A Formal Test of Asymmetric Correlation in Stock Market Returns and the Relevance of Time Interval of Returns – a Case of Eurozone Stock Markets

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Abstract: The paper examines the asymmetry of correlation between the Eurozone's stock market returns. The asymmetry of correlation is investigated pair-wise, by estimating the exceedance correlation between returns of two stock markets at a time. As markets can be very volatile, especially in crisis periods, and because there are investors with different investment horizons, we investigate whether the results are sensitive to time interval of stock market returns. We found that the results of the exceedance correlation estimates and the asymmetric correlation test do depend on the time interval of returns. When longer time interval returns (20-day moving average returns) are used, the Eurozone stock markets' returns' dynamics are more (pair-wise) correlated in the falling markets than in the up markets, while for daily returns, the correlations in the up markets are higher for most of the investigated Eurozone's stock indices pairs. An important implication of the results of the paper is that investors in stock markets should investigate the exceedance correlations and asymmetry of correlation for those return intervals (daily, weekly, monthly, etc.) that correspond to their investment horizon.

Keywords: stock markets; asymmetric correlation; Eurozone

1 Introduction

The study of asymmetric dependence (or asymmetric correlation) is important from the point of view of optimal portfolio allocation and risk management. Since the seminal works of [12] it is recognized that (international) diversification reduces a portfolio's total risk due to non-perfect positive co-movement between returns of the portfolio assets. However, from an investment perspective, diversification (low correlation between assets in a portfolio) is only desirable in falling (or ″down″) markets, whereas in rising (or ″up″) markets it is undesirable, and thus investors prefer assets that are highly correlated.

The benefits of diversification in stock markets have been questioned by a number of empirical studies (e.g. [11], [2], [5], [9], [13]), showing that correlations between returns of portfolios of stocks or between returns of stock indices are higher in down markets than in up markets[1]. The existence of asymmetric correlation implies that the practical benefits of diversification are substantially reduced for investors in stock markets. In [9], the authors argue that gaining information on asymmetric correlation can add substantial economic value to investors. The knowledge of asymmetric correlation in stock market returns is also important for supervisory authorities because of their implications for the stability of financial markets, and for the central banks in conducting monetary policy ([6], [3]).

The existent empirical studies on analysis of time-varying and potentially asymmetric dependence structures in stock markets predominately apply the multivariate GARCH models ([5], [13], [8]), copula functions ([10]) and the recently developed tests of asymmetric dependence ([11], [2], [9]). The measurement of asymmetry of correlation is not an easy task. In [4] and [7] it is noted that calculating correlations conditional on high or low returns, or high or low volatility, induces a conditioning bias in the correlation estimates. The recently developed tests of asymmetric dependence of [11], [2] and [9] resolve this issue as they measure correlation asymmetry by looking at behavior in the tails of the return distribution.

The novel test of correlation asymmetry of [9] has gained a lot of popularity due to its appealing features: it is a model-free test, so it can be used without having to specify a statistical model for the data. Unlike many of asymmetry tests that impose normality assumption on the data, the test allows for general distributional assumptions. The test statistic is also easy to implement and its asymptotic distribution follows a standard chi-square distribution under the null hypothesis of symmetry.

This paper provides the most recent evidence of asymmetry of correlation between Eurozone stock market returns for the period between December 3, 2003 and January 27, 2012, applying the test of Hong et al. (2007). Asymmetry of correlation is investigated pair-wise, by estimating the exceedance correlations between two stock market returns at a time. [11], [2], and [9] use monthly returns in their tests of asymmetry of correlation. Many investors in stock markets, however, have investment horizons that are shorter than one month. In this paper we examine whether the time interval of returns impacts the estimates of tests of asymmetry of correlation of [9] by comparing the results for 20 trading days (approximately one calendar month) moving average returns and daily returns.

1 For a review of factors that can influence the strength of comovement during up and down markets see [1].

2 Methodology

The asymmetry of correlation between stock market returns is investigated by estimating the exceedance correlations between two time series of stock market returns at a time. According to [11], exceedance is defined as a stock market return of a particular country that is above or below a certain exceedance level, c. Let $\{r_{1t}, r_{2t}\}$ be the returns of two stock markets (represented by two stock market indices) in period t. The exceedance correlation between the stock market returns at an exceedance level c is the correlation between the returns series, on condition that the returns of both stock indices are either at least c standard deviations above or at least c standard deviations below the mean value of the respective stock market returns:

$$\rho^{+}(c) = corr(r_{1t}, r_{2t} | r_{1t} > c, r_{2t} > c), \tag{1a}$$

$$\rho^{-}(c) = corr(r_{1t}, r_{2t} | r_{1t} < -c, r_{2t} < -c), \tag{1b}$$

where the returns are standardized to have zero mean and unit variance so that the mean and variance do not appear explicitly in the right-hand side of the equations (1a) and (1b).

