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## International Portfolio Diversification: Evidence from European Emerging Markets

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### **Abstract**

*This paper examines the short-term and long-term relationships among eight European stock markets from 2000 to 2008. Three of these markets are considered mature: Euronext, Germany and Greece. The remaining five are considered emerging: Bulgaria, Cyprus, Romania, Slovenia and Turkey. We apply exhaustive statistical and econometric tests together with long-run cointegration and correlation analyses that yield mixed results concerning the markets' relationships. We switch to a dynamic model of different interval moving averages, comparing the outcomes and revealing the individual characteristics of each market. The results are robust to sensitivity analysis based on partitioning the sample into multiple sub-periods and on translating indices to the Euro, the common currency for practically all of the markets. In addition, the Euronext and Germany stock exchanges serve as benchmarks and each equity market is examined from their point of view. Evidence shows that equity integration is existent, making international portfolio diversification less effective.*

**JEL Classification:** C10; G10; G13

**Keywords:** Portfolio diversification, European emerging stock markets, dynamic interdependency, cointegration, correlation.

### **1. Introduction**

The issue of stock market integration has become of fundamental significance to contemporary investment policy. The increase in liquidity and wealth has resulted in an explosion of the capital markets and cross-border investing has become a common practice. In search of alternative assets, investors have gradually shifted their interest to non-traditional emerging markets that promised increased returns. Banks and financial institutions have created new international products and services in order to satisfy the growing appetite of institutional and individual

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customers. Financial deregulation of the markets, relaxed currency exchange restrictions and corporate expansion have further contributed in globalization of the markets and potentially in stronger ties between the equity markets.

According to theory, this increased number of available assets offers higher portfolio diversification potential. However, there is mounting evidence that equity integration globally has developed to such a degree which leads to a compromise: the promising emerging markets fail to behave independently and stock linkages result in increased risk tolerance. In this paper we study the behavior of eight European stock markets, three mature and five emerging, in order to examine the potential for portfolio diversification. We apply exhaustive statistical and econometric tests together with long-run cointegration and correlation analyses that yield mixed results concerning the markets' relationships. We test both the means and the distributions of return and risk figures. Additionally, we apply a dynamic model of moving average correlations with two different intervals and use Euronext and Germany as benchmarks against all remaining stock exchanges.

## **2. Literature Review**

Integration in stock markets is an issue that has become of fundamental importance to researchers particularly in the last few years with the explosion of the trading volume internationally. The general idea refers to the homogeneity in the assets' behavior and their reaction to domestic or international news. In such a way, integration can refer to the domestic behavior of one market's traded assets, or to the relationship between international markets. In literature, comovement is usually referring to the behavior of many assets in one single market, and equity integration to that of many markets globally. Kearney and Lucey (2004) offer a comprehensive literature review on equity market integration and its definitions. The set up in global equity markets has changed significantly the last ten years; the dominance of the US stock market and those of Japan and the developed Europe has been challenged by the rising regional powers in Asia, Eastern Europe and Latin America, as a result of the tremendous shift in global wealth. There is no doubt that additional investment choices offer higher potential for portfolio diversification, and at first-look it seems that these new markets have managed to offer it. Nevertheless, there is a growing feeling among professionals and individual investors that global markets tend to move in a similar way, and local crises are exported outside the domestic borders (Thalassinos, Kiriazidis, 2003). Depending on the size of the market and the gravity of the problem, the effects travel quickly from market to market, sometimes in one single day, from the Far East to Asia, Europe and the Americas. The contemporary credit crisis that troubles equity markets, the Asia crisis in the first quarter of 2007, the London subway bombings in 2005, the September 11 tragic events and the Russian crisis in 1998 are just a few recent examples when capital markets reacted in quite analogous manner.

Comovement and integration, both domestically and internationally, have been explored in various contexts. In their seminal paper Barberis et al. (2005) classified comovement in return in sub-categories: the traditional fundamental one and the alternative friction-based one, under which return comovement is delinked from fundamentals due to market frictions and noise-trader sentiment. In an early study Ghosh et al. (1999) investigate short-run cointegration relationships among the US, Japan and nine Asia-Pacific markets and find mixed results: some stock markets followed Japan, some others the US and a few have no relationship at all. Huang et al. (2000) explore the causality and integration relationships among the equity markets of the South China growth triangle, Japan and the United States, and find no cointegration existing for the period from 1992 to 1997. Some exceptions do exist in between some local markets, but in the general picture is that markets move in an independent way. Caporale et al. (2005) also study the East-Asia regional markets and find contagion existing. In a long-run study Engsted and Tanggaard (2004) examine from 1918 to 1999 the US and UK markets and discover comovement that results from simultaneously revised investors' expectations. Li et al. (2005) study the return – volatility relationships in the twelve biggest international equity markets and reach the conclusion that stock return volatility is negatively correlated with stock returns.

A very important article that redefined the meaning of contagion is that of Forbes and Rigobon (2002) who distinguished interdependence from contagion. The former refers to a constantly strong linkage among the markets, whereas the latter refers to a situation when there is a significant increase in comovement due to a shock, concluding that there is “no contagion, only interdependence” in the markets. Although we find the definition of contagion very appealing we believe that interdependence is understating the significance of correlation in international markets. Phylaktis and Ravazzolo (2005) study linkages between the stock markets of the Pacific-basin and the US and Japan over a twenty year period, from 1980 to 1998. Their results show that the relaxation of the restrictions the later years might have strengthened international market interactions although the foreign exchange restrictions might not be enough on their own. Furthermore, exclusion tests show that one cointegrating vector exists but not all countries enter the cointegrating space revealing the individual characteristics of each market. Based on deregulation is also the paper by Tan and Tse (2002) who use Geweke's measure of feedback and show the linkages among the markets have increased substantially leading to higher levels of interdependency. Aggarwal et al. (2006) apply a dynamic cointegration approach to the seven largest stock markets of the EU in order to inquire for time-varying integration between these markets and the US. Their recursive cointegration analysis shows that the US and European equity markets are interdependent in the long-run and this phenomenon rises in the more recent years. In a similar manner, our analysis calculates the cointegrating trace and eigenvalue figures and correlation

values for our sample data both on a static and in a dynamic recursive way that is explained in the methodology section of this article.

