Optimal Portfolio Analysis for Selected Eastern Countries: Czech Republic, Hungary, Poland and Russia.

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Abstract

In this paper we examine the issue of possible portfolio diversification benefits into four selected Eastern stock markets: Czech Republic, Hungary, Poland and Russia. International Portfolio investment gradually increased during the late 2000's in this region. We construct international portfolios in dollars and local currencies using four different portfolio construction techniques, including two naïve portfolios, with random and equal weights and two professional ones, using past performance and the Markowitz mean variance portfolio method. Using a series of simulations, many portfolios are constructed per category using our data. The portfolios are then evaluated with standard portfolio evaluation methods. Our results confirm that the Markowitz portfolio construction methodology gives best results and at the same time we show that low correlation among the markets investigated allows the realization of important diversification benefits both in dollar and local currencies.

Keywords: Portfolio diversification; Markowitz Mean Variance Frontier; Selected Eastern Countries.

Jel classifcation: F3; F4; F21; G3; G11; G14; G15

Introduction.

International investment in the new capital markets of the former communist countries of Eastern Europe gradually increased during the late 1990s and the early 2000's. The purpose of this paper is to examine and evaluate alternative strategies of investing in four Eastern European [1] stock markets, those of Russia, the Czech Republic, Hungary, and Poland. In this context, we investigate the possibility of portfolio diversification benefits – enhanced risk adjusted returns- offered by these markets. Moreover, we are able to evaluate the performance of alternative portfolio construction techniques used by investment practitioners.

1 We choose these four countries mainly for data availability reasons ,because the MSIC collects only data for these four Easter countries.

Many market analysts have indicated that such markets represent excessive risks for investors, because they lack important characteristics of efficient markets, being thin, narrow and driven by poorly informed individuals rather than by fundamentals. Yet, investors willing to assume the additional risk present in these markets have been well compensated. Indeed, it cannot be assumed that investing in emerging stock markets is more risky compared to investments in more mature markets, unless risk is weighted by the expected returns. The average investor may increase his or her returns if they hold portfolios which include stocks of emerging markets. Since new/ emerging stock markets are not highly correlated and consequently do not fluctuate in tandem, it is expected that diversification leads to a higher return for a given risk (Markowitz, 1959, Sharpe 1963).

This study is not the first to investigate the dynamic linkages across national stock indexes, but to our knowledge is among only a few which investigate these four countries' stock markets. The dynamic linkages among the world's major markets have been studied since the late 1960s (e.g., Grubel, 1968; Granger and Morgenstern, 1970; Levy and Sarnat, 1970; Grubel and Fadner, 1971; Agmon, 1972; Bertoneche, 1979; Hilliard, 1979). Increased scrutiny and focus with more sophisticated methodologies is used in later studies, and Asian markets are included in the investigations, as in Schollhammer and Sands, 1985; Eun and Shim, 1989; Meric and Meric, 1989; Von Furstenberg and Jeon, 1989, 1991; Hamao, Masulis and Ng, 1990; Koch and Koch, 1991; Birati and Shachmurove, 1992; Chan, Gup and Pan, 1992; Malliaris and Urrutia, 1992; Roll, 1992, Friedman and Shachmurove, 1996). A few studies have focused on emerging Latin American economies (e.g., Bhagwati, 1993; Alonso, 1994; Gwyne, 1994 and Shachmurove, 1996.

The theoretical basis for our analysis is the standard CAPM model. In our analysis, we employed four different methods of constructing a hypothetical international portfolio consisting of different weights of the stock market indexes of the four countries under investigation. One of the goals of our study is to compare and evaluate the performance of the different portfolio construction methods. In order for our results to be independent of the timing of the portfolio construction, instead of dividing our sample into fixed, arbitrary periods for portfolio construction and evaluation,[2] we use all the available data to randomly obtain subsets with different starting points for the portfolio construction, different historic periods to inference information for the construction of the portfolio weights and different portfolio evaluation periods. More specifically, instead of obtaining estimates of the portfolio weights and the total and mean portfolio returns based on the same data set, we use an iterative technique with different starting dates for the portfolio construction, different historic periods preceding the portfolio and different portfolio evaluation periods. From the several portfolios per group constructed in this way, we obtain distributions of the total and mean returns, the risk and all the portfolio evaluation measures.
The construction methodology of our portfolios reflects the reality faced by an investor who has limited knowledge in creating and managing a portfolio of foreign stocks. We assume that some investors base their

[2] Usually the last period of the whole sample size.

decisions on past performance, or can use well known methodologies, hence we created two "sophisticated" portfolios based on simple or risk adjusted past returns. These are the Markowitz Portfolio and the Past Returns Portfolio. To represent investors without any portfolio management knowledge, but also in order to evaluate the performance of the two "sophisticated" portfolios, we created two portfolios with equal and random weights respectively, the "naïve" portfolios.

According to our results, the optimal portfolio was acquired through the application of the Markowitz Mean Variance approach, which on the average allocates 33.5% of the funds to Czech Republic, 19.6% in the market of Hungary, 32.4% of the portfolio to Poland and finally 14.3% of the total funds to Russia.

The remainder of the paper is organized as follows: Section 2 presents the portfolio construction techniques and section 3 discusses the data used. Section 4 presents the results from the portfolio evaluation and discusses the findings. Finally, section 5 provides a summary and concludes.

Portfolio Construction Techniques.

Four portfolio construction techniques have been used:

The Mean-variance (E–V) efficient frontier.

