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CROSS-SECTIONAL RETURNS FROM DIVERSE PORTFOLIO OF EQUITY INDICES WITH RISK PREMIA EMBEDDED[1]

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Abstract: The main purpose of this article is to extend evaluation of classic Fama-French and Carhart model for global equity indices. We intend to check the robustness of models results when used for a wide set of equity indices instead of single stocks for the given country. Such modification enables us to estimate equity risk premium for a single country. However, it requires several amendments to the proposed methodology for single stocks.

Our empirical evidence reveals important differences between the conventional models estimated on single stocks, either international or US-only, and models incorporating whole markets. Our novel approach shows that the divergence between indices of the developed countries and those of emerging markets is still persistent. Additionally, research on weekly data for equity indices presents rationale for explanation of equity risk premia differences between variously sorted portfolios.

Keywords: cross-sectional models, asset pricing models, equity risk premium, equity indices, new risk factors, sensitivity analysis, book to market, momentum, market price of risk, emerging and developed equity indices,

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INTRODUCTION

The phenomenon of equity risk premium and stock market returns fluctuations is thoroughly described in financial literature. The discussion started with the seminal papers introducing CAPM of Sharpe [1964], Lintner [1965] and Black [1972]. Then, it has greatly evolved with the three-factor model of Fama [1992] and four-factor model of Carhart [1997]. Nowadays, it concentrates around many other modifications which propose various set of risk factors in order to fully explain the variability of stock market returns. This paper aims to introduce several new ideas to this debate.

At the beginning we would like to stress the most popular effects revealed in financial literature, which were indicated as the most important risk factors explaining outperformance of the given groups of stocks:

- the robustness of outperformance of the value investing strategy (i.e. investing in stocks that have high book to market, dividends yield, earnings ratio, etc.) produce higher risk adjusted returns [Fama 1992], [Lakonishok 1994], [Arshanapalli et al. 1998], [Bondt and Thaler 1985] and [Bondt and Thaler 1987],
- size effects (i.e. small minus big stocks effect) [Fama and French 2012],
- momentum and reversal effect (i.e. winners minus losers effect) captured for many different time frames [Wu 2002], [Jegadeesh and Titman 1993], and [Asness 1995],
- liquidity effect [Rahim and Noor 2006], [Liu 2004],
- market factor, investment factor and return on equity factor [Chen et al. 2011],
- five factors, profitability and investment on the top of standard three-factor model [Fama and French 2015],
- betting against beta, i.e. long leveraged low-beta assets and short high-beta assets produce significant positive risk-adjusted returns [Frazzini and Pedersen 2014],
- accounting manipulation factor performs better for New EU Member states [Foye et al. 2013],
- cash-flow-to-price factor, momentum and market factor analyzed for 49 countries [Hou et al. 2011].

At the same time many authors claimed that CAPM still works, arguing that deviations due to missing factors are difficult to detect and it is relatively difficult to reject data-snooping bias in case of multifactor models [MacKinlay 1995]. Other kinds of biases which can be encountered while performing stock returns analysis include among others look ahead bias [Lo and MacKinlay 1990].

Based on the current state of the art for stock returns and the fact that very few papers covered the problem for equity indices returns so far, we want to better explain the diversity of equity indices returns and hence follow the conclusion

of Griffin [2002] who stated that Fama-French factors are country-specific rather than global.

Therefore, the main aim of this paper was to present a cross sectional analysis for global indices with special attention to equity risk premium. We want to find an answer to a question whether based on combination of well-known asset pricing models we are able to pick these equity indices which are relatively cheap (or expensive), at the same taking into account all other important risk factors.

Our main research questions are as follows:

1. Can models of [Fama and French 1992] and [Carhart 1997] be used for explanation of equity risk premium for global indices? Our intention is to answer this question on single equity indices basis and on aggregated level as well.
2. Can we say that beta coefficients are rather similar or do they differ among countries?
3. Are signs for beta coefficients coherent with the results for single stocks?
4. Can we say that the model of Carhart fully explain the variability of equity risk premium for worldwide indices?
5. Is it possible to distinguish countries with consecutively high beta sensitivities?
6. Which risk factor was the most important in portfolio construction?

Above mentioned questions helped us to plan the methodology section of this research.

METHODOLOGY AND DATA

Methodology

The methodology is based on the seminal paper of [Carhart 1997], who proposed the four-factor model for mutual funds analysis. One of the reason that we prefer the model of Carhart over the methodology of [Fama and French 1992] (the three-factor model for stocks return analysis) are the results of [Fama and French 2012] and comprehensive results obtained for emerging markets by [Cakici et al. 2013]. They focused on 18 emerging markets treating each of them separately and they revealed the significance of value and momentum everywhere except Eastern Europe and additionally noted that value factors and momentum factors were negatively correlated.