In addition, Chen et al. (2002) and Barari (2004) investigate the equity integration levels in Latin America. Chen et al. find a long-run relationship among the markets suggesting limited ability for risk diversification. Barari applies a time varying integration analysis on the stock markets of six countries of Latin America showing that integration is existent. Furthermore, that article distinguishes between an ever increasing global integration process from a decreasing regional integration, showing that regional markets lost their independent characteristics and gradually entered the global trend. Johnson and Soenen (2003) find a contemporaneous association between eight stock markets of the Americas and the US market. They argue that trade has a positive effect on stock market comovement whereas exchange rate volatility has a negative one. Similar are the results of another study of Johnson and Soenen (2002) that regards the integration of various Asian markets with that of Japan.

Likewise, our analysis involves stock markets with advanced trade transactions, limited cross-border regulations and single or linked currencies in most cases, allowing for economic integration. Voronkova (2004) and Syriopoulos (2004) examine a different region that of the emerging markets of Central Europe, with the developed ones of the UK, Germany, France and the U.S. Both studies conclude that strong ties among these markets exist, leaving little room for diversification. Syriopoulos finds stronger relationships between developed and emerging markets rather than between neighbors, meaning that international investors have even lower chance of risk diversification. On the contrary, an earlier study by Gilmore and McManus (2002) between the US and Central European markets finds no cointegrating relationship thus allowing for portfolio diversification. Nevertheless, it recognizes that same region markets of Central Europe move closely together. In a more recent study Kucukcolak (2008) finds cointegration existing among the eurozone markets of the UK, Germany, France and Greece, whereas Turkey's equity market remains rather independent, allowing for portfolio diversification. Martens and Poon (2001) instead of selecting the closing prices of each market they prefer the prices at 4 p.m. when the US, the UK and France markets are simultaneously operating. They find out a difference in market correlation estimates between synchronous and synchronized conditional measures, resulting to different portfolio strategies, respectively. A variation of this approach is used in our study by comparing the contemporaneous correlations among the markets during the sample period. Phylaktis and Xia (2006) offer a very interesting aspect of equity comovement, by exploring the contagion effects across the same sectors in different countries, showing that international contagion affects mainly sectors, leaving room for diversification. In the same way, Berben and Jansen (2005) examine the conditional correlations from 1980-2000 among the US, the UK and the German markets and find industry-level relationships. Brooks and Negro (2006) link

stock returns with company fundamentals and divide total shock into global, country and industry specific shocks, finding a significant link for global shocks.

The conclusions drawn by the existing literature is that equity market integration has increased in the last few years as a result of trade globalization, relaxed market restrictions, reduced transaction costs and the progress in technology and communication. Indeed, never before in history had it been so easy and affordable even to an individual investor, to monitor the price of assets listed in foreign stock markets and perform transactions simultaneously. Nevertheless, most research seems to doubt that the numerous investment choices offered in global stock markets constitute fully diversified alternatives and evidence shows that most markets are at least interdependent. Since markets are linked then the potential for portfolio diversification is limited and investors should lower their hedging expectations.

### **3. Data and Methodology**

This study examines eight organized stock markets: Euronext, Frankfurt, Athens, Istanbul, Bucharest, Sofia, Ljubljana and Nicosia. The indices selected are those preferred by international institutional analysts, which are respectively: Euronext-100, Dax-30, FTSE/ATHEX20, ISE-100, Bucha-BET, SOFIX, SBI-20 and CY-20. The daily closing prices of the stock indices have been selected through the Global Financial Data database. The time period examined spans from 2000 to 2008 and the number of observations in the sample for each index is 2050. In addition, the daily high and low prices (intraday range) have been collected for all markets but they were not available for all time: data for Frankfurt, Athens, Istanbul, Bucharest, and Nicosia are available from the beginning, whereas data Euronext from October 2000 and for Ljubljana and Sofia from May 2002. Bearing in mind that the major goal of this study is the inquiry of international diversification potential, the index prices have been collected in one single currency, the euro, incorporating exchange rate differences. It is noted that five markets are already euro denominated (Euronext, Germany, Greece, Slovenia and Cyprus), two have just entered the eurozone in January 2008 (Romania and Bulgaria) and Turkey remains in a long term orbit to enter the EU.

Daily index returns are calculated based on the logarithmic difference, as follows:

$$R_t = \ln \left( \frac{P_t}{P_{t-1}} \right)$$

Accordingly, Table 1 summarizes the average annual returns of the five stock exchanges in the greater Balkan and east Mediterranean region, i.e. Greece, Turkey, Romania, Bulgaria and Cyprus.

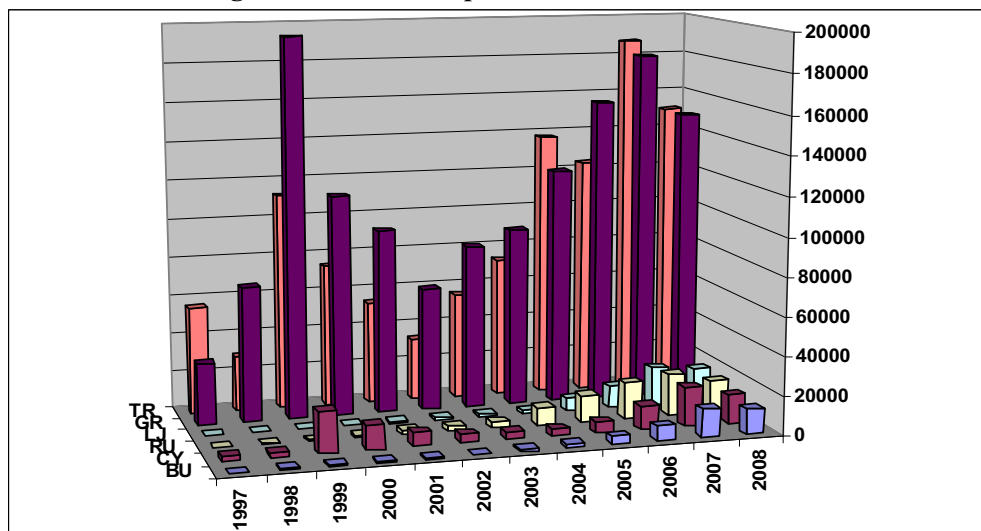
**Figure 1: Market Capitalization in thousands €**

