An Investigation into the Role of Market Beta in Asset Pricing: Evidence from the Romanian Stock Market

Ioan Popa, Radu Lupu, Cristiana Tudor

Abstract—In this paper, we apply the FM methodology to the cross-section of Romanian-listed common stocks and investigate the explanatory power of market beta on the cross-section of commons stock returns from Bucharest Stock Exchange. Various assumptions are empirically tested, such us linearity, market efficiency, the "no systematic effect of non-beta risk" hypothesis or the positive expected risk-return trade-off hypothesis. We find that the Romanian stock market shows the same properties as the other emerging markets in terms of efficiency and significance of the linear risk-return models. Our analysis included weekly returns from January 2002 until May 2010 and the portfolio formation, estimation and testing was performed in a rolling manner using 51 observations (one year) for each stage of the analysis.

Keywords—Bucharest Stock Exchange, Fama-Macbeth methodology, systematic risk, non-linear risk-return dependence.

I. INTRODUCTION

THE methodology developed by Fama and MacBeth (FM) [8] represents a landmark contribution toward the empirical validation or dismisal of the basic assumptions of the Capital Asset Pricing Model. FM first interpreted the CAPM as implying a basic linear relationship between stock returns and market betas which should completely explain the cross-section of returns at a specific point in time or for a specified sample period.

In order to test the effectiveness of the CAPM in justifying that observed cross-sectional variability of returns, FM designed and implemented a basic two-step regression methodology that eventually survived the first set of empirical results that it generated, to become a standard approach in the field.

In this paper, we attempt to apply the FM methodology to the cross-section of Romanian-listed common stocks. We are therefore concerned with the investigation of the explanatory power of market beta on the cross-section of commons stock returns from Bucharest Stock Exchange. The remainder of the

Ioan Popa is with the Department of International Business and Economics at the Academy of Economic Studies from Bucharest, 6, Romana, sect. 1, Bucharest, Romania; (e-mail: ioan.popa.rei@ gmail.com);
Radu Lupu is with the Department of International Business and Economics at the Academy of Economic Studies from Bucharest 6, Romana, sect. 1, Bucharest, Romania and with the Institute for Economic Forecasting at the Romanian Academy of Science, 13, 13 Septembrie, sect. 5, Bucharest, Romania (e-mail: radu.lupu@ rei.ase.ro;
Cristiana Tudor is with the Department of International Business and Economics at the Academy of Economic Studies from Bucharest 6, Romana, sect. 1, Bucharest, Romania (e-mail: cristianat@ gmail.com).

paper is organized as follows. Section 2 briefly presents related literature, Section 3 describes the data employed in our analysis and Section 4 describes the methodology. Further, Section 5 presents the empirical results while in Section 6 some conclusions are drawn.

II. LITERATURE REVIEW

The early empirical studies on the Sharpe-Linter-Mossin's CAPM investigate at least one of the following three aspects of the expected return-beta relationship. First, the expected return of a risky asset is linearly related to its beta coefficient and no other factor has an impact on its expected return. Second, the market risk premium should be positive. Third, the expected return of assets which are uncorrelated with the market equals the risk free rate.

Reference [20] found a positive relationship between systematic risk and the rate of return of individual assets, but this relationship was not completely linear. Other authors have computed beta for portfolios, rather than for individual assets (see for example [3], [9] or [1]). In this latter paper, the authors documented a positive relation between mean excess return and beta coefficient for portfolios, as stated by CAPM, although alpha (the intercept) exceeded the risk free rate. This finding (alpha bigger than the risk free rate) is also supported by other studies, both earlier and more recent ones, like [6], [15], [2], [8], [21] or [7]. In their 1973 paper, Fama and MacBeth found evidence in support of the CAPM after analyzing the American stock market before 1969. Nevertheless, other authors showed that the positive linear relationship between return and beta is disappearing in more recent periods; See [17], [13], or [7].

Unlike [7], who computed betas with monthly returns, [12] computed betas with annual returns and found a positive relationship between expected return of an asset and its beta coefficient. Further, [11] employed a conditional CAPM, where they allowed for betas and risk premiums to adjust and this model performed well in explaining expected returns. Reference [10] found that beta was an important risk factor in periods of declining markets, which is in fact when it matters, said the authors, while [16] investigated the risk-adjusted performance for 38 asset classes using a very broad index as a proxy for the market, and their results validated the CAPM.

On the other hand, [5] examine five Pacific Basin emerging markets (Hong Kong, Korea, Malaysia, Taiwan and Thailand)

and conclude that for all analyzed markets the relationship between average stock returns and market beta is weak.

