TESTING CAPM MODEL ON THE EMERGING MARKETS OF THE CENTRAL AND SOUTHEASTERN EUROPE

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Abstract

The paper examines if the Capital Asset Pricing Model (CAPM) is adequate for capital asset valuation on the Central and South-East European emerging securities markets using monthly stock returns for nine countries for the period of January 2006 to December 2010. Precisely, it is tested if beta, as the systematic risk measure, is valid on observed markets by analysing are high expected returns associated with high levels of risk, i.e. beta. Also, the efficiency of market indices of observed countries is examined.

Key words: *CAPM, European emerging markets, Beta validity, Market portfolio*

1. INTRODUCTION

CAPM (Capital Asset Pricing Model) model is based on the Markowitz modern portfolio theory which was further developed in the 1960 by William F. Sharpe (1963 and 1964) and John Linter (1965), for which Sharpe subsequently won the Nobel prize. Model for estimating the capital assets is a linear equilibrium model of returns on investments that explains returns above risk-free rate using covariance with the overall market. In order to quantify the risk of individual securities, as well as the risk of portfolio in relation to the overall market, CAPM model introduces a measure for the so-called systemic risk, the so called beta value, which indicates the level of sensitivity of change in return on securities in relation to changes in return on market portfolio. The model also argues that there is a positive linear relationship between the expected rate of return on an asset and its beta, i.e. that the expected return above the risk-free rate is linearly related to the non-diversifiable risk as measured by the asset's beta. Although theoretically the CAPM model is simple and rational, there are some significant limitations to the model which make it not work in practice, as it has been highlighted in many empirical studies. Thus, the first Black, Jensen and Scholes (1972) as well as Fama and MacBeth (1973) studies showed that there is a positive linear relationship between beta and the expected return, and that portfolios with higher beta have a higher yield, which is in agreement with the model's assumptions. But later research, as well as the most recent one, has shown that the relationship between systemic risk and expected return is not always significant. Thus, Michailidis, Tsopoglou, Papanastasiou, Mariola (2006) tested the model on the Greek market as one of emerging markets, and came to the conclusion that, contrary to the main hypothesis of the model, a greater risk (beta) does not mean higher yields. Kapil and Sakshi Choudhary (2010) reached the same conclusions researching the Indian capital market. There is an example that confirms the main settings of the model carried out at the Italian market (Canegrati, 2008). Trifan A.L. (2009) tested the model on the Romanian market and, among other things, found that the assessed regression model is not statistically significant, but despite that, the test results do not necessarily provide evidence against the CAPM, given that the test was conducted in the time period in which the Romanian market was affected by the global financial crisis. As for Croatia, there is a small number of tests conducted. Fruk and Huljak (2004) tested Sharpe-Lintner model on the Zagreb Stock Exchange, and showed that there is a definite positive relationship between returns and beta coefficients, but the question remains whether the beta coefficients can be used for making investment decisions. Perković (2011) also achieves similar results, and finds that the regression model is not representative and therefore questions the relationship between the beta and the return. Considering the specific characteristics of the emerging markets and a relatively small number of tests that assessed the effectiveness of the CAPM model, it was interesting to examine whether the beta was a valid measure of risk in these markets. This paper explores the viability of the CAPM model in the emerging markets of the Central and Southeastern Europe and examines whether beta is a suitable measure of risk in these markets. Also, to check whether the stock market indices of selected countries lie on the efficient curve and whether each index can be considered a substitute for the market portfolio, as the model implies, efficient frontiers for a particular capital market are formed. Countries included in the survey were: the Czech Republic, Hungary, Poland, Romania and Bulgaria - the EU member states; Croatia and Turkey - candidate countries for accession to the European Union; and finally Serbia and Bosnia Herzegovina - potential candidates for the EU membership.