Figure 1 offers a graphical representation of each market's capitalization in the last ten years. It is clearly noticeable that the size for each market varies heavily. Greece and Turkey have about the same capitalization while all remaining markets manage to reach the one tenth of the above size in the last few years. Understandably, Euronext and Germany are out of this graph due to their gigantic size compared to the above: Germany has a size that varies from 8 to 10 times bigger than that of Greece, and Euronext boasts a double (on average) size than that of Germany.

**Table 1: Annual Market Returns: Core markets**

<u>Year</u>	<u>Athens</u>	<u>Istanbul</u>	<u>Cyprus</u>	<u>Bucharest</u>	<u>Sofia</u>
1997-			n.a.		
1998	121.03%	-48.38%		51.14%	421.77%
1998-			n.a.		
1999	180.95%	289.93%		0.62%	-17.19%
2000-					
2001	-41.59%	-33.95%	-31.45%	30.12%	-6.60%
2001-					
2002	-16.63%	-28.38%	-15.49%	110.10%	-13.39%
2002-					
2003	-32.87%	-39.24%	-5.76%	9.20%	23.13%
2003-					
2004	32.70%	70.49%	55.51%	13.66%	99.80%
2004-	8.95%	31.86%	119.61%	197.35%	48.22%

2005					
2005-2006	32.69%	90.10%	64.52%	53.73%	108.51%
2006-2007	28.76%	-10.50%	-26.46%	39.32%	81.58%
2008, 1Q	14.84%	52.17%	-47.01%	14.14%	89.28%

The risk-free interest rates are not available for all countries during the sample period, thus volatility is measured through standard stock returns and not through excess stock returns. This article uses two proxies to calculate risk: the classical standard deviation and the daily volatility. In particular, we estimate the contemporaneous standard deviation, as follows:

$$\sigma_t = \sqrt{\frac{\sum_{t=1}^n (R_t - \bar{R})^2}{n-1}}$$

Accordingly, Tables 2a and 2b summarize the basic statistical characteristics of the return and series of all eight stock exchanges.

**Table 2a: Basic statistical characteristics; return series**

	Euronext	Germany	Greece	Turkey	Cyprus	Romania	Bulgaria	Slovenia
Mean	-4.36E-05	4.01E-05	-0.000186	-0.000261	-7.05E-05	0.000820	0.001364	0.000766
Median	0.000605	0.000787	0.000123	7.28E-05	-0.000202	0.001203	0.001021	0.000554
Maximum	0.063372	0.075527	0.086806	0.293711	0.081282	0.074192	0.217352	0.083109
Minimum	-0.070181	-0.091000	-0.096048	-0.288148	-0.110107	-0.103195	-0.197410	-0.063506
Std. Dev.	0.012770	0.015574	0.014172	0.033649	0.017187	0.015800	0.018721	0.007883
Skewness	-0.113613	-0.101143	-0.013011	-0.049189	-0.324519	-0.448576	-0.295495	0.206199
Kurtosis	6.420345	6.197180	7.598548	12.51117	6.932131	6.474006	32.33958	15.89310

**Table 2b: Basic statistical characteristics; price series levels**

	Euronext	Germany	Greece	Turkey	Cyprus	Romania	Bulgaria	Slovenia
Mean	794.4500	5295.725	1757.084	16352.16	705.7061	738.5685	323.3644	4427.736
Median	786.8900	5196.080	1750.740	14836.90	483.3550	425.9212	269.7088	4173.720
Maximum	1147.840	8105.690	3020.270	35385.21	1891.480	2383.645	996.7080	12242.00
Minimum	419.9500	2202.960	703.3700	4742.430	296.2800	157.5298	35.52750	1584.230
Std. Dev.	179.4685	1523.038	589.6326	8215.704	448.5664	589.8681	253.2866	2675.455
Skewness	0.006478	0.096840	0.122343	0.392800	1.125059	0.888046	0.697031	1.369733
Kurtosis	1.750966	1.881175	1.809243	1.890510	2.916626	2.528583	2.534986	4.307605

Altogether, multiple time series concerning each stock index under examination are prepared, i.e. the daily return, the standard deviation and the daily volatility. The simple arithmetic returns have been also calculated but for sake of space economy are not reported here since they offer no different conclusions to those of the logarithmic ones. The basic statistical characteristics of the return series are estimated and the distribution patterns are explored. In order to test for unit roots and stationarity, this study applies the augmented Dickey-Fuller test (ADF), the Phillips-Perron (PP) test, and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. The null hypothesis for the first two tests is that the series are non-stationary whereas for the KPSS the null hypothesis is the opposite, that is, that the series are stationary. Series are tested both on the levels and the first differences. The potential long run relationship between the series is then tested through the Johansen cointegration criterion that reports both the trace statistic and the maximum eigenvalue and gives a robust picture of the number of cointegrating relations between the series; cointegration tests are performed in pairs of two for all combinations of the eight series. We also use the two biggest markets, Euronext and Germany as benchmarks and plot the returns of each market against them taking the angle of a mature market international investor. Furthermore, correlation matrices between returns are prepared for the duration of the sample period; box and whiskers plots are applied to visualize the distribution of the series. The exhaustive tests inquire in depth the nature of the behavior of these markets and the way they interact among one another.