Following [11], [2], and [9], we test whether the correlation between the upper-tail returns (i.e., returns at least c standard deviations above the mean return) and the lower-tail returns (i.e., returns at least c standard deviations below the mean return) of the two stock markets are the same. Thus, the null hypothesis of symmetric correlation is

$$H_0 : \rho^{+}(c) = \rho^{-}(c), \tag{2}$$

for all $c \geq 0$.

In [9], the authors provide a model free test for the null of symmetric exceedance correlations. They show that for the m chosen number of different exceedance levels, the vector

$$\rho^{+}(c) - \rho^{-}(c) = [\hat{\rho}^{+}(c_1) - \hat{\rho}^{-}(c_1), \ldots, \hat{\rho}^{+}(c_m) - \hat{\rho}^{-}(c_m)], \tag{3}$$

after being scaled by $\sqrt{T}$ (T is the size of a random sample of the returns series), under the null hypothesis of symmetry has an asymptotic normal distribution with zero mean and positive definite variance-covariance matrix, Ω, for all possible true distributions of the data.

Under condition that r_{1t} and r_{2t} are larger than c simultaneously, the sample means and variance of these conditional time series are computed

$$\hat{\mu}_1^+(c) = \frac{1}{T_c^+} \sum_{t=1}^{T} r_{1t} \big| (r_{1t} > c, r_{2t} > c) , \qquad (4a)$$

$$\hat{\mu}_2^+(c) = \frac{1}{T_c^+} \sum_{t=1}^{T} r_{2t} \big| (r_{1t} > c, r_{2t} > c) , \qquad (4b)$$

$$\hat{\sigma}_1^+(c)^2 = \frac{1}{T_c^+ - 1} \sum_{t=1}^{T} [r_{1t} - \hat{\mu}_1^+(c)]^2 \big| (r_{1t} > c, r_{2t} > c) , \qquad (4c)$$

$$\hat{\sigma}_2^+(c)^2 = \frac{1}{T_c^+ - 1} \sum_{t=1}^{T} [r_{2t} - \hat{\mu}_2^+(c)]^2 \big| (r_{1t} > c, r_{2t} > c) , \qquad (4d)$$

where $\hat{\mu}_1^+(c)$ and $\hat{\mu}_2^+(c)$ are the estimated conditional means of the series and $\hat{\sigma}_1^+(c)^2$ and $\hat{\sigma}_2^+(c)^2$ the estimated conditional variance of the series.

The sample conditional correlation $\hat{\rho}^+(c)$ is then given by:

$$\hat{\rho}^+(c) = \frac{1}{T_c^+ - 1} \sum_{t=1}^{T} [\hat{X}_{1t}^+(c) \hat{X}_{2t}^+(c) \big| (r_{1t} > c, r_{2t} > c) , \qquad (5)$$

where $\hat{X}_{1t}^+(c) = \frac{r_{1t} - \hat{\mu}_1^+(c)}{\hat{\sigma}_1^+(c)}$, and $\hat{X}_{2t}^+(c) = \frac{r_{2t} - \hat{\mu}_2^+(c)}{\hat{\sigma}_2^+(c)}$. The same computations apply also for $\hat{\rho}^-(c)$.