If W is the vector of the holdings, μ the vector of the expected returns of the assets and Σ the variance covariance matrix of the returns , then the portfolio variance is $\sigma^2{}_p = w'\Sigma w$ and the portfolio returns is $\mu_p = w'\mu$. The Markowitz model, assumes that portfolios can be completely characterized by their mean return and variance (or risk) and minimizes the variance of the portfolio:

$$\min_{w.r.t \ \ w} w'\Sigma w \qquad (1)$$

subject to:

$$w'i = 0 \qquad (2)$$

where i is a vector of ones and Σ is a NxN variance – covariance matrix of the expected returns of the $j = 1,2,...,N$ indexes.

The equal weights portfolio.

According to this approach the weights of the four country indexes in the portfolio are defined as follows:

$$w_j = (1/\,Number\ of \quad Indexes) \ \text{for} \quad j = 1,2,...,4(country\ indexes) \qquad (3).$$

The random weights portfolio.

In this case, the weights of the portfolio were obtained randomly using for each weight a uniform distribution. In order to achieve that

$\sum_{j=1}^{N} w_j = 1$ an iterative correction technique using each time the previous weights was used until satisfaction of the above condition was reached.

The past returns weights portfolio.

In this model, we estimate the portfolio weights with a two step procedure using the past returns:
In the first step, we applied an iterative with respect to the parameter $0 \le \lambda \le 1$, maximization approach:

$$\max_{\hat{\lambda}} \sum_{j=1}^{N=4} (1-\hat{\lambda})\hat{\lambda}^{j})(\frac{1}{T-1}\sum_{t=1}^{T} d_{jt}) \qquad (4)$$

for $0 \le \lambda \le 1$

with d_{jt} : the returns of the $j = 1,2,.,4$ country indexes.
and in the second step we obtained the past returns weights using the relations :

$$\hat{w}_j = (1-\hat{\lambda})\hat{\lambda}^{j} \quad \text{and} \quad \sum_{j=1}^{n} \hat{w}_j = 1 \qquad (5)$$

The four different portfolio composition methodologies were chosen in order to reflect the fact that in every market there are sophisticated investors with some portfolio selection and management knowledge and others without such knowledge. Portfolios 1 and 4 correspond to the first category whereas portfolios 2 and 3 reflect the second group of investors.

Evaluation techniques are then applied to assess the optimal portfolio by comparing them to an appropriate benchmark, in our case the MSCI EM (Emerging Markets) Europe, Middle East and Africa Index.

Data.

This study uses daily closing values for the stock indices of the East European countries analyzed: Czech Republic, Hungary, Poland and Russia. The period under examination extends from July 12, 2001 through July 11, 2006, with a total of 1450 observations. They are value weighted, expressed in United States Dollars (USD) and local currency units, and not adjusted for dividends[3]. The performance of the Czech Republic, Hungary Poland and the Russian exchanges are recorded and compared with Morgan Stanley benchmarking Index[4]: the MSCI Emerging Markets Index.

[3] On the basis of the evidence provided by French et al. (1987), and Poon and Taylor (1992), it is expected that adjustment for dividends would not affect the results.

[4] The MSCI Emerging Markets Index is a free float-adjusted market capitalization index that is designed to measure equity market performance in the global emerging markets. As of May 2005 the MSCI Emerging Markets Index consisted of the following 26 emerging market country indices: Argentina, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Israel, Jordan, Korea,

Table 1 and Figures 1 and 2, provide the reader with a first, but informal, understanding of the basic characteristics of the trends and the variability of the levels and the returns of the indexes under analysis. Figure 1 presents a comparison over time between each country's index and the benchmarking index during the 'estimation' period. Figure 2 presents an analogous comparison of the density distributions of the market returns and the returns of the benchmarking index.

Figure 1. Diachronic comparisons of the four Eastern Stock Market indexes with the benchmark MSCI Index.

