Schröder, Michael

Working Paper

Investment opportunities in Central and Eastern European equity markets: an econometric examination of the risk-return relationships for western investors

ZEW Discussion Papers, No. 00-42

Provided in cooperation with:
Zentrum für Europäische Wirtschaftsforschung (ZEW)

Suggested citation: Schröder, Michael (2000) : Investment opportunities in Central and Eastern European equity markets: an econometric examination of the risk-return relationships for western investors, ZEW Discussion Papers, No. 00-42, http://hdl.handle.net/10419/24389

Non-technical summary

This study focuses on the diversification benefits of the most developed equity markets of Central and Eastern Europe (CEE). To evaluate these benefits of diversification we use so-called spanning tests based on a stochastic discount factor approach and estimated by General Methods of Moments (GMM). Spanning tests investigate whether the returns of test assets (in our case the returns of CEE equity markets) can be mimicked by the returns of some benchmark assets. If this is possible adding the test assets to the set of the benchmark assets does not improve the mean-variance efficient frontier.

In recent studies as for example DeSantis (1994), Harvey (1995) or Bekaert/Urias (1996) spanning tests have been successfully applied to emerging equity markets but these studies do not cover the emerging equity markets of Central and Eastern Europe. In addition our study addresses the diversification benefits not only for U.S. investors, as is the usual case in these empirical studies, but extends the analysis on British and German investors, too. A third feature that distinguishes our investigation from most other studies on this topic is the analysis of the effects of currency hedging on diversification benefits.

At a quick glance the CEE equity markets seem to offer significant and high diversification benefits. But this picture becomes cloudy after a thorough analysis. Only the equity markets of the Czech Republic, Slovakia and Slovenia contribute significantly to the diversification benefits. But a realisation of these benefits would imply to have not only long but also short positions in CEE equities. Taken into account transaction costs and limited access to futures and options markets it seems to be very doubtful that the theoretical diversification benefits can actually be realised. This result is in correspondence with recent studies on other emerging markets such as DeRoon/Nijman/Werker (2000).

The results of the study also show that the home currency of the investor is of some importance for the results of the spanning tests. The outcomes for British, German and U.S. investors are similar but not identical. Therefore it seems to be useful to analyse benefits of diversification not only from the point of view of U.S. investors but to take explicitly into account the currency of the investor. Another interesting result is that currency hedging clearly improves the possible performance of an investment in CEE equity markets.

What is now the consequence for investors that consider an investment in CEE equity markets? Our study comes to the result that a buy-and-hold investor could hardly benefit from such an investment. Only investors that have superior timing capabilities could profit from the remarkably strong swings in the levels of CEE equity indices in the past.

Investment Opportunities in Central and Eastern European Equity Markets

- An Econometric Examination of the Risk-Return Relationships for Western Investors -

Michael Schröder

Centre for European Economic Research (ZEW)

ZEW-Discussion Paper No. 00-42

November 2000

Keywords:
Spanning Test, Diversification, Emerging Markets, Central and Eastern Europe

JEL Classification: G12, G15, O16

Address:

Centre for European Economic Research (ZEW)
Dr. Michael Schröder
P. O. Box 10 34 43
D-68034 Mannheim

Tel.: ++49-621/1235-140
Fax: ++49-621/1235-223
E-mail: schroeder@zew.de

I. Introduction

The stock markets of Central and Eastern Europe (CEE) and of Russia have attracted enormous attention of institutional and private investors over the last ten years. Since the opening of the capital markets of these countries to foreign investors direct and portfolio investments from abroad have risen to remarkably high amounts. The increasing sums invested in mutual funds with a specialisation on Eastern European stock markets show that private investors are eager to gain by investing in CEE equities.

In the last years emerging equity markets have also attracted attention of academic researchers in the field of empirical finance. Several articles focus on the question whether investing in emerging equity markets can lead to significant diversification benefits.[1] DeSantis (1994) and Harvey (1995) find that emerging equity markets can clearly improve the performance of an equity portfolio that is only invested in developed equity markets. Bekaert/Urias (1996 and 1999) approximate the investment opportunities in emerging markets not by indices but by closed-end funds. This has the advantage of including realistic transaction costs which may be considerably in emerging markets. But nevertheless they also find significant performance improvements when the investment universe is allowed to include emerging equity markets. DeSantis (1995) also considers currency hedging. His results show that the improvement of the portfolio performance is significantly influenced by currency risk and the correct choice of a hedging strategy.

The aim of our study is to investigate the investment opportunities of CEE stock markets. The studies mentioned above analyse emerging equity markets from South-East Asia, Latin and South America and sometimes equity markets from Southern Europe, Africa or the Middle East. The equity markets of Central and Eastern Europe have so far not been included in studies on diversification benefits.[2] In our

---

[1] Diversification benefits mean a performance improvement of the portfolio by an upward shift of the efficient frontier. In other words, the portfolio performance is improved if an investor can earn a higher return at the same risk or can reduce the portfolio risk without reducing the return.

[2] To our knowledge there is only exception: Bugar/Maurer (1999) are analysing the diversification benefits of the Hungarian equity market from the point of view of German and Hungarian investors. They find that diversification benefits accrue only to Hungarian investors whereas for German investors the benefits are not statistically significant.

study we consider the equity markets of the most developed CEE countries: the Czech Republic, Hungary, Poland, Slovakia and Slovenia. We also include the Russian stock market into our analysis as it is the largest neighbour market of this region.

Another shortcoming of most empirical studies is that they usually analyse diversification benefits only from the point of view of an U.S. investor. But the currency risk can significantly change with the currency in which the portfolio returns are denominated. Therefore the results for an U.S. investor need not hold from the point of view of other investors that have different home currencies. In our study we therefore expand the analysis also to British and German investors. Thus, our results are applicable for the most important investors from Western industrialised countries. Like DeSantis (1995) we also consider currency hedging as an additional possibility to improve the performance of the equity portfolio.