Taking into account that our research is intended for equity indices we have to introduce several amendments to the initial methodology. Necessary modifications include:

- converting monthly to weekly data in order to reveal dynamics during shorter time intervals,
- introducing lags to the original models in order to use them for forecast purposes,

- including new risk factors that explain the diversity of returns more deeply,
- necessary conversion of well-known risk factors from the country level to the worldwide level,
- creating adequate zero investment portfolios that fully reflect the influence of particular risk factor on equity risk premium.

Before we present our model it is crucial to define the equity risk premium as the expected excess return of equities over the risk free rate. The point here is that current literature proposes many alternative ways to measure it, depending on what we want to focus on:

- historical returns approach:

$$ERP = \sum_{t=t_0}^{n} R_t - Rf_t \tag{1}$$

where R_t -Rf_t is excess return at time t over risk-free rate.

- earnings yield approach:

$$ERP = \frac{E}{P} - Rf_t \tag{2}$$

where $\frac{E}{P}$ is earnings to price ratio

- dividend yield approach:

$$ERP = \frac{D}{P} + g - Rf_t \tag{3}$$

where $\frac{D}{P}$ is dividend to price ratio and g is dividend growth rate.

- regression- and factor-based approach which can be characterized by point-in-time estimates instead of long-term estimates only, not dependent on e.g. tax policy, and which allows dynamic forecasts:

$$ERP = \alpha + \sum_{i=1}^{n} \beta_i X_{i,t} + \varepsilon_t \tag{4}$$

where $X_{i,t}$ is the *i*-th risk factor at moment t and β_i is sensitivity to this factor.

- survey-based approach which is often systematically biased, negatively correlated with future returns, and positively with previous returns.

The selection of particular definition can certainly affect final results but before we focus on that we describe factor models used in this research. We start with the Fama-French three-factor model:

$$(R_i - Rf_t) = \alpha + \beta_{MKT,i} * (R_m - Rf_t) + \beta_{HML,i} * HML_t + \beta_{SMB,i} * SMB_t \tag{5}$$

where $(R_i$-$Rf_t)$ is weekly return of equity index in excess to weekly risk free rate, $(R_m$-$Rf_t)$ is equally weighted equity index minus risk free rate, HML_t represents the

monthly premium of the book-to-market factor, and SMB_t is the monthly premium of the size factor. We assumed 3m Libor USD as risk free rate measure in our research.

Then we concentrate on the four-factor model of Carhart, which additionally introduces the WML factor:

$$(R_i - Rf_t) = \alpha + \beta_{MKT,i} * (R_m - Rf_t) + \beta_{HML,i} * HML_t + \beta_{SMB,i} * SMB_t + \beta_{WML,i} * WML_t \quad (6)$$

The WML factor is the monthly premium on winners minus losers (WML) and can be calculated by subtracting the equal weighted average of the highest performing firms from the equal weighed average of the lowest performing firms [Carhart, 1997]. The detailed procedure of calculating HML, SMB and WML risk factors is summarized below.

The HML is a zero-investment portfolio that is long on the highest decile group of book-to-market (B/M) equity indices and short on the lowest decile group. The difference of returns of these extreme decile groups is calculated in each weekly interval, which finally constitutes HML factor. Based on these returns we created cumulative returns for HML and then LMH zero investment portfolio (where LMH was created as the difference between lowest and highest decile group of book-to-market).

The SMB is a zero-investment portfolio that is long on the highest decile group of small capitalization (cap) equity indices and short on the lowest decile group. The difference of returns of these extreme decile groups is calculated in weekly interval as well. Similarly, based on these returns we created cumulative returns for SMB and then BMS zero investment portfolio (where BMS was created as the difference between lowest and highest decile group of small capitalization (cap) equity indices).

Lastly, the WML is a zero-investment portfolio that is long on the highest decile group of previous 2-month return winner equity indices and short on its lowest decile group (loser equity indices). The difference of returns of these extreme decile groups is calculated again for each weekly interval and based on that we create cumulative returns for WML and then LMH zero investment portfolio (where LMW was created as the difference between lowest and highest decile group of previous 2-month return winner equity indices).

Data and descriptive statistics

We used the data for the most comprehensive set of investable equity indices[2] covering the period between 1990 and 2015[3]. The detailed list of all equity

[2] For practical purposes we used only these indices which can be easily invested through options, futures or ETFs.

[3] For practical purposes the study was limited to 2000-2015 because of unavailability of longer time series for several of our risk factors.

indices and their descriptive statistics can be obtained upon request. Descriptive statistics for risk factor used in the study are presented in Table 1.