Following is the dynamic approach which manages to unveil the unique characteristics of market integration in this region. Building on the previous analysis we estimate the moving average figures for the time series, namely for return and volatility. This creates a unique data set with different range moving averages that offer smoothed series and underline the long term qualities. By examining the whole eight years of the sample period we can reach to robust conclusions concerning the long-run behavior of the markets. By applying a moving average method we partition the sample into multiple sub-periods that can identify different characteristics. The rationale is simple: an investor knows that in the long run same asset-class markets would probably yield similar results but in shorter intervals there could be adequate room for diversification.

In order to reveal time patterns we estimate two moving average intervals: first an interval of 20 and then of 200. Both are very popular moving averages with the first one representing a month's data and the second being the dominant long-run moving average in financial analysis. On the first approach, we estimate the moving average of the returns for 20 and 200. This is more of a smoothing approach in which we first estimate the moving average of the return series for 20 and 200 observations and then calculate the correlation matrix in between each of the eight



equity markets. Thus, the moving average is first calculated using the following

formula, for  $N=20$  and for  $N=200$ , as follows:  $F_{t+1} = \frac{1}{N} \sum_{j=1}^N P_{t-j+1}$

On the second approach, we use Euronext and Germany as benchmarks and estimate the daily correlations between the benchmark and each market, using the moving average interval of 20. The intuition behind this is that daily correlations may reveal different return patterns but in practice this means that an investor should proceed to transactions on a frequent basis. Knowing that frequent transactions raise portfolio costs we prefer to search for patterns that offer reasonable time intervals for portfolio transactions, i.e. about a quarter or more. In such a way both institutional and individual investors have enough time to receive, evaluate and check the information coming from the foreign markets and adjust their portfolio policies. Our calculations have also been done with an exponentially weighted moving average (EWMA) model, such as:

$$F_t = F_{t-1} + a(P_{t-1} - F_{t-1}) = aP_{t-1} + (1-a)F_{t-1}$$

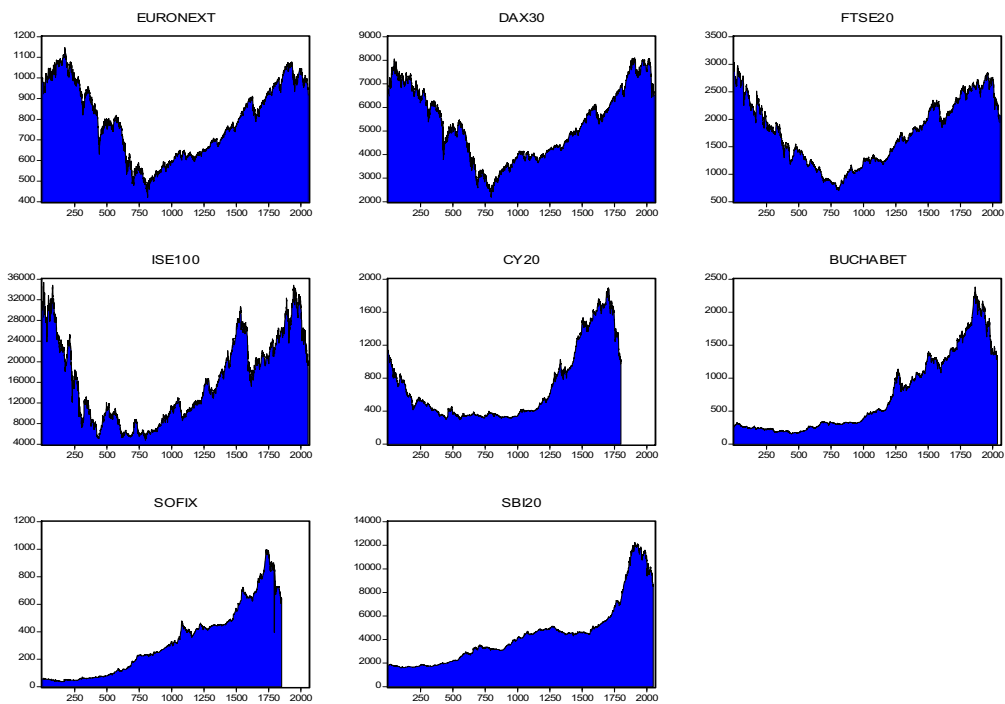
where  $a$  is the smoothing constant, and  $0 < a < 1$ . The speed at which older values are smoothed depends on  $a$ : for high values of  $a$  ( $a \rightarrow 1$ ) there is a greater weight on the previous observation, while low values of  $a$  put more emphasis on the forecast value and gives considerable smoothing. When  $a=1$  then SES yields a forecast that is equal to the last  $P_t$  observation. For our different  $a$  values our calculations have shown little extra information which in any way is not justified by the extra time and effort needed to be extracted. Bearing in mind the cost-efficiency factor we remain in a simple moving average rationale that is easy to prepare and offers quick and practical conclusions.

#### 4. Analysis

A closer look on Tables 2a and 2b can reveal interesting information for each market's behavior. For instance, with the exception of the Istanbul Exchange, all markets practically have a zero (0) mean return in the long run, satisfying a basic hypothesis for efficient markets. Second, price series appear all positively skewed whereas return series are negatively skewed. Kurtosis on the other hand appears at significantly larger values in return than in price series. The return series of Turkey, Bulgaria and Slovenia are highly kurtotic, with values of 12, 32 and 16, respectively. Likewise, the higher kurtosis values of the price series of Cyprus, Romania, Bulgaria and Slovenia (revealing clustering of stock prices around their mean) could be related to the relative short history of these markets and their low level of development. Graph 2 refers to the floating of the price series during the test period. It is interesting to observe how most markets co-move in a similar manner: Euronext, Germany, Greece, Turkey and Cyprus start high and then drop (the 2001-

2003 crisis) and then follow an upward trend until the end of 2007 where the current crisis took over. Unlike the above more developed markets, Bulgaria, Romania and Slovenia appear unaffected by the early crisis up to 2003; they remain relatively unchanged for a few years and then follow the upward trend that dominated the international markets. This visual observation is confusing: initially, one could say that the markets are independent this leaving ample room for portfolio diversification. After some point however, all markets seem to have the same behavior leading us to conclude that there are no significant benefits from international diversification.