DeSantis (1995) and Bekaert/Urias (1996, 1999) use spanning tests that are based on the stochastic discount factor approach and are estimated by the General Methods of Moments (GMM). These tests are generalisations of the spanning test developed by Huberman/Kandel (1987). The null hypothesis of spanning is that the returns of a set of benchmark assets is able to mimic the return of a set of additional assets, the test assets. If this is true the benchmark assets are spanning the returns of the test assets. In our case the benchmark assets are the major mature equity markets whereas the test assets are the above mentioned CEE equity markets. If the null hypothesis of the spanning test is rejected the inclusion of the CEE equity markets leads to a significant upward shift of the efficient frontier. Huberman/Kandel (1987) developed a general framework for spanning tests. But their empirical test is based on a regression approach using the assumption that the returns are independently and identically normally distributed. The tests of DeSantis (1995) and Bekaert/Urias (1996, 1999) overcome these shortcomings by using GMM estimation and a more general asset pricing assumption. As the return distributions of CEE equity markets strongly deviate from normality GMM estimation is highly recommendable.

This paper is organised as follows. In chapter II we give an overview of the ex-post performance of CEE equity markets. This includes particularly a description of the return distributions and the risk-return profiles for British, German and U.S. investors. The major part of chapter III consists of the description of the methodology of the spanning tests and the interpretation of the empirical results. We show the results

for CEE equity markets as a group and for each single CEE equity market. The spanning tests are performed for investments without currency hedge and for fully hedged CEE currencies. We also show results for different time periods to analyse possible changes in time. As a specific result we look at the composition of optimal portfolios which include CEE stock markets and try to answer the question whether diversification benefits can be realised in practice. Chapter IV concludes.

II. Ex-Post Performance of CEE Stock Markets

Throughout this study we use the 23 country indices of the MSCI World Index to represent the investment universe of the mature equity markets.[3] The CEE equity markets included in this study are those of the Czech Republic, Hungary, Poland, Slovakia and Slovenia. These are the five most developed CEE equity markets. We also include the Russian stock market as the largest neighbour market in this region. At the end of 1999 these markets together account for approximately 0.37% of the total world equity capitalisation. The CEE equity markets are represented by the most common national indices.[4] As these indices are price indices we also use the price indices of MSCI to avoid a downward bias of the mean returns of the CEE equity markets. For all calculations we use weekly data. All data - local equity indices, MSCI indices, currencies - have been collected using the Primark/Datastream database.

The aim of this chapter is to investigate the major characteristics of the return distributions of CEE equity markets. Table 1a describes the distributions of the CEE equity market returns. The calculations are based on weekly returns in local currency and refer to the time period 12 January 1994 until 29 December 1999. Due to lack of data the returns for Russia and the Czech Republic are calculated using a slightly shorter time period. Table 1b shows the results for the British, German and U.S.

---

[3] MSCI means Morgan Stanley Capital Investment. As the universe of the developed equity markets we include the 23 equity markets of the MSCI World Index. These are the equity markets of Austria, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Italy, Japan, Malaysia, the Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, UK and USA.

[4] The national CEE equity indices used in this study are PX50 (Czech Rep.), BUX (Hungary), WIG (Poland), RTS (Russia), SAX16 (Slovakia) and SBI (Slovenia).

equity indices as well as for the MSCI World Index to highlight some special characteristics of the CEE markets.

Table 1a: Characteristics of the Return Distributions of CEE Equity Markets

	BUX	PX50	RTS	SAX16	SBI	WIG
Mean	0.61	-0.24	0.97	-0.11	0.18	0.14
Standard Dev.	4.87	3.22	10.66	4.89	3.92	5.63
Skewness	0.42	-0.38	0.14	2.97	0.38	-0.56
Kurtosis	8.27	4.28	6.65	25.04	5.42	6.28
Max.	30.1	10.45	54.0	42.89	16.23	22.51
Min.	-16.5	-11.63	-43.87	-16.17	-16.13	-25.33
J.-B. Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Obs.	313	299	225	313	313	313
Period	1/12/94-12/29/99	4/20/94-12/29/99	9/6/95-12/29/99	1/12/94-12/29/99	1/12/94-12/29/99	1/12/94-12/29/99

Table 1b: Characteristics of the Return Distributions of Western Equity Markets

	MSCI Germany	MSCI UK	MSCI USA	MSCI World Index (in US-$)
Mean	0.33	0.20	0.38	0.27
Standard Dev.	2.84	2.03	1.97	1.67
Skewness	-0.54	-0.08	-0.67	-0.2
Kurtosis	4.46	2.92	4.91	3.83
Max.	9.95	5.81	6.25	5.59
Min.	-10.56	-5.45	-9.11	-5.49
J.-B. Test	0.0000	0.82	0.0000	0.004
Obs.	313	313	313	313
Period	1/12/94-12/29/99	1/12/94-12/29/99	1/12/94-12/29/99	1/12/94-12/29/99

Notes: The returns are weekly logarithmic returns in %, denominated in local currency. The only exception are the returns of the MSCI World Index which are denominated in U.S. dollar. The row "J.-B. test" shows the p-values of the Jarque-Bera test, which tests for deviations from the normal distribution.

One remarkable result is the negative mean return for the equity indices of the Czech Republic and Slovakia. This is rather unusual for equity indices over a relatively long time period. The other interesting feature of the CEE equity returns is the high probability of extreme positive or negative returns. This can be seen by the standard deviation, the kurtosis and the maximum and minimum values. The standard deviation is very large for most CEE countries, particularly for the equity markets of Russia, Poland, Slovakia and Hungary, for which it is more than two times larger than for example for the British or the U.S. market. The CEE equity returns also exhibit

an extremely large kurtosis. Although for all equity markets shown in tables 1a and 1b, except only the British market, the Jarque-Bera test signals a significant deviation from the normal distribution, the high kurtosis of most CEE equity returns is astonishing. It is much larger than the values for the Western equity returns and signals a high probability of extreme (negative and positive) returns. This is also emphasised by the large figures for maximum and minimum returns. And the Slovakian index is also strongly skewed to the right. An important conclusion from these figures is that the use of the normal distribution as a simplifying assumption in econometric estimation and tests is clearly not appropriate.