Table 1. Descriptive statistics for risk factors: R_m-R_f, HML, SMB and WML

	R_m	R_f	R_m-R_f	HML	HML top	HML bottom	LMH	SMB	SMB top	SMB bottom	BMS	WML 12m	WML top	WML bottom	LMW
nobs	795	795	795	795	795	795	795	795	795	795	795	795	795	795	795
NAs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	0.000	-0.17	-0.171	-0.072	-0.174	-0.182	-0.143	-0.129	-0.151	-0.140	-0.079	-0.115	-0.106	-0.185	-0.106
Maximum	0.001	0.071	0.071	0.143	0.113	0.099	0.072	0.079	0.118	0.096	0.129	0.106	0.097	0.097	0.115
1.Q	0.000	-0.01	-0.006	-0.011	-0.009	-0.013	-0.014	-0.012	-0.009	-0.006	-0.011	-0.011	-0.005	-0.011	-0.019
3. Q	0.000	0.011	0.011	0.014	0.016	0.014	0.011	0.011	0.014	0.011	0.012	0.019	0.015	0.014	0.011
Mean	0.000	0.001	0.001	0.001	0.002	0.007	-0.001	-0.000	0.001	0.001	0.000	0.003	0.004	0.000	-0.003
Median	0.000	0.004	0.003	0.000	0.004	0.006	-0.000	-0.001	0.002	0.002	0.001	0.004	0.005	0.001	-0.004
Sum	0.336	1.426	1.089	1.455	1.994	0.535	-1.455	-0.198	1.306	1.108	0.198	2.942	3.631	0.688	-2.942
SEMean	0.000	0.000	0.000	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.001
LCLMean	0.000	0.000	0.000	0.000	0.000	-0.009	-0.003	-0.001	0.000	0.000	-0.001	0.001	0.003	-0.001	-0.005
UCLMean	0.000	0.003	0.002	0.003	0.004	0.003	-0.000	0.001	0.003	0.002	0.001	0.005	0.006	0.002	-0.001
Variance	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Stdev	0.000	0.017	0.017	0.022	0.026	0.021	0.022	0.019	0.021	0.019	0.019	0.026	0.020	0.026	0.026
Skewness	0.726	-1.82	-1.843	0.551	-0.813	-1.108	-0.551	-0.260	-0.523	-0.887	0.260	-0.279	-0.432	-0.510	0.279
Kurtosis	-0.90	13.61	13.68	3.100	5.294	6.079	3.100	3.139	5.539	6.242	3.139	1.336	3.050	4.460	1.336
IR	7.845	0.771	0.582	0.619	0.742	0.219	-0.564	-0.092	0.568	0.537	0.093	1.092	1.826	0.244	-0.905
cum_ret	0.390	3.047	1.911	3.162	6.060	0.690	-0.760	-0.177	2.601	1.964	0.215	16.840	33.985	0.964	-0.944

The data cover the period between 1990-2015. Detailed time frames for every risk factor are summarized in the table. HML, SMB and WML represent differences in returns between extreme decile groups, top and bottom represent returns of extreme decile groups, LMH, BMS and LMW represent anti-factors.

Source: own calculations

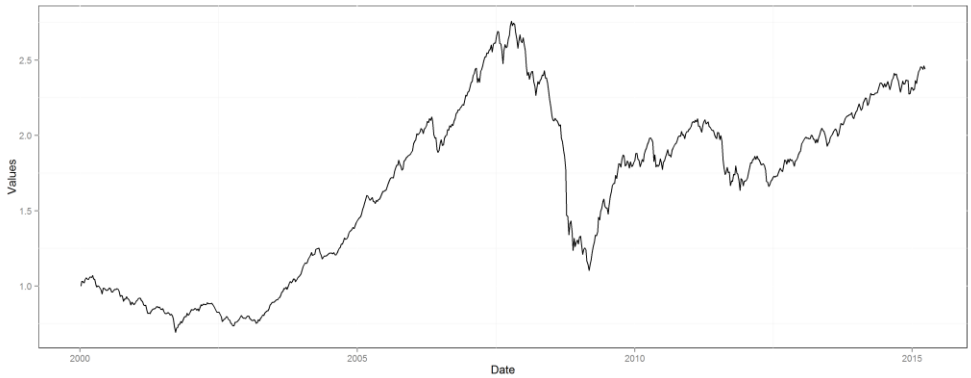
Analysis of risk factors

Detailed analysis of dynamics of the standard fours factors from the Carhart model helped us to define the final specification of the model. Our observation concerning these factors dynamics are shortly summarized below.

Figure 1 shows the dynamics of the first factor $(R_m\text{-}R_f)_t$. It does not significantly differ from equally weighted index path. This actually informs us that we analyzed the period of exceptionally low rates which have not a crucial impact on the value of this factor.

Figure 2 presents fluctuations of the second factor (HML_t). It reveals two distinctive periods. The first one (between 2000 and the beginning of 2012) shows a strong HML effect revealing much better behavior of equity indices with high book-to-market characteristics (Figure 2). Similar phenomenon was heavily presented in the literature for stock returns. Starting from 2012, the HML effect disappeared and totally transformed into the LMH effect what is quite surprising and requires some additional research.