**Figure 2: Graphical representations; price series**



A first basic test is the estimation the following F-statistic for the equality where this statistic follows an F distribution with  $G-1$  degrees of freedom in the numerator and  $N-G$  degrees of freedom in the denominator, that is:

$$F = \frac{SS_B / (G - 1)}{SS_W / (N - G)}$$

In this case SSB is the sum of squares between groups, SSW is the sum of squares within groups, G is the number of sub-groups and finally, N is the number of observations. Table 3a shows that the null hypothesis of equal means cannot be rejected.

**Table 3a: Test for equality of returns among series**

Method	df	Value	Probability
Anova F-statistic	(7, 15946)	0.004679	1.0000

This result may be disappointing in the sense that shows that in the long run all markets yield identical returns. Nevertheless, this is a typical case of passive portfolio management where investors just buy and hold an index portfolio and perform very limited transactions. Active portfolio management demands continuous correcting actions and for this reason we further test for equality of the distribution of the series, under the rationale that identical distributions would eliminate any room for diversification. Table 3b shows that under two different criteria, the Chi-square and the Kruskal-Wallis (with 7 degrees of freedom) the null hypothesis of equal distribution is rejected at the 5% level.

**Table 3b: Test for equality of distribution of series**

Method	df	Value	Probability
Med. Chi-square	7	15.46418	0.0305
Kruskal-Wallis	7	14.56812	0.0420

This last finding is very important and sets the basis for further examination of the stock markets' behavior. Equally important issue of fundamental value for portfolio management is the nature of risk relative to each market. A deeper look into the series is given with Tables 4a and 4b, following the same methodology previously applied.

**Table 4a: Test for equality of standard deviation mean (risk)**

Method	df	Value	Probability
Anova F-statistic	(7, 15946)	388.5144	0.0000

**Table 4b: Test for equality of distribution of standard deviation (risk)**

Method	df	Value	Probability
Med. Chi-square	7	2050.675	0.0000
Kruskal-Wallis	7	2758.940	0.0000
van der Waerden	7	2715.431	0.0000

Interesting enough, the tests show that neither the mean nor the distribution of risk is identical among the series. This clearly proves that the nature of risk is different from market to market and stands for another positive contribution to portfolio diversification: an experienced professional can identify different risk patterns and reactions between markets and position oneself accordingly for either risk minimization or mean maximization.

Still, the nature of risk is multidimensional and to avoid misspecification by using the classical standard deviation measurement, this article use volatility as an alternative means of estimating risk. Volatility series are calculated for each set, by using the intraday difference between the high and low as a percentage of the previous close, more particularly:

$$V_t = \frac{\text{High}_t - \text{Low}_t}{\text{Closing Price}_t} \times 100$$

This yields a new unique data set for each stock exchange, with Table 5 summarizing the basic statistical characteristics of the new series. The table is reported in the article because it manages to reveal a rather unexpected observation: the volatility mean of the developing markets is not necessarily higher than that of the developed ones. Contrary to common belief among professionals, developed markets do not show lower risk at least not for the tricky 2000-2008 period. With the exception of Turkey at 3.3%, all other markets have a mean between 1% and 2%, with Slovenia boasting the lowest average of 0.7%. Distribution skewness figures are also within a close range with Bulgaria and Slovenia having the highest. The picture changes however when kurtosis is taken into consideration: developed markets make a difference whereas developing ones demonstrate highly kurtotic behavior, probably due to their shorter history and lower level of maturity.

**Table 5: Basic statistical characteristics of volatility of return series**

	Euronext	Germany	Greece	Turkey	Cyprus	Romania	Bulgaria	Slovenia
Mean	0.013911	0.018871	0.015656	0.032796	0.017329	0.016727	0.010228	0.007224
Median	0.011100	0.015400	0.013300	0.026800	0.014500	0.013650	0.006915	0.005400
Maximum	0.095000	0.103300	0.086600	0.223300	0.147700	0.109900	0.111566	0.094200

Minimum	0.002100	0.002600	0.003700	0.000000	0.000000	0.001500	0.000000	0.000000
Std. Dev.	0.010183	0.013036	0.009661	0.021652	0.011174	0.011588	0.010496	0.006497
Skewness	2.368563	1.916966	2.544367	2.522846	2.949200	2.928273	3.298930	4.229669
Kurtosis	11.72174	8.002810	12.99844	13.90267	22.38962	16.87359	19.69397	37.04427

In the same manner as above, Tables 6a and 6b report the tests for equality of volatility means and distributions. Interesting enough the result is identical with those of standard deviation, the alternative risk proxy, showing that the nature of risk does not depend heavily on methods of calculation: both the means and the distributions are not equal, thus markets offer portfolio risk diversification opportunities.

**Table 6a: Test for equality of volatility means: not equal**

Method	df	Value	Probability
Anova F-statistic	(7, 14836)	654.2557	0.0000

**Table 6b: Test for equality of distribution of volatility**

Method	df	Value	Probability
Med. Chi-square	7	3001.781	0.0000
Kruskal-Wallis	7	4644.307	0.0000
van der Waerden	7	4786.261	0.0000

To further witness the nature of risk and its consistency regardless of the proxy used to arithmetically calculate it, the boxplots for each of the series are reported in Figure 3. Both standard deviation and daily volatility expose the more risky nature of the five less mature markets of Turkey, Cyprus, Bulgaria, Romania and Slovenia compared to mature three ones: first, the boxes are bigger representing the first and third quartile (middle 50%) of the data, and second, the whiskers spread out more and have numerous far outliers.