Table 2 compares the performance of an equity investment in the CEE stock markets for British, German and U.S. investors. The upper part of the table shows the mean return, the total variance and the decomposition of the variance into its components: *total variance = variance of the equity returns in local currency + variance of the currency returns + 2*covariance between local returns and currency returns.* The returns are calculated as excess returns i.e. as total returns minus the risk-free interest rate. The mean excess returns show a clear ranking: the highest returns are earned by German investors, U.S. have the second rank and British investors have the lowest return on average. This result is true for each of the six CEE equity markets. Even when the returns are corrected for risk the same ranking applies: the Sharpe ratio, i.e. the ratio of the mean excess return to the standard deviation of the returns, shows the same ranking between investors as the mean excess return. The reason of course is the different performance of the investors´ currency against the currencies of the CEE countries. Another apparent feature of the risk-return profiles is the dominance of the variance of the local returns. The variance of the local returns amounts to 85% or even sometimes 95% of the total variance. The currency risk seems therefore to be of only minor importance. The covariance between local and currency returns is negligible in all cases.

The lower part of table 2 shows the risk-return profiles for CEE equity markets when the currency is fully hedged.[5] As these risk-return profiles are virtually identical for all three investors we show them once only.

---

[5] The returns of the equity portfolios with currency hedge are calculated as *return in local currency + risk-free interest rate of the investor – risk-free interest rate of the CEE country*. This

Table 2: Risk-Return Profiles for British, German and U.S. Investors

	BUX	PX50	RTS	SAX16	SBI	WIG
Unhedged Country Portfolio of a British Investor						
Mean	0.17	-0.46	0.02	-0.34	-0.09	-0.22
Tot. Var.	24.88	12.67	123.18	25.99	17.94	34.91
Local Var.	23.73	10.38	113.62	23.97	15.38	31.77
Curr. Var.	0.9	1.72	15.72	1.47	1.82	1.35
2*COV	0.25	0.57	-6.16	0.55	0.74	1.79
Sharpe R.	0.034	-0.129	0.002	-0.067	-0.021	-0.037
Unhedged Country Portfolio of a German Investor						
Mean	0.28	-0.33	0.22	-0.23	0.01	-0.11
Tot. Var.	26.12	12.35	122.84	25.83	17.80	35.08
Local Var.	23.73	10.38	113.62	23.97	15.38	31.77
Curr. Var.	0.6	1.06	16.93	1.87	1.60	1.15
2*COV	1.79	0.91	-7.71	-0.01	0.82	2.16
Sharpe. R.	0.055	-0.094	0.020	-0.045	0.002	-0.019
Unhedged Country Portfolio of a U.S. Investor						
Mean	0.21	-0.41	0.058	-0.29	-0.052	-0.18
Tot. Var.	23.72	12.54	116.62	26.41	16.95	33.93
Local Var.	23.73	10.38	113.62	23.97	15.38	31.77
Curr. Var.	0.96	2.12	14.27	1.83	2.11	1.25
2*COV	-0.97	0.04	-11.27	0.61	-0.54	0.91
Sharpe R.	0.043	-0.116	0.005	-0.056	-0.012	-0.031
Hedged Country Portfolio for International Investors						
Mean	0.23	-0.45	0.29	-0.37	-0.05	-0.25
Tot. Var.	23.75	10.37	113.62	24.08	15.40	31.81
Sharpe R.	0.047	-0.14	0.027	-0.075	-0.013	-0.044
Period	1/12/94-12/29/99	4/20/94-12/29/99	9/6/95-12/29/99	1/12/94-12/29/99	1/12/94-12/29/99	1/12/94-12/29/99

Notes: All returns are weekly logarithmic returns in excess of the risk-free interest rate of the British, German or U.S. investor and are denominated in Pound Sterling, D-Mark and U.S. dollar, respectively. The returns are expressed in percent. The risk-free interest rate is the interbank interest rate with a duration of three months. The row "2*COV" is 2 times the covariance between local returns and currency returns. The total variance is equal to local variance + currency variance + 2*COV. The Sharpe ratio is defined as the mean return divided by the standard deviation. The risk and return figures for the hedged country portfolios are virtually identical for all three investors.

---

implies hedging using forward contracts. The risk-free interest rates are interbank rates and have a duration of 3 months.

For the German investor hedging the currency would have always reduced the mean return and the Sharpe ratio. The only exception is the Russian equity market where currency hedging would have slightly increased the returns. In case of a U.S. investor the hedging both the Russian and the Hungarian currency increased the return of the equity portfolio. In case of the British investor this is also true for the Slovenian stock market. The risk-return profiles for the three different investors show that it should be interesting to analyse the benefits of diversification not only from the point of view of U.S. investors. The results of the British and particularly the German investor are sufficiently different from the U.S. investor to expect different results.

III. Should CEE Stocks be included in a World Stock Portfolio?

The results of chapter II seem to be relatively discouraging concerning the benefits of an investment in CEE equities. Even for those markets where the return is not negative the Sharpe ratio is very low compared to other international equity markets. Nevertheless, the CEE equity markets might offer benefits of diversification in the context of an internationally diversified equity portfolio. And these benefits of diversification could be high enough to make CEE equities a valuable investment. A point of concern might be the time period used for the calculations above. The CEE equity markets are not well developed, some are even still in an infant status, and the return distributions are probably not stable over time. Therefore analysing the past might not be a reliable guide for the future.

