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International Equity Portfolios and Currency Hedging: The Viewpoint of German and Hungarian Investors

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1. Introduction

Grubel (1968) was the first who extended the theoretical concepts of modern portfolio selection developed by *Markowitz* to an international environment. Since that time a large number of empirical studies have examined the advantages of international portfolio diversification. The usual question, is whether adding foreign assets to a domestic benchmark portfolio improves the risk-return profile from the perspective of an investor located in a specific country. The earlier studies in the 70s, such as *Levy/Sarnat* (1970), *Lessard* (1973, 1976), *Solnik* (1974a), investigated the performance of ex post efficient portfolios and demonstrated that the benefits of internationally diversified portfolios rest on the idea of low co-movements between different national markets. More recent studies, including *Jorion* (1985), *Eun/Resnick* (1988, 1994), *Levy/Lim* (1994), *Liljeblum/Löflund/Krokfors* (1997) and *Rudolf/Zimmermann* (1998) evaluated different international portfolio strategies under more realistic conditions by using an "ex ante" or "out-of-the-sample" back-testing framework.

Compared to investments in domestic assets, fluctuating exchange rates represent an additional risk factor for investors who want to diversify their portfolio internationally. Therefore, it is important to study whether hedging the exchange rate risk is worthwhile and to which extent. A standard approach is to hedge the exchange rate risk completely by using forward contracts with unitary hedge ratios. Based on empirical evidence, proponents of such a hedging policy such as *Eun/Resnick* (1988, 1994) argue that relatively to its unhedged counterpart full currency hedging reduces the volatility of returns without a substantial reduction in returns. This led *Perold/Schulman* (1988) to argue that currency hedging is a "free lunch", i.e. currency hedging is costless in terms of returns while it reduces the risk. However, as *Adjaouté/Tuchschmid* (1996) pointed out, from a theoretical point of view, the unitary hedge ratio is the optimal one only if the exchange rate returns and local returns are uncorrelated and the forward exchange premium is an unbiased predictor of the future exchange rate returns. Nevertheless, empirical studies such as *Fama* (1984), *Frankel/Froot*, *Levy/Lim* (1994) and *Roll/Yan* (2000) have indicated that these restrictive assumptions are questionable. *Black* (1989) showed that under additional assumptions to the IAPM of *Solnik* (1974b), the hedge ratios should be identical for all investors regardless of their nationality and investors should never fully hedge their foreign currency exposures. Alternatively to the (fixed) unitary hedging policy, *Glen/Jorion* (1993), *Jorion* (1994), *Rudolf/Zimmermann* (1998), *Adjaouté/Tuchschmid* (1996) and *Larsen/Resnick* (2000) demonstrated that the currencies themselves can be treated as assets and the positions in them simultaneously optimised with the portfolio weights.

Most of the empirical work in the field of international diversification has focused on dollar-based investors or, at least, investors in large capital markets. Recently, the finance literature has attracted enormous attention about the diversification benefits from exposure in emerging equity markets. For example, *Lessard* (1973) took the viewpoint of a US-investor and studied the diversification benefits of an investment into Latin American countries. *Bekaert/Urias* (1996) examined the gains derived from emerging equity markets in Latin America, Asia and the Middle East using a data set on US- and UK-traded closed-end funds. *Bugár/Maurer* (1999) studied the benefits of a possible investment into Hungary, as an emerging market in the Eastern and Central European region, among other foreign countries from the viewpoint of a German investor. However, it also seems to be important to take the viewpoint of an investor who is located in an emerging market and investigate the effects of global investments from his perspective.

The objective of this paper is to review the theoretical and empirical arguments on the potential benefits from international diversification of stock portfolios by taking the viewpoint of a Hungarian investor, which is a fairly original database. To indicate the importance of the numeraire currency and to compare our empirical findings regarding the portfolio performance, the portfolio composition and the effectiveness of diversification from the viewpoint of such an emerging market investor with those of an investor from a more developed country, we also study the effects of international portfolio diversification from the perspective of a German investor. The economy (as well as the society) of both countries are influenced by a transition process that began with the collapse of socialism in Central and Eastern Europe at the end of the last decade. In examining the gains from international diversification, specific attention is paid to the question whether hedging the currency risk is beneficial on the performance of multi-currency portfolios.

The paper proceeds in the following way. Section 2 briefly describes the data used in the analysis and gives some important details on the Budapest Stock Exchange. In Section 3 we present the theoretical foundations of the benefits in terms of risk reduction and return gain of internationally diversified portfolios. Section 4 provides an ex post analysis of the benefits from German and Hungarian point of view by tracing out the ex post efficient set for the different hedging approaches considered. Section 5 evaluates the performance of various ex ante investment and hedging strategies and demonstrates the effect of estimation risk. Section 6 provides a summary and concluding remarks.

2. Data

The sample data consist of stock index returns of eight countries on a monthly basis from January 1991 to January 1999. The countries involved in the study are: Canada (CAN), Switzerland (CH), Germany (D), France (FR), Great Britain (GB), Hungary (HUN), Japan (JP) and the United States of America (US). The stock indexes which represent a well-diversified portfolio of each country are provided by Morgan Stanley Capital International (except Hungary). Each of the indices are value weighted, formed from major companies based on market capitalization, and adjusted for capital gains as well as dividend payments. The currencies of the selected countries are the most important in the international financial setting, with active currency forward markets which allows hedging the exchange rate risk. The data for the Hungarian stock exchange index (BUX) are obtained from the Budapest Stock Exchange. The BUX has been constructed since the beginning of January 1991. It is, like the MSCI-Indices, weighed by market value, and includes capital gains as well as dividend payments. At present the 21 companies quoted in the Hungarian stock exchange index represent 87.9 % of the market capitalisation of the listed firms on the Budapest

Stock Exchange. In order to get an insight to its market size and the transaction volume, Table 1 presents some details on the Budapest Stock Exchange.[1]

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Number of securities admitted to the BSE	6	22	40	62	120	166	167	149	144
Number of stocks admitted to the BSE	6	20	23	28	40	42	45	49	55
Capitalisation of the BSE (billion HUF)	16	54	202	458	884	1221	2390.9	5115	5470
Stock market capitalisation	16	38	47	82	182	327	852.5	3052	3020
Average daily turnover (million HUF)	34	40	134	737	838	1016	4618.7	27272	55836

Table 1: Main figures of the Budapest Stock Exchange from December 1990 to December 1998 . The data are year-end data in every case. (Source: Annual Report 1998, Budapest Stock Exchange).

The trading of futures for the official stock index of the Budapest Stock Exchange, the BUX index, currencies (Dollars, Deutsche Mark, and ECU) and 3-month T-bills started in March 1995. The turnover on the futures market continuously increased from 10.16 billion HUF in 1995 to 2934.47 billion HUF in 1998. The turnover on the currency futures market increased from 3.72 billion HUF to 973.96 billion in this time period.

To analyse the total returns from the Hungarian (German) point of view, we converted the local stock market index prices using month-end exchange rates for the Hungarian (German) currency. As a proxy for the risk-free rate we used the monthly money market returns provided by the Hungarian National Bank and Deutsche Bundesbank, respectively. For currency hedging, we have collected for each currency the one-month forward rates[2] against the US-Dollar on the first trading day of each month and used the non-triangular arbitrage condition[3] to obtain the quotes in Hungarian Forint (Deutsche Mark).

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[1] Further information about the Hungarian Stock Exchange as well as details on the composition of the BUX basket can be found in *Bugar/Maurer* (1999) and the Budapest Stock Index Manual.

[2] The forward rates against the US-Dollar (except USD/HUF) are the average of the bid and ask quotes and were obtained from Datastream. They are originally generated by the Barclay's Bank International, and observed on the first trading day of each one-month holding period. In the case of Hungary, the six-month USD/HUF forward rates are taken from the Budapest Stock Exchange database and converted into monthly premiums.