2. CAPM MODEL

Since Markowitz's modern portfolio theory had numerous limitations because of the need for calculating a large number of standard deviations and correlations for the income rates of all stocks in a portfolio, a model for estimating the capital assets was developed as a reaction to modern portfolio theory. In order to avoid the limitations William F. Sharpe in 1964 and John Lintner in 1965 developed the so called CAPM model (Capital Asset Pricing Model), which, using the same values as Markowitz model, i.e. the expected rate of return and risk, provided a simpler way of determining efficient portfolio of securities. The model establishes the existence of a positive linear relationship between the required rate of return on securities and the related risks in a portfolio context. The expected rate of return equals the sum of returns without risk and the risk premium that reflects diversification. The model is based on a set of basic assumptions and establishes that for higher more inevitable corporate risk investors expect a higher return, and that there is market equilibrium.

Assumptions of the CAPM model are:

1) Investors evaluate portfolios taking into account the expected rate of return and standard deviation over one-period horizon.

2) Investors prefer a portfolio with higher returns.

3) Investors are averse to risk.

4) There is a risk-free rate of return at which it is possible to lend and borrow.

5) The property is indefinitely divisible.

6) All investors have one-period holding horizon.

7) Information is currently free and available to all investors.

Investors have homogeneous expectations regarding the expected rate of return, standard deviation and covariance of securities.

To allow quantification of the risk of individual securities, but also of the entire portfolios in relation to the overall market, CAPM model introduces a measure for the systemic risk, the so-called beta value (β). It is used to indicate the sensitivity of change of return on a security to changes in return on market portfolio. Securities' beta depends on the operating lever (the structure of assets), financial lever (capital structure), and the situation in the industry (cyclicality, competition) and company.

The equation used for calculating beta for each individual security β_j is as follows

$$\beta_j = \frac{Cov(Rj, R_m)}{\sigma_m^2}$$

i.e. $$\beta_j = \frac{Cor(R_i, R_m)\sigma_j \sigma_m}{\sigma_m^2}$$

where R_j is the rate return of security *j*, R_m is the rate of return on the market (rate of return of the market portfolio). Therefore, a stock's beta depends on the "stock's correlation with market", own variability – standard deviation *(*σ_j*),* as well as on the variability of the market (σ_m).

For the securities for which:

1) β = 1, systemic risk is equal to the market risk in general, the yield of securities rises and falls in the same percentage as the market portfolio return;

2) β 〉 1, the yield rises and falls more than the market portfolio, which indicates high-risk securities (investments);

3) β 〈 1, the yield rises and falls less than the market one, which indicates less risky securities;

4) β 〈 0, the securities yield is reverse to the market portfolio yield.

The fundamental equation defines the relationship between the expected rate of return on security or portfolio and the estimated market risk. Expected rate of return *E(R)* equals the risk-free rate of return (R_f) increased by a risk premium (*RP*) which is expressed by the equation

$$E(R) = R_f + RP$$

or the equation

$$E(R) = R_f + (R_m - R_f)\beta$$

known as Security Market Line (SML). SML is used for individual securities. In the conditions of market equilibrium shows a linear connection between the required rate of return on individual securities and the systematic risk expressed by beta. The slope of the line, $R_m - R_f$, is the market risk premium. For the riskier security, i.e. for the security with greater beta, greater is the risk premium and finally greater is the rate of return. The required rate of return on any risky security equals the sum of risk-free rate of return and risk premium, and thus depends on the beta of the securities, the rate of return without risk and market risk premium. Therefore, the SML equation shows that the stock price can change without changing the company's cash flows, if the required rate of return changes are influenced by the change in nominal R_f, beta, or RP_m.

3. CAPM TESTING

3.1. Testing the relation between beta and return

Stocks are selected in the sample according to their share in the official stock exchange indices of the observed countries. 10 most liquid stocks will be considered for each market, taking into account the weight of stocks within a particular stock market index. The data were taken from the Reuters website for the period from 1st January 2006 to 31st December 2010, and for each share from the sample the monthly closing prices were taken, making a total of 60 trading data for each share. The sample of shares for selected countries is shown in Table 1. For the Czech Republic, Bulgaria, Bosnia and Herzegovina the sample is reduced due to insufficient number of shares in the official stock index traded in the last five years.

Cross section testing using MS Excel spreadsheet program will be used in testing the CAPM model in particular stock market, where, based on the return on 10 stocks, the expected yields and the betas of the corresponding stocks will be calculated. As a substitute for the market portfolio, official stock market index will be used. After that, the regression analysis of expected returns on stocks and their betas will be carried out using the software package SPSS.

