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TEST OF THE FAMA-FRENCH THREE-FACTOR MODEL IN CROATIA

Denis Dolinar[1]

Abstract:
This paper empirically examines the Fama-French three-factor model of stock returns for Croatia. In contrast to the results of Fama and French (1993) for the U.S. stock market, their three-factor model did not show so successful when describing risk-return relation of Croatian stocks. This paper shows that the Fama-French three-factor model is a valid pricing model, since it explains cross-section of average returns on stocks in Croatia, and that has a greater explanatory power in comparison to the CAPM. In the case of Croatian stock market, size and B/M factors are not always significant, but on average they individually have certain marginal explanatory power. Namely, they capture small common variation in returns that is missed by the market factor. Moreover, B/M factor has shown as a stronger common risk proxy in relation to size factor. Finally, there is still a large portion of common variation in stock return that may be explained by other factors. Because emerging capital markets bear their own specificity, special care needs to be taken when applying existing or developing new pricing models.

Keywords: Fama French, three factor model, systematic risk, asset pricing model, risk-return, Croatian stock market.

Jel Classification: G12

INTRODUCTION

During the last sixty years the search for common risk factors in the returns on stocks and bonds is of the great interest for researchers in the field of investment analysis and corporate finance. Because of their simple use, development possibilities and easy interpretation linear factor models have immediately become very popular in scientific papers when describing securities return-generating process, i.e. risk-return relation.

Till today a great number of factor models has been developed – primarily for the developed capital markets. Emerging capital markets, like Croatian, bear their own specificity – for instance: shorter history, lower level of knowledge and experience of capital market participants, development of institutional investors mostly under the control of commercial banks, lower market liquidity, etc. Lower overall level of

[1] **Denis Dolinar**, univ.spec.oec., Teaching and Research Assistant, Faculty of Economics and Business, University of Zagreb, Croatia.

development of Croatian capital market and capital markets of neighbouring countries is also followed by the modest number of researchers and scientific papers that explore the nature of emerging capital markets. In addition, there is a very small number of researchers and scientific papers that explore return-generating process or develop asset pricing models for securities on domestic and neighbouring capital markets.

The aim of this paper is to test the well-known Fama-French three-factor model of stock returns for Croatia, before developing new country-specific factor models for Croatian stock market. In other words, the aim of this paper is primarily to see whether size and B/M factors, defined by Fama and French, together with the market factor can serve as an appropriate stock pricing model.

The remainder of this paper is organized as follows. Then following section in short discusses the position of factor models within modern portfolio theory. The section after that describes specificities of the Fama-French three-factor model. The following section gives a quick review of Croatian stock market. The section after presents the data, its source, used methods and regression results of the test of Fama-French three-factor on Croatian stock market. The last section concludes the paper and suggests the direction for future research.

FACTOR MODELS

The objective of modern portfolio theory is to provide the means by which the investor can indentify his or her optimal portfolio (Sharpe, Alexander and Bailey 1999, 256). Modern portfolio theory is characterized by the use of wide range of models that imply interaction of both, company business performance and capital market. Consequently, today's financial analysis incorporates elements of macroeconomic theory, tools of microeconomic analysis, and others aspects of business analysis (Orsag et al. 2007, 6). First task in the investment process is security and market analysis, by which the risk and expected return attributes of the entire set of possible investment vehicles are assessed (Bodie, Kane, and Marcus 2002, 154).[2] Diversification (risk reduction), as a major motive for portfolio creation, is based on the assumption that the total risk (variance of expected return) of every security can be separated into two parts: the systematic (market or undiversifiable) risk and the specific (unique or diversifiable) risk. Since specific risk of individual securities can be significantly reduced or even eliminated through portfolio construction, thus systematic risk of a security is the only one relevant and determines expected return of that security.

Factor models are statistical models that assume that the return on a security is sensitive to the movements of various risk factors. They attempt to capture the major economic forces that systematically move the prices of all securities. Primary goal of security analysis is to determine these factors and the sensitivities of security returns to movements in them (Sharpe, Alexander and Bailey 1999, 256–257). Risk factor selection tends to limit on those factors that seem likely to be important, that is, factors that concern investors sufficiently that they will demand meaningful risk premiums to bear exposure to those sources of risk (Bodie, Kane, and Marcus 2002, 311). Haugen

[2] Second task in the investment process is formation of an optimal portfolio of securities, and its later performance evaluation. This part of investment process is not in the focus of this paper.

(2001, 154–157) separates various elements of stock's risk profile into the following groups: risk (in the sense of the state of economic environment), liquidity of the security, cheapness of the security, growth potential of the business, and technical factors.

Depending on the nature of selected risk factors Sharpe, Alexander and Bailey (1999, 270–275) present three primary statistical approaches (techniques) when estimating factor models: time-series approaches (mostly related to macroeconomic factors), cross-sectional approaches (mostly related to fundamental factors) and factor-analytic approaches (which use factor analysis and define "statistical" factors).[3] Special forms of factor models like Capital asset pricing model (CAPM) and Arbitrage pricing theory (APT) are models developed from the theories of capital market. Both models assume capital market equilibrium and imply a great number of assumption regarding investor's behaviour and efficient market characteristics. (Orsag 2003, 180, 191)

FAMA-FRENCH THREE-FACTOR MODEL

Among many papers written by Eugene F. Fama and Kenneth R. French two probably the most quoted are *"Common risk factors in the returns on stock and bonds"* and *"Multifactor Explanations of Asset Pricing Anomalies"*, which were published in 1993 and 1996. Both papers are primarily focused on stocks, or to be more precisely, on common risk factors in the stock returns.