[3] The non-triangular arbitrage condition means that in the relationship of any three currencies (namely in the „triangle" of these currencies) the forward rates should take such (equilibrium) values which exclude the possibility of making arbitrage profit. It can be proven that it is fulfilled if the interest rate parity theorem holds. In this case one can get the HUF (DM) forward rates against any currency by dividing the HUF (DM) forward rates against the US-Dollar and that of the US-Dollar against the third currency in question.

3. Risk and Return of International Investment Portfolios with Currency Hedging

Let be S_{it} the spot Hungarian Forint/Deutsche Mark (HUF/DM) price of foreign currency i at time t, and P_{it} the ith (i = 1, ….., N) foreign country stock index value. At the end of each investment period the total return measured from time t – 1 to t on an unhedged foreign investment for a Hungarian (German) investor in the ith stock market is defined as:

$$R_{i,HUF(DM)} = \frac{S_{it} P_{it}}{S_{it-1} P_{it-1}} - 1 = (1+R_i)(1+e_i) - 1 = R_i + e_i \ + \ R_i e_i \qquad (1)$$

The total return depends on the local return $R_i = P_{it} / P_{it-1} - 1$ on the ith stock market and the exchange rate return $e_i = S_{it} / S_{it-1} - 1$ of the ith local currency against the Hungarian Forint (Deutsche Mark) numeraire currency.

Equation (1) shows that the total return of an international investment represents both an exposure to security and currency risk and an opportunity to benefit from security and currency returns.[4] Therefore, it is clear that a properly designed currency hedging strategy is important for the financial success of an international investment. In this paper we use currency forward contracts to hedge the exchange rate risk.[5] A currency forward contract is an agreement between two parties to buy (long position) or sell (short position) foreign currency with current spot price S_i at a future date at an exchange rate F_i (the forward price) determined at the time of the transaction.[6] If the interest rate parity theorem $f_i = (1 + i)/(1 + i^*) - 1$ holds, then the forward premium (domestic currency units per foreign currency unit) $f_i = F_i / S_i - 1$, represents the difference between the nominal zero-coupon default free interest rates (i.e. the riskless interest rate) with the same maturity as the forward contract of the domestic (i) and the foreign (i^*) country.[7] In the case of $i < i^*$ the forward premium can be negative, which is referred to as a forward discount. As many other kinds of financial derivatives, currency forward contracts are offered by commercial banks and/or are traded on organised financial markets and typically have fixed short maturities of one to nine months. Neglecting margin requirements, currency forward contracts produce a random payoff, but do not absorb capital upon closing of the position. The financial success from a forward short position offset possible gains and losses from currency fluctuations on the investment in the foreign stock market.

If the investor takes the opportunity to hedge his currency exposure by selling at time t – 1 some part h_i of the initial value of the investment forward, the total return measured from time t – 1 to t on such a hedged foreign investment for a Hungarian (German) investor in the ith stock market is defined as:

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4 Cf. *Eaker/Grant* (1990), p. 30.

5 See *Hin/Kuo/Lee (*1994) for a comparison of the hedging effectiveness of currency forwards versus currency options.

6 Cf. *Abken/Shrikhande* (1997), p. 37.

7 As noted in *Eun/Resnick* (1988), p. 205 and *Roll/Yan* (2000), p. 122 the interest rate parity is within the bounds of transaction costs a pure no-arbitrage condition which holds in international capital markets without investment barriers.

$$R^h_{i,HUF(DM)} = R_{i,HUF(DM)} + h_i(f_i - e_i) = R_i + e_i + R_i e_i + h_i(f_i - e_i) \quad (2)$$

where h_i is the hedge ratio. In the case of $h_i = 0$ the currency exposure of the investment is unhedged. Conversely, when $h_i = 1$ we get the unitary hedge ratio, sometimes referred to as the fully hedged strategy. It is noteworthy, that an unitary hedge ratio does not eliminate the currency risk of the foreign stock position perfectly, because of fluctuations in the foreign stock market value the investment result is unhedged. However in practice, the remaining currency exposure, which is represented in the cross product $R_i e_i$, should be small over short (e.g. weekly or monthly) hedging intervals.[8]

In order to study the performance of an international multi-asset portfolio we extend equation (1) as follows:

$$R_p = \sum_{i=1}^{N} x_i R_{i,HUF(DM)} \quad (3)$$

where R_p is the total return on the unhedged portfolio of a Hungarian (German) investor and x_i represents the fraction of wealth invested in the ith of the N stock markets. Using (2) and (3), the return on a portfolio in which the investor hedge some part of the currency exposure with foreign exchange forward contracts is given by:

$$R^h_p = R_p + \sum_{i=1}^{N} h_i x_i (f_i - e_i) \quad (4)$$

To be able to evaluate the different investment and hedging strategies (i.e. the probability distributions of portfolio returns) determined by the vector of portfolio weights x_i and hedge ratios h_i in a quantitative framework, it is necessary to introduce a formal criterion for investment decision making under uncertainty. In this paper we take the standard assumption of a risk averse investor who uses variance or standard deviation (sometimes referred to as volatility) of returns as the measure of risk and applies the mean-variance rule introduced by *Markowitz* to evaluate the different portfolio strategies. This means that a higher expected return and a lower variance of return is more desirable for the investor. The expected return of a global investment portfolio can be calculated by

$$\mathrm{E}(R^h_p) = \sum_{i=1}^{N} x_i \mathrm{E}(R_i) + \sum_{i=1}^{N} x_i (1-h_i) E(e_i) + \sum_{i=1}^{N} h_i x_i f_i + \Delta E \quad (5)$$

where $\Delta\mathrm{E} = \sum \mathrm{E}(R_i e_i)$ stands for the expected cross-term returns. The variance of the portfolio return is given by

$$Var(R^h_p) = \sum_{i=1}^{N}\sum_{j=1}^{N} x_i x_j \operatorname{cov}(R_i, R_j) + 2\sum_{i=1}^{N}\sum_{j=1}^{N} x_i x_j (1-h_j)\operatorname{cov}(R_i, e_j) +$$
$$+ \sum_{i=1}^{N}\sum_{j=1}^{N} x_i x_j (1-h_i)(1-h_j)\operatorname{cov}(e_i, e_j) + \Delta\mathrm{Var} \quad (6)$$

where $\operatorname{cov}(R_i, R_j)$ is the covariance between the returns in the ith and jth local stock market, $\operatorname{cov}(R_i, e_j)$ is the covariance between the ith local stock market return and the

[8] Cf. *Jorion* (1989), p. 50 or *Abken/Shrikhande* (1997), p. 40.

jth exchange rate return, the cov(e_i, e_j) stands for the covariance between the exchange rates returns of the ith and jth currency and ΔVar represents the contribution of the cross product terms to the variance of the portfolio return. As can be seen from (5) and (6) hedging some part of the currency exposure affects the portfolio expected return and variance. If R_i and e_j are negatively correlated, partial hedging or not hedging the currency risk at all can lead to a portfolio variance which is smaller than the variance of the fully hedged portfolio. If $f_i > E(e_i)$ for some markets, it is also possible that the expected return on a hedged portfolio is higher than that of the unhedged counterpart.

