CAPM ON POST-CRISIS CAPITAL MARKETS OF EUROPEAN TRANSITION COUNTRIES

Maja Marijanović Bilić
Mira Dimitrić
Dunja Škalamera-Alilović

ABSTRACT

Capital Assets Pricing Model (CAPM) is one of the best known and the most controversial valuation model in finance. It was created as significant contribution to the theory of financial economics occurred during the 1960s when a number of researchers, among whom William Sharpe was the leading figure, used Markowitz's portfolio theory as a basis for developing a price theory for financial assets, and was awarded by the Nobel Prize in 1990. Since then it has been broadly applied to estimate cost of equity. However, many papers find discrepancies between the CAPM and the markets, and empirical evidences do not justify the CAPM in many cases.

This paper tests CAPM on the most liquid stocks on selected markets of European transition countries, including Croatia in two post-crisis periods (2009-2013; 2011-2015). The main hypothesis is that CAPM is not applicable to the capital markets of European countries in transition. Also, the official stock indices in observed countries do not lie on efficient frontier, and cannot serve as an adequate substitute for the market portfolio. And finally, beta is not the appropriate measure of systematic risk, because returns and betas do not move in accordance with each other.

Keywords:

CAPM, transition countries, capital markets in post-crisis periods, systematic risk

1 INTRODUCTION

CAPM establishes the existence of a positive linear relationship between the required rate of return 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 underlying concept of CAPM is that investors are rewarded for only that portion of risk which is not diversifiable. This non-diversifiable variance is termed as beta. The beta of a security is a measure of how much market risk is faced by a particular security, i.e. the sensitivity of an asset with respect to market portfolio. Stability of beta is very important, since for almost all investment decisions betas play a significant role in risk management.

CAPM is broadly applied to estimate cost of equity. However, many papers find discrepancies between the CAPM and the markets, and empirical evidence does not justify the CAPM in many cases. This paper tests the validity of CAPM on emerging European markets and whether beta is a suitable measure of risk. Furthermore, it interrogates 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.

2 THEORETICAL BACKGROUND

The valuation of financial assets and risk assessments are an important part of investment management. CAPM was developed during 1960s by William F. Sharpe (Sharpe, 1964), John Lintner (Lintner, 1965) and Jan Mossin (Mossin, 1966) based on Markowitz's modern portfolio theory. The basic concept of Markowitz's Mean-Variance (M-V) model is the equilibrium between return and risk (Aljinović et al., 2008), which can be done in a well-composed portfolio. The risk is diminished by the diversification effect, and correlation of instruments determines the level of risk reduction (Vidučić, 2006). Although the Markowitz's M-V model is still used, the large number of input variables makes it very complex and hard to handle. Additionally, it does not explicitly reflect systematic or market risk. Therefore, the evolution to a one-index model (CAPM) very much simplifies the design of portfolio.

CAPM is a linear equilibrium model explaining the returns above risk-free rate using covariance of individual investment returns with the overall market. A risk-free investment in the model implies that a rational investor picks a linear combination between market portfolio and a risk-free investment depending upon his risk preferences (Fruk and Huljak, 2004). CAPM model introduces beta as systematic risk measure by sensitivity of instrument returns to market return. Systematic risk cannot be avoided with the help of diversification and is only relevant in portfolio risk assessment (Bodie et al., 2006).

Although the CAPM is a rational and logical model with only a few input variables, its basic assumptions[1] are considered unrealistic and the model is broadly criticised. The assessment of the model's parameters is very hard, which diminishes its objectivity and applicability (Vidučić, 2006; Fernandez, 2015); the theoretical underpinnings of the model are claimed to be flawed by circularity (Dayala, 2012; Lai and Stohs, 2015).

Empirical research (Roll, 1977; Grauer, 1999; Fama and French 2004; Bodie et al. 2006; Prono, 2015) questions the applicability of CAPM by pointing out to the problems of designing the market portfolio, and variability in significance of the beta/return relationship. Some claim the main weakness to be the CAPM implementation issues rather than the weakness of the underlying concept (Novak, 2015).