Fama and French (FF) argue that many of the CAPM average-return anomalies are related, and that they are captured by their three-factor model. The model says that the expected return on a portfolio in excess of risk-free rate $[\mathrm{E}(\mathrm{R_i}) - \mathrm{RF}]$ is explained by the sensitivity of its return to three factors: (1) the excess return on a broad market portfolio $(\mathrm{RM} - \mathrm{RF})$; (2) the difference between the return on a portfolio of small stocks and the return on a portfolio of large stocks (SMB); and (3) the difference between the return on a portfolio of high-book-to-market stocks and the return on a portfolio of low-book-to-market stocks (HML). Thus, the expected excess return on a certain asset is defined as follows (Fama and French 1996, 55).

Eq. (1) $$\mathrm{E}(\mathrm{R_i}) - \mathrm{RF} = \mathrm{b_i}[\mathrm{E}(\mathrm{RM}) - \mathrm{RF}] + \mathrm{s_i}\mathrm{E}(\mathrm{SMB}) + \mathrm{h_i}\mathrm{E}(\mathrm{HML})$$

FF initial premises when developing three-factor model (based on their previous papers) were: (1) cross-section of average returns on the U.S. stocks shows little relation to the CAPM's market ß's or ICAPM's consumption ß's, (2) empirically determined variables (especially size and B/M) that have no special standing in asset-pricing theory show reliable power to explain the cross-section of average returns. Also, the approach to testing asset-pricing model was different in those two papers in relation to their previous papers. Instead of the standard use of cross-sectional approach (regressions) on variables like size and B/M, FF used the time-series regression approach. Thus, monthly returns on stocks were regressed on the returns to a market

[3] Some of the better known factor models are: Sharpe's index model (1963), Merton's ICAPM (1973), macroeconomic model of Chen, Roll and Ross (1986), fundamental model of Fama and French (1993 and 1996), Rosenberg's (BARRA) fundamental model (1974), etc.

portfolio of stocks and two mimicking portfolios — for size and B/M factors (Fama and French 1993, 3–4).

The reason why factors – size and B/M – can proxy certain amount of systematic risk exposure is their relation to economic fundamentals. Companies that have high B/M (a low stock price relative to book value) usually tend to have lower earning power (profitability) for some period and positive slopes on HML. Strong companies with persistently high earnings have low B/M and negative slopes on HML (Fama and French 1996, 56). Size factor is also related to profitability. Small companies usually tend to have lower earnings power. Some explanations for the size effect can be found in the fact that bigger companies overcome bad economic condition easily in relation to the small ones. Consequently, high B/M characteristic is somewhat tilted toward smaller stocks (Fama and French 1993, 7–8). To conclude, FF suggests that state variables of special hedging concern to investors is related to relative distress (Fama and French 1996, 82).

FF summarize that size and B/M, along with the market factor, are indeed proxy for sensitivity to common risk factors in stock returns. Moreover, intercepts from three-factor regressions are all close to 0, what is the evidence that the FF factor model is well specified asset pricing model, i.e. model captures much of the variation in the cross-section of average stock returns. But these three factors alone cannot explain the large difference between the average returns on stocks and treasury bills (Fama and French 1993, 5). Finally, FF (1996) conclude that finding state variables that can explain the common variation in returns, like SMB and HML, do not solve the problem of valid explaining why the state variables produce special premiums. (Fama and French 1996, 77) More details on the methodology used in FF (1993) paper and eventual differences from them used in this paper are discussed later.

CROATIAN STOCK MARKET

The Zagreb Stock Exchange (ZSE) represents a central Croatian equities marketplace. The exchange trades stocks of Croatian companies, as well bonds and commercial bills. The ZSE was first established in 1907 and was active until 1911. It was reopened in 1919, closed down again in 1945 and reestablished in 1991. During the last 20 years the ZSE experienced huge development in both, technological and trading aspect. As of March 31, 2013, market capitalization of listed companies on the ZSE is 138.6 billion kuna (US$ 23.9 billion).

From 2005 to 2007 Croatian and regional capital markets were under the influence of investors optimism. Thus, a significant increase was realised in both, turnover and growth sense. After 2007 this equity boom ended and upcoming economic crisis has taken its place. Growing risk aversion among investors struck equity indices and market liquidity. Figure 1 shows strong market contraction in the period of 2007 to 2013.

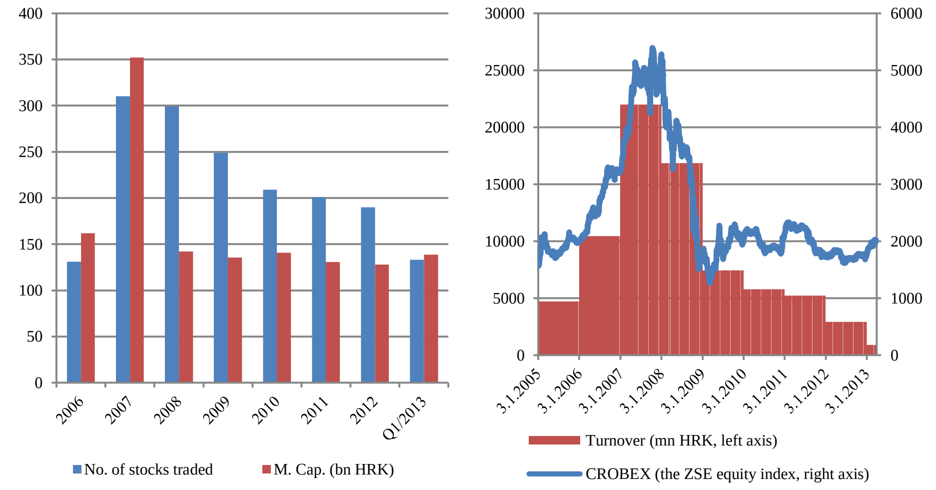

Figure 1. The ZSE trading statistic

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This section empirically examines the Fama-French three-factor model of stock returns for Croatia. Among that, two additional models are tested: one-factor market model (algebraically similar to CAPM) and two-factor model based only on size and B/M variables. The first part of the section describes data selection and data sources. The second part describes variables in the tested models. The last part of the section presents regression analysis and their results.