The authors of [9] prove that the null hypothesis of symmetric correlation can be tested by the J_p statistics which under the null hypothesis and under certain regularity conditions is asymptotically chi-square distributed with m degrees of freedom

$$J_p = T(\hat{\rho}^+(c) - \hat{\rho}^-(c)) \hat{\Omega}^{-1} (\hat{\rho}^+(c) - \hat{\rho}^-(c)) \sim \chi_{\boldsymbol{m}}^{\boldsymbol{2}} , \qquad (6)$$

where $\hat{\rho}^+(c) - \hat{\rho}^-(c)$ is defined by equation (3) and $\hat{\Omega}$ is consistent estimate of the asymptotic covariance matrix of $\hat{\rho}^+(c) - \hat{\rho}^-(c)$. The variance-covariance matrix is given by

$$\hat{\Omega} = \sum_{1-T}^{T-1} k(\frac{1}{p}) \hat{\gamma}_1 , \qquad (7)$$

where $\hat{\gamma}_1$ is an $N \times N$ matrix with (i, j)-th element

$$\hat{\gamma}_1(c_i c_j) = \frac{1}{T} \sum_{t=|l|+1}^{T} \hat{\varsigma}_t(c_i) \hat{\varsigma}_{t-|l|}(c_j), \tag{8}$$

and

$$\hat{\varsigma}_t(c) = \frac{1}{T_c^+}[\hat{X}_{1t}^+(c)\hat{X}_{2t}^+(c) - \hat{\rho}^+(c)]\Big|(r_{1t} > c, r_{2t} > c) - \frac{1}{T_c^-}[\hat{X}_{1t}^-(c)\hat{X}_{2t}^-(c) - \hat{\rho}^-(c)]\Big|(r_{1t} < -c, r_{2t} < -c), \tag{9}$$

where $k(\cdot)$ is a Bartlett kernel function that assigns a suitable weight to each lag of order l; p is the smoothing parameter or lag truncation order.

3 Data and Empirical Results

The symmetry of correlation between returns of Eurozone's stock markets, listed in Table 1, is analyzed for the period from December 3, 2003 to January 27, 2012. The main stock indices returns were used as proxies for stock market returns of particular countries. The returns were calculated as the differences in the logarithms of the daily closing prices of indices ($\ln(P_t) - \ln(P_{t-1})$, where P is an index value). The stock indices included are: the ATX (for Austria), CAC40 (for France), DAX (for Germany), FTSE100 (for the U.K.), FTSEMIB (for Italy), ISEQ (for Ireland), and IBEX35 (for Spain). Days with no trading in any of the observed market were left out. The data for stock indices is Yahoo! Finance. Table 1 presents descriptive statistics of the data.

Table 1

Descriptive statistics of stock indices returns

	Min	Max	Mean	Std. deviation	Skewness	Kurtosis	Jarque-Bera statistics
ATX	-0.1637	0.1304	0.00018	0.0187	-0.2891	11.4275	5705.57***
CAC40	-0.0947	0.1059	-0.00003	0.0158	0.1642	10.4452	4440.75***
DAX	-0.0743	0.1080	0.00028	0.0153	0.1162	9.4645	3345.76***
FTSE100	-0.0927	0.1079	0.00014	0.0135	0.1914	12.3669	7027.12***
ISEQ	-0.1396	0.0973	-0.00024	0.0173	-0.5573	9.8403	3840.51***
FTSEMIB	-0.0997	0.1087	-0.00028	0.0162	-0.1569	9.6681	3563.07***
IBEX35	-0.116	0.1348	-0.00008	0.0160	0.0099	12.0721	6580.83***

*Notes: The Jarque-Bera statistics: *** indicate that the null hypothesis (of normal distribution) is rejected at a 1% significance level.*

All series display significant leptokurtic behavior as evidenced by the large kurtosis with respect to the Gaussian distribution. The Jarque-Bera test rejects the hypothesis of normally distributed time series. We also tested for the stationarity of time series by the Augmented Dickey-Fuller (ADF) test, the Phillips-Perron (PP) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, and the results led to conclusion of no unit root in returns series[2].

Table 2 reports pair-wise Pearson's correlation coefficients for the returns of stock indices. Notably, the greatest correlation is observed between the DAX-CAC40, CAC40-FTSE100 and CAC40-FTSEMIB, while the lowest is between ISEQ and IBEX35.

Table 2
Pearson's correlation of Eurozone stock market returns

	ATX (Austria)	CAC40 (France)	DAX (Germany)	FTSE100 (U.K.)	ISEQ (Ireland)	FTSEMIB (Italy)	IBEX35 (Spain)
ATX	1						
CAC40	0.8187	1					
DAX	0.7867	0.9332	1				
FTSE100	0.7994	0.9262	0.8717	1			
ISEQ	0.7179	0.7619	0.7093	0.7528	1		
FTSEMIB	0.7933	0.9171	0.8633	0.8395	0.7097	1	
IBEX35	0.7819	0.8926	0.8350	0.8230	0.6900	0.8880	1

Notes: All the correlation coefficients are significantly different from zero.