In order to determine for a given menu of risky assets the set of portfolios that minimise risk for given levels of expected return (i.e. the mean-variance efficient frontier), the following parametric quadratic optimisation problem should be solved for the vector of portfolio weights (x_1, x_2,…., x_N) and the vector of hedge ratios (h_1, h_2,…., h_N) simultaneously:

$$\begin{aligned} &\min Var(R_p^h; x_i, h_i) \\ &\text{subject to} \\ &E(R_p^h) = E \\ &\sum_{i=1}^{N} x_i = 1 \\ &0 \le x_i \le 1;\ 0 \le h_i \le 1 \qquad i = 1,2,...,N \end{aligned} \tag{7}$$

Solving the problem (7) for some level of portfolio expected return requires that 2N-1 variables, i.e. N investment proportions and N-1 hedge ratios be determined[9]. The optimal investment proportions generally depend on the hedge ratios, which themselves are affected by the currency positions. As special cases of this simultaneous choice of investment and hedge positions, which can be referred to as *optimal currency hedging*, the unhedged and the fully hedged strategy can also be handled by setting all of the hedged ratios to be equal to $h_i = 0$ and $h_i = 1$, respectively. In these cases we should optimise with respect to N variables, namely the investment proportions only. According to the conditions in (7) we require that the investment budget is totally invested in risky international stock portfolios only, that is we exclude the possibility of lending or borrowing on the risk-free interest rate. Additionally, we exclude short sales, i.e. negative portfolio weights, on the stock market investments as well as on the currency forward contracts. These are typical constraints for regulated institutional investors such as mutual funds or insurance companies in both countries.[10]

[9] We should only consider N-1 hedge ratios, because we do not need a forward contract for the domestic currency. For the latter the hedge ratio can be set equal to zero in the optimisation problem (7).

[10] For example, in the case of German mutual funds and insurance companies, both kinds of restrictions are codified in the supervision acts, i.e. the Gesetz über Kapitalanlagegesellschaften (KAGG) and the Versicherungsaufsichtsgesetz (VAG). Short sales are also forbidden in Hungary according to the Securities Act (Act CXI, 1996).

4. Ex Post Analysis of the Gains from International Portfolio Diversification

4.1 Risk and Return Characteristics of Different Stock Markets

Table 2 presents the average arithmetic returns and standard deviations of local returns, exchange rate returns and (hedged/fully hedged) total returns which could be realised by a Hungarian (German) investor on the different individual stock markets during the period of April 1995 – January 1999 (the returns are monthly percentage returns).

	CAN	**CH**	**GER**	**FR**	**GB**	**HUN**	**JP**	**US**
Average Returns (% p.m.)								
Local	1.45	2.55	2.31	2.14	1.64	4.62	0.03	2.40
Hungarian Perspective								
Exchange Rate	1.18	0.86	0.85	0.94	1.38	0	0.78	1.34
Total (unhedged)	2.68	3.38	3.14	3.05	3.02	4.62	0.78	3.78
Total (fully hedged)	2.84	3.36	3.58	3.53	2.85	4.62	1.77	3.92
German Perspective								
Exchange Rate	0.24	-0.02	0	0.10	0.51	-0.83	0.10	0.44
Total (unhedged)	1.75	2.52	2.31	2.24	2.16	3.86	0.12	2.89
Total (fully hedged)	1.37	2.80	2.31	2.08	1.39	3.41	0.32	2.26
Standard Deviation of Returns (% p.m.)								
Local	4.83	5.80	5.55	5.71	3.47	13.84	5.24	4.20
Hungarian Perspective								
Exchange Rate	2.45	2.03	1.30	1.32	2.17	0	4.13	1.93
Total (unhedged)	6.03	5.48	5.02	5.13	3.51	13.84	6.40	4.87
Total (fully hedged)	4.95	6.09	5.75	5.85	3.69	13.84	5.39	4.36
German Perspective								
Exchange Rate	3.09	1.19	0	0.52	2.39	1.27	4.45	2.61
Total (unhedged)	6.70	5.90	5.55	5.74	4.35	14.46	6.81	5.74
Total (fully hedged)	4.75	5.83	5.55	5.70	3.49	13.56	5.27	4.19

Table 2: Summary statistics of individual stock markets calculated from the calculated from the period of April 1995 – January 1999.

Looking at the mean returns and the standard deviations presented in Table 2, it can be observed that they are quite different for the period under consideration. For example the highest local mean return could be gained in the Hungarian stock market (4.62%) and the lowest was registered for the Japanese stock market (0.03%). But the high returns for the Hungarian stock market have been accompanied with the highest volatility (13.84%) which is more than twice as high as that of the Japanese stock market (5.24%).[11]

In case of Hungary all of the exchange rate returns are positive and have a relatively high contribution to the total mean return. For Switzerland we got the lowest relative contribution with about 25%, which is also relatively high. It is due to the continuous depreciation of the Hungarian Forint in the whole period studied. From the German

[11] It seems to be questionable if these sort of enormously high (in the case of Hungary) or low (in the case of Japan) historical stock markets returns are maintainable for the future. However, answering these question is beyond the scope of this paper.

point of view the exchange rate returns are considerably lower[12] but almost in every case positive. This observation seems to be in contradiction to the traditional picture of the “strong Deutsche Mark”, but it is in coincidence with the depreciation of the German currency against the US-Dollar (for example) we experienced in the period considered. From the German perspective the exchange rate return for the Hungarian investment is –0.83, which indicates the appreciation of the Deutsche Mark against the Hungarian Forint.

It is worth mentioning that from the viewpoint of a Hungarian investor for every country the mean return for a fully hedged investment was substantially higher than that of the local stock market return, indicating high positive forward premiums. According to the interest rate parity theorem this can be explained by the fact that the Hungarian money market returns were much more higher than those of other countries over the period considered. For example the average monthly money market return for Hungary was 1.45% and for Germany only 0.29%. So, the corresponding theoretical average forward premium of 1.16% is very close to the difference between the total return of a fully hedged portfolio in German stocks from the perspective of a Hungarian investor and the local stock return in Germany, i.e. 3.58% - 2.31% = 1.27%.

It is also interesting that from the Hungarian perspective for 5 out of the 7 foreign countries the mean return for a fully hedged investment was higher than that of the unhedged one. (From the German perspective - with the exception of Switzerland and Japan - the reverse was true). The explanation of this fact is that besides the Hungarian Forint continuously depreciated in the period examined, the forward rates on average overestimated the rate of depreciation of the HUF (i.e. the difference between f_i and e_i in formula (2) was on average positive).

Looking at the standard deviation of returns for the unhedged and fully hedged investments it can be seen that for a German investor fully hedging the currency risk has reduced the volatility of returns in all stock markets. The above mentioned risk reducing effect was not observable from the perspective of a Hungarian investor. Indeed, the standard deviation of return for the fully hedged investment was only in three cases (for the Canadian, the Japanese and the US stock markets) lower than that of the unhedged counterpart.

Comparing the row of the local standard deviations of returns to that of the fully hedged investments it can be observed that the numbers are not the same either in the case of Germany or Hungary. This confirms the earlier statement that „fully” hedging does not eliminate all of the currency risk. The explanation is that because of the fluctuations in foreign stock index values the amount to hedge is unknown. The remaining risk, which is expressed by ΔVar in the formula (6), is due to the variance of

[12] In relation with the exchange rate returns it is worth mentioning that in January 1999 in the eleven countries (the members of the Economic and Monetary Union (EMU)) of the European Union the common European currency, the Euro was launched. The exchange rates among the currencies of these countries were irreversibly fixed, and the Euro has become the official currency for which the exchange rates are determined. It means that within the EMU the exchange rate return component is zero from that time, and there is no currency risk anymore. Only Germany and France are members of the EMU among the countries we considered in our study.

the cross-term and the covariance of this term with the local return, i.e. $\Delta Var = \mathrm{var}(R_i e_i) + \mathrm{cov}(R_i, R_i e_i)$. The difference between the standard deviation of return for the fully hedged investment and that of the local stock market is positive in every case from the Hungarian perspective, and because of the short hedging interval it is relatively small but not negligible (it is in the range of 0.14 and 0.29). From the German perspective, the above mentioned difference is positive in some countries and in others negative but at the same time it is very small (its absolute value - with the exception of Hungary - falls between 0.01 and 0.08).

4.2 The impact of Co-movements between Stock and Currency Returns

From equation (6) it can be seen that the lower the correlation terms between the different return components are, the higher the potential risk reduction benefits may be in an internationally diversified portfolio. Table 3 provides the correlation terms between local stock market returns, the exchange rate returns and the cross-correlation terms between the stock and the exchange rate returns calculated by using monthly data from April 1995 to January 1999. The results for both countries are presented in one table in order to make the comparison of the terms instructive.