Data selection and data sources

This paper focuses on the stocks that are (or were) listed on the Zagreb Stock Exchange in the period from April 2007 till March 2013. Not all stocks are chosen for the model testing in the paper. Following conditions have to be met: (1) stock is common; (2) stock issuer is nonfinancial company; (3) stock has at least one trading record per month, in the period from March till March of the next year (i.e. at least 13 months of trading in a row). The number of stocks satisfying the test conditions varies year by year. All in all, 145 stocks satisfied defined criteria at some point during the observed six-year period.

Stock prices were downloaded from the ZSE web page[4]. Data on market capitalisation (market value of equity) of the companies are taken from the ZSE periodical (quarterly and annual) trading reports. Data on book values of equity are extracted from annual financial statements (audited and consolidated if available), that are disclosed on the ZSE. Returns of Treasury bills were downloaded from the web page of the Ministry of Finance of Croatia.

[4] www.zse.hr

Like FF (1993), this paper uses monthly stock returns. Size value is market value of equity at the end of March of year t. B/M value is book value of equity divided by market value of equity, both at the end of December of year t-1.

Variables in the Fama-French three-factor model

In March[5] of each year (from 2007 till 2012), all stocks that satisfy above defined criteria, are split: (1) into two groups by size – small vs big (S vs B), and (2) into two groups by B/M – high vs low (H vs L). Unlike FF, who used six portfolios, in this paper four portfolios (B, S, H and L) are formed from sorts of stocks on size and B/M, mainly because of the modest number of stocks that were available for analysis. In both cases splitting criteria is the median. Those four portfolios are here to incorporate economic fundamentals into the model in the way they form new portfolios (BH, BL, SH and SL) from the intersection of the two size and two B/M groups. Monthly value-weighted returns on the four portfolios are calculated from March of year t to March of year t+1. Their purpose is to mimic the underlying risk factors in returns related to size and B/M variable.

Hereinafter, definitions of Fama-French variables in the context of this paper are given.

RM-RF variable, or excess market return, is a proxy for the market factor in stock returns. Where RM is a monthly return on the value-weighted portfolio of the stocks in the four size-B/M portfolios, and where RF is a monthly return on the three-month Croatian Treasury bill rate at the moment of issuing.

SMB variable is meant to mimic the risk factor in returns related to size. It is the difference between the simple average of the monthly returns on the two small-stock portfolios (SH and SL) and the simple average of the monthly returns on the two big-stock portfolios (BH and BL). This way influence of B/M was isolated from the different returns behaviours of small and big stocks.

Similarly, **HML** variable is meant to mimic the risk factor in returns related to B/M. It is the difference between the simple average of the monthly returns on the two high-stock portfolios (SH and BH) and the simple average of the monthly returns on the two low-stock portfolios (SL and BL). This way the influence of size was isolated from the different returns behaviours of high B/M and low B/M stocks.

R_i-RF, or excess stock return, is a dependent variable in the model, i.e. a variable to be explained in relation to above defined risk factors. R_i is a monthly return on 37 selected stocks[6], and again, RF is the one-month bill rate. 37 stocks, whose returns were chosen to be explained by the model, were selected as an intersection of two criteria: (1) at least 72 months of trading in a row[7], and (2) market capitalization in top 50 stocks over the observed six-year period. 37 stocks that are chosen together account

[5] FF (1993) took June as the month for mimicking portfolio construction.

[6] FF (1993) uses excess returns on 25 portfolios formed on size and B/M as dependent variables in the time-series regressions.

[7] Following stocks are exceptions: ATGR-R-A, HT-R-A and INA-R-A. These stocks have shorter return time-series because of their later listing on the ZSE, or because of regulatory issues. This exception is made because of their significant market capitalisation and good liquidity.

around 60% of total market capitalization of stocks on the ZSE[8], and more than 80% of total turnover of stocks on the ZSE.

Short descriptive statistic of independent variables and explanatory returns are shown in Table 1, while descriptive statistic for 37 selected stocks is shown in Table 2.