**Figure 3: Box and whiskers plot: Standard deviation (S) and daily volatility (V)**

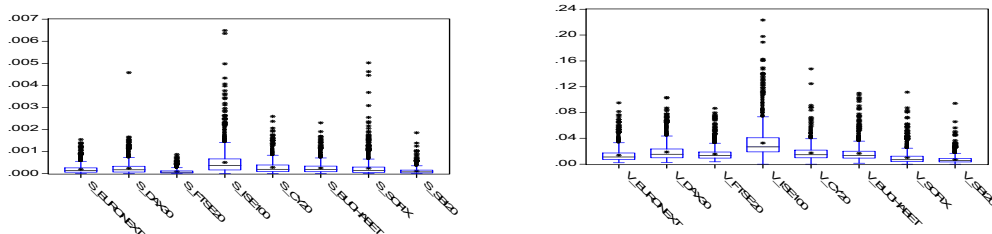
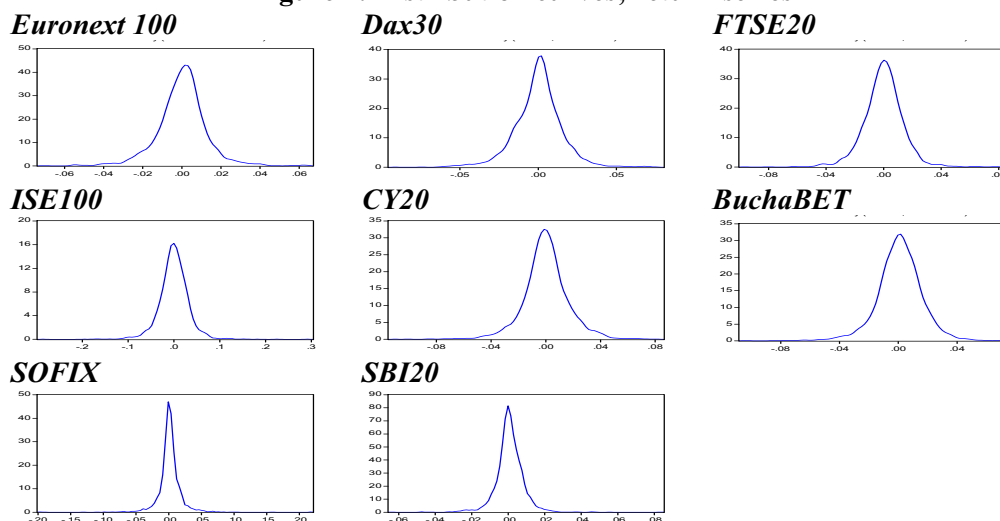


Figure 4 offers the individual distribution curve for each of the eight return series of the sample. Notice the skewness and kurtosis for the less mature markets which are also described in Table 2a and uncovers their relative smaller depth and development.

**Figure 4: Distribution curves; return series**

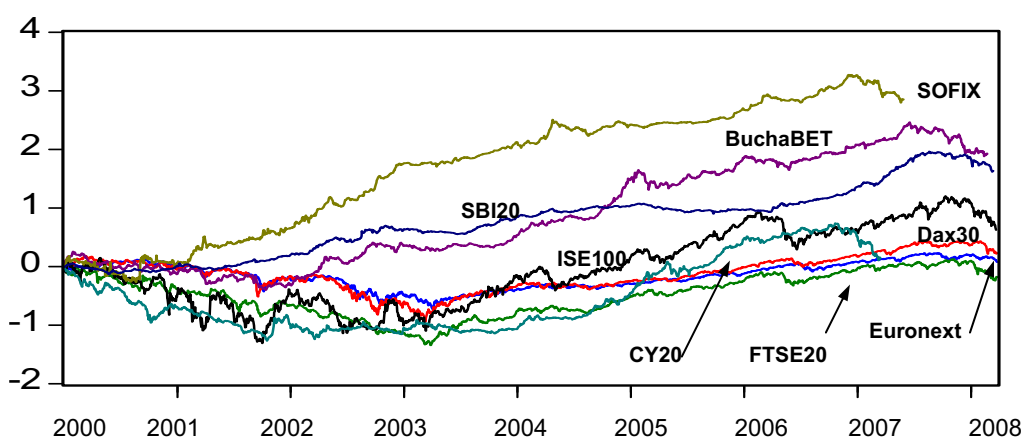


Still, it could sound unfair to reach a general conclusion that all markets qualitatively and quantitatively are rather similar. A basic axiom in portfolio theory is that high risk choices yield high return and this sample markets do not stray from this: Figure 5 is constructed by setting 2000 as the base year for all markets. Cumulative returns are graphed from 2000 onwards showing that indeed the smaller and riskier stock exchanges have managed to outperform the more mature ones. More important, the size of this extra performance is very big especially for the three emerging Balkan markets of Bulgaria, Romania and Slovenia. On the contrary, investors who had put their money on the markets of Euronext, Germany, Greece, Turkey and Cyprus in 2000 would have found themselves in the beginning of 2008 either with negative or with minimal returns.

We believe that the major reason that the first three exchanges boast such high returns during this period is due to their infant stage during the initial 2000-2003 crisis: a second look in Figure 1 shows that the size of these markets was insignificant back then, and their international exposure was non-existent. In other words, international portfolio managers had minimal investments (low positions) in these countries letting domestic investors influence the index; domestic institutional and individual investors do not necessarily adapt their behavior to international news but rather follow their countries' developments. This is additional proof that the

more a market develops and opens its borders to international funds, the higher the correlation with the international trend, since decision makers are based in certain financial centers.

**Figure 5: Cumulative returns**



## 5. Cross-market Analysis

The so forth analysis has yielded mixed results: markets do have some common characteristics but simultaneously leave some room for potential diversification effects. Another basic criterion to evaluate their individual behavior and independence is the classical unit root and cointegration framework, testing for random walk patterns. The goal here is simple and clear: we first need to find out if the time series are same-level integrated and if cointegration does exist and in what context. Table 7 summarizes the unit root tests for levels (panel A) and for the first differences (panel B). As mentioned earlier, we use two tests that have non-stationarity as the null hypothesis (ADF and PP) and one test that has stationarity as the null (KPSS) in order to endure robustness in our results. The findings prove that all series are first level integrated  $I(1)$  satisfying the first prerequisite for random walk.