Lupu [14] analysed the Bucharest Stock Exchange traded stocks distributional properties and showed that their returns are skewed and kurtotic but they become "more normal" as we go from daily frequency to monthly frequency. Reference [22] investigates the explanatory power of beta for the Romanian stock market studying the January 2000-March 2008 period and finds that contrary to the CAPM, the relationship between stock returns and beta is insignificant, even when beta is the only explanatory variable.

Another category of empirical studies is preoccupied with discovering other important risk sources, besides systematic risk, which may help explaining returns of risky assets. After 1970, many empirical studies found evidence that many other factors are important risk sources for expected return of individual assets. All these findings are evidence against CAPM, which states that only market matters when explaining returns.

III. DATA AND METHODOLOGY

As mentioned before, the FM methodology assumes that variability in market betas accounts for a significant portion of the cross-sectional variability of stock returns at a certain point in time, or for a specified sample period.

The following two-parameter model for expected returns is proposed by FM:

$$E(\widetilde{R}_i) = E(\widetilde{R}_0) + [E(\widetilde{R}_m) - E(\widetilde{R}_0)] * \beta_i, \qquad (1)$$

where where $\beta_i = \dfrac{\text{cov}(\widetilde{R}_i, \widetilde{R}_m)}{\sigma^2(\widetilde{R}_m)}$ and can be interpreted as

the risk of asset i in the portfolio m, measured relative to $\sigma(\widetilde{R}_m)$, the total risk of m. The intercept in (1) is the expected return on a security whose return is uncorrelated with $(\widetilde{R}m)$, a so-called *zero-beta security*.

In words, equation (1) implies that the expected return on security i equals the expected return on a security that is riskless in the portfolio m - ($E(\widetilde{R}_0)$) plus a risk premium represented by β_i, times the difference between $E(\widetilde{R}m)$ and $E(\widetilde{R}_0)$.

Assuming that the betas are known, the FM methodology is generalized into:

$$R_{it} = \hat{\gamma}_{1t} + \hat{\gamma}_{2t}\hat{\beta}_{i,t-1} + \hat{\gamma}_{3t}\hat{\beta}^2{}_{i,t-1} + \hat{\gamma}_{4t}\overline{s}_{i,t-1}(\hat{\varepsilon}_i) + \hat{\eta}_{it} \qquad (2)$$

If CAPM holds, then $\hat{\gamma}_{1t}$ in equation (1) should equal the risk-free rate, while $\hat{\gamma}_{2t}$ represents the power of beta as a risk source on Bucharest Stock Exchange. The factor β_i^2 is included to test linearity and $s_i(\varepsilon_i)$ represents all non-systematic risk. The disturbance term $\hat{\eta}_{it}$ is assumed to have

zero mean and to be independent of all other variables in the model.

Hence, from equation (2) we are able to test some of the major implications of the CAPM simply through basic statistical analysis of the estimates for the various $\hat{\gamma}$ coefficients, under the assumption that both the returns and (consequently) the parameters describing their stochastic process are normally distributed and temporally IID.

The hypotheses to be tested will therefore be:

- C1 – Linearity: The relationship between the expected return on a security and its risk in any efficient portfolio m is linear or Ho: $E(\widetilde{\gamma}_{3t}) = 0$;

- C2 – No systematic effect of non-beta risk: Ho: $E(\widetilde{\gamma}_{4t}) = 0$;

- C3 – Positive Expected Risk-Return Trade-off: Ho: $E(\widetilde{\gamma}_{2t}) = E(\widetilde{R}_{mt}) - E(\widetilde{R}_{0t}) > 0$;

- C4 (CAPM) – The intercept equals the risk-free rate, or Ho: $E(\widetilde{\gamma}_{0t}) = R_f$;

- C5 – Market Efficiency: all the stochastic coefficients and the disturbances $\hat{\eta}_{it}$ are fair games.

As mentioned in FM methodology, if the $\hat{\beta}_i$ coefficients are less than perfectly positively correlated then $\hat{\beta}$ of portfolios can be more precise estimates of the true coefficients than those for individual portfolios. Hence, we use the same approach to construct portfolios and then reduce the loss of information caused by not using individual assets by ranking the portfolios according to the values of the individual coefficients first and, in order to reduce the regression effect we recomputed the coefficients again in another sample.

We used data on the stocks traded on the Bucharest Stock Exchange from January 2002 to May 2010. The analysis was performed for weekly returns as we considered the daily returns to contain too many short term irregularities[1] and the monthly returns are not providing enough historical data to allow for the use of the FM methodology. Nowadays there are 62 stocks trading at the Bucharest Stock Exchange but they had very nonregular evolution. In order to use a homogenous sample we looked for assets that were traded for the whole period in the most continuous manner and we decided not to accept stocks for which we recorded lack of prices in more than 10% of the whole sample. 30 stocks were selected according to these constraints. Matlab was used for the computation of all the results.

---

[1] Previous research showed that the daily returns violate the normal distribution assumption required by the CAPM, this being a reason for which the FM are also using monthly returns for their analysis.