Table 1. Descriptive statistic for independent variables (explanatory returns) — from April 2007 to March 2013 (72 observations)

Variable	Mean	Std. Dev.	t(mn)	Maximum	Minimum	Skewness	Kurtosis
RF	0.00304	0.00157	16.41855	0.00612	0.00083	0.70578	2.41795
RM	-0.00335	0.07109	-0.40040	0.23591	-0.22610	0.13033	6.36073
RM-RF	-0.00639	0.07117	-0.76239	0.23401	-0.23097	0.08537	6.39199
SMB	-0.01144	0.04060	-2.39053	0.11445	-0.10838	0.68482	4.14524
HML	0.00311	0.03491	0.75602	0.11356	-0.06582	0.88316	4.55733
Autocorr. for lag	**RMRF**	**SMB**	**HML**	**Correlations**	**RMRF**	**SMB**	**HML**
1	0.2332	-0.0496	0.0687	RMRF	1.0000		
2	0.0105	-0.0612	-0.0394	SMB	-0.1334	1.0000	
12	0.0652	-0.0369	-0.0780	HML	0.1203	0.1847	1.0000

Table 2. Descriptive statistics for 37 stocks and their returns — from April 2007 to March 2013 (72 observations)

	Company's		**Stock's**	**Return's**						
Stock	Size* (mn HRK)	B/M*	Liquidtiy* (% of total turnover)	Mean	Std. Dev.	t(mn)	Max.	Min.	Skew.	Kurt.
ADPL-R-A	492.5	1.649	1.46%	-0.0025	0.1178	-0.1786	0.4214	-0.3203	0.4609	5.3771
ADRS-R-A	3,698.1	1.277	0.79%	-0.0048	0.1010	-0.4023	0.5069	-0.3372	0.8964	13.0521
ATGR-R-A	1,811.0	0.535	1.76%	0.0003	0.0868	0.0296	0.2500	-0.2497	0.2999	4.6581
ATPL-R-A	1,543.0	1.365	6.14%	-0.0086	0.1453	-0.5045	0.4697	-0.5611	0.0776	6.4242
BLJE-R-A	1,108.6	1.222	1.67%	-0.0127	0.1235	-0.8727	0.3919	-0.3457	0.7591	5.0249
DDJH-R-A	309.9	1.673	1.25%	-0.0031	0.1392	-0.1868	0.4353	-0.3350	0.4061	3.8014
DIOK-R-A	755.2	0.833	0.53%	-0.0167	0.1972	-0.7185	0.7346	-0.5269	0.7880	5.3287
DLKV-R-A	1,195.9	0.799	4.36%	-0.0289	0.1486	-1.6508	0.3502	-0.4352	0.2382	3.3738
ERNT-R-A	2,576.3	0.559	3.95%	-0.0057	0.1031	-0.4669	0.2767	-0.2994	-0.0064	3.4046
HDEL-R-A	263.0	1.487	0.58%	-0.0075	0.2090	-0.3052	1.0336	-0.4526	1.8718	10.5980
HT-R-A	22,485.8	0.551	20.18%	-0.0065	0.0579	-0.9004	0.1422	-0.1558	-0.3275	3.6196
HUPZ-R-A	868.3	0.721	0.42%	-0.0054	0.0792	-0.5798	0.2464	-0.1822	0.5639	4.1956
IGH-R-A	614.1	1.184	3.89%	-0.0134	0.1983	-0.5723	0.8333	-0.4251	1.4294	6.9975
INA-R-A	25,940.2	0.637	10.45%	0.0145	0.1452	0.8068	0.8444	-0.4100	2.5917	18.7128
INGR-R-A	581.6	1.942	3.75%	-0.0300	0.1905	-1.3344	0.6062	-0.4082	1.0713	4.9615
IPKK-R-A	263.8	1.858	0.58%	-0.0071	0.1524	-0.3960	0.6521	-0.4000	1.3083	7.3984
JDPL-R-A	416.3	2.708	1.20%	-0.0077	0.1691	-0.3859	0.8997	-0.5157	1.9618	13.7051
JNAF-R-A	2,315.8	1.431	0.64%	0.0015	0.1527	0.0852	0.7442	-0.3997	2.1727	11.8938
KNZM-R-A	5,056.9	0.374	0.56%	-0.0039	0.1267	-0.2587	0.3917	-0.3901	0.2891	5.1631
KOEI-R-A	1,480.0	1.008	2.21%	0.0048	0.1259	0.3219	0.3683	-0.4178	0.0316	4.8658
KORF-R-A	752.3	3.373	1.69%	0.0041	0.1537	0.2273	0.5303	-0.3415	0.8226	4.5844
KRAS-R-A	634.0	1.075	0.49%	-0.0023	0.0986	-0.2008	0.3956	-0.3139	0.6338	6.6163
LEDO-R-A	1,520.2	0.497	1.31%	0.0154	0.1419	0.9236	0.4431	-0.3428	0.2419	3.9531
LKPC-R-A	407.1	0.598	0.98%	-0.0073	0.1577	-0.3901	0.5436	-0.3888	0.8957	6.0845
LKRI-R-A	1,069.9	0.339	0.79%	0.0026	0.1854	0.1209	1.0436	-0.3191	2.5525	15.2821
LRH-R-A	805.2	1.604	0.49%	-0.0047	0.1314	-0.3058	0.3837	-0.3333	0.2462	3.4345
PODR-R-A	1,814.7	1.003	2.23%	-0.0046	0.1010	-0.3852	0.4865	-0.2480	1.3982	9.5009
PTKM-R-A	604.7	1.677	2.38%	0.0109	0.1566	0.5922	0.8652	-0.4764	2.0265	14.8799
RIVP-R-A	1,255.5	1.549	0.43%	-0.0050	0.1365	-0.3136	0.7600	-0.2999	2.2487	15.2584
SNHO-R-A	487.1	1.845	0.40%	0.0044	0.1737	0.2153	0.7009	-0.4032	0.9656	5.5232
THNK-R-A	592.3	1.063	0.81%	-0.0166	0.1679	-0.8384	0.5440	-0.3747	0.6671	3.8094
TISK-R-A	1,036.5	0.637	0.73%	-0.0015	0.1540	-0.0818	0.3741	-0.3775	0.5823	3.5610
TNPL-R-A	1,559.2	1.849	0.49%	-0.0273	0.1233	-1.8783	0.5295	-0.4303	0.7874	8.6624
ULPL-R-A	428.6	1.506	1.39%	-0.0248	0.1421	-1.4831	0.7066	-0.5034	1.2626	12.8936
VDKT-R-A	276.5	1.563	0.76%	0.0047	0.2256	0.1781	0.8233	-0.4931	0.8939	5.2785
VIRO-R-A	837.6	0.720	1.54%	0.0060	0.1504	0.3412	0.4651	-0.4574	0.2257	5.0931
ZVZD-R-A	568.3	1.894	0.28%	-0.0018	0.1542	-0.0988	0.6485	-0.3480	1.7335	9.1798

* Simple average for observed six-year period.