A more complicated analysis has been applied in the cointegration space: rather than reporting simple cointegration vectors we estimated all possible combinations in pairs. Table 8 reports the cointegrating vectors found for each pair; the results show that not all markets enter the cointegration space, proving an absence of a long run equilibrium relationship. When examined in depth, Table 8 offers valuable results: first of all, it seems that the small markets of Bulgaria and Slovenia have the least relationships to all markets. Romania closely follows and then Cyprus. Turkey reports two vectors with each of the mature markets, confusing





(0.55)

**Note:** Based on Johansen's cointegration test, estimating both trace and maximum eigenvalue statistics. First figure denotes number of cointegrating vectors. Number in parenthesis denotes trace statistic of at least one cointegrating equation. When the number of cointegrating vectors is zero (0) no trace statistic is reported.

These findings constitute another proof of the fact that the level of stock integration depends heavily on the level of maturity of each market. The more a market develops by updating its rules and regulations and loosening the flows of capital, the more interdependent it becomes. The stock exchange of Greece has been dominated since 2003 by international funds mainly originating from central European Union institutional clients. Turkey on the other hand, although closer to the European financial centers, it has been preferred by fund managers across the Atlantic, i.e. the US. That could be perhaps one of the reasons of its marginally different behavior from that of the neighboring (and of similar size) Greek market. The future of the smaller, but rapidly developing, markets of the sample could perhaps prove that they gradually be dominated by foreign funds and enter the channel of international floating.

The time series of sample have been also examined for correlation. The daily returns have been taken in pairs, for the common sample and during the whole eight year period. In search of the theoretical perfect negative correlation our analysis has come up with correlation coefficients that are not disappointing. Table 9 reports the coefficients for each potential pair and the universal conclusion is that all figures are very close to zero (no correlation). All coefficients have been tested for significance (at the 5% level) and most have been found marginally significant (results are not reported for sake of simplicity). The correlation matrix does report a few negative correlations which nevertheless are minimal; our conclusions appear to further support the prevailing sentiment that markets have neither a strong nor a positive correlation over time.

**Table 9: Correlations; return series (in pairs)**

	<i>Euronext</i>	<i>German</i>	<i>Greece</i>	<i>Turkey</i>	<i>Cyprus</i>	<i>Romania</i>	<i>Bulgaria</i>	<i>Slovenia</i>
<i>Euronext</i>	1.0000							
<i>German</i>	0.0211	1.0000						
<i>Greece</i>	0.0485	0.1041	1.0000					
<i>Turkey</i>	0.0153	0.0171	0.0444	1.0000				

<i>Cyprus</i>	0.0315	-0.0171	-0.0046	-0.0174	1.000		
<i>Romania</i>	0.0006	-0.0011	0.0108	0.0002	-0.0575	1.0000	
<i>Bulgaria</i>	0.0187	-0.0098	0.0040	-0.0148	-0.0443	0.0197	1.0000
<i>Slovenia</i>	0.0402	0.0536	0.0246	0.0176	-0.0063	0.0052	-0.0151 1.0000

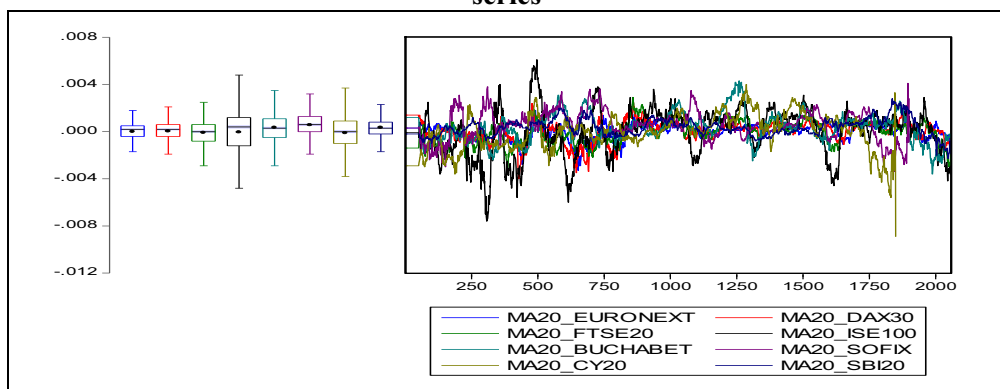
## 6. Dynamic Approach Model

Hitherto, the analysis has been based on the typical sample of daily observations and their characteristics. We construct a unique data set that consists of the moving averages of the daily returns, for each stock exchange, at different time intervals. One set is constructed with a moving average of twenty (20) in order to catch the monthly patterns, and another set at an interval of two hundred (200), which represents the industry standard for long-term patterns. Our main goal is to discover potential qualities that fail to show up on the daily observations. Furthermore, the cost of daily monitoring of the prices is rather prohibiting, thus making a monthly (MA20) or longer (MA200) benchmark more practical for portfolio transactions.

Table 10 reports the correlation coefficients when daily observations of the sample are taken in intervals of 20 and recalculate for the new series. What has not been clear so far with previous analysis it suddenly shows up now: correlation figures increase and depart from the very small (almost zero) sizes from Table 9. A close look into the tables shows the differences: Euronext to Germany correlation jumps to 0.70 from 0.02, Euronext to Greece from 0.05 to 0.4, Germany to Greece from 0.10 to 0.55, and Greece to Turkey from 0.04 to 0.52. The three mature markets enjoy the highest positive correlations, closely followed by Turkey. The inherent relationship among these markets is proven with this examination. On the contrary, the smaller five stock markets are left behind with some pairs having negative coefficients. Bulgaria for instance seems to have a negative relationship with Euronext and Germany offering an opportunity for diversification.