Table 1: Share sample for each of the observed markets

Croatia (CROBEX)	Hungary (BUX)	Poland (WIG20)	Turkey (ISE30)	Serbia (BELEXline)	Romania (BET-C)	Czech Republic (PX)	Bulgaria (SOFIX)	Bosnia and Herezegovina (SASX10)
ADRS-R-A	EGIS	ACPP	AKBNK	AIKB	SNPP	CEZP	ALBB	BHTSR
ATPL-R-A	FHBK	BAPE	ISCTR	IMLK	BRDX	ERST	CCBS	BSNLR
ERNT-R-A	FOTH	KGHM	KCHOL	ENHL	AZOM	BKOM	DOVUHL	JPESR
PODR-R-A	MOLB	PKNA	TURPS	MTLC	BATR	SPTT	IHLBL	JPEMR
ZABA-R-A	MTEL	PKOB	TCELL	PRGS	ROBIO	CETV	SOFAR	FDSSR
KOEI-R-A	OTPB	TPSA	GARAN	AGBN	SCDB	ORCO	CENHL	ENISR
DLKV-R-A	PANP	TVNN	VAKBN	ALFA	ROOLT	TABK		IKBZRK
IGH-R-A	RABA	BREP	YKBNK	BMBI	RORRC	UNPE		
KRAS-R-A	GDRB	GETI	AKENDR	CCNB	SCD			
PBZ-R-A	ESTM	LTOS	DYHOL	TGAS	ROARS			

In order to test the validity of the CAPM model on each stock market it is necessary to calculate the expected rate of return and beta of each stock. The following equation is used for calculating the expected rate of return of the stock X:

$$E(R_X) = \frac{\sum_{t=1}^{M} R_X(t)}{M}$$

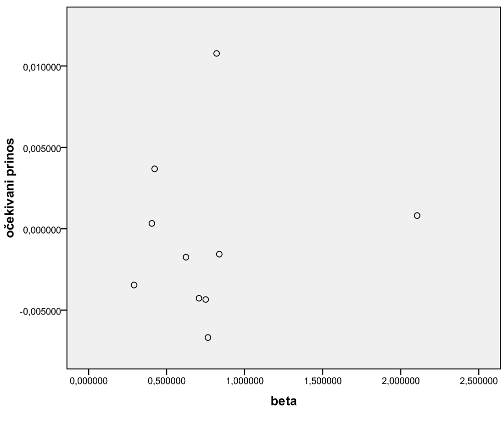
where M is the number of observed data, in this case number of monthly rates of return of the security X. Equation for calculating beta is:

$$\beta_x = \frac{Cov(x, M)}{\sigma_m^2}$$

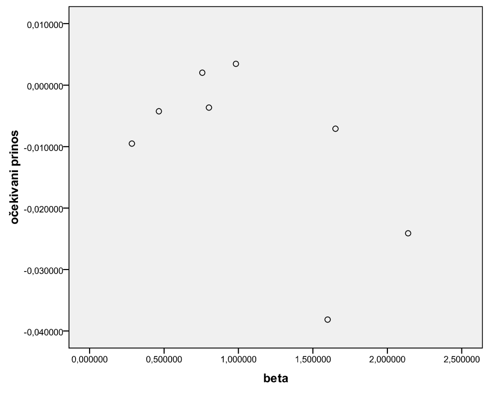
where *Cov(x, M)* is the covariance of the security *x* and the market portfolio and σ_m^2 is variance of the market portfolio.

After the expected return and beta have been calculated, in order to test the relatedness, i.e. analytical mathematical form of relationship between beta and expected returns, regression analysis is carried out of the expected return as the dependent variable of the regression line and beta as the independent variable. Scatter diagrams for all nine countries show that there is no correlation between the observed variables, which can be seen in Figure 1.