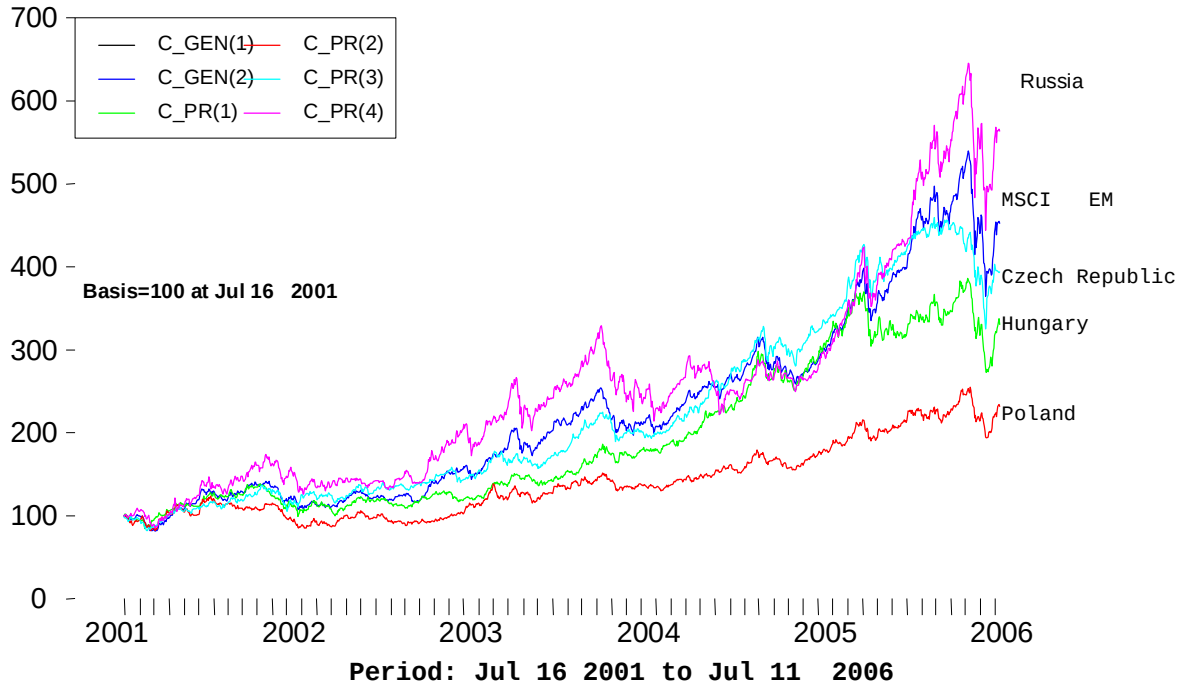


Table 1 provides some descriptive statistics. As expected in emerging markets, the standard deviations appear overall higher in the individual countries compared to the benchmarking index, which suggests a higher level of risk. These risks are accompanied by higher mean returns, especially in US Dollars. The majority of the returns also display positive skewness and negative kurtosis, while the Jarque-Bera test rejects the null hypothesis of normality at the 5% level.

Malaysia, Mexico, Morocco, Pakistan, Peru, Philippines, Poland, Russia, South Africa, Taiwan, Thailand, Turkey and Venezuela.

Regarding the suitability of the reference index, MSCI Emerging Markets, we must accept that it is relatively representative of the trends in the markets being studied, given that during the period under review it moved between the indexes of the four countries that participate in the portfolios[6]

Table 1. Summary statistics of the daily stock market index returns and the selected benchmark index over the sample period .
Panel 1: in US Dollars.

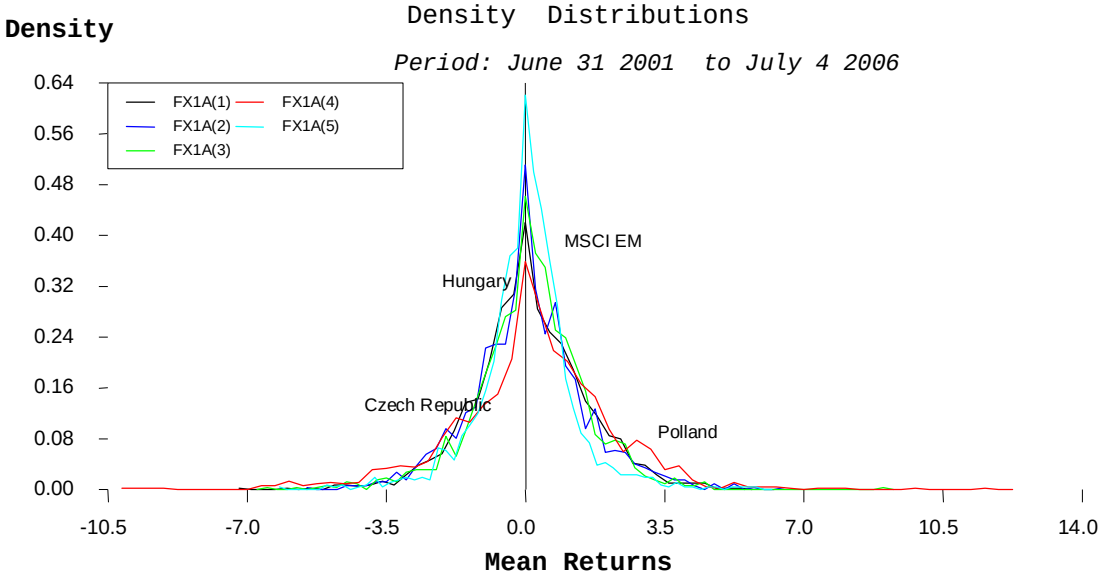
Stock Markets Indexes	*Total Returns(%)*	*Mean Returns(%)*	*Standard Deviations*	*Kurtosis*	*Symmetry*	*Jarque Bera*
Czech Republic	273,8793	0,126601	1,59849	-0,25606	1,883102	205,0159
Hungary	177,9512	0,099485	1,61271	0,048264	0,999906	54,32477
Poland	555,3548	0,159978	1,506638	-0,11361	2,39278	310,9965
Russia	401,7749	0,153314	2,057632	-0,29404	3,230675	580,4903
MSCI Emerging Markets Index	352,2226	0,135958	1,532616	-0,55343	3,00743	552,857

Panel 2: in local currency.

Czech Republic	193,5261	0,103851	1,450964	-0,11123	1,448405	115,6
Hungary	113,2503	0,07447	1,441392	0,223863	1,287114	99,97506
Poland	281,9014	0,115631	1,403228	-0,18251	2,792443	426,9512
Russia	398,5765	0,152748	2,056044	-0,29516	3,226833	579,2973
MSCI Emerging Markets Index	295,0409	0,124439	1,496894	-0,5085	3,124523	581,2356

Source: Our Estimates.

Figure 2. Comparisons of density distributions of returns of four Eastern European stocks Markets and o benchmarking MSCI Index.



The Empirical Results.