We used each year as a sample for portfolio formation and the next two years for re-estimation and testing. Hence, the first period for the portfolio formation consisted in 50 returns computed in the year 2002 for the 30 stocks. They were grouped in 5 portfolios of 6 stocks each ranked with respect to their beta coefficients. For a rolling window starting at the beginning of the next year (first time it is the year 2003) we computed again the beta coefficients for each stock as well as the standard deviation of the residuals (representing the non-beta risk) for each window (a total of 51 windows and as many re-estimations). These computations were then used to calculate mean values for the beta coefficients, their squared values and the non-beta risk over each of the 5 portfolios.

The next step consisted in the computation of the returns for each six stock portfolio in each day of the testing period (the year 2004) and then run regressions of these returns on the three explanatory variables across the 5 portfolios.

The whole analysis was retaken in a rolling manner such that the next period of portfolio formation was the year 2003, the estimation was done in 2004 and the testing in 2005. Hence, the last period for the portfolio formation was the year 2008, and the re-estimation and testing was done for 2009 and 2010 respectively.

IV. TESTING THE POWER OF BETA AS A RISK SOURCE ON BSE: EMPIRICAL RESULTS

Table 1 shows the mean values of the beta coefficients for each year in the multiple regressions performed for the 30 stocks from January 2002 until May 2010. We also provide information about the t-statistics and the R-squared distributions for each year. Each input of the table is a result (average or standard deviation) of 51 observations.

TABLE I AVERAGES OF BETA COEFFICIENTS, T-STATISTICS AND R-SQUARED FOR ALL THE CROSS-SECTION REGRESSIONS

	Formation 2002 Estimation 2003 Testing 2004		Formation 2003 Estimation 2004 Testing 2005	
	Mean values	Standard deviation	Mean values	Standard deviation
Coefficients	0.1673 0.2558 -0.4729 -8.8370	2.2651 2.7221 4.2498 93.3279	0.4584 -0.6316 0.5591 -12.0876	4.1949 5.9720 5.5828 118.230
T-statistics	-0.6149 2.2074 -2.0752 0.2266	14.4992 15.1584 14.6453 14.6813	0.4500 -0.2775 0.3184 -0.5577	4.7713 4.8674 4.5662 4.5859
R-squared	0.7331	0.2764	0.8210	0.2009

	Formation 2004 Estimation 2005 Testing 2006		Formation 2005 Estimation 2006 Testing 2007	
	Mean values	Standard deviation	Mean values	Standard deviation
Coefficients	-0.1487 0.0489 0.1641 6.4909	0.5832 1.6376 3.4956 24.6423	-0.1487 0.0489 0.1641 6.4909	0.5832 1.6376 3.4956 24.6423
T-statistics	-2.0857 1.5456 -1.2244 1.9885	7.4519 7.4329 7.2385 6.9935	-2.0857 1.5456 -1.2244 1.9885	7.4519 7.4329 7.2385 6.9935
R-squared	0.7355	0.2573	0.7355	0.2573

	Formation 2006 Estimation 2007 Testing 2008		Formation 2007 Estimation 2008 Testing 2009	
Coefficients	-0.0028 0.2803 -0.3782 -2.2936	1.3490 4.0260 5.1478 40.1451	0.2565 -1.9453 3.4741 -0.2837	1.7050 9.6117 17.3326 17.0930
T-statistics	0.0904 0.3213 -0.3478 -0.6255	2.9807 4.2897 4.2661 2.6695	-2.8875 1.9900 -2.0195 2.6373	13.7950 13.3645 13.9486 12.9316
R-squared	0.7251	0.2589	0.7959	0.2323

	Formation 2006 Estimation 2007 Testing 2008	
Coefficients	-0.0028 0.2803 -0.3782 -2.2936	1.3490 4.0260 5.1478 40.1451
T-statistics	0.0904 0.3213 -0.3478 -0.6255	2.9807 4.2897 4.2661 2.6695
R-squared	0.7251	0.2589

We notice that even though the t-statistics are not significantly different from 2 or -2 in many cases, the coefficients seem to show almost the same sign in many instances and the R-squared coefficients are higher than 70% in all the cases, which means that the independent variables used in our analysis perform well in the explanation of the portfolio returns.

V. CONCLUSION

This paper uses weekly returns from January 2002 until May 2010 to test for the Fama MacBeth [8] methodology on the Bucharest Stock Exchange. The analysis was performed on a rolling basis in which one year was used to form the portfolios, the next year for the estimation and next one for the testing. We had therefore 7 recomputations of the FM methodology each year consisting in a sample of 51 returns.

We chose the weekly frequency due to the fact that the daily returns were proved to have very non-normal distributions, hence violating the assumptions of the CAPM model, while the monthly returns would have not helped us in terms of sample size and statistical power for the performance of our analysis.