Next, we report the estimates of the exceedance correlation and the results of the test of correlation symmetry for the particular pair-wise investigated stock markets for 20-day moving average returns, computed at singleton exceedance level $c = \{0\}$ (Table 2). The second column of Table 3 reports the p-value of the J_p statistics and the third column the difference between the upper-tail and lower-tail correlation, $\hat{\rho}^+(c) - \hat{\rho}^-(c)$. Following [8] the test of correlation asymmetry is computed also for a set of exceedance levels, $c = \{0, 0.5, 1, 1.5\}$. The results for the set of exceedance levels and the corresponding p-values are given in columns four through eight.

Notably, for a singleton exceedance level, $c = \{0\}$, as well as for a set of excedance levels, $c = \{0, 0.5, 1, 1.5\}$, the difference between the upper-tail and the lower-tail correlations, $\hat{\rho}^+(c) - \hat{\rho}^-(c)$, is negative. Stock markets are thus more correlated in down than in up markets, which is in accordance with the findings of

2 The results are not presented here, but can be obtained from the author.

[11], [2], and [9]. The test of correlation asymmetry, however, does not significantly (at 5% significance level) reject the null hypothesis of symmetry of the upper- and lower-tail correlations for any observed stock indices pairs.

Table 3

Results of the correlation asymmetry test for 20-day simple moving average returns of stock indices

Stock market indices	$c=\{0\}$		$c=\{0,0.5,1,1.5\}$				
	p-value	$\hat{\rho}^+(c)-\hat{\rho}^-(c)$	p-value	$\hat{\rho}^+(c)-\hat{\rho}^-(c)$; $c=0$	$\hat{\rho}^+(c)-\hat{\rho}^-(c)$; $c=0.5$	$\hat{\rho}^+(c)-\hat{\rho}^-(c)$; $c=1$	$\hat{\rho}^+(c)-\hat{\rho}^-(c)$; $c=1.5$
ATX-CAC40	0.2073	-0.2924	0.4299	-0.2924	-0.2036	-0.2014	-0.3531
ATX-DAX	0.2934	-0.2638	0.5247	-0.2638	-0.1732	-0.1471	-0.2940
ATX-FTSE100	0.1872	-0.3479	0.3648	-0.3479	-0.3266	-0.4320	-0.1359
ATX-FTSEMIB	0.4659	-0.1978	0.1408	-0.1978	0.0001	0.1827	0.3955
ATX-ISEQ	0.4755	-0.1954	0.8696	-0.1954	-0.2167	-0.2347	-0.0128
ATX-IBEX35	0.3866	-0.1884	0.4262	-0.1884	-0.0761	0.2006	0.2253
CAC40-DAX	0.7461	-0.0743	0.9954	-0.0743	-0.0723	-0.0859	-0.0850
CAC40-FTSE100	0.6231	-0.1107	0.9479	-0.1107	-0.1054	-0.1706	-0.1874
CAC40-ISEQ	0.5537	-0.1247	0.5050	-0.1247	-0.0711	-0.2439	-0.3445
CAC40-FTSEMIB	0.6509	-0.1037	0.7332	-0.1037	-0.1155	-0.2291	-0.3686
CAC40-IBEX35	0.4144	-0.1484	0.6594	-0.1484	-0.1283	-0.0196	-0.1419
DAX-FTSE100	0.4321	-0.1879	0.7667	-0.1879	-0.1894	-0.2837	-0.3368
DAX-ISEQ	0.7764	-0.0637	0.5081	-0.0637	-0.0459	-0.1836	0.1378
DAX-FTSEMIB	0.7285	-0.0902	0.5067	-0.0902	-0.0204	-0.0575	-0.2808
DAX-IBEX35	0.6623	-0.0882	0.5015	-0.0882	0.0650	0.1717	0.0042
FTSE100-FTSEMIB	0.3275	-0.2299	0.5743	-0.2299	-0.2121	-0.3097	-0.1834
FTSE100-ISEQ	0.2692	-0.2768	0.4039	-0.2768	-0.2855	-0.4956	-0.5434
FTSE100-IBEX35	0.4629	-0.1327	0.6741	-0.1327	-0.0328	-0.0779	0.0662
ISEQ-FTSEMIB	0.9093	-0.0281	0.2965	-0.0281	0.1179	-0.0116	0.1391
ISEQ-IBEX35	0.6658	-0.0814	0.4716	-0.0814	0.0906	0.2512	-0.0377
FTSEMIB-IBEX35	0.7441	-0.0772	0.9300	-0.0772	0.0025	0.0754	0.1302