Using daily data from July 12, 2001 through July 11, 2006 and the aforementioned portfolio construction techniques, we generated for each portfolio category several random portfolios, using an iterative approach. Instead of choosing a standard[5] period for portfolio evaluation, which is the typical methodology in the relevant literature, we used subsamples of our data in the time estimation period, to obtain different (random) starting periods for portfolio construction, different (random) historic periods in order to construct the portfolio weights and different (random) portfolio evaluation periods. Thus, instead of obtaining a single estimate of the total returns and the portfolio weights, using this iterative technique, we obtained distributions of the mean and total returns, distributions of the associated risks, distributions of the portfolio weights for the four countries and distributions of the portfolio evaluation measures. Taking the standpoint of institutional investors, we also make the assumption that an investor cannot partake in short selling and the duration of each portfolio is set at 150 days[6].

Table 2. Average Portfolio Weights[7].

Panel 1: in US Dollars.

	Czech Republic	Hungary	Poland	Russia
Portfolio 1 (Markowitz)	0.3354	0.1966	0.3242	0.1438
Portfolio 2 (Equal Weights)	0.25	0.25	0.25	0.25
Portfolio 3 (Random Weigths)	0.2538	0.2486	0.2490	0.2487
Portfolio 4 (Past Returns)	0.0981	0.0314	0.0947	0.7758

Panel 2: in Local Currencies.

Portfolio 1 (Markowitz)	0.3781	0.1847	0.3208	0.1163
Portfolio 2 (Equal Weights)	0.25	0.25	0.25	0.25
Portfolio 3 (Random Weights)	0.2496	0.2518	0.2482	0.2504
Portfolio 4 (Past Returns)	0.1460	0.0347	0.0888	0.7305

Source: Our Estimates.

Table 2 presents the 'average' portfolio weights of the four country indexes for the four portfolio construction techniques using the data in USA dollars and local currencies.

[5] Usually using the last period of the whole sample size.

[6] Our results do not change for higher or lower period of portfolio implementation.

[7] The average portfolio weight is defined as: $\overline{w}_j = \frac{1}{(N_{iters} - 1)} \sum_{j=1}^{Niters} w_{ij}$ with w_{ij} the estimated weight of the i country at the j iteration.

According to the estimates of Table 2, there are not serious differences in the average portfolio weights using USA dollars and local currencies, especially in the first three types of portfolios. We notice however significant differences among the four portfolio construction techniques. The Markowitz and the two naïve portfolio techniques have quite similar and relatively balanced average weights. Exception is the case of the past returns portfolio which allocates a weight of 77.5% to the stock market of Russia, 14,6% to the Czech Republic and minimal weights for Hungary and Poland. The application of the Markowitz mean variance approach on the average allocates 33.5% of the funds to Czech Republic, 19.6% in the Market of Hungary, 32.4% of the to Poland and finally 14.3% of the total funds to Russia. Quite analogous are the weights using the two naïve portfolio construction techniques. Figure 3 presents graphically the density distributions of the weights of the four Eastern country indexes using the Markowitz Mean Variance Algorithm.

Figure 3. Density Distributions of the portfolio weights of the four Eastern country Indexes using the Markowitz Mean Variance Approach.

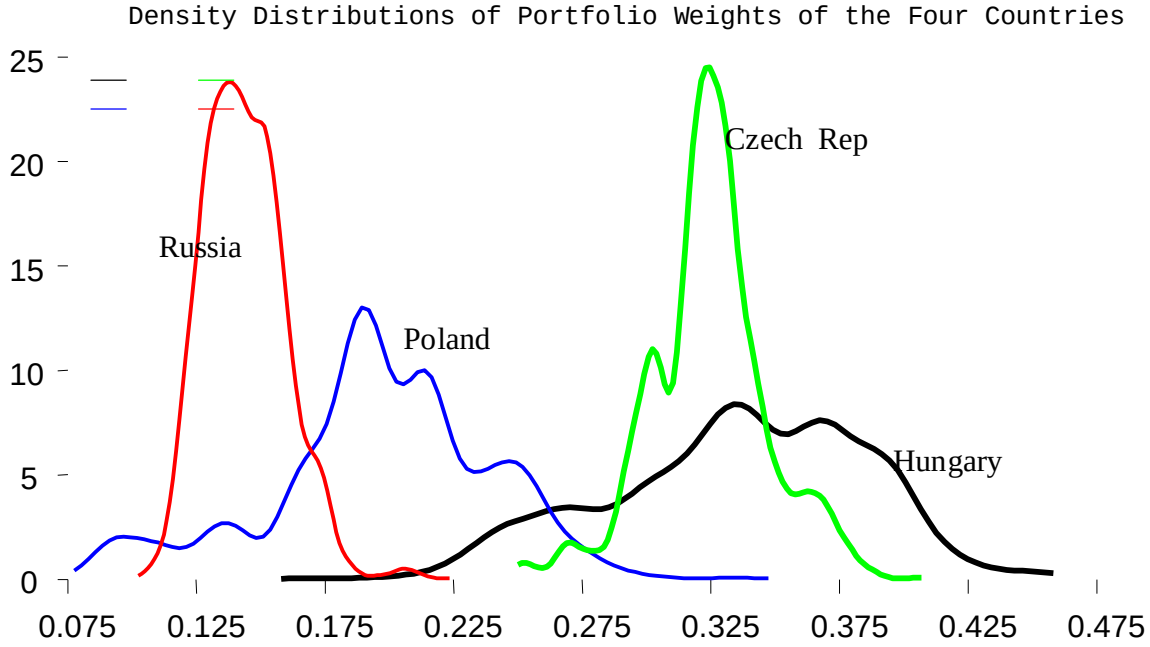


Table 3: Statistics for the Average Returns[8] of the four East European stock markets, the four portfolios and the two benchmarking indices during the periods of portfolio implementation.