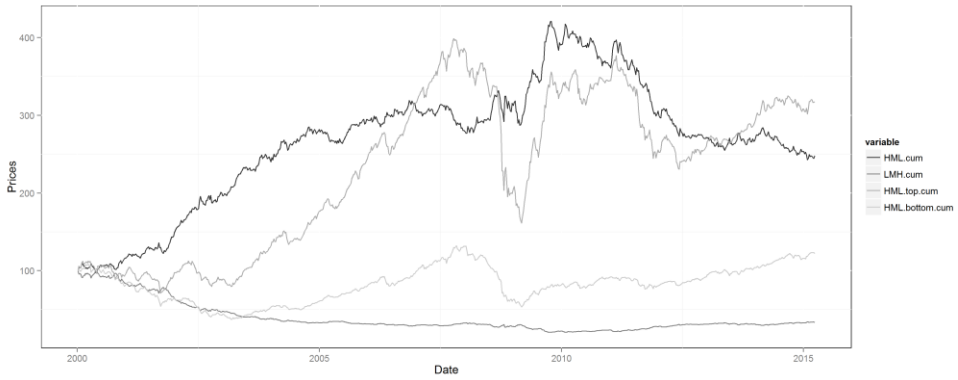
Figure 1. Dynamics of cumulative R_m-R_f factor



R_m-R_f factor was calculated on data between 1990-2015 and presents cumulative returns for R_m-R_f factor calculated on weekly data

Source: own calculations

Figure 2. Cumulative returns of HML factor with top/bottom 20% percentiles

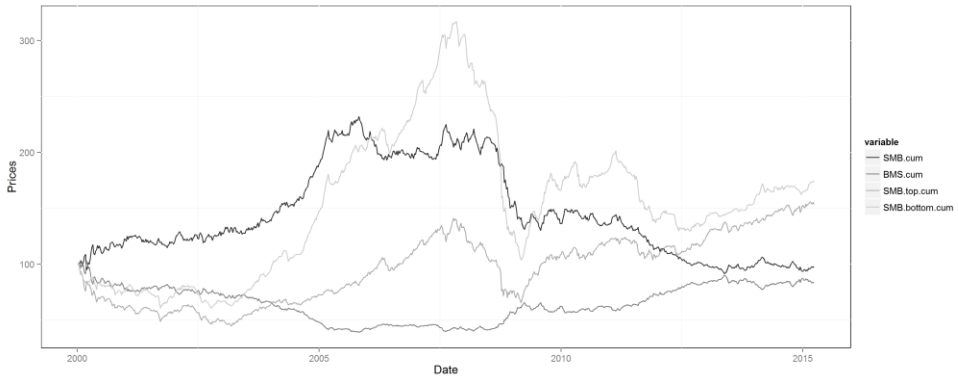


HML factor was calculated on data between 2000-2015 and presents cumulative returns for HML factor calculated on weekly data

Source: own calculations

Fluctuations of third risk factor (SMB_t) are presented in the Figure 3. It can be divided into two differing periods as well. The first period ends in 2006 and is characterized by outperformance of small capitalization equity indices. In the second period (between 2006 and 2015) this effect is totally reversed and we can see high outperformance of big capitalization equity indices.

Figure 3. Cumulative returns of SMB factor with top/bottom 20% percentiles

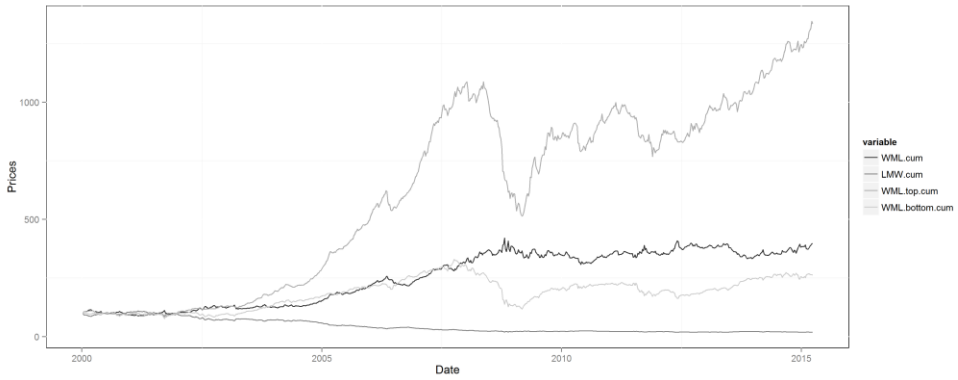


SMB factor was calculated on data between 2000-2015 and presents cumulative returns for SMB factor calculated on weekly data

Source: own calculations

Finally, the fourth risk factor (WML_t) reveals the strongest WML effect (Figure 4) which is stable during the whole period and exactly confirms the short-term momentum effect observed in financial literature.

Figure 4. Cumulative returns of WML factor with top/bottom 20% percentiles



WML factor was calculated on data between 2000-2015 and presents cumulative returns for WML factor calculated on weekly data for the last two months

Source: own calculations

RESULTS

Detailed results of regression for the Carhart model are presented in Table 2.