In spite of many critiques, the model is still being used on various capital markets and represents a framework for further research on association between risk and return on financial instruments.

3 HYPOTHESES AND METHODOLOGY

Capital markets of countries in transition are interesting to foreign investors. Namely, it is considered that they may offer high returns and that they offer the advantages of diversification. The main reason is low correlation with capital markets of developed countries, which considerably lowers the systematic risk of foreign investor.

3.1 Hypotheses development

One of the basic features of countries in transition are underdeveloped capital markets with a low level of liquidity. Other important characteristics that greatly influence the level of efficiency of financial system in transitional countries include: unpredictable political situations, questionable transparency and application of the rule of law, low level of information reliability, and corruption. There is a great supremacy of banks and credit institutions over all other financial institutions and forms of investment and financing. This leads to the situation that individual investors (households) do not invest in financial instruments at all. They direct their savings in form of deposits to bank accounts, and loans are the principle mode of indebtedness (Žiković, 2009).

CAPM restrictive assumptions and vast specificities of transitional capital markets led to the main research hypothesis:

H1: CAPM is not applicable to the capital markets of European countries in transition.

Specifically, contrary to what the CAPM proposes, beta/returns relationship is plagued by problems of beta assessment in transitional countries. First, there is a problem of beta imprecision due to errors stemming from instruments which are not traded on daily basis. That is a common feature of large number of instruments in transitional capital markets. The second problem arising from the previous feature is underestimation of importance of such instruments in calculation of beta. These arguments led to the formulation of the first auxiliary hypothesis:

H1a: In European transitional countries, returns and betas do not move in accordance with each other, therefore beta is not an appropriate measure of systematic risk.

Next specific problem arises in definition of a representative market portfolio as a set of all risk assets in transitional economies. Usual proxy in developed countries is each capital market's index. Underdeveloped transitional capital markets have indices of considerably lower quality mainly due to imperfect information, but also due to the fact that almost all indices do not include dividends as the part of return, which they should. Therefore, transitional capital market index role as a substitute for market portfolio is being tested.

H1b: Official stock market indices in observed European transitional countries do not lie on efficient frontier and cannot serve as an adequate substitute for the market portfolio.

3.2 Sample and data collection

The empirical test of the above stated hypotheses is conducted on the sample of eight European transitional countries. Seven are members of the European Union. Researched member countries from Eastern and Central Europe that accessed EU in 2004 are: Poland, the Czech Republic, Hungary, Slovenia and Baltic countries[2] (Estonia, Latvia and Lithuania). Next two countries in the sample are Romania (accessed in 2007) and Croatia (accessed in 2013). The last country in the sample is Turkey, a potential candidate country for accession to EU.

The official capital market indices used in this research are: CROBEX (Croatia), WIG20 (Poland), PX (Czech Republic), BET-C (Romania), BUX (Hungary), SBI TOP (Slovenia), OMXBBGI (Baltic countries) and BIST30 (Turkey). BUX (Hungary) is the only index that includes dividends in calculation of total return.

---

[1] **Homogeneous expectations, unlimited amounts of risk-free investments, unlimited division of assets, the same time horizon, no transaction costs, perfect information, rational and risk-averse investor, focus only on return and volatility.**

[2] **Baltic countries are tested as one entity since they have a common capital market.**

CAPM model testing in developed markets usually assumes the observation time horizon of five years. In this research, the test is performed on two post-crisis periods (after 2008, which is considered a crisis year, and its inclusion would deteriorate the quality of test results, and would fog the post-crisis perspective of this research). The first period (54 months) is from Jan. 1, 2009 to June 30, 2013 and second (54 months) is from Jan. 1, 2011 to June 30, 2015. This approach allows comparison of results between the two periods in search of differences relative to the temporal distance from crisis (2008). Although six months shorter than five years (in order to include the latest data, to keep the periods the same length, and to avoid data from 2008), the periods are still long enough for the beta to adapt to long-term values and to absorb short-term shocks. Official listings of stock prices were collected from official web sites of the observed stock markets and Wall Street Journal.