Panel 1: in Dollars

Stock Markets	***Mean Returns (%)***	***Standard Deviation***	***Kurtosis***	***Skewness***	***Maximum (%)***	***Minimum (%)***	***Sharp Index***	***LPM***
Portfolio 1 (Mean Variance)	0,147545	0,011064	-0,48036	3,37492	0,827889	-0,63463	0,152877	0,007466
Portfolio 2 (Equal Weights)	0,141502	0,014834	-0,66246	3,742216	1,062513	-0,88041	0,142783	0,010099
Portfolio 3 (Random Weights)	0,138717	0,01163	-0,52762	3,412204	0,768246	-0,68022	0,13666	0,007882
Portfolio 4 (Past Returns)	0,142518	0,016518	-0,46704	3,384136	1,400615	-1,27047	0,104527	0,011403
Czech Republic	0,143618	0,014657	-0,24722	2,834831	1,050234	-0,80412	0,110215	0,009804
Hungary	0,099576	0,014533	-0,88276	4,822077	1,089247	-1,19132	0,07718	0,00971
Poland	0,176362	0,014068	-0,21551	4,693888	1,090072	-0,99621	0,136407	0,009226
Russia	0,134034	0,018527	-0,25515	3,255672	1,495848	-1,35494	0,084996	0,012805
MSCI Emerging Markets Index	0,129437	0,013567	-0,54627	3,842462	0,993901	-1,01273	0,109928	0,009445

Panel 2: in Local Currencies.

Portfolio(Mean Variance)	0,117448	0,010278	-1,02909	5,178585	0,759662	-0,83844	0,134321	0,006937
Portfolio(Equal Weights)	0,115281	0,013905	-1,0364	5,104979	0,965366	-1,14095	0,129195	0,009483
Portfolio(Random Weights)	0,114561	0,010951	-0,8566	4,786981	0,939787	-0,84479	0,122401	0,00745
Portfolio(Past Returns)	0,128083	0,016264	-0,61111	3,234781	1,242695	-1,07923	0,096044	0,01122
Czech Republic	0,112058	0,013546	-0,83501	4,729958	1,065581	-1,06689	0,091516	0,008906
Hungary	0,076704	0,012911	-0,69764	5,119245	1,142098	-1,04383	0,066822	0,008479
Poland	0,136743	0,013149	-0,94528	8,048436	1,052865	-1,07721	0,119515	0,008814
Russia	0,132947	0,01846	-0,54353	3,745601	1,40195	-1,2078	0,085379	0,012745
MSCI Emerging Markets Index	0,117346	0,013193	-0,69646	3,965681	1,109312	-0,95878	0,105285	0,009179

Source: Our Estimates.

According to our results, as presented on Table 3, we may conclude that the average returns of the portfolios are positive irrespective of the currency we use.

In addition, the returns of the Mean Variance portfolio outperform the respective mean returns of the other three portfolios in USA Dollars, while in local currencies the best average performance is achieved by the past returns portfolio. The average mean returns of the four portfolios are within the expected borders defined from the historical average returns of the four countries indexes. In the case of the USD

[8] The average returns are defined as follows: $\frac{1}{N_{iter}-1}\sum_{iter=1}^{N_{iter}}[\frac{1}{T_{iter}-1}\sum_{t=1}^{T_{iter}}(\sum_{j=1}^{N} w_{j,iter} d_{j,t,iter})]$

portfolios, all portfolios outperform the benchmarking MSCI Europe Index. However, in local currencies only the two "sophisticated" portfolios (mean variance and past returns) outperform the MSCI Emerging Markets Index, while the "naïve" ones are not far below. Analogous are the results of the total returns, shown in graphs 4 and 5 where we show the distributions of the total as well as the average portfolio returns.

The standard deviations of the portfolios are in most cases lower compared to the respective risks of the country and benchmarking indexes. In addition, the Mean Variance Portfolio has the lowest possible standard deviation compared with the other three portfolios. Figure 6 in which we compare the densities or the standard deviations of the four portfolios verify that the Mean Variance Portfolio has the lowest possible standard deviation. Analogous conclusions can be derived about the portfolios risks, using the Lower Partial Moment and Sharp criterions. As can be seen in Table 3, the Mean Variance Portfolio has Lower Partial Moment compared with the analogous country and benchmarking index. Additional evidence is available in Figure 6 were we compare the Lower Partial Moment density distributions of the four portfolios. Analogous results can be obtained using the Sharp criterion. The comparisons in the seventh column of Table 3 and the density distribution in Figure 7 confirm once more the potential of the four portfolios to reveal the lowest risk compared with the analogous country and benchmarking indexes.

Regarding the risk of the four portfolios it is obvious that the Markowitz portfolio has the lowest risk independently of the method we measure the risk using the standard deviation or the *Sharp*[9] and *Lower Partial Moment*[10] criteria.
With respect to the kurtosis of the mean returns, the Mean Variance portfolio has the lowest kurtosis. All the portfolios reveal positive skewness with the portfolio of the past returns to display the highest.

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[9] *The Sharp Ratio(1966*) is a traditional total performance measure used to measure the expected return of the two portfolios per unit of risk:

$$\textit{Sharp Ratio}_j = \frac{\sum_{s=1}^{T} d_{js} - r^f}{\sigma_j} \quad \textit{for } j = 1,2,...,4 \quad \textit{with } d_j = \textit{Returns of the j index}$$

in the portfolio evaluation period and $r_r^{\ f} =$ is the risk free return. In our analysis we assumed a risk free return equal to 3.5%.