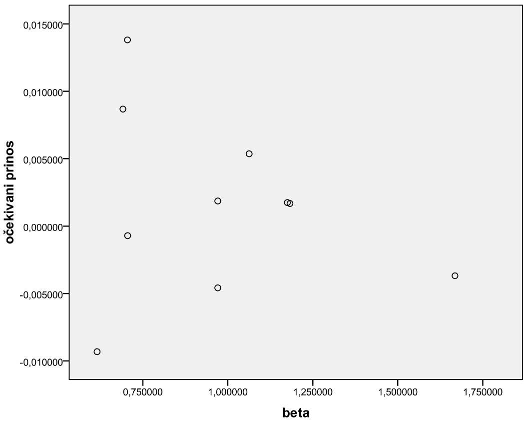
Croatia



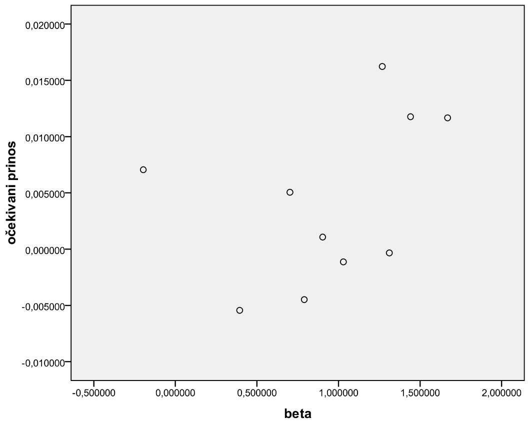
Czech Republic



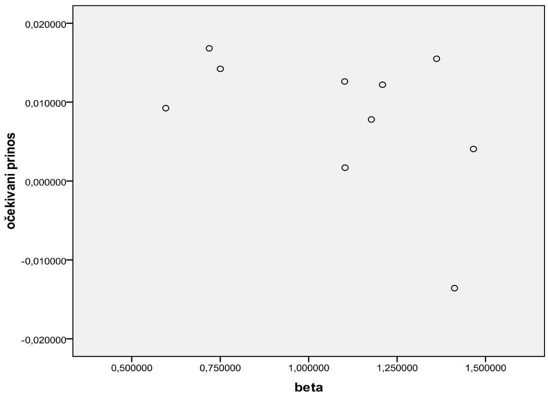
Hungary



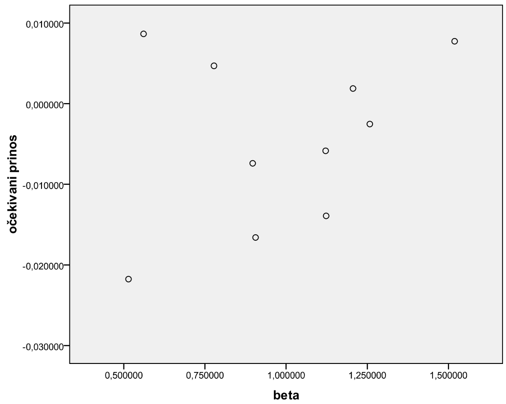
Poland



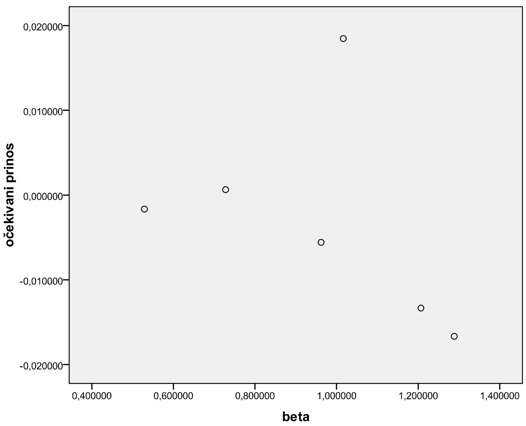
Turkey



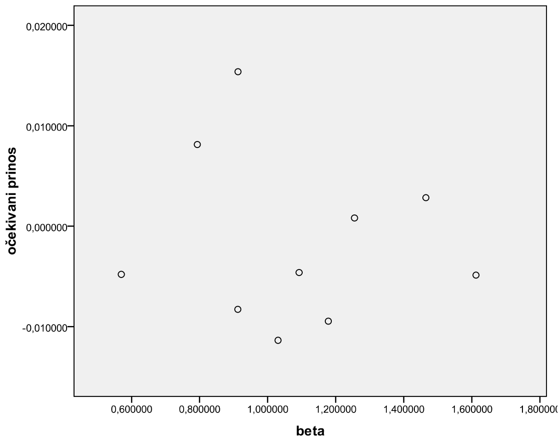
Serbia



Romania



Bulgaria



Bosnia and Herzegovina

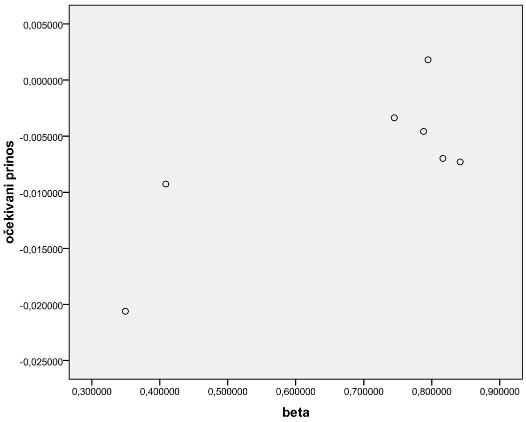


Figure 1: Scatter diagrams of the expected return and betas in the observed markets

Since the scatter diagram suggests that there is no correlation between the observed phenomena because there is no imaginary line that runs between the points on this graph, we can conclude that there is no correlation between the observed variables because one can not define whether the increase in one variable follows the growth or decline in other observed variables. Table 2 shows the basic data in the evaluated model for all nine markets.

Table 2. Basic data for the evaluated model

	Croatia	Czech Republic	Hungary	Poland	Turkey	Serbia	Bulgaria	Romania	Bosnia and Herzegovina
R	0,107	0,606	0,208	0,390	0,481	0,295	0,406	0,119	0,766
r^2	0,011	0,368	0,043	0,152	0,232	0,087	0,165	0,014	0,587

We can see that the relationship between beta and expected return measured by the linear correlation coefficient is positive and weak in all countries except the Czech Republic and Bosnia and Herzegovina, and for all countries the coefficient of determination has shown that the model is not representative.

Furthermore, analysis of divergence variance was performed (ANOVA), and the values of the F-test with empirical significance are shown in Table 3.

Table 3. Empirical significance

	Croatia	Czech Republic	Hungary	Poland	Turkey	Serbia	Bulgaria	Romania	Bosnia and Herzegovina
α^*	76.9 %	11.1%	56.5 %	26.6%	15.9%	40.8%	42.4%	74.3%	5.5%

Hypotheses about the significance of the model[1]:

$H_0 .....\beta_1 = \beta_2 = ... = \beta_k = 0$
$H_1 .....\exists \beta_j \neq 0 \qquad j = 1,2,....,k$

According to the Table 3 the empirical significance for all the countries is more than 5 % ($\alpha^* > 5\% \rightarrow H_0$). Therefore, the initial hypothesis that the evaluated regression model is not statistically significant in all countries is accepted.

Finally, after all nine countries have been tested we can conclude that the regression model is not representative, but also not statistically significant in all countries, which makes the possibility of applying the CAPM model in these markets very questionable. Since the coefficient of linear correlation measures the relationship between beta and expected returns, the test results have shown that for all countries except the Czech Republic and Bosnia and Herzegovina a weak relationship has been established. However, these results should be taken away with a grain of salt since the sample of shares for these two countries was not the same as for other markets.

3.2. Creating efficient portfolios

To check whether the stock market indices of selected countries lie on the efficient frontier and whether each index can be considered a substitute for the market portfolio, as the model implies, efficient frontiers for a particular capital market are formed. Testing is conducted for the period from 1st January 2010 until 31st March 2011. For each stock the weekly closing prices from observed stock markets are taken, and stocks are selected for the sample according to the share in the official stock market indices. Having calculated the weekly returns, the next step is to calculate the efficient portfolio and set up an efficient frontier for each of the observed capital markets. The mathematical problem of portfolio optimization is defined as follows:

$$\max E(R_\pi) = \pi' \cdot E(R) = \sum_{i=1}^{N} \pi_i \cdot E(R_i),$$

with limitations:

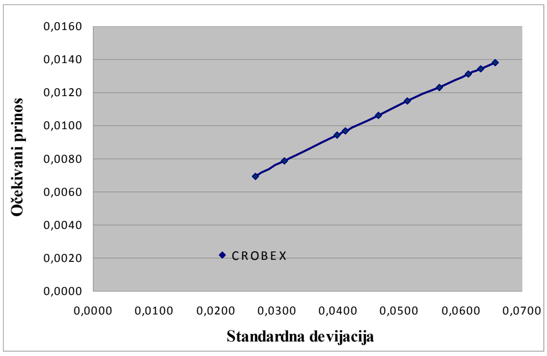
$$\pi' S \pi = c$$

$$\sum_{i=1}^{N} \pi_i = 1$$

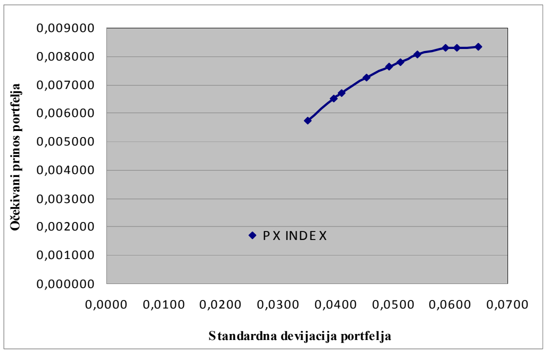
[1] Of course, these ‘betas' are not from the CAPM model.

where c is a constant that shows the risk measured by variance that an investor is willing to accept. Unknown variables in this model are weights of individual stocks in the portfolio π_i, $i \in \{1,2,...,N\}$, and vector π with π_i as its components. Efficient frontiers are calculated in the case of banned short-term selling, and the given problem of optimization is solved using Excel spreadsheet. Figure 2 shows the efficient frontier formed with respective stock indices for each of the markets.