[8] This number would be even higher if stocks of financial companies (banks, insurances, closed-end funds, etc.) were excluded from the total market capitalization of stocks on the ZSE.

Regression analysis

Common variation in returns has been captured trough the time-series regressions. The slopes (parameters) and R^2 values are direct evidence of that common variation (systematic risk). Like FF (1993), beside famous FF (1996) three-factor model (Eq. 4), two additional models are tested: two-factor model (Eq. 3) and one-factor model (Eq. 2). This way a better view can be taken regarding the role that each risk factor has.

Eq. (2) $R_{t\,i} - RF_t = a_i + b_i(RM_t - RF_t) + e_{t\,i}$

Eq. (3) $R_{t\,i} - RF_t = a_i + s_i SMB_t + h_i HML_t + e_{t\,i}$

Eq. (4) $R_{t\,i} - RF_t = a_i + b_i(RM_t - RF_t) + s_i SMB_t + h_i HML_t + e_{t\,i}$

One-factor model can be called a market model. Its formula is identical to CAPM formula, and alike to Sharpe's security characteristic line formula. Excess market return (i.e. overall stock market) has been chosen as a factor that explains common variations in returns. R^2 values are in the range from 0.10 to 0.68; 0.44 on average. Thus, market factor leaves much variation in returns that can be explained by other factors. All b parameters (slope coefficients) are statistically significant. Details of the regression analysis on 37 stocks are shown in table 3.

Two-factor model incorporates other two factors: size and B/M. R^2 values are modest; ranging from 0.00 to 0.22; 0.085 on average. Between the two factors, B/M shows much greater explanatory power. 22 of the 37 h parameters (slope coefficients related to HML – B/M factor) are statistically significant (5% level), in contrast to 3 of the 37 s parameters (slope coefficients related to the SMB – size factor). Thus, it can be stated that in this model the size factor is of little use in explaining common variation in returns. Details of the regression analysis on 37 stocks are shown in table 3.

Table 3. Regression results for one-factor and two-factor model

	One-factor model				Two-factor model					
Stock	**b**	**t(b)**	**R^2**	**s(e)**	**s**	**t(s)**	**h**	**t(h)**	**R^2**	**s(e)**
ADPL-R-A	1.217	9.103	0.54	0.08	-0.014	-0.042	0.794	1.979	0.06	0.12
ADRS-R-A	1.004	8.360	0.50	0.07	-0.380	-1.302	0.789	2.323	0.08	0.10
ATGR-R-A	0.822	7.751	0.49	0.06	0.092	0.291	0.398	1.124	0.03	0.09
ATPL-R-A	1.400	7.878	0.47	0.11	0.433	1.015	0.737	1.485	0.05	0.14
BLJE-R-A	1.259	8.810	0.53	0.09	-0.360	-1.011	1.039	2.508	0.09	0.12
DDJH-R-A	1.415	8.738	0.52	0.10	0.307	0.808	1.612	3.647	0.18	0.13
DIOK-R-A	1.340	4.618	0.23	0.17	0.815	1.402	0.604	0.894	0.05	0.20
DLKV-R-A	1.530	9.032	0.54	0.10	0.466	1.096	1.142	2.312	0.10	0.14
ERNT-R-A	0.927	6.962	0.41	0.08	-0.066	-0.212	0.103	0.286	0.00	0.10
HDEL-R-A	2.191	9.373	0.56	0.14	0.345	0.607	2.490	3.768	0.19	0.19
HT-R-A	0.463	5.796	0.35	0.05	-0.152	-0.732	-0.307	-1.317	0.06	0.06
HUPZ-R-A	0.370	2.944	0.11	0.08	-0.129	-0.540	-0.064	-0.230	0.01	0.08
IGH-R-A	1.838	7.340	0.43	0.15	-0.335	-0.595	1.977	3.024	0.12	0.19
INA-R-A	1.600	11.191	0.67	0.08	-1.052	-2.424	-0.320	-0.626	0.10	0.14
INGR-R-A	1.653	6.567	0.38	0.15	1.046	1.962	1.431	2.308	0.14	0.18
IPKK-R-A	1.204	5.678	0.32	0.13	0.030	0.066	0.889	1.695	0.04	0.15
JDPL-R-A	1.691	8.477	0.51	0.12	0.408	0.862	1.668	3.033	0.14	0.16
JNAF-R-A	1.247	5.986	0.34	0.12	-0.909	-2.204	1.827	3.810	0.20	0.14
KNZM-R-A	1.258	8.353	0.50	0.09	-0.225	-0.599	0.678	1.552	0.04	0.13
KOEI-R-A	1.372	10.270	0.60	0.08	-0.313	-0.860	1.033	2.440	0.08	0.12
KORF-R-A	1.503	8.092	0.48	0.11	0.357	0.852	1.763	3.612	0.18	0.14
KRAS-R-A	0.806	5.956	0.34	0.08	-0.233	-0.799	0.607	1.794	0.05	0.10
LEDO-R-A	1.383	8.060	0.48	0.10	-0.030	-0.072	0.778	1.592	0.04	0.14
LKPC-R-A	1.579	8.512	0.51	0.11	-0.042	-0.088	0.138	0.250	0.00	0.16
LKRI-R-A	1.788	7.889	0.47	0.14	0.103	0.194	1.705	2.771	0.11	0.18
LRH-R-A	0.759	3.769	0.17	0.12	-0.148	-0.380	0.742	1.641	0.04	0.13
PODR-R-A	1.068	9.580	0.57	0.07	-0.238	-0.801	0.625	1.810	0.05	0.10
PTKM-R-A	1.515	7.953	0.47	0.11	-0.298	-0.655	1.214	2.295	0.07	0.15
RIVP-R-A	0.622	2.862	0.10	0.13	0.018	0.044	0.986	2.124	0.06	0.13
SNHO-R-A	1.061	4.030	0.19	0.16	-0.494	-0.979	1.367	2.330	0.08	0.17
THNK-R-A	1.886	11.134	0.64	0.10	0.188	0.395	1.580	2.853	0.12	0.16
TISK-R-A	1.458	7.626	0.45	0.11	0.576	1.298	1.022	1.982	0.09	0.15

