SNO	0.678050	0.243838	0.831514	0.678080
STZ	0.686913	0.762964	0.416403	0.523759
TLV	0.707452	1.060215	0.394091	0.577352
TBM	0.316495	1.763778	0.922124	1.074341
SNP	1.598115	1.304529	1.169295	1.235192
Portfolio 1	1.248311	1.143194	1.122805	1.136652
Portfolio 2	0.610613	0.632910	0.790951	0.739177
Portfolio 3	0.559324	0.545840	0.876493	0.773109
Portfolio 4	0.462661	1.007409	0.780230	0.810459

In order to test the stability of beta coefficient it can also be used the Chow test (*Chow Breakpoint Test*).

Results

The results confirm that the intercept is statistically insignificant, upholding theory, for both individual assets and portfolios.

Coefficients **alfa** and **beta** - the following conclusions can be drawn from the data available in *CAPM - Estimated Coefficients and Statistics* (table no. 1):

- alfa: the constant of the model (intercept). According to CAPM theory, the value of the constant has to be equal to zero. The data in the table confirm this hypothesis.
- beta: is the estimated coefficient of the model. By interpreting values *t-stat*. and *prob*., one may observe that beta is significantly different from zero, having inferior to the unit values for the assets less volatile than the market index and superior to the unit values for a volatility superior to that of the market.

- according to expectations, the daily returns are not normally distributed and the values of coefficients Skew (different from 0) and Kurtosis (over 3) suggest asymmetry and a leptokurtic shape of distribution.

Stability of coefficient **beta -** the following conclusions can be drawn from the data available in *CAPM - Split Sample - Estimated Beta* (table no. 2) and the findings of the Chow test:

- one may observe that beta is not stable over time for part of the analyzed assets, registering periods with higher or lower volatility, ranging from beta inferior to the unit to beta superior to the unit or vice versa.

Portfolios - the following conclusions can be drawn from the findings:

- coefficient **alfa** is statistically insignificant;
- coefficient **beta** is significantly different from zero, having a superior to the unit value for Portfolio 1 (consisting of SNP, BRD, TLV, ALR, ATB and SCD stocks) only, which therefore has a higher volatility than the market, the other portfolios having a beta inferior to the unit, with values ranging from 0.739177 and 0.810459;
- the values for $\mathbf{R^2}$ and $\mathbf{R^2}$ **modified** are better than the values of individual assets;
- the analysis of subperiods, as well as the Chow test confirm the stability in time of coefficient beta for Portfolios 1, 2 and 3.

Conclusions

CAPM is considered to be an elegant theory with significant implications to the valuation of the assets and the investors' behavior. The use of this model is constantly questioned on the grounds of the hypotheses of an ideal world which underpin it. There are several arguments to approach it:

- the forecasting value of the CAMP can be identified by examining the findings in the real world meaning that the valuation of the assets and of the portfolios selected by the investors overlaps with the estimations of the model not so much in a strictly quantitative manner as in a strong qualitative manner;
- even though the model does not accurately illustrate the current state of things, it may be used to estimate a future trend of the investors' behavior, taking into account the financial innovation, the improved regulations and the integration of the capital markets;
- CAPM may be used as a standard to understand the functioning of the market and the causes which determine the prices of the assets and the investors' behavior, even by considering the analysis of the deviations from the model;
- the results confirm that the intercept is statistically insignificant, upholding theory, for both individual assets and portfolios;
- the tests do not necessarily provide evidence against CAPM, the data sample including also the time period in which the Romanian capital market was affected by the global financial crisis, however other simulations can be built, more close to reality, improving the model and offering an alternative which also takes into account the specific conditions of local capital market.

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