Comparing Panel (I) to Panel (II) of Table 3, it can be seen that the correlation terms are much higher among the local stock market than among the exchange rate returns. To be more formal we compared the average coefficient of correlation as *Meric/Meric* (1989) and *Longin/Solnik* (1995) suggested, and tested the null hypothesis stating that the correlation between the returns is equal to zero. The average correlation term is 0.64 for the local stock market returns, and it is in all cases except one (between Hungary and Japan) significantly different from zero at the 5% level. In contrast to this, the average correlation of the exchange rate returns are much lower, i.e. 0.26 in the case of Hungary and 0.25 in the case of Germany.[13] Additionally, there are some negative as well as positive correlations between the exchange rate returns for both countries which are significant at the 5%-level.

The average cross-correlation terms among local stock market returns and exchange rate changes (see Panel III) are –0.15 and 0.19 for Hungary and Germany, respectively. From the Hungarian perspective the correlation between the local stock market and the exchange rate return is negative for all European countries and Japan as well, and often in magnitude to be statistically significant at the 5% level. It means that the opposite movements of stock markets and exchange rates offset rather than reinforce the exchange rate volatility. These statements are not applicable from the German point of view, because in this case we found only for the changes of the Swiss and the Japanese currency negative correlation terms with the stock market returns we considered (see Panel III/B in Table 3). This is in coincidence with the positive value of the average cross-correlation mentioned above.

[13] *Eun/Resnick* (1988) pointed out the reverse of this fact. They found a higher correlation among exchange rate movements than among the local stock market returns from the viewpoint of US investors.

	CAN	CH	D	FR	GB	HUN	JP	US
(I) Correlation between stock market returns in local currencies								
CAN	1	0.59	0.63	0.64	0.72	0.57	0.35	0.82
CH		1	0.74	0.78	0.68	0.60	0.49	0.61
D			1	0.85	0.68	0.48	0.53	0.64
FR				1	0.68	0.54	0.50	0.60
GB					1	0.56	0.44	0.63
HUN						1	0.18	0.53
JP							1	0.44
US								1
(II/A) Correlation between exchange rate returns against the Hungarian Forint								
CAN	1	-0.19	-0.36	-0.39	0.39	0	-0.06	0.84
CH		1	0.83	0.75	0.08	0	0.17	-0.14
D			1	0.90	0.10	0	0.03	-0.34
FR				1	0.10	0	-0.05	-0.32
GB					1	0	0.04	0.49
JP						0	1	0.03
US						0		1
(II/B) Correlation between exchange rate returns against the Deutsche Mark								
CAN	1	0.03	0	-0.07	0.61	0.59	-0.25	0.91
CH		1	0	-0.10	-0.09	-0.32	-0.14	0.01
FR			0	1	0.05	0.16	0.11	0.00
GB			0		1	0.42	-0.18	0.68
HUN			0			1	-0.28	0.66
JP			0				1	-0.28
US			0					1
(III/A) Correlation between stock market returns (in local currencies) and exchange rate returns against the Hungarian Forint								
CAN	0.28	-0.47	-0.52	-0.49	-0.11	0	0.15	0.10
CH	0.28	-0.40	-0.56	-0.53	-0.12	0	0.03	0.21
D	0.40	-0.49	-0.57	-0.57	0.04	0	-0.08	0.35
FR	0.39	-0.58	-0.62	-0.59	0.02	0	0.04	0.35
GB	0.26	-0.39	-0.52	-0.49	-0.32	0	0.13	0.12
HUN	0.27	-0.47	-0.59	-0.64	-0.21	0	0.19	0.16
JP	0.30	-0.31	-0.45	-0.37	0.00	0	-0.09	0.23
US	0.34	-0.46	-0.54	-0.54	-0.09	0	0.08	0.09
(III/B) Correlation between stock market returns (in local currencies) and exchange rate returns against the Deutsche n Mark								
CAN	0.42	-0.22	0	0.04	0.19	0.52	-0.30	0.33
CH	0.49	-0.05	0	0.01	0.22	0.55	-0.19	0.47
D	0.57	-0.18	0	-0.06	0.40	0.56	-0.14	0.59
FR	0.56	-0.31	0	0.01	0.37	0.62	-0.27	0.58
GB	0.48	-0.09	0	0.01	0.06	0.52	-0.26	0.41
HUN	0.54	-0.15	0	-0.15	0.18	0.59	-0.36	0.48
JP	0.40	-0.03	0	0.19	0.24	0.45	-0.03	0.39
US	0.50	-0.16	0	-0.05	0.25	0.53	-0.21	0.37

Table 3: Each entry in Panel (III) denotes the correlation between the row stock market return in local currency and the column exchange rate return against the Hungarian Forint/Deutsche Mark using time series returns from 04/1995 – 01/999. Using the t-statistic (with 44 degrees of freedom) suggested in *Anderson* (1984, p. 109) the upper and lower bounds for the empirical coefficients of correlations in order to reject H_0: "zero correlation" at the 5% level of significance are $\pm$ 0.246.

In order to get an insight into the risk reduction potential of currency hedging on a multi-currency investment, we decomposed the variance of the equally weighted unhedged portfolio the same way as *Eun/Resnick* (1994, p. 145) did. Therefore, by utilising the information in Tables 2 and 3 regarding the input parameters, we calculated the portfolio variance according to formula (6) for the special case of $h_i = h_j = 0$ and $x_i = x_j = 1/N$. The results are given in Table 4.

Component	***Hungarian Perspective***		***German Perspective***	
	Absolute contribution	Relative contribution	Absolute Contribution	Relative Contribution
$\sum_{i=1}^{N}\sum_{j=1}^{N}(1/N)^2 \operatorname{cov}(R_i, R_j)$	23.24	100.45 %	23.24	82.12 %
$\sum_{i=1}^{N}\sum_{j=1}^{N}(1/N)^2 \operatorname{cov}(e_i, e_j)$	0.94	4.06 %	1.01	3.57 %
$2\sum_{i=1}^{N}\sum_{j=1}^{N}(1/N)^2 \operatorname{cov}(R_i, e_j)$	-1.74	-7.53 %	4.10	14.49 %
ΔVar	0.70	3.02 %	-0.05	-0.18 %
$Var(R_p) =$	23.14	100 %	28.30	100 %

Table 4: Decomposition of the variance of the unhedged equally weighted portfolio

It is clear from Table 4 that in the case of Hungary a large portion (100.45 %) of overall portfolio risk came from stock market volatility and co-movements between different stock markets. The exchange rate changes have a decreasing effect on the risk component due to the market volatility as well as on the total risk of the portfolio. This is in accordance with our conclusions regarding the negative signs of most of the cross-correlation terms in Panel III/A in Table 3 as well as the negative sign of the third risk component in Table 4 (-1.74). All in all, for a Hungarian investor the low (negative) proportion of the exchange rate related risk component does not promise a further significant decrease in risk by means of hedging. In the case of Germany the exchange rate volatility accounts for about the 18% of the volatility of the total return. This indicates that for a German investor there is some room left for risk reduction by hedging the exchange rate risk on a multi-currency portfolio. *Eun/Resnick* (1988) demonstrated for the period of 1980-1985 that for an American investor exchange rate volatility accounted for about 50% of the volatility of the dollar returns from an internationally diversified portfolio, which is clearly in contrast with our results.

4.3 Hedging Policies and Efficient Frontiers

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In this subsection we examine the potential gains from adding assets of mature financial markets into a local stock portfolio as well as the impact of the three different hedging approaches considered by comparing their risk-return characteristics to those of the domestic portfolio. Therefore, the optimisation problem (7) was solved by using the input parameters presented in Table 2 and 3 and the graph of the efficient frontier was plotted for the unhedged, fully hedged and optimally hedged currency exposures. The results are shown on Figure 1a from Hungarian and on Figure 1b from the German perspective. The German and the Hungarian domestic portfolio is labelled by „GER" and „HUN", respectively, on the figures.