Notes: Two sets of exceedance levels were used to perform the test. The first is the singleton $c=\{0\}$ *and the second is* $c=\{0,0.5,1,1.5\}$. $\hat{\rho}^+(c)-\hat{\rho}^-(c)$ *represents the difference in correlation for the exceedance level* c *. P-value is a significance level of rejecting the null hypothesis of symmetric correlation. The lower the p-value, the more asymmetric are the lower- and the upper-tail correlations.*

As noted by [9], a large difference of correlation of returns between up and down markets does not mean that there is necessarily a genuine difference in the population parameters. There are always differences in the sample estimates simple due to sample variations. We can observe that for some stock indices pairs $\hat{\rho}^+(c)-\hat{\rho}^-(c)$ gets more negative when exceedance level increases (for instance CAC40-FTSE100, DAX-FTSE100 or FTSE100-ISEQ), whereas for some others the difference between the upper- and lower-tail correlation reduces or even becomes positive (for instance ATX-FTSEMIB, ATX-IBEX35, FTSEMIB-IBEX35).

This striking difference in exceedance correlations between stock markets has important implications for investors in investigated stock markets. As already noted, from the investment perspective, a low correlation between asset returns is only desirable in falling markets, whereas in the up markets, a high correlation is desirable. The investors that internationally diversify their portfolios in stock markets for which $\hat{\rho}^{+}(c)-\hat{\rho}^{-}(c)$ is positive and increases with exceedance level would therefore be better off than those who invest in stock markets for which $\hat{\rho}^{+}(c)-\hat{\rho}^{-}(c)$ is negative and becomes even more negative when the exceedance level increases.

Let us now take into account that stock markets can be very volatile, especially in crisis periods. For investors with shorter investment horizons (shorter than 20 trading days) it is therefore important to know whether the time interval of returns impacts the estimates of exceedance correlation and correlation asymmetry test. For this purpose, the exceedance correlations and test of asymmetric correlation of [9] were recomputed for daily returns.

As the results in Table 4 show, for a singleton exceedance level, $c=\{0\}$, there are now 5 out of 21 investigated stock market pairs for which the lower-tail correlation (i.e. for returns below the mean return for each the returns series) is higher than the upper-tail correlation: ATX-ISEQ, CAC40-DAX, CAC40-DAX, DAX-IBEX35, and FTSE100-ISEQ. However, for a set of exceedance levels $c=\{0,0.5,1,1.5\}$ we find that as the exceedance level is increased, the upper-tail correlation normally exceeds the lower-tail correlation, and at the exceedance level $c=\{1.5\}$ the upper-tail correlation is higher than lower-tail correlation for all investigated stock market pairs. For a singleton exceedance level, as well as for the set of exceedance levels, the null hypothesis of symmetric correlation, however, still cannot be rejected for any of investigated stock markets pair.

Comparing the results of Tables 3 and 4, evidently the results of exceedance correlation estimates are very much dependent on the time interval of returns. Whereas for the 20-day moving average returns, the upper-tail correlations are mostly smaller than lower-tail correlation, for daily returns the upper-tail correlations are higher than the lower-tail correlations for most of investigated stock indices pairs (or all indices pairs at exceedance level $c=1.5$). Another implication for investors in the investigated stock markets is therefore to investigate exceedance correlations and asymmetry of correlation for those returns intervals (daily, weekly, monthly, etc.) that correspond to their investment horizons.