This chapter has the aim to answer the question whether CEE equity markets offer significant benefits of diversification. If yes, these equity markets could improve the performance of a world stock portfolio and should therefore be included in this portfolio. To shed light on the stability of this analysis we use different time periods for the empirical tests.

III.1 The Methodology of the Spanning Tests

Our analysis of the benefits of diversification uses the testing procedure developed by DeSantis (1995) and Bekaert/Urias (1996). These authors developed a spanning test based on the estimation of stochastic discount factors. A spanning test answers the question whether additional assets can significantly improve the efficient fron-

tier. In the following equation the return of an asset under test RT(t), in our study a CEE equity market, is equal to a linear combination of the returns of the benchmark assets $RB_i(t)$. In our tests these benchmark assets are the indices of the 23 equity markets that constitute the MSCI World Index. $\varepsilon(t)$ is an error term with mean zero.

$$(1) \qquad RT(t) = c + g_1 \cdot RB_1(t) + ... + g_{23} \cdot RB_{23}(t) + \varepsilon(t)$$

According to Huberman/Kandel (1987) that first described a spanning test in a mean-variance framework, two conditions have to be fulfilled for spanning:

$$(2) \qquad c = 0 \text{ and } \sum_{i=1}^{23} g_i = 1$$

If it is possible to mimic RT(t) using the returns of the benchmark assets, as is stated by equation (1), then RT(t) is actually redundant. In this case the 23 different returns $RB_i(t)$ can reproduce the returns of this CEE equity market. If instead mimicking is rejected then adding the CEE equities to the benchmark assets improves the efficient frontier.

The spanning test of DeSantis (1995) and Bekaert/Urias (1996) are based on a stochastic discount factor framework. The asset pricing restriction imposed by this approach is

$$(3) \qquad E(m_{t+1}(R_{t+1} + \iota) \mid I_t) = \iota$$

In formula (3) R is an (n x 1) vector of net asset returns[6], m is the stochastic discount

factor, I_t is the set of information available at time t and ι is a (n x 1) vector of ones. The stochastic discount factor is a random variable. In standard models of intertemporal utility optimisation the stochastic discount factor is the intertemporal marginal rate of substitution.[7] Usually in empirical studies the following linear stochastic discount factor is used:

$$(4) \qquad m_{t+1} = a + (R_{t+1} - E(R_{t+1}))' \beta$$

---

[6] The net asset returns are defined as *[(Asset Price (t) + Cash Flows (t)) / Asset Price (t-1)] – 1*.

[7] See Cochrane (2000) for further information on the stochastic discount factor approach.

Hansen/Jagannathan (1991) have shown that the linear projection of the stochastic discount factor onto the vector of asset returns has the lowest possible variance in the class of all stochastic discount factors that satisfy equation (3). The constant a is equal to the expected value $E(m_{t+1})$ of the stochastic discount factor.

For the development of the spanning test used in this study it is helpful to decompose the return vector as well as the vector of the beta coefficients into two components: a first part that refers to the benchmark assets and a second part concerning the assets under test:

(5) $$R \equiv [RB, RT]' \text{ and } \beta \equiv [\beta_B, \beta_T]'$$

It is assumed that the vectors referring to the benchmark assets have n(B) and the vectors concerning the test asset have n(T) elements with n = n(B)+n(T).

Bekaert/Urias (1996) proof that the following restrictions on the stochastic discount factor (4) are equivalent to the restrictions of the Huberman/Kandel test (2) and that both tests therefore are equivalent under the assumptions of Huberman and Kandel:

(6) $$\beta_T = 0 \quad \text{and} \quad E(m_{t+1}(R_{t+1} + \iota)) = \iota$$

These restrictions mean that the stochastic discount factors that price all assets, the benchmark as well as the test assets, can be formed without using the returns of the test assets. That is equal to say that the test assets are redundant and can be mimicked by the benchmark assets.

The following spanning test developed by DeSantis (1995) and Bekaert/Urias (1996) is a reformulation of (4) and (6) in the framework of a GMM test. The GMM approach has two advantages. First, it allows an uncomplicated estimation of the stochastic discount factors because equation (3) can be directly used as the moment conditions. And second and most important the GMM estimation does not require normally distributed asset returns. This is particularly important for the analysis of emerging market returns as these returns show remarkably large deviations from a normal distribution (see Table 1a). Within the framework of the GMM estimation it is also relatively easy to correct for heteroskedasticity and autocorrelation.

The spanning test can be obtained by applying (4) and (6) to two different points of the efficient frontier. The well-known two fund separation theorem implies that any

portfolio on the efficient frontier can be obtained using two different portfolios of the efficient frontier. Therefore if the efficient frontiers spanned by the two sets (a) international equity markets and (b) international equity markets plus CEE equity markets, are different at two points then they are different at all points. Because adding new assets can only improve the efficient frontier (or be irrelevant in the case of full redundancy), a rejection of spanning means that the CEE equity markets move the efficient frontier significantly upwards and therefore provide benefits of diversification.

Equation 7 shows the moment conditions for the spanning test under the condition that the beta coefficients of the test assets are zero:

(7)

$$h(\beta_B^{a_1}, \beta_B^{a_2}) = \frac{1}{T}\sum_{t=1}^{T}\begin{bmatrix} R_{t+1}[m_{t+1}^{a_1} \left| \beta_T^{a_1} = 0\right] + a_1 - \iota \\ R_{t+1}[m_{t+1}^{a_2} \left| \beta_T^{a_2} = 0\right] + a_2 - \iota \end{bmatrix} = 0$$

Using the linear formulation (4) for the stochastic discount factor (7) becomes:

(8)

$$h(\beta_B^{a_1}, \beta_B^{a_2}) = \frac{1}{T}\sum_{t=1}^{T}\begin{bmatrix} (R_{t+1}[a_1 + (RB_{t+1} - \mu_B)'\beta_B^{a_1}]) + a_1 - \iota \\ (R_{t+1}[a_2 + (RB_{t+1} - \mu_B)'\beta_B^{a_2}]) + a_2 - \iota \end{bmatrix} = 0$$

Here μ_B is the vector containing the sample means of the benchmark returns *RB*.