Table 2. Regression results for the Carhart model

index	country	ticker	n	a	t.a.	Rm-Rf	t.Rm-Rf	HML	t.HML.	SMB	t.SMB.	WML	t.WML.	Rsq	F
Developed markets															
Euro STOXX 50	Europe	SX5E	795	-0.002	-2.808	1.466	41.480	-0.204	-7.617	-0.054	-1.741	-0.110	-5.148	0.727	527.10
CAC 40	France	CAC	795	-0.002	-2.652	1.426	41.001	-0.195	-7.407	-0.076	-2.472	-0.093	-4.459	0.723	514.69
AEX-Index	Netherlands	AEX	795	-0.002	-2.808	1.473	40.674	-0.227	-8.307	-0.018	-0.563	-0.093	-4.249	0.715	494.57
DAX	Germany	DAX	795	-0.001	-0.939	1.495	37.928	-0.206	-6.925	-0.105	-3.020	-0.109	-4.606	0.694	448.82
FTSE 100	UK	UKX	795	-0.001	-2.255	1.122	37.665	-0.165	-7.324	-0.070	-2.657	-0.098	-5.472	0.694	447.84
FTSE MIB	Italy	FTSEMIB	795	-0.002	-3.317	1.524	36.100	-0.130	-4.067	0.001	0.036	-0.060	-2.348	0.656	376.68
OMX Stockholm 30	Sweden	OMX	795	-0.001	-1.245	1.359	33.616	-0.189	-6.182	-0.102	-2.840	-0.083	-3.411	0.639	349.14
OMX Helsinki 25 Index	Finland	HEX25	795	-0.001	-1.894	1.508	33.903	-0.117	-3.484	-0.090	-2.300	-0.073	-2.709	0.637	346.76
Vienna Stock Exch	Austria	ATX	795	-0.001	-1.154	1.423	33.371	0.058	1.809	-0.019	-0.508	-0.082	-3.191	0.633	341.17
S&P500	USA	SPX	795	-0.001	-1.224	1.065	31.884	-0.142	-5.638	-0.144	-4.871	-0.089	-4.418	0.629	335.10
BEL 20	Belgium	BEL20	795	-0.001	-1.552	1.255	32.850	-0.194	-6.703	0.057	1.672	-0.092	-3.987	0.616	317.48
S&P/ASX 200	Australia	AS51	795	-0.001	-1.202	0.927	32.605	-0.032	-1.468	-0.038	-1.519	-0.016	-0.962	0.611	309.98
Oslo SE OBX Index	Norway	OBX	795	0.000	0.064	1.432	31.935	-0.040	-1.168	-0.054	-1.374	-0.056	-2.068	0.606	303.26
IBEX 35 Index	Spain	IBEX	795	-0.001	-1.986	1.372	31.487	-0.068	-2.063	-0.043	-1.113	-0.095	-3.624	0.605	301.91
Luxembourg SE	Luxembourg	LUXXX	795	-0.002	-2.178	1.355	32.646	-0.002	-0.066	0.063	1.728	-0.002	-0.087	0.600	296.82
OMX Kopenhagen 20	Denmark	KFX	795	0.000	0.618	1.227	31.417	-0.112	-3.781	0.016	0.460	-0.090	-3.834	0.598	294.00
S&P/TSX 60	Canada	SPTSX	795	-0.001	-1.074	1.048	30.106	-0.085	-3.220	-0.080	-2.598	-0.028	-1.331	0.578	270.55
Swiss Market Index	Switzerland	SMI	795	-0.001	-0.817	1.076	28.347	-0.228	-7.960	0.021	0.617	-0.140	-6.127	0.567	258.67
Hang Seng Index	Hong Kong	HSI	795	-0.001	-1.401	1.291	28.285	-0.071	-2.070	-0.143	-3.533	-0.026	-0.954	0.552	243.46
Irish SE 20 Price Index	Ireland	ISEQ20P	524	-0.001	-1.112	1.306	21.173	0.083	1.478	-0.179	-2.664	-0.056	-1.379	0.549	157.64
Prague SE Index	Czech Rep	CTXEUR	795	-0.001	-0.803	1.444	27.652	0.156	3.952	0.023	0.490	-0.083	-2.632	0.548	239.89
MSCI Singapore Index	Singapore	MXSG	795	-0.001	-2.058	1.141	28.154	-0.030	-0.967	-0.075	-2.087	-0.006	-0.234	0.540	232.25
PSI20 Index	Portugal	PSI20	795	-0.002	-3.355	1.080	26.739	0.009	0.298	-0.018	-0.502	-0.063	-2.586	0.523	216.73
Nikkei 225 Index	Japan	NKY	795	-0.001	-1.810	1.143	23.789	-0.038	-1.054	-0.167	-3.933	-0.004	-0.127	0.469	174.74
NZE 50 Gross Index	Zealand	NZSE50FG	742	0.001	1.261	0.523	17.762	-0.003	-0.136	0.010	0.335	-0.012	-0.661	0.329	90.34
ICEX Main Index	Iceland	ICEXI	795	-0.001	-0.594	0.451	6.035	0.114	2.021	0.082	1.244	-0.025	-0.557	0.060	12.54