[10] *We* calculate the LPM as*:* $LPM(a,t) = \frac{1}{K}\sum_{T-1}^{K} Max[0, t - r_t]^a$

where a is the investor's risk tolerance value and degree of the lower partial moment, t is the target return, K is the number of observations r_t is the portfolio's return during period t. Following Gilmore et. Al (2005), we therefore take the standpoint of the risk-averse investor by letting a = 2 and a target return equal to zero.

Figure 4. Comparisons of the *density* distributions of the total Returns of the four portfolios

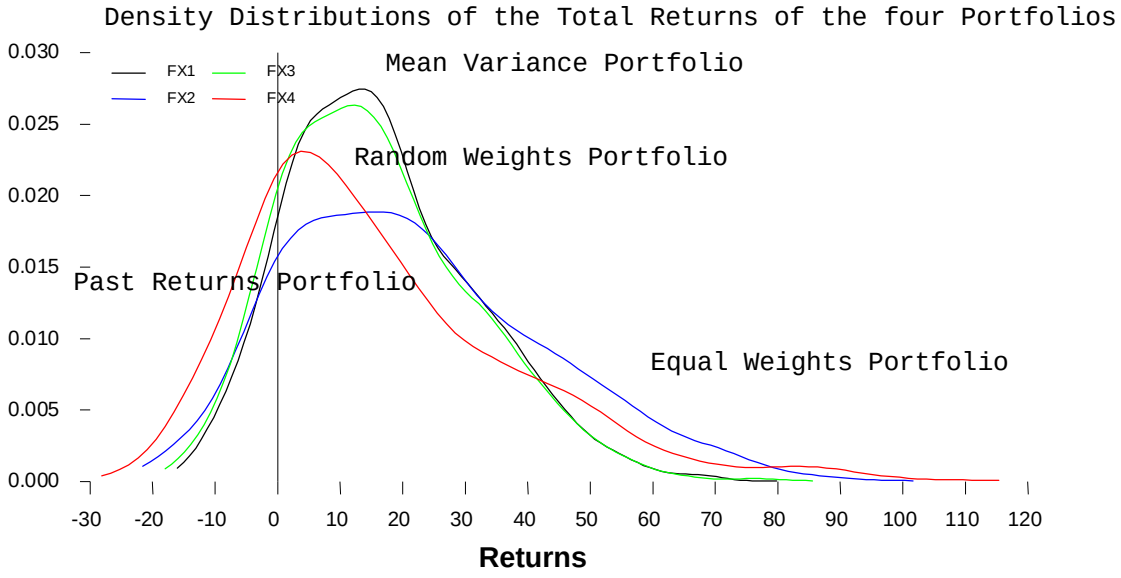


Figure 5. Comparisons of the density distributions of the average returns of the four portfolios.

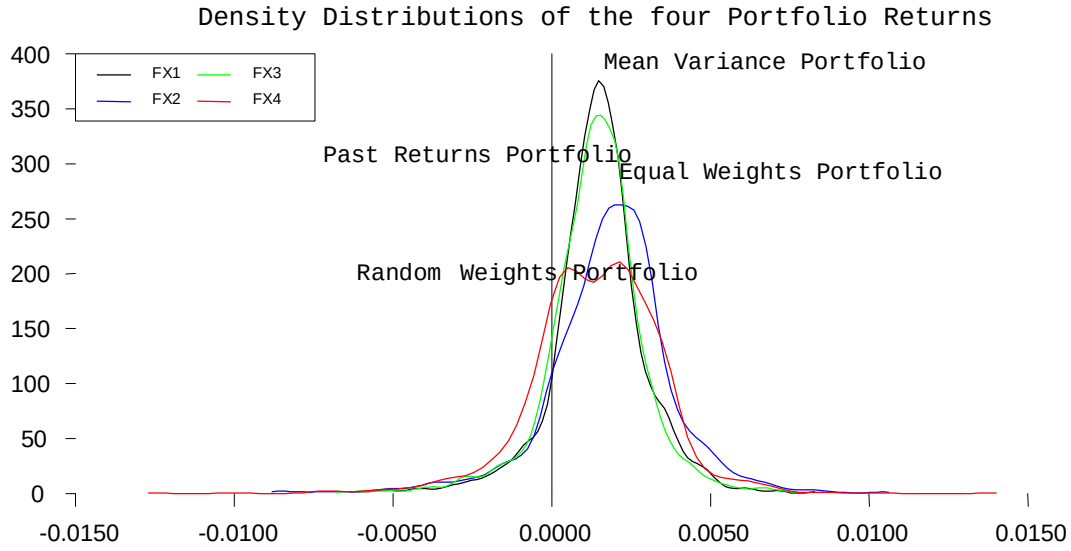


Figure 6. Comparisons of the density distributions of the Standard Deviations of the returns of the four portfolios.