Table 3. (*continued*)

Stock	One-factor model b	t(b)	R^2	s(e)	Two-factor model s	t(s)	h	t(h)	R^2	s(e)
TNPL-R-A	1.216	8.261	0.49	0.09	0.328	0.907	0.659	1.567	0.05	0.12
ULPL-R-A	1.309	7.255	0.43	0.11	-0.179	-0.441	1.351	2.866	0.11	0.14
VDKT-R-A	2.260	8.506	0.51	0.16	0.866	1.337	1.520	2.017	0.09	0.22
VIRO-R-A	1.749	12.331	0.68	0.09	-0.302	-0.690	1.146	2.251	0.07	0.15
ZVZD-R-A	1.354	6.697	0.39	0.12	-0.436	-1.062	2.103	4.399	0.22	0.14

Fama-French three-factor model has proved as the best in capturing strong common variation in stock return, among other two factor models. Results are naturally better since this model incorporates all three factors. R^2 values are in the range from 0.12 to 0.73; 0.51 on average. Greater explanatory power is the result of certain marginal explanatory power of size and B/M factors, which is added to the explanatory power of the one-factor model. As expected, all b parameters (slope coefficients related to market factor) are statistically significant (5% level). Again, between the size and B/M factors, B/M factor demonstrated its dominance, although not as strong as in two-factor model. Namely, 17 of the 37 h parameters were statistically significant, in contrast to 13 of the 37 s parameters that were statistically significant (5% level). Details of the regression analysis on 37 stocks are shown in table 4.

Table 4. Regression results for Fama-French three-factor model

Stock	b	t(b)	s	t(s)	h	t(h)	R^2	s(e)
ADPL-R-A	1.217	9.138	0.329	1.396	0.422	1.541	0.58	0.08
ADRS-R-A	0.966	7.998	-0.108	-0.503	0.494	1.988	0.53	0.07
ATGR-R-A	0.829	7.845	0.311	1.382	0.159	0.630	0.52	0.06
ATPL-R-A	1.447	8.402	0.841	2.760	0.294	0.832	0.54	0.10
BLJE-R-A	1.219	8.553	-0.016	-0.064	0.666	2.275	0.56	0.08
DDJH-R-A	1.399	10.100	0.702	2.863	1.184	4.158	0.67	0.08
DIOK-R-A	1.422	4.952	1.217	2.392	0.169	0.287	0.30	0.17
DLKV-R-A	1.560	10.046	0.906	3.295	0.665	2.083	0.64	0.09
ERNT-R-A	0.954	6.966	0.203	0.839	-0.188	-0.669	0.42	0.08
HDEL-R-A	2.155	10.923	0.953	2.728	1.831	4.515	0.71	0.12
HT-R-A	0.477	6.160	-0.025	-0.151	-0.445	-2.395	0.42	0.05
HUPZ-R-A	0.379	2.924	-0.022	-0.095	-0.180	-0.674	0.12	0.08
IGH-R-A	1.765	7.259	0.164	0.380	1.437	2.875	0.50	0.14
INA-R-A	1.593	11.952	-0.557	-2.291	-0.772	-2.713	0.73	0.08
INGR-R-A	1.716	7.593	1.530	3.825	0.906	1.950	0.53	0.13
IPKK-R-A	1.201	5.588	0.369	0.969	0.521	1.179	0.34	0.13
JDPL-R-A	1.690	9.412	0.885	2.783	1.151	3.118	0.63	0.11
JNAF-R-A	1.114	5.695	-0.595	-1.717	1.487	3.698	0.46	0.11
KNZM-R-A	1.250	8.096	0.128	0.468	0.295	0.931	0.51	0.09
KOEI-R-A	1.340	10.095	0.065	0.277	0.624	2.285	0.63	0.08
KORF-R-A	1.485	9.199	0.777	2.717	1.309	3.944	0.64	0.09
KRAS-R-A	0.783	5.662	-0.012	-0.047	0.368	1.295	0.35	0.08
LEDO-R-A	1.390	7.992	0.362	1.176	0.353	0.988	0.50	0.10
LKPC-R-A	1.633	8.626	0.419	1.250	-0.361	-0.928	0.52	0.11
LKRI-R-A	1.764	8.128	0.601	1.563	1.165	2.611	0.55	0.13
LRH-R-A	0.733	3.559	0.059	0.162	0.518	1.225	0.19	0.12
PODR-R-A	1.055	9.272	0.060	0.298	0.303	1.294	0.58	0.07
PTKM-R-A	1.480	7.737	0.120	0.354	0.762	1.938	0.51	0.11
RIVP-R-A	0.588	2.690	0.184	0.474	0.806	1.793	0.15	0.13
SNHO-R-A	0.982	3.702	-0.217	-0.461	1.067	1.956	0.23	0.16
THNK-R-A	1.881	12.324	0.719	2.661	1.005	3.203	0.73	0.09
TISK-R-A	1.501	8.368	1.000	3.147	0.563	1.528	0.55	0.11
TNPL-R-A	1.252	8.773	0.681	2.697	0.276	0.941	0.56	0.08
ULPL-R-A	1.265	7.182	0.179	0.572	0.964	2.663	0.49	0.10
VDKT-R-A	2.328	9.520	1.524	3.519	0.808	1.608	0.61	0.14
VIRO-R-A	1.727	12.268	0.185	0.743	0.618	2.137	0.71	0.08
ZVZD-R-A	1.246	6.832	-0.085	-0.262	1.722	4.592	0.54	0.11