The moment conditions h(.) use the restriction that the beta coefficients of the test assets (i.e. the CEE equity markets) are zero. Thus the spanning test is a likelihood-type test which estimates the beta coefficients under the null hypothesis that CEE equity markets are spanned by the benchmark assets. The vector h(.) has 2*n elements. The two different points on the efficient frontier that are used in this test are represented by a_1 and a_2. These two constants can be chosen arbitrarily. The choice of a_1 and a_2 does not affect the results of the test. From (4) it can be seen that a_1 and a_2 are the expected values of the stochastic discount factor at these two different points.

The next step is the estimation of the beta coefficients. This is done by minimising

(9) $$h(\beta_B^{a_1}, \beta_B^{a_2})' \; W \; h(\beta_B^{a_1}, \beta_B^{a_2})$$

with respect to the beta coefficients. The test statistic derived from this estimation is

(10) $$MV = T \cdot h(\hat{\beta}_B^{a_1}, \hat{\beta}_B^{a_2})' \; W \; h(\hat{\beta}_B^{a_1}, \hat{\beta}_B^{a_2})$$

where the h(.)-function is evaluated using the beta estimates from (9). The test statistic MV is asymptotically chi-square distributed with 2*n(T) degrees of freedom.

W is a positive definite and symmetric weighting matrix.[8] Bekaert/Urias (1996) investigate the statistical properties of seven different specifications of W. Their results show that their test statistic MV_3 has the best properties and is therefore used not only by the authors themselves but also in other empirical studies on gains from international diversification as e.g. by Errunza/Hogan/Hung (1999).[9] In our own empirical analysis on CEE equity markets we therefore also choose the test statistic MV_3 proposed by Bekaert and Urias.

III.2 The Empirical Results of the Spanning Tests

Table 3 shows the results of the spanning tests when all CEE equity markets are tested together. To cope with possible time variation of the risk-return characteristics of CEE equity markets the analysis is conducted for the full sample (1994–99) and sub-samples. The interpretation of the results is clear: all p-values are below one percent. Therefore for all three investors the inclusion of all CEE equity markets to a diversified portfolio of mature international equity markets leads to a significant improvement of the efficient frontier. The results are shown for a small group which consists of the equity markets of Hungary, Poland, Slovakia and Slovenia and a

---

[8] For a detailed description of the estimation procedure and the derivation of the test statistic see Bekaert/Urias (1996), pp. 841-844 and DeSantis (1995), pp. 8-11.

[9] For further details on the different weighting matrices analysed and their empirical size and power see Bekaert/Urias (1996), pp. 843-846. Denote the vector under the sum in equation (8) as f(t). Then the W matrix of the MV_3 test statistic uses the f(t) vectors without removing the mean but corrects for serial correlation using the well-known procedure of Newey and West. As Bekaert and Urias state, f(t) should be serially uncorrelated under the null hypothesis. The investigation of the empirical f(t) vectors in our own applications indeed shows no signs of autocorrelation. Therefore, we choose only one lag for the Newey-West correction of the weighting matrix when calculating the MV_3 test statistic.

large group where the equity markets of the Czech Republic and of Russia are added to the other four markets. This separation is only due to different availability of data for the CEE equity markets. The results for the large group are slightly worse than for the small group but all p-values are still below one percent.

Table 3: P-Values of the Spanning Tests for CEE Countries as a Group

	British Investor		German Investor		U.S. Investor	
	Unhedged	Hedged	Unhedged	Hedged	Unhedged	Hedged
Small Group						
1994-99	**0.0000**	**0.0000**	**0.0007**	**0.0008**	**0.0000**	**0.0001**
1996-99	**0.0000**	**0.0000**	**0.0018**	**0.0003**	**0.0004**	**0.0002**
1998-99	**0.0020**	**0.0007**	**0.0028**	**0.0015**	**0.0003**	**0.0003**
Large Group						
1996-99	**0.0011**	**0.0000**	**0.0052**	**0.0007**	**0.0007**	**0.0004**
1998-99	**0.0077**	**0.0041**	**0.0092**	**0.0019**	**0.0010**	**0.0011**

Notes: The small group consists of Hungary, Poland, Slovakia and Slovenia. For this group the necessary data are available from January 1994 on. The large group is equal to the small group plus Russia and the Czech Republic. "Hedged" means that the CEE currency risk is fully hedged. The currency risk of the non-CEE countries is not hedged. Bold figures indicate a significance level of less than 1%.

The rejection of spanning is a usual result for emerging equity markets. Harvey (1995) finds clear evidence of an outward shift of the efficient frontier when emerging equity markets are added to a portfolio of mature equity markets.[10] The same result has been found by DeSantis (1994). Bekaert/Urias (1996) find also strong evidence against spanning when using equity indices but the results worsen when transaction costs are taken into account. The inclusion of transaction costs might be a crucial point for the evaluation of diversification benefits. This point will be discussed at the end of this chapter.

Another feature of table 3 is that the p-values are almost the same for fully hedged and unhedged CEE equity returns. The importance of currency hedging has so far been only analysed for mature capital markets. From the empirical literature on asset pricing the question whether currency hedging improves the performance of a portfolio of equities cannot be answered clearly. DeSantis (1995) for example finds that an U.S. investor can only benefit from investing in international developed equity

[10] Harvey (1995) uses intersection tests for the period January 1976 until June 1992. His sample of emerging equity does not include CEE equity markets.

markets when applying an optimal hedging strategy. No hedging or a full hedge does not result in a performance improvement. To give another example, Glen/Jorion (1993) find clear evidence that from the point of view of an U.S. investor currency hedging can improve the performance for an international bond portfolio and a portfolio of equities and bonds. But for a portfolio that consists only of equities hedging the currency is not helpful. Therefore, the results of table 3 are unusual insofar as for all three investors currency hedging seems to be not only useful but leads even to (slightly) better results than investing in CEE equity markets without currency hedge.