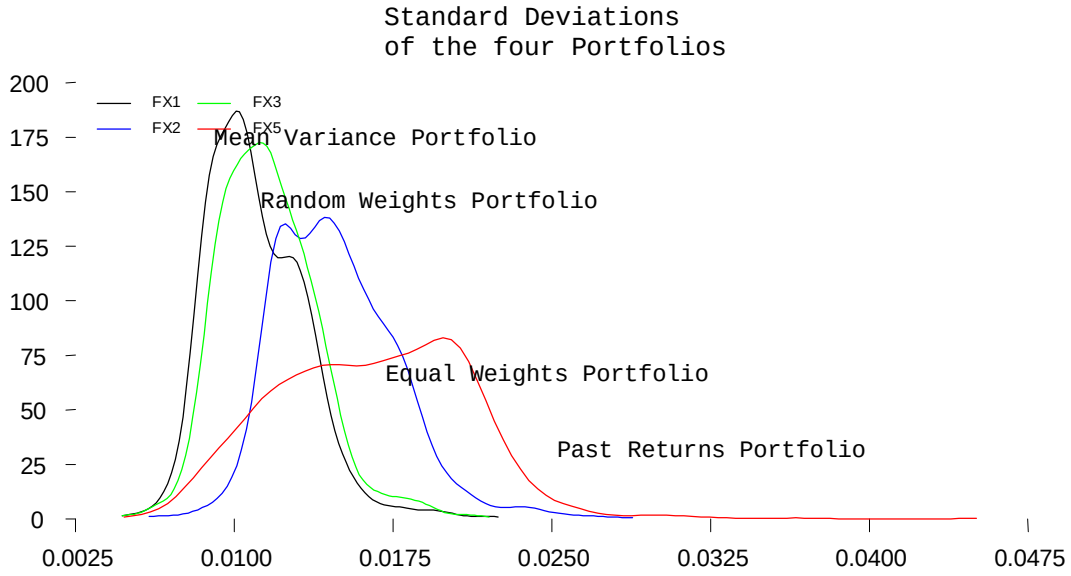


Figure 7 . Comparisons of the density distributions of the Lower Partial Moment coefficient of the four portfolio techniques.

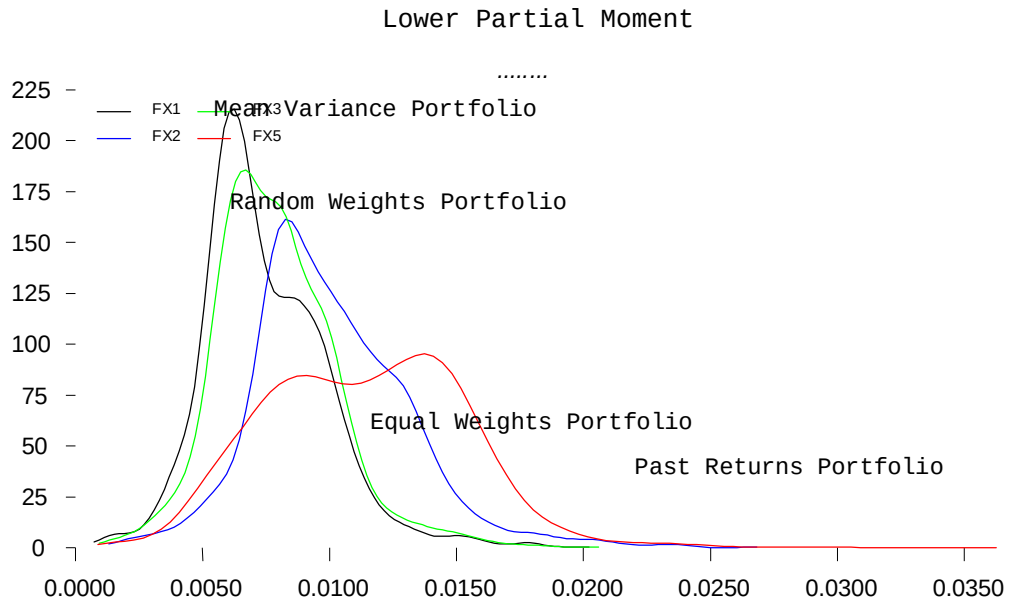


Figure 8. Comparisons of the density distributions of the Sharp Ratio of the four portfolio techniques.