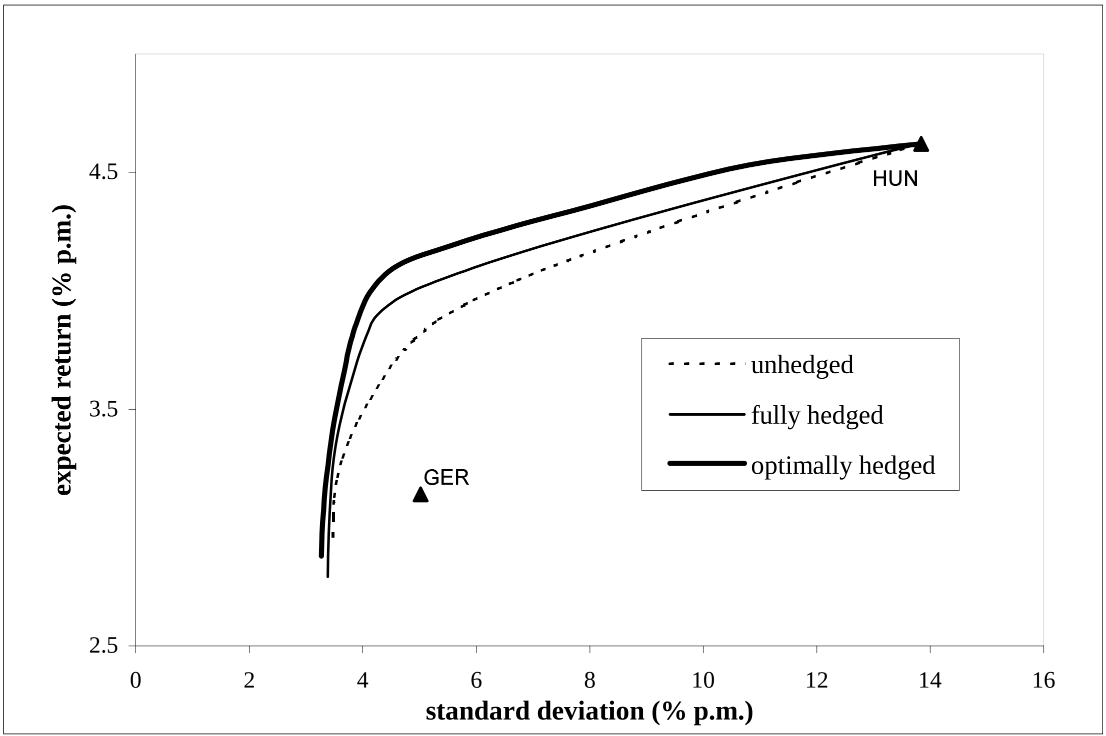

Figure 1a: Efficient frontiers for different hedging strategies from the perspective of a Hungarian investor

In the case of Hungarian investors both hedged frontiers lie above the unhedged one, expressing the fact that hedging the currency risk for Hungarian investors could be a way to increase the expected return and decrease the risk of an internationally diversified investment. In other words: the Hungarian investors could potentially utilise the speculative return as well as the variance-reduction component of hedging in the period considered. The optimally hedged efficient portfolios lie (by construction) on the highest curve in the standard deviation-expected return space, which indicates their dominance in terms of mean-variance efficiency. However, the resulting efficient frontier with forwards, included as an asset class in the portfolio optimisation process, is very close to that of the unitary hedging strategy.

It is remarkable that the Hungarian domestic portfolio constitutes the meeting point of the three efficient frontiers with the different hedging approaches. As the investment with the highest expected return (and at the same time with the highest risk as well), it should be the „uppermost" point on the unhedged efficient frontier because in generating the efficient portfolios short sales were excluded. From the perspective of the Hungarian investor, the investment into the German stock index can be regarded as a (mean-variance) inefficient investment.

With respect to the efficiency of the Hungarian domestic portfolio, one can raise the question, whether it is worthwhile for a Hungarian investor to move to the international „scene” to search for a multi-currency portfolio instead of investing into a domestic one. A crude answer, which can be given to the question at this stage[14], is yes. It seems to be obvious that the main motivation for a Hungarian investor to select an international stock portfolio instead of its domestic counterpart is the endeavour to reduce the large risk which can be experienced in the domestic stock market. This may be regarded as a downward movement on the efficient frontier, which belongs to a particular hedging approach.

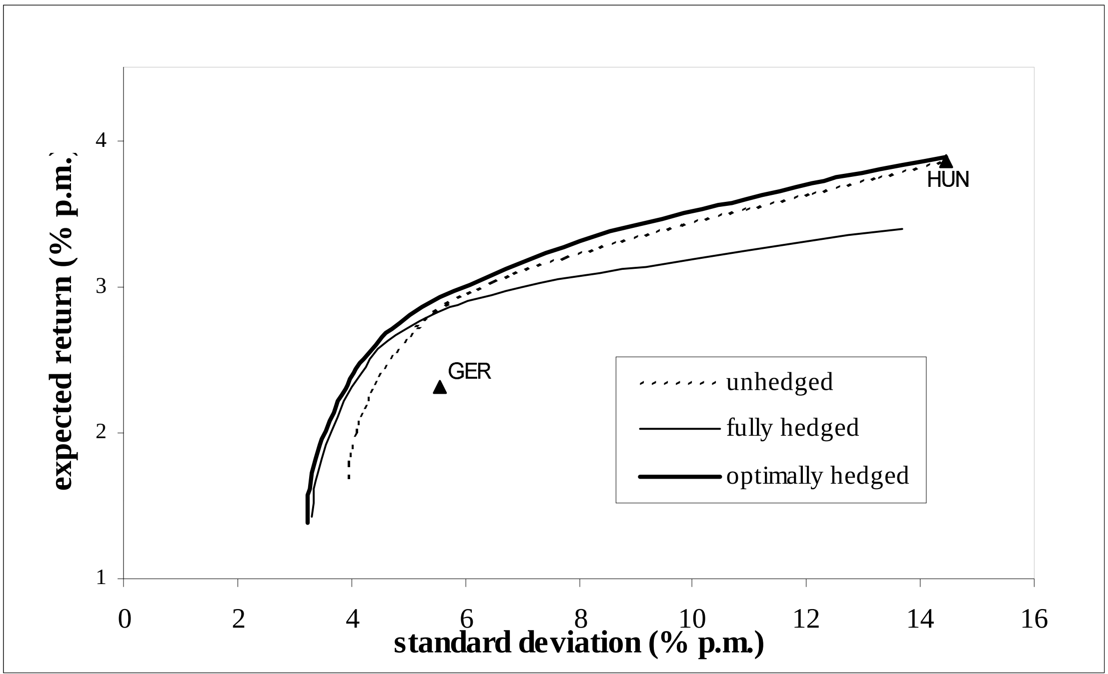

Figure 1b: Efficient frontiers for different hedging strategies from the perspective of a German investor

For the German investors the fully hedged efficient frontier crosses the unhedged one. This means that fully hedging the currency risk is not efficient against no hedging, especially, if the investors are willing to take high risk. In other words: above a critical risk level (namely, above the value of the standard deviation at the meeting point of the curves, which is 5.05 %) it was not worthwhile for German investors to fully hedge their multi-currency portfolios, because they could not utilise the advantages of hedging either in terms of increasing the return or lowering the risk.

It can be seen in Figure 2 that the unhedged and the optimally hedged efficient frontier of a German investor also contain the Hungarian stock index as the efficient investment with the highest mean and standard deviation. It means the tendency that the German investors were eager to invest into the Hungarian stock market in the period

[14] In a further analysis of some ex ante portfolio strategies, which is presented in the next section, we try to give a more refined answer to this question.

considered can be explained in the mean-variance framework: in particular, there was a potential for German investors to realise high returns in Hungary as soon as they were willing to take high risk.