Table 4 shows the results of the spanning tests for each single CEE equity market. An obvious outcome of these tests is that only for the equity markets of the Czech Republic, Slovenia and Slovakia spanning can be rejected. This means that for our three periods under consideration the inclusion of the equity markets of Hungary, Poland and Russia did not add value to an internationally diversified equity portfolio. But again currency hedging is recommended for those equity markets for which spanning is rejected. And in almost all cases when the hedged equity returns show a significant portfolio improvement the p-values are higher compared to the case of no currency hedging. It is also important to note that there is some time variation in the significance of the spanning tests. For Slovenia for example spanning is rejected for the first and the third period for German investors, but not for the second period. This time variation of diversification benefits was also found in earlier studies on emerging equity markets.[11]

The results of table 4 are similar for all three investors but in contrast to table 3 there are also some important differences that could be important for an investment decision. Therefore, the results for an U.S. investor should not be simply applied for British and German investors.

---

[11] For an overview see Shawky/Kuenzel/Mikhail (1997). Usually the correlation serves as the major indicator of diversification benefits. Meric/Meric (1989) and Longin/Solnik (1995) for example test whether correlation matrices are constant over time and find evidence of instability. Longin/Solnik (1995) and Errunza/Hogan/Hung (2000) analyse conditional correlation using GARCH-type models and show that there is significant instability. Bekaert/Harvey (1995) show time variation of market integration, which is a topic closely related to diversification benefits.

Table 4: P-Values of the Spanning Tests for each single CEE Country

	British Investor		German Investor		U.S. Investor	
	Unhedged	Hedged	Unhedged	Hedged	Unhedged	Hedged
Czech Republic						
1996-99	0.1015	**0.0001**	**0.0233**	**0.0018**	0.1059	**0.0010**
1998-99	**0.0264**	**0.0013**	**0.0157**	**0.0092**	**0.0316**	**0.0067**
Hungary						
1994-99	0.2403	0.7312	0.0941	0.2872	0.2882	0.5946
1996-99	0.1429	0.4910	0.0550	0.1743	0.2902	0.6216
1998-99	0.1776	0.5329	0.2697	0.2816	0.1521	0.2666
Poland						
1994-99	0.4002	0.3514	0.5500	0.3083	0.5096	0.3866
1996-99	0.0441	0.9624	0.6267	0.5766	0.7141	0.7922
1998-99	0.1445	0.9959	0.6700	0.7841	0.7355	0.8283
Russia						
1996-99	**0.0294**	0.4772	0.1022	0.8307	0.4388	0.9262
1998-99	0.2079	0.9434	0.6213	0.6700	0.4993	0.9562
Slovakia						
1994-99	**0.0389**	**0.0094**	0.0597	**0.0235**	0.0717	**0.0430**
1996-99	**0.0000**	**0.0000**	**0.0003**	**0.0000**	**0.0000**	**0.0000**
1998-99	**0.0076**	**0.0059**	**0.0077**	**0.0083**	**0.0122**	**0.0146**
Slovenia						
1994-99	**0.0008**	**0.0000**	**0.0015**	**0.0011**	**0.0000**	**0.0000**
1996-99	0.0831	**0.0006**	0.1299	0.0646	**0.0075**	**0.0011**
1998-99	**0.0120**	**0.0004**	**0.0077**	**0.0048**	**0.0008**	**0.0007**

Notes: For most CEE countries the necessary data is available from January 1994 on. Only the data of the Czech Republic and Russia start later. “Hedged” means that the CEE currency risk is fully hedged. The currency risk of the non-CEE countries is not hedged. Bold figures indicate a significance level which is less or equal than 5%.

To give an economic evaluation of the significance of performance improvement the maximum attainable Sharpe ratio is calculated for our small and large CEE equity groups and for different time periods. The Sharpe ratio is defined as the mean portfolio return minus the risk-free interest rate and divided by the standard deviation of the portfolio returns. The Sharpe ratio measures the reward for risk and a higher Sharpe ratio therefore indicates a better compensation for investment risk. Table 5 shows the maximum Sharpe ratios for optimal portfolios consisting of the benchmark assets and all CEE equity markets.

Table 5: Maximum Sharpe Ratios when all CEE Countries are Part of the World Portfolio

	British Investor		German Investor		U.S. Investor	
	Unhedged	Hegded	Unhedged	Hedged	Unhedged	Hedged
Small Group						
1994-99						
Without	0.310	0.310	0.298	0.298	0.299	0.299
With CEE	0.331	0.335	0.319	0.366	0.319	0.327
Large Group						
1996-99						
Without	0.395	0.395	0.394	0.394	0.394	0.394
With CEE	0.441	0.441	0.442	0.463	0.441	0.452
1998-99						
Without	0.566	0.566	0.551	0.551	0.551	0.551
With CEE	0.662	0.693	0.655	0.685	0.656	0.687

Notes: The Sharpe ratio is defined as the mean excess return divided by the standard deviation of the returns. The figures show the maximum attainable Sharpe ratio of the optimum world portfolio. The only restriction of the optimisation is that the weights sum to one. Short positions are allowed. The small group consists of Hungary, Poland, Slovakia and Slovenia. For this group the necessary data are available from January 1994 on. The large group is equal to the small group plus Russia and the Czech Republic. “Hedged” means that the CEE currency risk is fully hedged. The currency risk of the non-CEE countries is not hedged. The Sharpe ratios in the row “without” are equal for “unhedged” and “hedged” as in this case only the developed equity markets are considered.