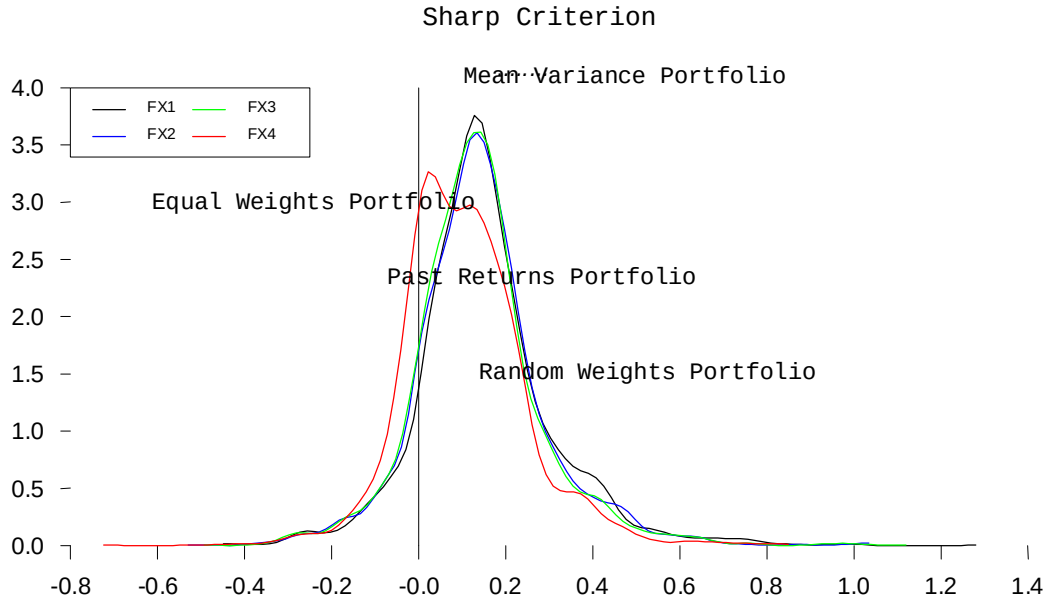
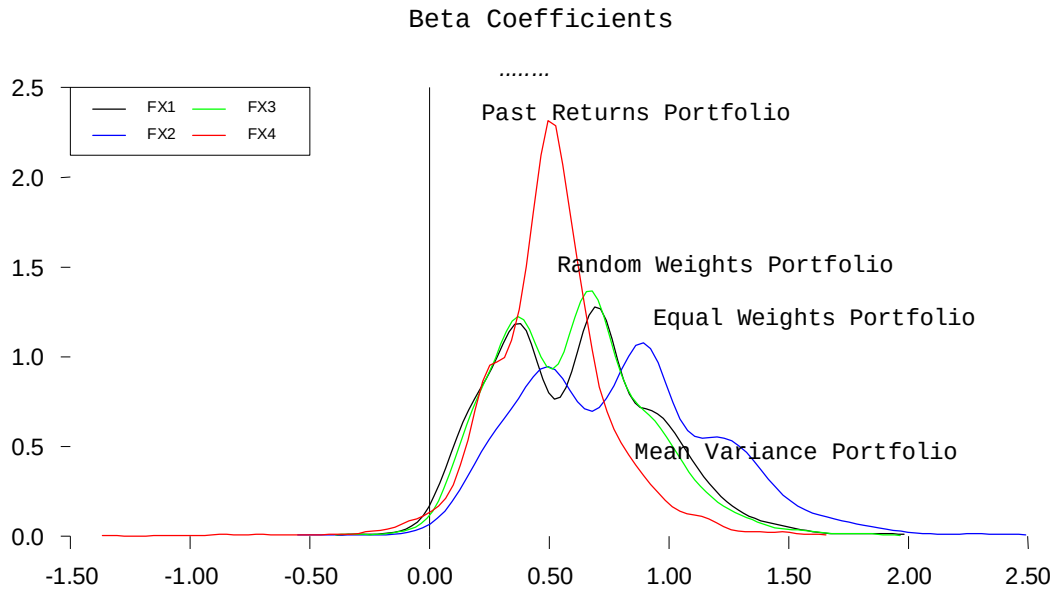


Figure 9. Comparisons of the density distributions of the Beta Coefficients of the four portfolio techniques with respect the MSCI Emerging Markets Index



Finally Figure 9 presents a comparison of the distributions of the Beta Coefficients of the four portfolios with respect to MSCI Emerging Markets benchmarking index. The (average) portfolio's betas[11] are 0,607588 (1.99), 0,799169 (2.49), 0,597004 (1.96) and 0,502636 (1.85) for MSCI Emerging Markets benchmarking index, well below the corresponding market beta of one. Hence, they are less volatile than the market, as represented by the MSCI Emerging Markets benchmarking index.

Conclusion.

This paper studies the daily stock market returns of four Eastern countries and the prospect of investment for the purposes of diversification. The period from July 12, 2001 through July 11, 2006, is used as the basis of the analysis. Using an iterative technique with randomly selected historical and portfolio implementation periods we applied four portfolio techniques to construct the optimal portfolio of these countries.

The design of the portfolios reflects the realities faced by any potential investor, as two of the portfolios are based on professional portfolio management techniques (Markowitz and past returns) while the other two (random weights and equal weights) reflect the potential behavior of individual investors without professional knowledge.

The weights of the optimal portfolio are derived as the average of the 5000 different iterations with respect to the date of the portfolio starting evaluation period, for the four portfolio construction techniques. The optimal portfolio, acquired through the application of the Markowitz Mean Variance approach, on the average allocates 33.5 percent of the funds to Czech Republic, 19.6 percent in the Market of Hungary, 32.4 percent of the to Poland and finally 14.3 percent of the total funds to Russia.

The (average) portfolio's betas[12] are 0,607588 (1.99), 0,799169 (2.49), 0,597004 (1.96) and 0,502636 (1.85) respectively against the MSCI Emerging Markets benchmarking index, well below the corresponding market beta of one. Hence, they are less volatile than the market, as represented by the MSCI Emerging Markets benchmarking index.

The above results are valid on average, which must be taken into account by those who wish to become active investors in emerging markets. In any case, it is well known that there are no investment activities without risk. The optimal portfolio derived above does take into account market volatility risks, since it is based on the risk adjusted allocation of funds into baskets of foreign securities. Therefore, investors are rewarded for the additional risk they are bearing by higher premiums.

While the higher returns available occasionally in Emerging markets might be quite appealing, additional, possibly non quantifiable risk factors need to be both examined and accounted for. There are intrinsic dangers in foreign investment such as incomplete or immature legal and regulatory framework, for example.

[11] Number in parenthesis are t-statistics.
[12] Number in parenthesis are t-statistics.

Concluding, our analysis confirms the widely accepted notion (Grubel, 1968, Hamao, Ronald &Ng, 1990, Levy,&Sarnat, 1970) that it is beneficial for the contemporary investor to possess a well diversified portfolio, rather than to limit his investments to a single market. The low correlation among stock markets implies that their movements are not perfectly synchronized. Consequently, investing in a portfolio consisting of allocations in several foreign exchanges permits an investor to counterbalance the risk that an adverse fluctuation in any given market will have a considerable effect on the return of his or her portfolio.

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