Malta SE Index	Malta	MALTEX	795	0.000	-0.694	0.182	4.370	0.031	0.977	0.038	1.038	0.049	1.937	0.027	5.58
Emerging markets															
MEX BOLSA IPC	Mexico	MEXBOL	795	0.001	1.003	1.179	25.069	0.028	0.796	-0.255	-6.139	-0.068	-2.407	0.525	106.66
M1HU Iran	Iran	M1HU	742	-0.001	-0.965	1.893	24.477	0.265	4.388	-0.165	-2.182	-0.130	-2.727	0.521	16.44
Budapest SE	Hungary	BUX	795	0.000	-0.549	1.339	26.069	0.063	1.632	-0.006	-0.128	-0.111	-3.590	0.520	190.81
KOSPI 200 Index	South Korea	KOSPI2	795	-0.001	-1.102	1.184	21.807	0.231	5.619	-0.534	-11.131	-0.035	-1.083	0.519	40.44
FTSE JSE Namibia	Namibia	FTN098	588	0.000	0.082	1.098	20.162	0.097	2.018	-0.341	-6.033	-0.001	-0.037	0.511	135.66
Bovespa	Brazil	IBOV	795	-0.001	-0.632	1.389	23.098	0.229	5.046	-0.307	-5.769	-0.021	-0.572	0.491	23.19
FTSE/JSE Top40	South Africa	TOP40	795	0.001	1.073	1.106	24.507	-0.028	-0.826	-0.154	-3.857	-0.035	-1.298	0.490	69.82
Russian Trad System	Russia	RTSI	795	0.000	-0.172	1.699	20.993	0.498	8.145	-0.291	-4.059	-0.070	-1.436	0.466	76.58
WIG20 Index	Poland	WIG20	795	-0.001	-1.181	1.191	22.441	0.071	1.774	-0.127	-2.695	-0.097	-3.043	0.460	38.21
S&P CNX Nifty	India	NIFTY	795	0.001	0.832	1.184	21.860	-0.123	-3.004	-0.098	-2.050	0.045	1.377	0.408	118.96
Ipsa	Chile	IPSA	795	0.000	0.173	0.783	19.133	0.046	1.498	-0.285	-7.869	0.036	1.462	0.407	3.00
Athens SE General	Greece	FTASE	795	-0.005	-3.468	1.498	18.806	0.196	3.262	-0.079	-1.120	-0.129	-2.680	0.377	119.60
OMX sTallinn Index	Estonia	TALSE	795	0.001	1.166	1.017	20.418	0.005	0.135	0.460	10.441	0.065	2.174	0.376	213.92
MSCI Taiwan Index	Taiwan	TAMSCI	795	-0.002	-1.650	1.036	18.124	0.069	1.589	-0.228	-4.514	-0.011	-0.318	0.360	136.39
Cyprus SE General	Cyprus	CYSMMAPA	551	-0.006	-2.601	1.536	12.345	0.971	8.590	0.172	1.302	0.068	0.842	0.359	106.83
Jakarta LQ45 Index	Indonesia	LQ45	795	0.001	0.880	1.027	15.887	0.014	0.286	-0.514	-8.986	0.052	1.342	0.351	200.59
Merval Buenos Aires	Argentina	MERVAL	795	0.002	1.502	1.627	18.892	0.112	1.714	-0.021	-0.275	-0.032	-0.616	0.351	0.94
OMX Vilnus Index	Lithuania	VILSE	794	0.001	0.716	0.881	18.478	0.057	1.587	0.448	10.632	0.060	2.100	0.346	65.92
SET50 Index	Thailand	SET50	795	0.000	-0.331	1.083	18.286	0.083	1.849	-0.133	-2.538	0.054	1.499	0.339	6.27
Colcap	Colombia	COLCAP	662	0.002	1.581	0.777	13.310	0.149	3.108	-0.298	-5.116	0.032	0.880	0.298	5.38
Ljubljana SE	Slovenia	SBITOP	625	-0.001	-1.049	0.822	15.790	-0.082	-1.820	0.180	3.396	0.000	-0.011	0.297	3.65
Belgrde SE	Serbia	BELEX15	494	-0.001	-0.730	1.110	13.353	-0.084	-1.090	0.484	5.178	0.164	2.970	0.276	21.74
Bucharest SE	Romania	BET	795	0.002	1.510	1.121	16.186	0.140	2.680	0.136	2.216	0.076	1.820	0.271	104.56
FTSE Bursa Malaysia	Malaysia	FBMKLCI	795	0.000	-0.313	0.592	15.895	0.000	-0.003	-0.054	-1.638	0.063	2.808	0.264	24.51
Istanbul SE 30 Index	Turkey	XU030	795	0.001	0.483	1.449	15.174	0.100	1.383	-0.038	-0.445	-0.006	-0.096	0.257	70.97
PSEi Index	Philippines	PCOMP	795	0.000	0.456	0.840	15.078	0.041	0.981	-0.030	-0.610	0.001	0.031	0.253	31.19