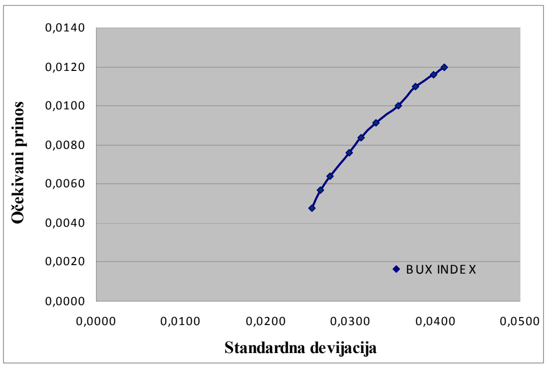
Croatia



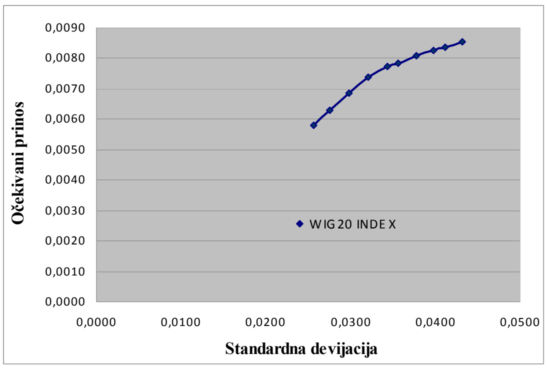
Czech Republic



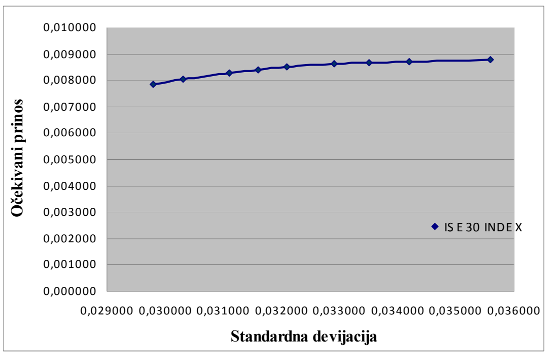
Hungary



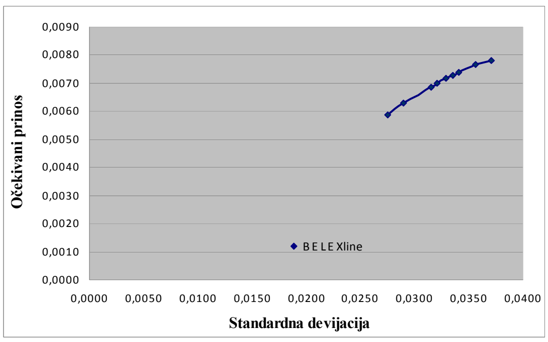
Poland



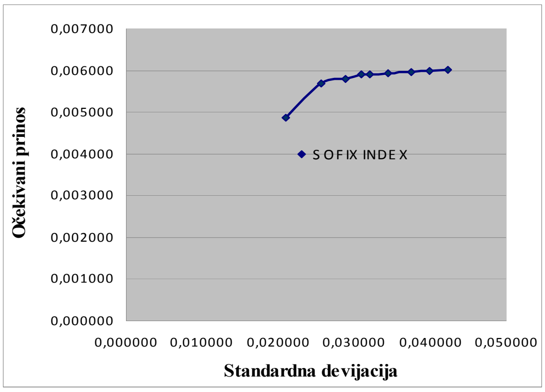
Turkey



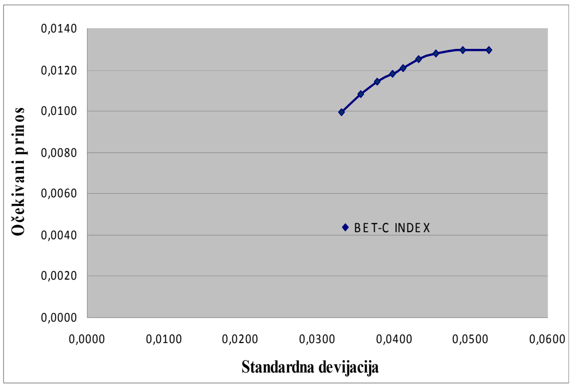
Serbia



Bulgaria



Romania



Bosnia and Herzegovina

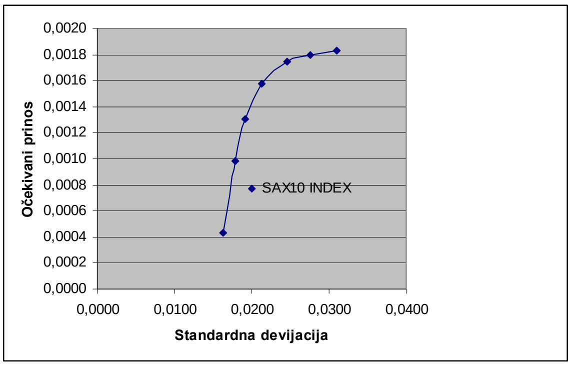


Figure 2: Efficient frontier and stock market indices for each particular market

Once the effective frontiers in all markets have been created we can see that all the countries show the same results, i.e. stock market indices of the selected Central and Southeastern European countries do not lie on the efficient frontier and therefore cannot be considered an adequate substitute for the market portfolio. Since that the stock indices are not effective, they cannot be regarded as a market portfolio of the model as stated in the assumptions, so that neither the beta, which measures the sensitivity of changes of return on securities to return on market portfolio, cannot be a reliable measure of systemic risk, and the apparently expected correlation between beta and expected return does not apply on the actual data.

4. CONCLUSION

The cross sectional analysis of the obtained test results shows that the CAPM is not adequate for assessing the capital assets on observed Central and Southeastern European emerging markets. To test the validity of beta as a measure of risk using regression analysis, it was found that higher yields do not mean a higher beta, so it is not a valid measure of risk in these markets. Finally, by applying the Markowitz portfolio theory the efficient frontier for each market was determined, and it was found that the stock market indices do not lie on the efficient frontier and thus do not represent an efficient portfolio and can, therefore, not be regarded as a market portfolio of models, as is usually assumed.

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