The results show an increase in the Sharpe ratio between 0.02 (period 1994-1999, U.S. investor, unhedged) and 0.136 (period 1998-1999, U.S. investors, hedged). One clear result is the strong time dependency of the performance improvements: for the period from 1994 until 1999 all results show only very small increases in the Sharpe ratio but for the period 1998 until 1999 the increases are relatively large. Another result confirms the importance of currency hedging: in all cases the maximum Sharpe ratio for the portfolio with hedged CEE currencies is at least as high as without currency hedging. This result is true for all three investors.

As the exact distribution of the Sharpe ratio is not known a statistical test of the significance of the change in the Sharpe ratio cannot be employed. Bekaert/Urias (1996) use Monte Carlo simulations which consider different numbers of test assets to assess the critical values of a change in the Sharpe ratio at the five percent level. In case of only one test asset an increase of the Sharpe ratio of at least 0.057 is needed to reject the null hypothesis of no change at the five percent level. With 12

test assets a change of as much as 0.254 is necessary. It is difficult to assess the applicability of these simulation results to our analysis.[12] Therefore, these figures can only give hints about the critical values. As we have four test assets in the case of the small group and six test assets for the large group we are somehow in the middle of the range calculated by Bekaert and Urias. Therefore, a change of the Sharpe ratio should perhaps be about 0.1 or even 0.14 to be significantly different from zero at the five percent level. This means that possibly only the results for the period 1998 until 1999 are really high enough to be significantly different from zero.

The maximum Sharpe ratios of table 5 refer to the optimal portfolio. This portfolio is calculated by a usual mean-variance optimisation procedure:

$$\begin{aligned} &\underset{(w)}{\text{maximise}} \ \left\{ w' E(R_t) - 0.5 \cdot \lambda \cdot w' Var(R_t) w \right\} \\ &s.t. \ \sum_i w_i = 1 \end{aligned} \tag{11}$$

The function in brackets is maximised with respect to the portfolio weights w. The only restriction is that the weights sum to one. There is no short sales restriction i.e. the weights can be positive or negative. The risk aversion parameter λ is strictly positive. In the optimum the following condition holds:

$$E(R_t) + \gamma \cdot \iota = \lambda \cdot Var(R_t) w \tag{12}$$

The Lagrange multiplier γ refers to the restriction on the sum of the weights. As the risk aversion parameter is unknown we can calculate the optimal weights only up to a scale factor. Table 6 summarises the results of the optimisation for the different time periods by showing the sign of the optimal portfolio weights.[13] "S" means a short position and "L" a long position.

---

[12] Bekaert/Urias (1996) assess the test on the Sharpe ratio for a sample of 152 data points. In our applications we have between 313 (period 1994-99) and 104 (period 1998-99) observations. For further information about the Monte Carlo simulations see Bekaert/Urias (1996), pp. 844-846.

[13] The optimisation has been done using the sample mean returns and the sample variance-covariance matrix as the parameterisation of E(R) and Var(R). For the period 1994 until 1999 the four "small group" CEE countries have been used and for the other two periods all six CEE countries.

Table 6: Short and Long Positions of CEE Countries in the World Portfolio

	British Investor		German Investor		U.S. Investor	
	Unhedged	Hegded	Unhedged	Hedged	Unhedged	Hedged
Czech Republic						
1996-99	S	S	S	S	S	S
1998-99	L	L	L	S	L	S
Hungary						
1994-99	L	L	L	S	L	L
1996-99	L	L	L	L	L	L
1998-99	S	S	S	S	S	S
Poland						
1994-99	S	S	S	L	S	S
1996-99	S	S	S	S	S	S
1998-99	L	L	L	L	L	L
Russia						
1996-99	S	L	S	L	S	L
1998-99	S	S	S	S	S	S
Slovakia						
1994-99	S	S	S	S	S	S
1996-99	S	S	S	S	S	S
1998-99	S	S	S	S	S	S
Slovenia						
1994-99	L	L	L	S	L	S
1996-99	S	L	S	S	S	L
1998-99	L	L	L	L	L	L

Notes: The tables shows whether the CEE countries have a long (L) or short (S) position in the optimal world portfolio. The only restriction of the optimisation is that the weights sum to one. The Sharpe ratios of these world portfolios are shown in table 5. For most CEE countries the necessary data is available from January 1994 on. Only the data of the Czech Republic and Russia start later. "Hedged" means that the CEE currency risk is fully hedged. The currency risk of the non-CEE countries is not hedged.

An obvious result is that the composition of the optimal position – even using only the sign of the country weights – is clearly dependent on the sample period. Therefore, past optimal weights are not very useful for the determination of future optimal weights, even the sign can hardly be forecasted. Only in case of Slovakia a short position would have been optimal for all three time periods.

There are two other interesting results: in most cases the investment recommendations ("short/long in country x") are very similar for British, German and U.S. investors and the use of hedged or unhedged equity returns did not often change the

sign of the investment position. But nevertheless currency hedging seems to be highly important as it almost always increased the maximum attainable Sharpe ratio (see Table 5).

The empirical spanning tests have two major possible shortcomings. One shortcoming addresses the question whether short positions are realistic and the other deals with the importance of transaction costs. As can be seen from table 6 allowing for short positions is essential for the realisation of diversification benefits. Applying the optimisation procedure (11) with the additional restriction of no short sales ($w \geq 0$) leads to the result that in all cases, i.e. all periods, all investors, hedged, unhedged, CEE equity markets would never be part of the optimal portfolio! This means when short sales are not possible nothing of the diversification benefits could be realised. This is indeed a very strong result. A similar result has been found by Bekaert/Urias (1999). They show for international emerging equity markets, which do not include CEE equity markets, that the attainable increase in the Sharpe ratio is strongly reduced when short sales are restricted to a portfolio weight of $w \geq -10\%$. As the options and futures markets in the CEE countries are even much less developed than the equity markets there are serious doubts on the possibility of unrestricted short selling of the equity index.