Table 4
Results of the correlation asymmetry test for daily returns of stock indices

Stock market indices	$c=\{0\}$		$c=\{0,0.5,1,1.5\}$				
	p-value	$\hat{\rho}^{+}(c) - \hat{\rho}^{-}(c)$	p-value	$\hat{\rho}^{+}(c) - \hat{\rho}^{-}(c)$; $c=0$	$\hat{\rho}^{+}(c) - \hat{\rho}^{-}(c)$; $c=0.5$	$\hat{\rho}^{+}(c) - \hat{\rho}^{-}(c)$; $c=1$	$\hat{\rho}^{+}(c) - \hat{\rho}^{-}(c)$; $c=1.5$
ATX-CAC40	0.6306	0.0619	0.7039	0.0619	0.1106	0.2168	0.3106
ATX-DAX	0.5106	0.0766	0.4122	0.0766	0.1904	0.2569	0.3491
ATX-FTSE100	0.7974	0.0344	0.6866	0.0344	0.1151	0.2375	0.3208
ATX-FTSEMIB	0.5358	0.0767	0.8903	0.0767	0.1276	0.2025	0.1723
ATX-ISEQ	0.6364	-0.0635	0.0779	-0.0635	0.0362	0.0071	0.2445
ATX-IBEX35	0.8477	0.0250	0.5700	0.0250	0.0530	0.2076	0.3122
CAC40-DAX	0.9919	-0.0014	0.9999	-0.0014	0.0085	0.0190	0.0262
CAC40-FTSE100	0.9118	0.0177	0.9991	0.0177	0.0344	0.0629	0.0709
CAC40-ISEQ	0.9822	-0.0033	0.5144	-0.0033	0.0449	-0.0349	0.0979
CAC40-FTSEMIB	0.8868	0.0187	0.9777	0.0187	0.0483	0.0885	0.1420
CAC40-IBEX35	0.9201	0.0132	0.8917	0.0132	0.0340	0.0706	0.1795
DAX-FTSE100	0.9816	0.0034	0.9946	0.0034	0.0280	0.0625	0.0898
DAX-ISEQ	0.8467	0.0254	0.0586	0.0254	0.0887	-0.1046	0.1005
DAX-FTSEMIB	0.8390	0.0241	0.9919	0.0241	0.0536	0.0860	0.1002
DAX-IBEX35	0.9860	-0.0020	0.8721	-0.0020	0.0265	0.1177	0.1235
FTSE100-FTSEMIB	0.7304	0.0459	0.9030	0.0459	0.0841	0.1473	0.2024
FTSE100-ISEQ	0.9542	-0.0089	0.1047	-0.0089	0.0342	-0.1126	0.1168
FTSE100-IBEX35	0.8241	0.0291	0.8704	0.0291	0.0466	0.1154	0.1898
ISEQ-FTSEMIB	0.8115	0.0307	0.4956	0.0307	0.0862	0.0727	0.2560
ISEQ-IBEX35	0.9592	0.0064	0.4934	0.0064	0.1024	0.1175	0.2512
FTSEMIB-IBEX35	0.8245	0.0288	0.9574	0.0288	0.0642	0.1369	0.2098

Notes: Two sets of exceedance levels were used to perform the test. The first is the singleton $c=\{0\}$ and the second is $c=\{0,0.5,1,1.5\}$. $\hat{\rho}^{+}(c)-\hat{\rho}^{-}(c)$ represents the difference in correlation for the exceedance level c. P-value is a significance level of rejecting the null hypothesis of symmetric correlation. The lower the p-value, the more asymmetric are the lower- and the upper-tail correlations.

Conclusions

This paper provides the most recent evidence of the asymmetry of correlation between Eurozone stock market returns for the period between December 3, 2003 and January 27, 2012, applying the test of [9]. The asymmetry of correlation was investigated pair-wise, by estimating the exceedance correlations between two stock market returns at a time. In order to check whether the results are sensitive to time interval of stock market returns, computations were performed for 20-day moving average returns and for daily returns.

We found that when 20-day moving average returns are used, the Eurozone stock markets' returns dynamics are more (pair-wise) correlated in falling markets than in up markets, whereas the opposite holds true for daily returns. This, however,did not impact the results of the test of correlation asymmetry for the data of our sample.

The results of the paper have important implications for investors in the investigated stock markets. From an investment perspective, low correlation between asset returns is only desirable in falling markets, whereas in up markets it is undesirable, and thus investors prefer assets that are highly correlated. The investors that internationally diversify their portfolios in stock markets for which the difference between correlation in up and down markets is positive, and increases with exceedance level, would therefore be better off than those who invest in stock market for which the difference in the upper- and lower-tail correlation is negative and becomes even more negative when the exceedance level increases. Investors in the investigated stock markets should investigate the exceedance correlations and the asymmetry of correlation for those returns intervals (daily, weekly, monthly, etc.) that correspond to their investment horizons.

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