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# International portfolios and currency hedging: viewpoint of Polish investors

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## Abstract

**Purpose** – The purpose of this paper is to empirically examine the benefits of international equity portfolios from the viewpoint of Polish investors.

**Design/methodology/approach** – Eight national stock markets are included in the sample and three different portfolio forming strategies – Equally-Weighted Portfolio (EWP), Minimum Variance Portfolio (MVP) and Tangency Portfolio (TP) – are adopted to construct the international diversified portfolios. In order to reveal the impact of currency hedging, the performance of a non-hedged versus a fully-hedged strategy is estimated. Finally, for comparison purpose, performances of the international portfolios from US investors' perspective are also examined.

**Findings** – Using monthly data from 1999 to 2008, the results show that from an *ex post* basis, an equally-weighted global portfolio offers risk reduction opportunities for Polish investors and performance improvement potentials for US investors. In addition, US investors seem to fare better leaving their foreign investment unhedged, while Polish investors benefit from currency hedging. However, *ex ante* analysis reveals that when short-selling is allowed, TP outperforms other portfolios and the risk-adjusted portfolio performance could be enhanced by currency hedging.

**Originality/value** – In summary, the *ex post* analysis suggests that global portfolio either reduces risk or improves return. Compared to the domestic portfolio, the international portfolio reduces the portfolio risk while maintaining certain level of portfolio return for Polish investors who experience unusual high volatility in domestic market. On the other hand, an international portfolio yields higher portfolio return with similar risk level, as compared to the domestic portfolio, for US investors who suffer losses in the domestic market. A full currency hedging strategy benefits Polish but not US investors. Hedging or not, the risk of the local stock market is the major contributor to the risk of the equally-weighted portfolio for both Polish and US investors.

**Keywords** Poland, United States of America, International investments, Portfolio investment, Diversification, Foreign exchange

**Paper type** Research paper



## I. Introduction

The case for international portfolio diversification was established in the 1960s and 1970s. Since then, the benefits of diversifying internationally have been well documented in finance literature. The major rationale for international investing rests on low correlation between country markets that allows investors to reduce the volatility, or total risk, of a global portfolio. Because a single national equity market contains an element of systematic risk that cannot be eliminated through further diversification, investors who hold pure domestic portfolios are significantly exposed to their country's economic cycles. For example, the recent sub-prime crisis and the declining economic conditions in the USA during the period between late 2007 and early 2009 led to the high volatility of US stock market and great losses by US investors.

On the other hand, investors that diversify internationally can reduce the systematic risk associated with single-market investment. Even if international diversification exposes investors to additional source of risk – the currency risk, investors could still be better off as they can find a way to control the currency risk through various currency-hedging techniques. In general, international diversification provides an efficient frontier that dominates the domestic-only efficient frontier.

The last two decades have witnessed steady growth in international investing by American institutions and individuals. It is reported that in 2001, 34 percent of all US households that invested in mutual funds diversified their portfolios internationally by owning either a global or an international mutual fund (Investment Company Institute (ICI), 2001). Recently, however, the benefits of international investing have been questioned because of the rising correlations between markets in various countries. The broad tendency towards liberalization and deregulations in the money and capital markets of developed as well as developing countries has led global markets to greater integrations, which in turn could reduce the benefits from portfolio diversification. In addition, most of the research in the field of international diversification has been focused on dollar-based investors. It seems equally important to investigate the effects of global diversification from the viewpoint of an emerging market investor in order to thoroughly evaluate opportunities offered by global portfolios.

The main purpose of this paper is to empirically examine the benefits of international portfolio diversification from the viewpoint of a Polish investor. For Polish investors, the reestablishment of the stock exchange after the collapse of the communist regime opened the possibilities of investing. The Polish stock exchange, the Warsaw Stock Exchange (WSE), has been functioning for nearly two decades. The WSE began activity in its present form on April 16, 1991 when only five stocks were listed on the first trading day. Since then the WSE has been developing and growing rapidly and is now perceived as well established on the European market. In September 2008, the stock exchange was recognized as an “Advanced Emerging” exchange by FTSE. As for July 1, 2009, 376 companies were listed on the WSE with a total market capitalization of PLN 545,934.68 million (\$174,002.85 million). Recently Polish investors have started investing not only in the domestic market but also globally, especially because of the introduction of globally oriented mutual funds. The question is how much do Polish investors benefit from international diversification. For comparison purpose, we will analyze the potential benefits of global portfolios from the viewpoint of both a Polish investor (emerging-country-based investor) and of a US investor (developed-market-based investor). In addition, we will investigate the impact of currency hedging strategies on global portfolio performance.

This study begins with a literature review in Section II, followed by discussion of methodology and data description in Section III. *Ex post* analysis results are discussed in Section IV. Out-of-sample empirical results are discussed in Section V, with a concluding Section VI.