The other shortcoming is the absence of transaction costs in the spanning tests. Bekaert/Urias (1996) address this problem by using closed-end funds as the investment vehicle for the emerging markets. In contrast to the market indices the prices of the closed-end funds include transaction costs and therefore represent the investment possibilities more realistically. Not surprisingly they find that transaction costs can significantly reduce the benefits from diversification. Another interesting approach is to include both a short sales restriction and transaction costs into the spanning test itself. This has been done by DeRoon/Nijman/Werker (2000). Their results show that the spanning hypothesis for world-wide emerging equity markets cannot be rejected.[14]

For the diversification benefits of the CEE equtiy markets analysed in our study this means that there are probably no diversification benefits for private investors as these investors have hardly any access to the options and futures markets in Central

[14] The emerging markets that are included in DeRoon/Nijman/Werker (2000) do not cover Central and Eastern Europe.

and Eastern Europe. Only institutional investors could have a chance to realise the diversification benefits as this group of investors has relatively small transaction costs and the possibility to use futures and options markets. But also in this case there are usually strong restrictions for the use of financial derivatives such as in case of open-end mutual funds and pension funds. Therefore, only the so-called hedge funds might be in the position to benefit from an investment in CEE equity markets because they have almost no restrictions with regard to the composition of their portfolio.

IV. Summary

This study focusses on the diversification benefits stemming from an investment in CEE equity markets. To evaluate the benefits of diversification we use spanning tests that are based on a stochastic discount factor approach and estimated by GMM. In earlier studies as for example DeSantis (1994), Harvey (1995) or Bekaert/Urias (1996) spanning tests have been successfully applied to emerging equity markets but these studies do not cover CEE markets. In addition, our study addresses the diversification benefits not only for U.S. investors, as is usually the case in these studies, but extends the analysis on British and German investors. A third feature that distinguishes our investigation from most other studies on this topic is the analysis of the effects of currency hedging on diversification benefits.

At a quick glance the CEE equity markets seem to offer high diversification benefits. But this picture becomes cloudy after a thorough analysis. Only the equity markets of the Czech Republic, Slovakia and Slovenia contribute significantly to the diversification benefits. But a realisation of these benefits would imply to have not only long but also short positions in CEE equities. Taken into account transaction costs and limited access to futures and options markets it seems to be very doubtful that the theoretical diversification benefits can actually be realised. This result is also in correspondence with recent studies on other emerging markets such as DeRoon/Nijman/Werker (2000).

The results of the study also show that the home currency of the investor is of some importance for the results of the spanning tests. The situations of British, German and U.S. investors are similar but not identical. Therefore, it seems to be useful to apply not only the results for U.S. investors for other international investors but to take explicitly into account the currency of the investor. Another interesting result is

that currency hedging clearly improves the possible performance of an investment in CEE equity markets.

What is now the consequence for investors that consider an investment in CEE equity markets? Our study comes to the clear result that a buy-and-hold investor could hardly benefit from such an investment. Only investors that have superior timing capabilities could profit from the remarkably strong swings in the levels of CEE equity indices.

References:

Bekaert, G. and C. R. Harvey (1995): Time-Varying World Market Integration, Journal of Finance, vol. 50, pp. 403-444.

Bekaert, G. and M. S. Urias (1996): Diversification, Integration and Emerging Market Closed-End Funds, Journal of Finance, vol. 51, pp. 835-869.

Bekaert, G. and M. S. Urias (1999): Is there a free Lunch in Emerging Market Equities?, Journal of Portfolio Management, Spring 1999, pp. 83-95.

Bugar, G. and R Maurer (1999): International Portfolio Diversification for European Countries: The Viewpoint of Hungarian and German Investors, Proceedings of the Ninth International AFIR-Colloquium, 1999, Tokio, pp. 63-91.

Cochrane, John (2000): Asset Pricing, Internet Textbook, last Update: June 2000, http://www-gsb.uchicago.edu/fac/john.cochrane/research/Papers/finbook.pdf

DeRoon, F. A., T. E. Nijman and B. J. M. Werker (2000): Testing for Mean-Variance Spanning with Short Sales Constraints and Transaction Costs: The Case of Emerging Markets, Journal of Finance, forthcoming.

DeSantis, G. (1994): Asset Pricing and Portfolio Diversification: Evidence from Emerging Financial Markets, in Mike Howell (ed.): Investing in Emerging Markets, London, pp. 175-198.

DeSantis, G. (1995): Volatility Bounds for Stochastic Discount Factors: Tests and Implications from International Financial Markets, Working Paper No. 95-5, Dept. of Finance and Business Economics, School of Business Administration, University of Southern California.

Errunza, V., K. Hogan and M.-W. Hung (1999): Can the Gains from International Diversification be Achieved without Trading Abroad?, Journal of Finance, vol. 54, pp. 2075-2107.

Glen, J. and P. Jorion (1993): Currency Hedging for International Portfolios, Journal of Finance, vol. 48, pp. 1865-1886.

Hansen, L.P. and R. Jagannathan (1991): Implications of Security Market Data for Models of Dynamic Economics, Journal of Political Economy, vol. 99, pp. 226-262.

Harvey, C. R. (1995): Predictable Risk and Returns in Emerging Markets, Review of Financial Studies, vol. 8, pp. 773-816.

Huberman, G. and S. Kandel (1987): Mean-Variance Spanning, Journal of Finance, vol. 42, pp. 873-888.

Longin, F. and B. Solnik (1995): Is the Correlation in International Equity Returns Constant: 1960-1990?, Journal of International Money and Finance, vol. 14, pp.3-26.

Meric I. and G. Meric (1989): Potential Gains from International Portfolio Diversification and Inter-Temporal Stability and Seasonality in International Stock Market Relationships, Journal of Banking and Finance, vol. 13, pp. 627-640.

Shawky, H. A., R. Kuenzel and A. D. Mikhail (1997): International Portfolio Diversification: A Synthesis and an Update, Journal of International Financial Markets, Institutions and Money, vol. 7, pp. 303-327.