**Table 10: Correlations, moving average (20) series**

	<i>Euronext</i>	<i>Germany</i>	<i>Greece</i>	<i>Turkey</i>	<i>Romania</i>	<i>Bulgaria</i>	<i>Cyprus</i>
<i>Euronext</i>	1.0000						
<i>Germany</i>	0.7061	1.0000					
<i>Greece</i>	0.44341	0.5468	1.0000				
<i>Turkey</i>	0.3613	0.4955	0.5199	1.0000			
<i>Romania</i>	0.1632	0.2389	0.2919	0.3071	1.0000		
<i>Bulgaria</i>	-0.1660	-0.1035	0.0696	-0.0537	0.1541	1.0000	
<i>Cyprus</i>	0.0371	-0.0370	0.2797	0.1633	0.1396	0.0907	1.0000
<i>Slovenia</i>	-0.0057	-0.0282	-0.0306	0.0771	0.3512	0.0692	-0.0977

**Figure 6: Correlation development with boxplot of the moving average (20) series**

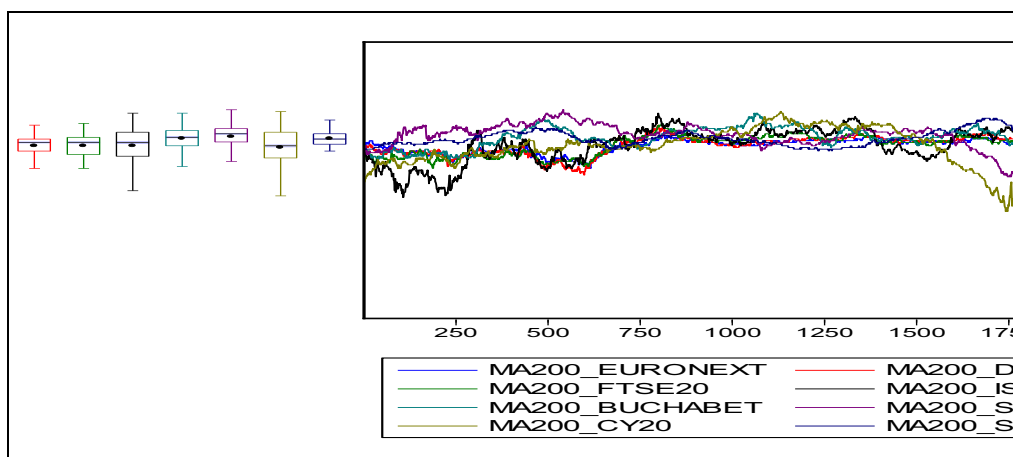
The smoothing effect of the monthly moving average (20) has been further enhanced when taken the industry standard moving average of two hundred days. Our rationale is simple: if monthly data reveal trends that were hidden in daily data, then most probably longer period sets of data should move to the same direction and verify the existence of such trends.

**Table 11: Correlations, moving average (200) series**

Correlation	Euronext	Germany	Greece	Turkey	Romania	Bulgaria	Cyprus
Euronext	1.0000						
Germany	0.9258	1.0000					
Greece	0.8568	0.8877	1.0000				
Turkey	0.6528	0.6875	0.8001	1.0000			
Romania	0.2792	0.2235	0.4547	0.5454	1.0000		
Bulgaria	-0.4899	-0.4925	-0.3490	-0.2967	0.1080	1.0000	
Cyprus	0.1650	0.0930	0.3062	0.2438	0.3966	0.4877	1.0000
Slovenia	0.0057	0.0246	-0.0321	0.0757	0.2695	-0.1759	-0.5501

Indeed, Table 11 constitutes a robust proof of a long term pattern. The correlation coefficients have all increased regardless of the sign. For instance, the Euronext to Germany figure has reached 0.93 and that of Germany to Greece 0.89. Accordingly, the negative Bulgaria to Euronext figure has reached -0.49, same with Bulgaria to Germany. Most results are rather disappointing for portfolio diversification since most markets pose a great interdependence between them. Equally useful are Figures 6 and 7, as they show two things simultaneously: first the boxplot for each of the moving average series and second the graph for the whole sample period. It is clear that the fluctuations in the second graph are limited and the range of the boxplots is narrower from the smoothing effect.

**Figure 7: Correlation development with boxplot of the moving average (200) series**



## 7. Conclusion

This article has examined the particular characteristics of the time series of eight European stock exchanges for the period 2000 to 2008. This period includes an initial bear market until spring 2003, a durable upward trend until the fourth quarter of 2007 and, a downward trend that still is under development. The capital markets of the sample are categorized in two tiers: three belong in the mature markets and the remaining five are considered developing but have significantly unequal capitalization.

The major contribution of this article is that it offers a first comparison of the characteristics of such a set of markets for such a comprehensive period of time. Unique data sets are constructed based on the daily closing, high and low prices of the relevant indices in order to examine in depth how the markets float in the long run, and how many opportunities for portfolio diversification are offered. The conclusions are mixed and depend from the subjective point of view of the professional who will use them: on the one hand, our analysis has shown that most markets are cointegrated which means that there is long term equilibrium; on the other hand, differences in behavior are existing but they appear minor especially when seen from distance. Return, risk and volatility distributions are not equal, but return means are; it seems that the end result is the same but the paths could be different. Correlation figures verify some relationship but their ups and downs reveal periods of high tension and periods of calmness when each market seems to walk down their own road. Moving average calculations offer a smoothening effect but

cannot hide periods when international portfolio diversification could have proved beneficial.

In general, there seems to be an underlying relationship among the markets that sometimes becomes very strong and sometimes relaxes. A professional portfolio manager would definitely expect lower correlation among the markets so that assets could indeed offer alternative risk-return combinations. Nevertheless this does not seem to hold true, especially in the recent years when markets appear to react in synchronicity. We adopt the findings of other researchers that the minimization of obstacles like legislation, capital flows and common currency (euro in this case) significantly increases the interdependence of the markets. Under such circumstances, international portfolio diversification could probably be achieved through cross-industry selections rather than cross-national ones, and through careful selections of individual stocks. A last comment refers to the ability of profit making in the short-run horizon, through continuous intraday transactions that could take advantages the markets' inefficiencies: such a portfolio management technique still includes both high transaction and information costs despite the lower institutional commissions and the relaxed legislative obstacles. Bearing in mind the cost-benefit result we strongly believe that continuous transactions could yield profits only on a theoretical level, making such an effort a classical zero-sum game. Further analysis should shed more light to cost efficient international transactions that would overcome contemporary problems and offer adequate opportunities for profitable international portfolio management during various time periods.

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