Samples of stocks are formed according to their share in official stock exchange indices in the observed countries. There are ten stocks in each country's sample (with three exceptions[3]). Composition of the samples in two post-crisis periods is not completely the same; there are 11 changes (out of total of 79 stocks). All changes are visible in the list of stocks in Appendix 1. The selection of stocks was made according to two criteria of volume of trade. First is liquidity of stock which means that a certain stock has been traded with in more than 75% of total trade days in observed periods, or it is among first 25% ranked according to the number of trade days. The second criteria is market capitalisation which is considered high if it is higher than the median market capitalisation of common stocks on the last day of the observed period. All of the sample stocks are included in market indices and therefore interesting for potential investors.

3.3 Data analysis

In testing CAPM in European transitional countries, expected returns and related betas are calculated based on the monthly prices of selected stocks, and the regression analysis is performed. Monthly prices (average last price in a month) were chosen since daily or weekly prices would induce the problem of unsynchronised trading due to discontinuation of data time series. Monthly returns were calculated both for stocks and for stock market indices, which are taken as the best approximation of total market indices. The CAPM assumption of normal distribution of stock returns through time is tested by Kolmogorov-Smirnov test. Not compliant stocks are excluded from further analysis. Accordance of movement of returns and betas is tested with linear regressions where betas are independent and returns are dependent variables. For these analyses, the statistical software package SPSS was used.

In testing adequacy of stock market indices as proxies for market portfolio, efficient portfolios that represent the efficiency frontier of the market, are determined. This is done by optimisation of the relationship between expected returns and risk (measured by standard deviation of returns) for each observed market. The optimisation procedures were performed by MS Excel Solver software.

4 RESULTS AND DISCUSSION

Two sets of results reflect the argumentation for two auxiliary hypotheses. The first tested the main relationship embodied in CAPM: strong positive relationship between risk (beta) and return (yield). The total of 16 regressions were performed: two for each of the eight selected European transitional countries. Five stocks from each observed period are excluded from further analysis due to non-normal distribution of returns (shaded fields in Appendix 1). The results of regressions are presented in Table 1.

---

[3] Czech sample includes nine stocks since they were traded continuously in both periods. Slovenian sample in the second period includes six stocks, only seven are quoted on the market and for one data set is not complete.

Table 1 CAPM in European transitional countries - regression results

	Slope	R	R²	F	Sig. F
Croatia					
Post-crisis period 1	-0.0019	0.032	0.001	0.0082	0.93
Post-crisis period 2	-0.027	0.593	0.351	4.334	0.071*
Poland					
Post-crisis period 1	0.0159	0.155	0.024	0.173	0.69
Post-crisis period 2	-0.0066	0.36	0.129	1.189	0.307
Czech Republic					
Post-crisis period 1	-0.0022	0.093	0.009	0.052	0.827
Post-crisis period 2	-0.016	0.534	0.285	1.197	0.354
Romania					
Post-crisis period 1	-0.0074	0.425	0.181	1.767	0.22
Post-crisis period 2	0.0076	0.134	0.018	0.147	0.712
Hungary					
Post-crisis period 1	0.0062	0.318	0.101	0.787	0.404
Post-crisis period 2	-0.0073	0.411	0.169	1.421	0.272
Slovenia					
Post-crisis period 1	-0.0383	0.527	0.278	3.074	0.118
Post-crisis period 2	0.0096	0.237	0.056	0.237	0.652
Baltic countries					
Post-crisis period 1	0.0128	0.3	0.09	0.595	0.47
Post-crisis period 2	0.0017	0.049	0.002	0.019	0.893
Turkey					
Post-crisis period 1	0.0151	0.554	0.307	3.097	0.122
Post-crisis period 2	0.0065	0.345	0.119	1.083	0.328

*Notes: *p=0,1*
Source: Authors.