Tel Aviv 25 Index	Israel	TA-25	795	0.000	0.297	0.774	15.672	-0.036	-0.959	-0.017	-0.392	0.072	2.407	0.250	218.25
Ukraine PFTS Index	Ukraine	PFTS	795	0.002	1.054	1.214	13.848	0.093	1.411	0.203	2.612	0.107	2.030	0.206	3.30
FTSE Nasdaq Dubai 20	UAE	DUAE	458	0.000	0.138	1.128	10.692	-0.342	-3.341	0.429	3.465	0.022	0.311	0.205	25.82
SOFIX	Bulgaria	SOFIX	752	0.001	0.841	0.866	11.747	-0.040	-0.706	0.491	6.867	0.090	2.012	0.178	6.17
Egyptian EGX30	Egypt	EGX30	795	0.002	1.124	1.023	12.244	-0.038	-0.601	0.252	3.412	0.100	1.986	0.162	152.09
MBI 10	Macedonia	MBI	534	0.000	0.255	0.899	9.669	-0.080	-0.936	0.388	3.847	0.128	2.080	0.156	7.07
MONEX20	Montenegro	MONEX20	629	0.003	1.607	0.845	8.721	0.062	0.737	0.559	5.672	0.166	2.749	0.142	21.07
Mauritius SE	Mauritius	SEMDEX	795	0.001	1.414	0.401	10.891	0.012	0.420	0.084	2.589	0.093	4.184	0.136	12.75
FTSE China A50	China	XIN9I	609	0.000	0.310	0.706	8.102	-0.385	-5.031	-0.056	-0.630	0.071	1.277	0.133	66.83
KSE 15 Index	Kuwait	KSX15	149	0.000	-0.018	0.251	1.816	0.053	0.463	-0.218	-1.819	-0.145	-2.179	0.130	167.91
FTSE NSE Kenya 25	Kenya	FNKEN2	204	0.002	1.465	0.581	4.529	-0.061	-0.530	-0.057	-0.428	0.171	2.376	0.112	22.53
Bahrain Bourse	Bahrain	BHSEASI	559	-0.001	-0.884	0.239	6.634	-0.095	-2.897	0.231	6.036	0.033	1.429	0.106	73.33
Quatar Exchange Index	Quatar	DSM	795	0.002	1.734	0.652	9.371	-0.105	-1.994	0.207	3.356	0.075	1.787	0.102	172.11
Vietnam HO Chi Minh	Vietnam	VNINDEX	765	0.001	0.732	0.664	7.509	0.138	2.016	-0.278	-3.258	0.103	1.901	0.101	20.67
OMX Riga Index	Latvia	RIGSE	794	0.001	0.776	0.547	8.375	0.072	1.458	0.259	4.483	0.057	1.446	0.099	46.70
Muscat Securities	Oman	MSM30	795	0.000	0.496	0.448	8.811	-0.129	-3.355	0.106	2.359	0.095	3.085	0.096	18.32
TASI Tadawul All	SaudiArabia	SASEIDX	795	0.002	1.328	0.605	8.556	-0.216	-4.046	0.152	2.425	0.033	0.780	0.095	65.51
Slovak Share Index	Slovakia	SKSM	795	0.001	1.065	0.323	5.922	-0.050	-1.210	0.351	7.280	0.042	1.265	0.085	189.38
Colombo SE All Share	Sri Lanka	CSEALL	795	0.002	2.321	0.459	7.998	0.033	0.763	0.166	3.267	0.084	2.425	0.083	213.47
Laos SE Composite	Laos	LSXC	219	0.002	1.053	0.395	2.025	0.277	1.630	0.219	1.065	0.220	2.096	0.064	17.76
Karachi SE Index	Pakistan	KSE100	795	0.003	2.846	0.448	6.452	-0.029	-0.548	-0.095	-1.544	0.048	1.147	0.061	111.23
Ghana SE Composite	Ghana	GGSECI	221	0.004	3.714	0.081	0.869	0.080	0.991	0.162	1.650	-0.063	-1.243	0.053	0.55
Tunisia SE	Tunisia	TUSI20	430	0.002	2.093	0.158	3.330	0.098	2.084	0.060	1.067	0.013	0.396	0.051	101.28
NGSE All Share Index	Nigeria	NGSEINDX	795	0.001	1.331	0.321	4.846	0.041	0.811	0.022	0.384	0.113	2.817	0.035	5.69
Casablanca SE	Morocco	MCSINDEX	795	0.000	0.363	0.205	4.841	-0.041	-1.274	0.008	0.223	0.027	1.074	0.030	68.28
MSE Top20 Index	Mongolia	MSETOP	795	0.006	2.272	0.497	2.970	0.000	-0.002	0.310	2.097	0.193	1.914	0.016	51.32
Iraq SE Index	Iraq	ISXGI	290	-0.001	-0.542	0.122	0.765	-0.114	-0.792	0.242	1.397	-0.127	-1.367	0.013	29.20
Tanzania Share Index	Tanzania	DARSTSI	434	0.004	4.498	0.027	0.622	-0.050	-1.181	0.017	0.320	-0.027	-0.895	0.005	21.35