5. Out-of-the-Sample Analysis

5.1 Design

The results in the previous section suggest that internationally diversified portfolios have a potential to perform better than their domestic counterpart and hedging some part of the currency exposure improves the risk-return profile. However, due to the ex post nature of this technique, it is only determined afterwards what should have been done before. Thus, an important question is whether the promised benefits of creating a multi-currency portfolio accrue if investment decisions are solely based on prior information.[15]

A prominent approach in evaluating the performance of different investment and hedging strategies under realistic conditions is to use an “ex ante” or “out-of-the-sample” back-testing procedure.[16] In such a context it is necessary to set rules for portfolio selection. Similarly to other researchers in the field of international diversification, we considered the three ordinary portfolio selection strategies, namely the ones which resulted in the equally weighed portfolio (EQW), the minimum variance portfolio (MVP) and the tangency portfolio (TG).

In the case of the EQW approach, which is often referred to as the naive diversification, the same fractions of the budget are invested into each stock market. It can be regarded as the simplest way to benefit from international diversification without using any information on the security returns, risks and co-movements.[17] Since we are also interested in the impact of currency hedging on portfolio performance, we calculate the EQW-strategy without hedging and with fully hedging the currency risk.

The global minimum variance portfolio attempts to identify the investment weights (and hedge ratios) with the lowest risk, not explicitly using any information on the asset-specific expected returns, so they are not required as input parameters to solve the portfolio selection problem. Therefore, this investment strategy indicates the po-

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[15] Cf. *Glen/Jorion* (1993), p. 1882.

[16] See for example *Eun/Resnick* (1988,1994), *Glen/Jorion* (1993), *Levy/Lim* (1994), *Liljeblom/Löflund/Krokfors* (1997) or *Bugar/Maurer* (1999).

[17] It should be noted that if all means, standard deviations and correlation coefficients were equal for all countries we would get the EQW as the optimal portfolio. Looking at the empirical mean returns and the variances presented in Table 2, we can observe that they are different. To be more precise, we tested the null hypothesis stating that the mean returns of the local stock index portfolios, the exchange rates, the unhedged and fully hedged investment for the different countries are equal. The test is based on a single factor analysis of variance (ANOVA) and has an asymptotic F-distribution with (7, 360) degrees of freedom. From the viewpoint of a German investor the null hypothesis cannot be rejected at the 5% level in any of the cases, either for the local returns or the exchange rate returns, while in the case of a Hungarian investor, for the exchange rate returns it can. In contrast to these mixed results for the means, by applying the *Brown-Forsythe* test, the null hypothesis for the equality of the variance of the different return series can be rejected in all cases from the viewpoint of both countries at the 5% significance level. The test statistic has an F-distribution with (7, 360) degrees of freedom (cf. *Brown/Forsythe* (1974) and *Conover* e*t al.* (1981) for a discussion of this test).

tential for risk reduction which is attainable by investing internationally rather than in the domestic stock market. Excluding short sales, (and depending on the hedging approach applied) the minimum variance portfolio can be calculated by solving the following constrained optimisation problem:

$$\begin{gathered} \min Var(R_p^h; x_i, h_i) \\ \text{subject to} \\ \sum_{i=1}^{N} x_i = 1 \\ 0 \le x_i \le 1;\ 0 \le h_i \le 1 \qquad i=1,2,...,N \end{gathered} \tag{8}$$

In the case of the tangency portfolio (TG) we are looking for the combination of assets which maximises the risk-adjusted performance measured by the *Sharpe* (1966), the ratio of excess return over the risk-free rate to volatility. The *Sharpe*-ratio measures the slope of the line connecting the risk-free rate with the tangency portfolio on the efficient frontier. Such a strategy explicitly uses information on the expected returns and the covariance matrix of the different investments. Formally, taking the hedging policy also into consideration, the tangency portfolio can be identified by solving the optimisation problem as follows:

$$\begin{gathered} \max S(x_i, h_i) = \frac{E(R_P^h) - r_f}{\sqrt{Var(R_P^h)}} \\ \text{subject to} \\ \sum_{i=1}^{N} x_i = 1 \\ 0 \le x_i \le 1;\ 0 \le h_i \le 1;\ i=1,2,...,N \end{gathered} \tag{9}$$

where r_f is the rate of return of a risk-free asset (with respect to the length of the investment period).

In order to implement the out-of-sample framework, two different time horizons are used. To obtain estimates for the expected return vector and the covariance matrix, a sliding window of 48 months (the first was from April 1991 to March 1995, the second was from May 1991 to April 1995 etc.) prior to the beginning of the holding period was reserved.[18] Then, we identified the investment weights and the hedge ratios for a holding period of the subsequent month forward in solving the optimisation problems (8) and (9).[19] Using new statistical information at the end of each month, the portfolios were revised, shifting the in-the-sample estimation period by one month. In total, with this rolling technique, we generated 46 non-overlapping out-of-sample monthly returns for each investment and hedging strategy, which can be regarded as 46 independent investment decisions with a holding period of one month.

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[18] The data available on the Hungarian stock (starting in January 1991) and currency futures market (starting in March 1995) restricted our choice in terms of sample returns.

[19] If the expected return of the tangency portfolio has a lower expected return as the riskless interest rate, i.e. a negative anticipated Sharpe-ratio, all the budget is invested in the riskless asset for this period, cf. *Liljeblom/Löflund/Krokfors* (1997).

To estimate the inverse of the variance-covariance matrix (**C**) of the returns stated in terms of the numéraire currency we used the unbiased estimator of this matrix proposed by *Jobson/Korkie* (1981a):

$$\mathbf{C}^{-1} = \frac{T - N - 2}{T - 1} \cdot \mathbf{S}^{-1} \tag{10}$$

where T is the length of the time series of the estimation period, **S** is the usual N x N sample variance-covariance matrix of asset returns and N is the number of assets. In our case T = 48 and N = 8 (in the case the hedge ratios are fixed) or N = 15 (for optimally hedged portfolios). With this information in hand, the investment weights and the hedge ratios of the minimum variance portfolio can be obtained at the beginning of the 46 out-of-sample periods by solving the optimization problem (9).

To determine the TG portfolio, the investor has to obtain some estimate of the expected return on each assets and a risk free asset. As a proxy for the risk-free rate we used the monthly money market returns at the beginning of each out-of-sample investment period provided by the Hungarian National Bank from the viewpoint of an Hungarian investor and the Deutsche Bundesbank from the viewpoint of an German investor, respectively. According to the expected return vector a first approach is to use the ex post (historical) sample mean return vector of the time series of the specific stock returns. As *Jorion* (1985,1986) showed, the problem with such an estimation is that because of the sample mean is exposed to estimation risk, it could be very unstable over time.[20] Due to the high influence of the expected return vector on the weights of the tangency portfolio, this estimation risk can lead to a substantial instability of portfolio weights. This instability can be responsible for extreme, volatile portfolio returns in the out-of-sample investment periods.

A possibility to control for input parameter estimation risk is to use the *Bayes/Stein* estimation techniques derived by *Jorion* (1985, 1986), i.e. to pool the data from all countries and combine the estimation and optimisation process. Therefore, the expected return vector **e** should be forecast as a linear combination of the (N x 1) ex post historical sample mean-return vector **e** and the mean return e_0 from the ex post minimum variance portfolio of N assets:

$$\mathbf{e}^{*} = (1 - w)\mathbf{e} + w\mathbf{1}e_0 \tag{11}$$

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[20] Variances and correlations of portfolio returns are also exposed to estimation risk, but as *Merton* (1980), *Jorion* (1986), *Kallberg/Ziemba* (1984), *Kaplanis* (1988), *Meric/Meric* (1988), *Longin/Solnik* (1995) or *Liljeblom/Löflund/Krokfors* (1997) and others have pointed out, these parameters are generally more stable over time. Using the *Jennrich* χ^2-test of equality of two matrices, we tested the intertemporal stability of the correlation matrix of the local-, exchange rate- and total returns, by dividing the total estimation period into two adjacent sub-periods: 04/1991–03/1995 and 04/1995– 1/1999. In none of the cases (neither for Germany nor for Hungary), the null hypothesis of the equality of the two correlation matrices can be rejected at the usual 5% level of significance.

where **1** is a vector of ones and w represents a shrinkage factor for shifting the elements of **e** towards e_0.[21] Using arguments from statistical decision theory *Jorion* (1985, 1986) shows that an optimal – in the sense to minimize a specific loss function – technique to estimate the shrinkage factor can be calculated as follows:

$$w = \frac{(N+2)(T-1)}{(N+2)(T-1) + (\mathbf{e} - e_0 \mathbf{1})^T T \mathbf{S}^{-1} (T - N - 2)(\mathbf{e} - e_0 \mathbf{1})} \qquad (12)$$

Utilising the results given by (11) and (12) in estimating the expected return vector and formula (10) in estimating the variance covariance matrix, and then solving the optimisation problem (9) results in the "*Bayes-Stein*" tangency portfolio (BST). It should be noted, that equation (11) is general enough to encompass the other portfolio selection rules. If $w = 0$ we can get the tangency portfolio and for $w = 1$ the minimum variance portfolio respectively.