Although parameters related to size and B/M factors have not shown statistical significance among all stocks that were selected, SMB and HML mimicking returns individually capture certain small shared variation in stock returns that is missed by the market factor. Moreover, the slopes on SMB and HML are systematically related to the size and the B/M characteristics of a company, what can be seen from the figure 2 and figure 3. As expected, there is a negative relation between the company size and expected return premium for size risk taken in that company stock. Also, there is a positive relation between the company B/M characteristic and expected return premium for B/M risk taken in that company stock. Again, figures show that B/M factor is a bit stronger common risk proxy in relation to size factor.

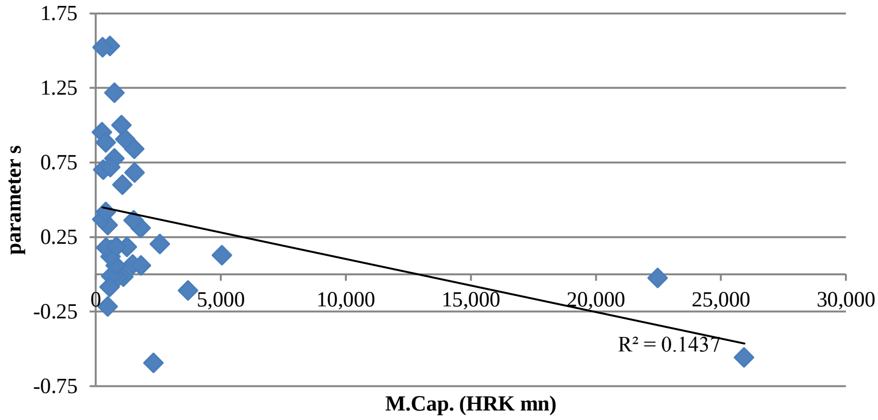

Figure 2. Relation between the company size and expected return premium for size risk

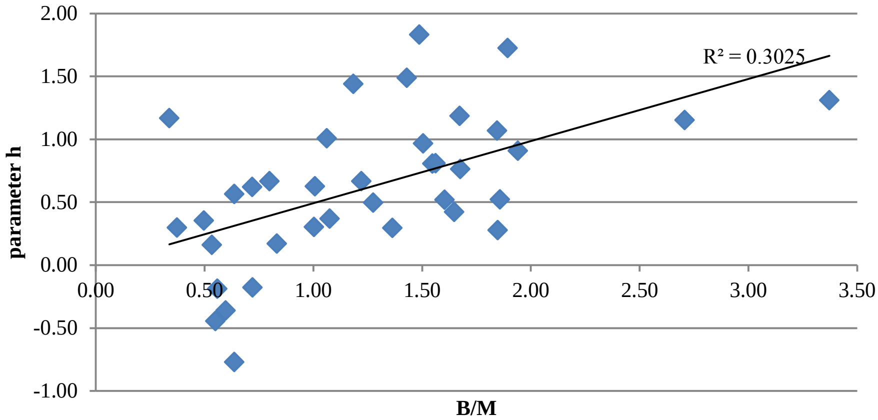

Figure 3. Relation between the company B/M characteristic and expected return premium for B/M risk

Test of how well the average premiums for the three proxy factors explain cross-section of average returns on stocks focuses on the intercepts in the time-series regressions. Acceptable pricing model should have the intercepts indistinguishable from 0 (Fama and French 1993, 34–35). Regression results on all three models show that they properly describe cross-section of average returns. Intercepts values (parameters a) in the test of FF three-factor model are all indistinguishable from 0 (at 5% level of statistical significance). In other two models almost all intercepts were indistinguishable from 0. Namely, only 1 of the 37 intercepts was statistically significant (5% level) in both, one-factor and two-factor model. Values of intercepts for all three models among 37 stocks are shown in table 5.