Still, the weekly returns were proved to be "more normal" than the daily ones but still quite skewed and fat-tailed to comply with the assumptions.

We showed that the weekly frequency does not provide proof for the existence of the linear model, as the coefficients were not statistically significant in many cases. However, the coefficients of determination showed that the four independent variables succeed to explain the portfolio returns computed in the years we used for the testing. This result is in keeping with previous analysis that found that the linear models do not hold on the emerging stock markets.

REFERENCES

[1] Black, Fischer, Michael C. Jensen and Myron Scholes, "The Capital Asset Pricing Model: Some Empirical Tests," in *Studies in the Theory of Capital Markets*. Michael C. Jensen, Ed. New York: Praeger, pp. 79-121, 1972;

[2] Blume, Marshall, Irwin Friend, "A new look at the Capital Asset Pricing Model", *Journal of Finance* 28, 28:1, pp. 19-33, 1973;

[3] Blume, Marshall, "Portfolio theory: a step toward its practical application", *Journal of Business*, 43, 2, pp. 152-174, 1970;

[4] Campbell J., Lo A., MacKinlay A., *The Econometrics of Financial Markets*, 1997, Princeton University Press;

[5] Chui, Andy C. W. and K. C. John Wei, "Book-to-market, firm size, and the turn-of-the-year effect: Evidence from Pacific-Basin emerging markets", *Pacific-Basin Finance Journal*, vol. 6, issue 3-4, pages 275-293, 1998;

[6] Douglas, George W, *Risk in the Equity Markets: An Empirical Appraisal of Market Efficiency*. Ann Arbor, Michigan: University Microfilms, Inc, 1968;

[7] Fama, Eugen, Kenneth French, „The cross-section of expected stock returns", *Journal of Finance* 47, 2, pp. 427-465, 1992;

[8] Fama, Eugene, James MacBeth, „Risk, return and equilibrium: empirical tests", *Journal of Political Economy* 81, Issue 3, pp. 607-636, 1973;

[9] Friend, Irwin and Marshall Blume, "Measurement of Portfolio Performance under Uncertainty." *American Economic Review*. 60:4, pp. 607-636, 1970;

[10] Grundy, Kevin and Burton G. Malkiel. „Reports of Beta's Death Have Been Greatly Exaggerated", *Journal of Portfolio Management* 22, pp. 36-44, 1996;

[11] Jagannathan, Ravi, Z Wang, „The conditional CAPM and the cross-section of expected returns", *Journal of Finance* 51, 1, pp. 3-53, 1996;

[12] Kothari, SP, J Shanken, RG Sloan, „Another Look at the Cross-section of Expected Stock Returns", Journal of Finance 50, 50:1, pp. 185-224, 1995;

[13] Lakonishok, Josef, Alan Shapiro, „Systematic risk, total risk and size as determinants of stock market returns", *Journal of Banking and Finance* 10, 10:1, pp. 115- 132, 1986;

[14] Lupu, R, "Using the GARCH model for the BET index of the Romanian Capital Market", Romanian Economic Journal, ISSN: 1454-4296, no. 17, 2005.

[15] Miller, Merton, and Myron Scholes, *Rates of Return in Relation to Risk: A Re-examination of Some Recent Findings*, in Michael C. Jensen, ed.: Studies in the Theory of Capital Markets (Praeger Publishers, New York), pp. 47-78, 1972;

[16] Reilly, F. K., Wright, D. J., "Analysis of Risk-Adjusted Performance of Global Market Assets", *Journal of Portfolio Management*, 30.3, 63-78, 2004;

[17] Reinganum, Marc, „A new empirical perspective on the CAPM", *Journal of Financial and Quantitative Analysis* 16, 16:4, pp. 439-462, 1981;

[18] Roll R., Ross S., "On the Cross-Sectional Relation between Expected Returns and Betas", 1994, *Journal of Finance*, Vol. 49, pp. 101-122;

[19] Shanken J., "On the Estimation of Beta-Pricing Models", *Review of Financial Studies*, Vol. 5, No. 1, pp. 1-33,1992;

[20] Sharpe, W.F. and Cooper, G.M., "Risk-return classes of New York Stock Exchange common stocks", *Financial Analysts Journal* (March-April), 46-54, 1972;

[21] Stambaugh, Robert F. 1982. "On The Exclusion of Assets from Tests of the Two-Parameter Model: A Sensitivity Analysis." Journal of Financial Economics. 10:3, pp. 237-268;

[22] Tudor, Cristiana, Tudor, C.,"Price Ratios and the Cross-section of Common Stock Returns on Bucharest Stock Exchange: Empirical Evidence," Journal for Economic Forecasting, Institute for Economic Forecasting, vol. 6(2), pages 132-146, 2009;