5.2 Out-of-Sample Performance

For each strategy the average return, standard deviation (STD) of returns and the *Sharpe*-ratio are calculated and presented in Table 5. Furthermore, the performance of each portfolio strategy is compared to that of the domestic stock index by testing the difference between the *Sharpe*-ratios with the z-statistic developed by *Jobson/Korkie* (1981b). The average portfolio weights (as well as the hedge ratios) are reported in the next subsection.

It can be concluded from the results in Table 5 that for Hungarian investors the benefits from internationally diversified portfolio strategies accrued in terms of risk reduction. It can be observed that each of the strategies promised a lower mean return than the Hungarian investment. The risk reduction benefits turned out to be economically significant, even the riskiest strategy (EQW with fully hedged currency risk) ended in a more than 60 % risk reduction compared to the domestic stock index.

In terms of risk adjusted performance, the fully hedged strategies produced the best results among all the strategies considered. It is worth mentioning that the performance improvement of the least sophisticated one, the fully hedged naive strategy was also significant at the 10 % level. All in all, the hedged strategies performed better than their unhedged counterparts. The performance improvement of the unhedged strategies was not statistically significant at the usual 5 (10) % level for any of the strategies. This, however, may have more to do with the relatively low power of the JK-test. It is interesting that the main effect of hedging was not that it further reduced the risk of the unhedged portfolios but it increased the mean return (creating a multi-currency portfolio for a Hungarian investor could in itself drastically reduce the risk of a domestic investment). It is due to the fact that the rates of depreciation in HUF were on average overestimated by the forward rates in the time period examined.

[21] It should be noted that there is an analogy in actuarial risk theory, the so-called credibility estimation, cf. e.g. *Klugman* (1992) and *Makov* et al. (1996).

	German Perspective				Hungarian Perspective			
Strategies	Mean	STD	Sharpe-ratio	JK-statistic	Mean	STD	Sharpe-ratio	JK-statistic
No Hedging								
EQW	2.23	5.32	0.37	-0.04	3.06	4.81	0.34	-1.07
MVP	1.93	4.49	0.37	-0.04	3.05	4.30	0.37	-1.01
TG	2.37	5.37	0.39	-0.12	3.21	4.59	0.39	-1.03
BST	2.29	5.03	0.40	-0.21	3.21	4.41	0.40	-1.18
Fully Hedging								
EQW	1.96	4.79	0.35	0.13	3.33	4.97	0.38	-1.57*
MVP	1.73	3.76	0.38	-0.10	3.26	3.96	0.46	-1.75**
TG	2.38	4.80	0.44	-1.12	3.81	4.37	0.54	-2.09**
BST	2.23	4.54	0.43	-1.05	3.68	4.29	0.52	-1.99**
Optimal Hedging								
MVP	1.72	3.77	0.38	-0.15	3.19	4.03	0.43	-1.55*
TG	2.35	4.82	0.42	-0.87	3.47	4.31	0.47	-1.80**
BST	2.35	4.76	0.43	-0.99	3.47	4.30	0.47	-1.80**
Domestic	2.31	5.55	0.36	-	4.62	13.84	0.23	-

Table 5: Performance statistics of 46 out-of-the-sample portfolio returns in the period from April 1995 to January 1999. EQW is the Equally Weighted Portfolio, MVP is the Minimum Variance Portfolio, TG is the Tangency Portfolio, BST is the *Bayes-Stein* Tangency Portfolio. 48 previous months were used in the estimation of mean returns and covariance matrixes. *Jobson/Korkie* z-statistic tests the difference between Sharpe-ratios for each strategy against the domestic portfolio (* and ** indicates significance at 10 % and 5 % level, respectively. The (arithmetic) mean returns and the standard deviation (STD) of returns are reported in % per month.

In terms of risk adjusted performance, the fully hedged strategies produced the best results among all the strategies considered. It is worth mentioning that the performance improvement of the least sophisticated one, the fully hedged naive strategy was also significant at the 10 % level. All in all, the hedged strategies performed better than their unhedged counterparts. The performance improvement of the unhedged strategies was not statistically significant at the usual 5 (10) % level for any of the strategies. This, however, may have more to do with the relatively low power of the JK-test. It is interesting that the main effect of hedging was not that it further reduced the risk of the unhedged portfolios but it increased the mean return (creating a multi-currency portfolio for a Hungarian investor could in itself drastically reduce the risk of a domestic investment). It is due to the fact that the rates of depreciation in HUF were on average overestimated by the forward rates in the time period examined.

In the case of Germany, similarly to Hungary, the highest Sharpe-ratio was observed for the fully hedged TG strategy. The second highest performance could be registered for the optimally- as well as the fully hedged BST portfolios, but the nearly 20 % improvement did not turn out to be statistically significant. The lowest standard deviation of the realised portfolio returns could be measured on the fully hedged MVP, but it only indicates a slightly higher than 12 % benefit in terms of risk reduction. All in all, it can be concluded that for German investors the benefits from international diversification of stock portfolios were not so clear-cut as for their Hungarian counterparts, either in terms of risk reduction or performance improvement. Indeed, we were not able to find a strategy among all of the internationally diversified investments examined for which the performance improvement compared to the domestic stock index would have been statistically significant.

As an alternative to the *Sharpe* performance index, we also evaluated the performance of the strategies by using second degree stochastic dominance. An advantage of this approach is that this evaluation criterion does not suffer from the usual criticisms concerning the mean-variance criterion, because it does not assume any specific distribution for the returns and it is consistent with a very broad class of utility function representing risk aversion.[22] In addition, there are two other reasons in favour of the stochastic dominance approach, namely the *Jobson-Korkie* statistic, which was used to detect whether the performance impovement was significant, has a little power in general (as we mentioned earlier) and it also relies on the normal distribution for the returns. The results of the second degree stochastic dominance analysis are presented in Table 6.[23]

	No Hedging				*Fully Hedging*				*Optimal Hedging*		
	EQW	MVP	TG	BST	EQW	MVP	TG	BST	MVP	TG	BST
The German Perspective											
SSD			X	X			X	X		X	X
SSDR							X	X		X	X
The Hungarian Perspective											
SSD		X	X	X		X	X	X		X	X
SSDR							X				

Table 6: Second degree stochastic dominance analysis of 46 out-of-sample portfolio returns in the period of April 1995 – January 1999. "X" indicates an efficient portfolio strategy in the sense of second degree stochastic dominance without (SSD) or with a risk free asset (SSDR), respectively.