The results show not a single argument in favour of valid CAPM application in European transitional countries. The results on the value of slope could be all rounded to zero and half of them even suggest inverse relationship, which is contrary to the main prediction of the theory. Consequently, the significance of the modelled relationships is non-existent (only one regression, Croatia post-crisis period 2, conforms to the weakest criterion of p=0.1, but shows the negative relationship). The strength of correlation (R) reveals some accordance in movement of returns and betas. Semi-strong coefficients (>0.5) are detected in four cases out of which only one (Turkey post-crisis period 1) describes the positive relationship, and the rest negative. Explanatory power of all presented models is very low (the highest one explaining 35.1% of the variation in returns based on variation of beta – Croatia post-crisis period 2, but in unpredicted negative direction).

The influence of the crisis is also not confirmed. It would be expected that the validity of CAPM would be greater if distance from crisis was longer. The first regressions reflect the relationship between returns and

betas in the period right after the crisis, whereas the second regressions reflect the same relationship put in a time-frame more distant to the crisis (three-year lag). Results show that there is no discernible pattern in change of results in relation to the distance from crises.

All parameters which resulted from this empirical analysis fully support the first auxiliary hypothesis that returns and betas do not move in accordance with each other, making beta an inappropriate measure of risk. That is a substantial support to the main hypothesis of CAPM being an inadequate tool for capital markets in European transition countries.

The second auxiliary hypothesis is tested by calculation of market index distance to efficiency frontier. The more distant the market index is, the less suitable it is as an efficient portfolio proxy. The distance is measured by comparison of the returns of index and appropriate position on the efficiency frontier determined by the level of variability (standard deviation) that is embodied in the market index.

Results are presented in Table 2 for the selected countries in two observed periods.

Table 2 Efficient portfolios and market indices of selected European transition countries (in %)

	Market index return (%)	Efficient portfolio return (%)	Distance to efficiency frontier (in percentage points)
Croatia CROBEX			
Post-crisis period 1	0.05	1.31	-1.26
Post-crisis period 2	-0.49	0.27	-0.76
Poland WIG20			
Post-crisis period 1	0.62	2.57	-2.28
Post-crisis period 2	-0.3	0.91	-1.21
Czech Republic PX			
Post-crisis period 1	0.2	1.58	-1.38
Post-crisis period 2	-0.45	1.1	-1.55
Romania BET-C			
Post-crisis period 1	1.18	1.72	-0.54
Post-crisis period 2	0.48	0.48	0
Hungary BUX			
Post-crisis period 1	0.84	1.09	-0.25
Post-crisis period 2	-0.06	0.84	-0.9
Slovenia SBI TOP			
Post-crisis period 1	-0.72	-0.38	-0.34
Post-crisis period 2	-0.26	0.14	-0.4
Baltic countries OMXBBGI			
Post-crisis period 1	1.8	1.8	0
Post-crisis period 2	0.23	1.53	-1.3
Turkey BIST 30			
Post-crisis period 1	1.92	2.47	-0.55
Post-crisis period 2	0.39	0.9	-0.51

Source: Authors.

Results show that in 16 observations only two indices lie on the efficiency frontier (Romania BET-C, post-crisis period 2, and Baltic countries OMXBBGI, post-crisis period 1). That is fully in support of the second auxiliary hypothesis: market indices are not efficient portfolios in European transitional countries. Other evidence also proves that even in the case of two efficient portfolios the effect on the significance of CAPM was none (Table 1). The fact that only the Hungarian index BUX includes dividends (as it should), made no effect on BUX efficiency compared to other countries. Finally, there is no detectable positive influence of distance from crisis on improvement of market index efficiency (half of indices lowered the distance to frontier, and half enlarged it).

Being efficient or not, capital market indices do not add to the quality of CAPM application in European transition countries. That is additional support to the main hypothesis of CAPM being not suitable for application in capital markets in European transition countries.