The data cover the period between 2000-2015. Results are sorted from the highest to the lowest Rsquared values, for developed and emerging markets separately. Additionally, all significant *t*-Statistics are marked with grey background. Factors are based on top/bottom decile groups. WML factor is based on returns form last 2 months

Source: own calculations

In the results section we refer only to the four-factor model because its explanatory power was higher than three-factor model. Our results for equity indices are in many ways similar to well know studies for stock returns ([Lieksnis 2010], [Davis et al. 2000]), however they do not reveal so strong effects as was presented in the literature before. Therefore our main conclusions can be summarized as follows:

1. The highest explanatory power of the four-factor model we observe mainly for developed equity indices. In this group almost all Rsquared values are higher that 50%. On the other hand, for emerging markets they get much lower values.
2. The results of regressions for developed countries with highest Rsquared coefficients have negative (but close to zero) alpha coefficients (significant in 50% of cases) which informs us that there was no any additional returns which were not explained by four-factor model.
3. On the other hand, most alpha coefficients for emerging equity indices are positive but still rather insignificant.
4. Stability of risk factors effects can be observed only with regards to WML factor, which reveals a strong short-term momentum effect stable over 15 years period of research.

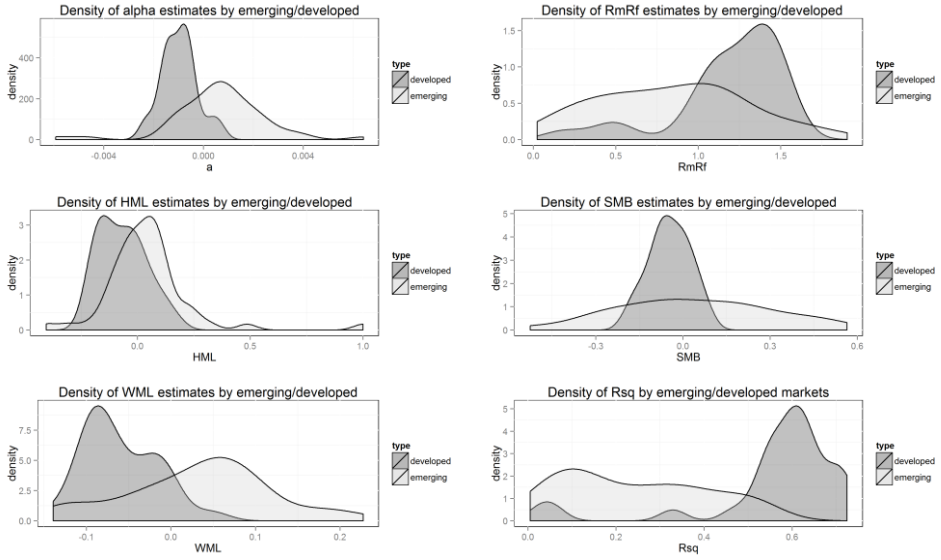
In order to draw more conclusions with regards to different results for developed and emerging markets, we analyzed the densities of parameters estimates and Rsquared values separately for these two types of equity indices (Figure 5).

Conclusions can be summarized as follows:

1. We observe significant difference between positive alpha for emerging and negative alpha for developed markets.
2. Beta for (R_m-R_f) factor is substantially higher for developed countries and additionally less diversified across countries.
3. The sensitivity to HML factor is higher for emerging markets, however again it is much more diversified for emerging equity indices.
4. The means of SMB beta estimates are almost equal, however their diversity is much higher for emerging market as well.
5. Characteristics of WML beta estimates is very similar to HML but the difference between means of beta and the diversity of betas is even larger.
6. Separate histograms for Rsquared for developed and emerging markets confirmed previous observations that regression for developed markets have higher explanatory power than these for emerging markets.

Above mentioned observations suggest that the four-factor model of Carhart can be quite robust approach for developed markets with high explanatory power. However, it should be amended and enhanced with additional risk factors for emerging markets.

Figure 5. Kernel density of parameter estimates and Rsquared values using Gaussian kernel function, separately for developed and emerging equity indices



The data cover the period between 2000-2015 (from 1990 only for R_m-R_f factor).

Source: own calculations

SUMMARY

It is not easy to summarize results which are only partly in line with other studies already presented in the literature and are only the first part of rather larger attempt to fully understand cross-section of equity indices returns. The most intriguing part revealing some light on equity indices returns is the difference of results for developed and emerging markets.

The main result is that using the well-known four-factor model we can only explain the variability of developed markets returns. On the other hand, emerging market equity indices require further investigation and research should be focused mainly on additional factors and on novel model implementation.

Further research should address the following questions:

- Are sensitivities to risk factors stable during various phases of economic cycles?
- Do correlations among international equity markets differ between high and low volatility periods?
- Can we build a zero investment portfolio with positive alpha based on analyzed risk factors?
- Which risk factor is the most important in portfolio construction?

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