As can be seen from Table 6, in the case of a Hungarian (German) investor the second degree stochastic dominance (SSD) efficient set contains 8 (6) portfolios. Our results are in consensus with *Levy* (1992) who pointed out that the drawback of a stochastic dominance rule is that it generally results in a relatively large efficient set. It is due to the fact that in many cases this framework is unable to rank the two risky options under consideration. *Levy/Kroll* (1978) showed that a sharper decision (and in most cases a substantially smaller efficient set) can be obtained once a riskless asset is allowed. That is why we also determined the efficient set of investments by using the SSDR framework. An other important reason in our case to employ it is to be comparable with the results presented in Table 5 (the *Sharpe* index also assumes the existence of risk free borrowing or lending). It is clear from Table 6 that for Hungary the SSDR efficient set contains only one portfolio, namely the fully hedged tangency one. For Germany the SSDR efficient set consists of four investments, in particular the fully hedged and optimally hedged tangency and *Bayes-Stein* tangency portfolios. It can be seen from Table 5 that these are the strategies with the highest *Sharpe*-ratios.

[22] An overview of the theoretical connections of second degree stochastic dominance, expected utility and "non-expected" utility decision rules could be found in *Levy* (1992) and *Sarin/Weber* (1993).
[23] From a technical point of view we implemented the algorithms developed in *Levy* (1992, 1998).

5.3 Portfolio Composition

The average portfolio weights (as well as the mean hedge ratios for the optimal hedging approach) of the out-of-sample portfolio strategies considered are presented in Table 7.

German Perspective								
	CAN	CH	GER	FR	GB	HUN	JP	US
Unhedged Portfolio Strategies								
MVP	0.01	25	16.62	0.47	19.16	0	21.26	17.49
TG	0	68.11	5.61	0	8.63	0.10	0.12	17.44
BST	0	55.05	9.27	0	16.14	0	4.46	15.08
Fully Hedged Portfolio Strategies								
MVP	7.14	5.67	5.96	0	21.69	0	9.99	49.56
TG	2.11	58.32	1.10	0	0	0.13	0.98	37.35
BST	2.19	38.89	1.10	0	0	0	0.98	37.35
Optimally Hedged Portfolio Strategies (hedge ratios in parenthesis)								
MVP	7.40 (100)	7.29 (12.44)	5.90 (-)	0 (0)	20.95 (100)	0 (0)	10.90 (26.15)	47.56 (99.86)
TG	2.17 (100)	56.26 (84.95)	1.15 (-)	0 (0)	1.95 (0)	0.10 (100)	0.81 (100)	37.56 (98.28)
BST	2.18 (100)	53.69 (93.58)	0.78 (-)	0 (0)	1.60 ()	0.07 (100)	0.93 (100)	40.75 (99.18)
Hungarian Perspective								
	CAN	CH	GER	FR	GB	HUN	JP	US
Unhedged Portfolio Strategies								
MVP	0.02	17.99	25.31	0	16.00	0	7.25	33.44
TG	0	51.91	9.13	0	6.14	0.63	0.42	31.77
BST	0	34.66	17.38	0	10.68	0	1.29	36
Fully Hedged Portfolio Strategies								
MVP	7.23	6.21	5.95	0	21.62	0	9.99	49.01
TG	1.48	6.13	3.43	0.09	0.49	0.46	1.46	86.45
BST	3.43	5.56	6.15	0	6.70	0.05	3.91	74.20
Optimally Hedged Portfolio Strategies (hedge ratios in parenthesis)								
MVP	6.4 (100)	7.2 (30.56)	7.8 (88.46)	0 (0)	20 (90.5)	0 (-)	10.4 (99.04)	48.2 (98.34)
TG	1 (100)	22.5 (6.67)	5.2 (55.77)	0 (0)	4.8 (0)	0 (-)	1.1 (90.11)	65.4 (96.94)
BST	1.4 (100)	19.4 (9.79)	5.2 (71.15)	0 (0)	4.4 (0)	0 (-)	1.5 (100)	68.1 (97.94)

Table 7: Average Portfolio Weights (%) of 46 out-of-the-sample portfolios in the period of April 1995 – January 1999. 48 previous months are used for the estimation of mean returns and the covariance matrix of returns. The average hedge ratios for the optimally hedged portfolios are also given in percentage.

Looking at the portfolio weights in Table 7, we can conclude that - on average - the portfolios are not well diversified among the eight countries studied. The role of France and Hungary is zero (or nearly zero) in the composition of the optimal international portfolios, and the weights for the Canadian and the Japanese stock index are also very small in most cases. All in all, only Switzerland, the US, Great Britain and Germany play a significant role in constructing the portfolios.

Observing the average portfolio weights for those strategies with the highest performance, it can be seen that from the German perspective (namely, in the case of the fully hedged and the optimally hedged TG- and BST-portfolios) Switzerland got the highest weight before the US. From the Hungarian perspective, in the case of the fully hedged portfolio, which had the best performance, the US took the leading role (the average weight in the US stock index is more than 85 %). This can be explained by the very good performance of the US stock market in the period considered, the appreciation of the US-Dollar against the Hungarian Forint as well as by the fact the USD forward rates on average overestimated the rate of depreciation of the HUF. It is also worth mentioning that the US kept its leading role in all international portfolio strategies we examined, but the weights are not so high as in the case of the fully hedged tangency portfolio.

Comparing average weights of the tangency and those of the Bayes-Stein tangency portfolio for a particular hedging policy (either from the perspective of a Hungarian or a German investor), we can realise that they are quite similar. We can make same conclusion by comparing the portfolio weights in the case of the full hedging and those of the optimal hedging approach for a particular portfolio selection strategy. For example, in the case of the fully hedged and the optimally hedged MVP from the Hungarian perspective the average investment weights are 7.23, 6.21, 5.95, 0, 21.62, 0, 9.99, 49.01 and 6.4, 7.2, 7.8, 0, 20, 0, 10.4, 48.2, respectively. It is also observable that in the case of the optimally hedged approach the hedge ratios for the currencies of those countries, which play the most significant role of determining a particular investment portfolio, are very close to 1 (100 %), i.e. the currencies in question are almost fully hedged.

6. Summary and Conclusions

In this paper we have investigated the potential benefits of the international diversification of stock portfolios from the viewpoint of investors of two European countries, Hungary and Germany. In order to reveal the gains from global investments, we have evaluated the performance of internationally diversified portfolio strategies compared to domestic portfolio holdings in an ex post and ex ante basis. Following the work of *Eun/Resnick* (1994), *Liljeblom/Löflund/Krokfors* (1997) and others, the portfolio strategies taken into consideration have been the equally weighted-, the minimum variance-, and the certainty-equivalence-tangency-strategy. As a technique to control parameter uncertainty in the expected return vector, the *Bayes-Stein* estimation was used. The role of hedging the currency risk on the performance of the portfolios was also investigated by using two different approaches. The major findings of the analysis are summarised as follows.

Firstly, it can be concluded that joining the international flow of capital by global investments can pay off even for the investors of an emerging capital market. Indeed, it is clear from our empirical investigation that the most important benefit of a global investment, which could have been realised by a Hungarian investor in the period considered, is that international diversification drastically reduced the risk of the domestic stock investment. The gains from international diversification for German investors were not so clear-cut as for their Hungarian counterparts, either in terms of risk reduction or performance improvement. Secondly, all in all, the hedged strategies performed better than their unhedged counterparts in our ex ante analysis. In terms of risk-adjusted performance measured by the Sharpe-ratio and in terms of SSDR efficiency as well, from the perspective of Hungarian investors the fully hedged CET, while from the viewpoint of German investors the fully- and optimally hedged CET and BST produced the best results. Thirdly, our findings on the ex post mean-standard deviation efficient frontiers confirmed that fully hedging the currency risk is not necessarily worth. Indeed, in the case of Germany the efficient frontier with fully hedging crossed the unhedged one, indicating the fact that above a certain risk level a fully hedged portfolio can be dominated by its unhedged counterpart. Despite the fact that on the ex post basis the unhedged and fully hedged portfolios are always dominated by the optimally hedged ones, on the basis of their realised returns (namely in our ex ante empirical analysis) the optimally hedged approach did not turn out to be better than the fully hedged one, either in risk reduction potential or in a possibility for performance improvement. It can be due to the higher estimation risk, because in the case of optimal hedging there is a need to estimate more parameters.

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