Table 5. Regression intercepts and their significance (for all three factor models)

	One-factor model		Two-factor model		Three-factor model	
Stock	**a**	**t(a)**	**a**	**t(a)**	**a**	**t(a)**
ADPL-R-A	0.002	0.239	-0.008	-0.568	0.005	0.482
ADRS-R-A	-0.001	-0.166	-0.015	-1.205	-0.004	-0.498
ATGR-R-A	0.004	0.457	-0.002	-0.215	0.007	0.841
ATPL-R-A	-0.003	-0.216	-0.009	-0.508	0.006	0.496
BLJE-R-A	-0.008	-0.758	-0.023	-1.559	-0.010	-0.975
DDJH-R-A	0.003	0.256	-0.008	-0.481	0.007	0.707
DIOK-R-A	-0.011	-0.543	-0.012	-0.509	0.003	0.130
DLKV-R-A	-0.022	-1.843	-0.030	-1.709	-0.014	-1.199
ERNT-R-A	-0.003	-0.295	-0.010	-0.757	0.000	0.029
HDEL-R-A	0.003	0.208	-0.014	-0.608	0.008	0.581
HT-R-A	-0.006	-0.962	-0.011	-1.418	-0.005	-0.814
HUPZ-R-A	-0.006	-0.683	-0.010	-0.981	-0.006	-0.601
IGH-R-A	-0.005	-0.263	-0.026	-1.129	-0.008	-0.433
INA-R-A	0.017	1.646	0.000	0.023	0.013	1.290
INGR-R-A	-0.022	-1.256	-0.025	-1.150	-0.007	-0.442
IPKK-R-A	-0.002	-0.163	-0.013	-0.671	0.000	0.008
JDPL-R-A	0.000	0.006	-0.011	-0.572	0.007	0.502
JNAF-R-A	0.006	0.437	-0.018	-1.025	-0.006	-0.404
KNZM-R-A	0.001	0.107	-0.012	-0.742	0.002	0.144
KOEI-R-A	0.011	1.109	-0.005	-0.334	0.009	0.934
KORF-R-A	0.011	0.811	0.000	-0.018	0.015	1.298
KRAS-R-A	0.000	-0.023	-0.010	-0.820	-0.002	-0.162
LEDO-R-A	0.021	1.745	0.010	0.552	0.024	1.905
LKPC-R-A	0.000	-0.015	-0.011	-0.567	0.006	0.436
LKRI-R-A	0.011	0.686	-0.005	-0.206	0.014	0.886
LRH-R-A	-0.003	-0.205	-0.012	-0.728	-0.004	-0.266
PODR-R-A	-0.001	-0.100	-0.012	-0.995	-0.001	-0.136
PTKM-R-A	0.018	1.300	0.001	0.037	0.016	1.164
RIVP-R-A	-0.004	-0.267	-0.011	-0.660	-0.005	-0.295
SNHO-R-A	0.008	0.436	-0.009	-0.407	0.002	0.095
THNK-R-A	-0.008	-0.630	-0.022	-1.131	-0.002	-0.223
TISK-R-A	0.005	0.354	-0.001	-0.061	0.015	1.120
TNPL-R-A	-0.023	-2.159	-0.029	-1.904	-0.015	-1.469
ULPL-R-A	-0.020	-1.525	-0.034	-2.025	-0.021	-1.604
VDKT-R-A	0.016	0.856	0.007	0.255	0.031	1.753
VIRO-R-A	0.014	1.410	-0.004	-0.221	0.014	1.378
ZVZD-R-A	0.004	0.266	-0.016	-0.958	-0.003	-0.238

CONCLUSION

This paper shows that pricing models built for developed capital markets, like the U.S., can be applied to an emerging capital market, like Croatian. However, their success in explaining risk-return relation cannot be so easily copied from one market to another. Emerging capital markets bear their own specificity that needs to be taken into account when applying existing or developing new pricing models. In that context the three-factor Fama-French model has imposed as a logic starting point.

In contrast to the results of Fama and French (1993) for the U.S. stock market, their three-factor model was not so successful when describing a risk-return relation of Croatian stocks. Based on regression analysis of the time-series of 37 stocks on the ZSE following conclusions can be made: (1) the excess market return factor (RM-RF) is always statistically significant and captures huge portion of common variation in stock returns; (2) size (SMB) and B/M (HML) factors are not always significant, but on average they individually have certain marginal explanatory power, i.e. they capture small common variation in returns that is missed by the market factor; (3) B/M factor has shown as a stronger common risk proxy in relation to the size factor; (4) Fama-French three-factor model has proved as a better pricing model (has a greater explanatory power) in comparison to the one-factor market model (to the CAPM as well); (5) Fama-French three-factor model is a valid pricing model since it explains cross-section of average returns on stocks in Croatia; (6) there is still large portion of common variation in stock return that may be explained by other factors.

Several reasons can be named why Fama-French three-factor model for Croatian stock market does not show statistical significance that it has in FF (1993) paper. One of the reasons is inadequate statistical background. Time-series of stock prices in Croatia are not correct for stock splits; a simple registry of dividend payments does not exist; a registry of financial statements of companies is impractical for any serious research. Other reasons can be found in the specificity of emerging capital markets. Lower liquidity in general is a result of lower level of knowledge and experience of capital market participants, huge influence of commercial banks on overall financial system, and a small number of institutional investors and individual investors. Also, Croatian companies listed on the ZSE are in general smaller in size in comparison to the listed companies in developed capital markets.

Further research will focus on solving several issues that could be crucial when developing stock pricing model for emerging stock markets. For instance: how to improve separation between small and big companies when defining size factor; how to incorporate liquidity issues in the model; how to estimate the effect of company industry membership in the model; are there any new, unrevealed, risk factors (or models) that are better in explaining common variation in stock return; how do changes in return frequency and different statistical tests influence explanatory power of a pricing model? Finally, the aim and purpose of new findings is in some degree to improve today's financial industry practice.

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