5 CONCLUSION

The empirical study shows that the Capital Asset Pricing Model cannot explain the risk return relationship on observed European transitional markets. Regression analysis was used to test the validity of beta as a measure of risk in both post crisis periods (2009-2013; 2011-2015). It was found that higher returns do not mean a higher beta, so beta is not a valid measure of risk in these markets. Furthermore, by applying the Markowitz portfolio theory, it was proved that official stock indices of the observed transitional capital markets, with the exception of the Baltic stock index in post-crisis period 1 and Romania stock index in post-crisis period 2, are not effective and cannot be considered as a substitute for an adequate market portfolio, since they do not lie on the efficient frontier. In conclusion, CAPM model based on numerous empirical and theoretical shortcomings is not adequate for assessment of capital assets on observed markets of European transitional countries.

These results point out the necessity of empirical underpinning of basic relationship between the risk and return and not just to the problems of measurement and approximation of parameters.

REFERENCES

1. Aljinović, A., Marasović, Z., and Šego, B., 2008. *Financijsko modeliranje*. Zagreb: Zgombić & Partneri.

2. Bodie, Z., Kane, A., and Marcus, A., 2006. *Počela ulaganja*. Zagreb: Mate.

3. Dayala, R., 2012. The Capital Asset Pricing Model: A Fundamental Critique. *Business Valuation Review*, 31 (1), 23–34.

4. Fama, E.F. and French, K.R., 2004. The Capital Asset Pricing Model: Theory and Evidence. *Journal of Economic Perspectives*, 18 (3), 25–46.

5. Fernandez, P., 2015. CAPM: An Absurd Model. *Business Valuation Review*, 34 (1), 4–23.

6. Fruk, M. and Huljak, I., 2004. Testiranje Sharpe-Lintnerova modela na Zagrebačkoj burzi. *Financijska teorija i praksa*, 28 (1), 77–91.

7. Grauer, R.R., 1999. On the Cross-sectional Relation between Expected Returns and Betas. *The journal of finance*, 49 (1), 101–121.

8. Lai, T.-Y. and Stohs, M.H., 2015. Yes, CAPM Is Dead. *International Journal of Business*, 20 (2), 144–158.

9. Lintner, J., 1965. Security prices, risk, and maximal gains from diversifivation. *Jf*, 20 (4), 587–615.

10. Mossin, J., 1966. Equilibrium in a capital asset market. *Econometrica*, 34 (4), 768–783.

11. Novak, J., 2015. Systematic Risk Changes, Negative Realized Excess Returns and Time-Varying CAPM Beta. *Czech Journal of Economics and Finance*, 65 (2), 167–190.

12. Prono, T., 2015. Market proxies as factors in linear asset pricing models: Still living with the roll critique. *Journal of Empirical Finance*, 31, 36–53.

13. Roll, R., 1977. A critique of the asset pricing theory's tests Part I: On past and potential testability of the theory. *Journal of Financial Economics.*

14. Sharpe, W.F., 1964. Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. *The Journal of Finance*, 19 (3), 425–442.

15. Vidučić, L., 2006. *Financijski menadžment.* Zagreb: RRiF plus.

16. Žiković, S., 2009. *Market risk in transition countries - value at risk approach.* Rijeka: Ekonomski fakultet Sveučilišta u Rijeci.

Appendix 1 Sample stocks

		Post-crisis period 1		Post-crisis period 2	
	Croatia				
1	ADPL-R-A	AD Plastik			
2	ADRS-P-A	Adris			
3	ATGR-R-A	Atlantic grupa			
4	DLKV-R-A	Dalekovod			
5	ERNT-R-A	Ericsson Nikola Tesla			
6	HT-R-A	HT			
7	KOEI-R-A	Končar-elektroindustrija			
8	KORF-R-A	Valamar Adria Holding	replaced by KRAS-R-A	Kraš	
9	LEDO-R-A	Ledo	replaced by PODR-R-A	Podravka	
10	PTKM-R-A	Petrokemija			
	Poland				
1	ACP	Asseco Poland			
2	BHW	Bank Handlowy w Warszawie			
3	BRE	BRE Bank	replaced by PEO	Bank Polska Kasa	
4	BZW	Bank Zachodni WBK			
5	EUR	Eurocash			
6	KGHM	KGHM Polska Miedz			
7	PGN	Polskie Gornictwo Naftowe i Gazownictwo			
8	PKN	Polski Koncern Naftowy ORLEN			

		Post-crisis period 1		Post-crisis period 2	
9	PKO	Powszechna Kasa Oszczednosci Bank Polski			
10	TPS	Telekomunikacja Polska	replaced by PZU	Powszechny Zaklad Ubezpieczen Spolka Akcyjna	
	Czech Republic				
1	CEZ	CEZ	CEZ		
2	ERBAG	Erste Group Bank AG	ERBAG		
3	KOMB	Komercni Banka			
4	ORCO	Orco Property Group	replaced by CETV	Central European Media Enterprises	
5	PEGAS	Pegas Nonwovens			
6	TABAK	Philip Morris CR			
7	TELEC	Telefonica Czech Republic	replaced by O2 CR	O2 Czech Republic	
8	UNIPE	Unipetrol a.s.	UNIPE		
9	VIG	Vienna Insurance Group			
	Baltic countries				
1	APG1L	Apranga APB			
2	BLT1T	Baltika			
3	CTS1L	City Service AB			
4	OEG1T	Olympic Entertainment Group			
5	OLF1R	Olainfarm AS			
6	SFG1T	Silvano Fashion Group			
7	TAL1T	Tallink Grupp			
8	TEO1L	TEO LT AB			
9	TKM1T	Tallinna Kaubamaja			
10	TVEAT	Tallinna Vesi			
	Romania				
1	ALR	Alro S.A. Slatina			
2	ATB	Antibiotice S.A. Iasi			
3	BRD	BRD-Groupe Societe Generale.			
4	BRK	SSIF Broker			
5	RRC	Rompetrol Rafinare S.A. Constanta			
6	SCD	Zentiva			

		Post-crisis period 1	Post-crisis period 2	
7	SNP	OMV Petrom S.A.		
8	TEL	C.N.T.E.E. TRANSELECTRICA		
9	TGN	Societatea Nationala de Transport Gaze Naturale Transgaz		
10	TLV	Banca Transilvania		
	Hungary			
1	ANY	ANY Security Printing PLC		
2	DANUBIUS	Danubius Szalloda es Gyogyudulo Nyrt.		
3	EGIS	EGIS Pharmaceutical PLC	replaced by ELMU	Budapest Electricity
4	FHB	FHB Mortgage Bank Co. PLC		
5	MOL	MOL Nyrt.		
6	MTELEKOM	Magyar Telekom Telecommunications PLC		
7	OTP	OTP Bank Nyrt.		
8	PANNERGY	PannErgy Nyrt.	PANNERGY	
9	RABA	Raba Nyrt.		
10	RICHTER	Gedeon Richter Nyrt.		
	Slovenia			
1	GRVG	Gorenje		
2	IEKG	Intereuropa	not traded any more	
3	KBMR	Nova Kreditna Banka Maribor	not traded any more	
4	KRKG	Krka		
5	LKPG	Luka Koper	data set not complete	
6	MELR	Mercator	not traded any more	
7	PETG	Petrol		
8	POSR	Pozavarovalnica Sava		
9	TLSG	Telekom Slovenije		
10	ZVTG	Zavarovalnica Triglav		

		Post-crisis period 1	Post-crisis period 2	
	Turkey			
1	AKBNK	Akbank T.A.S.		
2	BIMAS	BIM Birlesik Magazalar		
3	GARAN	Turkiye Garanti Bankasi		
4	HALKB	Turkiye Halk Bankasi		
5	ISKUR	Turkiye Is Bankasi		
6	KCHOL	KOC Holding		
7	SAHOL	Haci Omer Sabanci Holding		
8	TCELL	Turkcell Iletisim Hizmetleri		
9	THYAO	Turk Hava Yollari A.O.		
10	TUPRS	Tupras Turkiye Petrol Rafinerileri		