## II. Literature review

Most studies of global diversification conclude that international investing helps reducing risk and/or increasing return in the portfolio. Based on the mean-variance model of portfolio choice, Grubel (1968) and Levy and Sarnat (1970) found substantial benefits for investors with internationally diversified portfolios. They concluded that

adding foreign securities to a domestic portfolio raised the Markowitz mean-variance efficient frontier above that of the portfolio with only domestic holdings. Solnik (1974) found that variability of returns of an internationally diversified portfolio would be one-tenth as risky as a typical security and half as risky as a well-diversified portfolio of US stocks. Using data between 1968 and 1985, Grauer and Hakansson (1987) confirmed that international portfolios had superior performance than pure US portfolios.

Jorion (1989) showed that potential benefits from international diversification were still substantial despite increased correlation among different indices. In his study, the US stocks and foreign stocks as a group (the EAFE index unhedged) had a correlation of 43 percent for the time period 1978-1988. Over that period, foreign security markets outperformed US stock market by 7.1 percent per year with a slightly higher volatility (17.2 percent for foreign stocks compared to 16.5 percent for US stocks). In addition, Thomas (1988) studied 15 foreign equity markets based on data from 1975 to 1987 and found that most foreign equity markets were less risky than the average US stock market. Recent studies such as Driessen and Laeven (2007) and Coeurdacier and Guibaud (2011) re-confirm benefits from international portfolio diversification.

The other important issue in the research on international portfolio has evolved around the impact of foreign exchange risk. Most studies conclude that currency hedging reduces risk of a global portfolio compared to that of an unhedged portfolio. Jorion (1985) and Eun and Resnick (1988) showed that currency hedging with forward contracts against foreign exchange risk led to significant profits. Proponents of hedging argue that full currency hedging reduces the volatility of returns without a commensurate reduction in returns. For example, studying international portfolios composed of bond and stock markets in Germany, Japan, and the UK, Perold and Shulman (1988) found that currency hedging reduced risk without affecting returns of US investors. Although each of these markets on a stand-alone basis was more volatile than the US market, each of the markets was less volatile than the US market when being hedged. Diversifying among the non-US stock markets reduced the volatility by only 2-4 percent from their individual volatility. Meanwhile, hedging the non-US portfolio reduced the portfolio risk by about 6-8 percent while the returns were the same. This finding implied that currency hedging is a "free lunch."

It is suggested in the literature that when the forward rates are perfect forecasts of expected returns on spot rates, hedging does not change expected portfolio returns but reduces risk substantially. As a result, full hedging (100 percent hedging) should be incorporated. On the other hand, no-hedging is advised if the returns from currency exposure could be forecasted with some accuracy and there is potential benefit from investment into currencies (treated as a separate asset class). Other studies recommend a hedging ratio contingent on specific market conditions. For example, Black (1989) developed a universal hedging formula whereas the hedge ratio depends on the expected (above the risk-free) return on the world market portfolio, the volatility of the world market portfolio and the exchange rate volatility averaged across all investors and all countries. Black's model indicated that the proportion hedged would range from 30 to 77 percent, depending on expected returns on the world market portfolio. Glen and Jorion (1993), Jorion (1994) and Kritzman (1993) advocated the mean-variance optimization that relies on finding an optimal hedge ratio based on relative volatilities and historical correlations between assets and currencies in which they are denominated.

Recently, Hamza *et al.* (2007) analyzing data from 21 countries during 1992-2004 period documented that, in general, certain “selective” strategies outperform the other strategies at 12- and one-month horizons. This indicates active currency hedging is beneficial. However, their results for sub-periods show that no strategy continuously dominates.

While most of the prior studies have focused on the impact of international diversification from perspectives of developed-country investors, several studies have examined the benefits of portfolio diversification from emerging-country investors’ viewpoints. For example, Bugår and Maurer (2002) and Walker (2008) discussed the currency hedging decision for international equity investing from the perspective of emerging-market-based investors. Walker (2008) investigated whether or not currency hedging would both increase expected returns and reduce risk. The assumption was that hard currencies (developed countries’ currencies) act as natural hedges against global portfolio’s losses, since they tend to appreciate with respect to emerging market currencies when the world portfolio return is negative. For example, when global stock markets fall, the capital flights from emerging markets result in depreciation of local currencies. Walker (2008) studied currency-hedging decision from the perspectives of Brazilian, Chilean, Peruvian, Colombian, and Mexican investors and concluded that currency hedging was not a free lunch in those cases as it increased the volatility of returns. Specifically, currency betas have significantly increased as international trade has grown and many countries have adopted floating exchange rate regimes. Therefore, currency hedging actually increased the volatility of investing in global portfolios, but it should have also generally increased expected returns.

### III. Data and methodology

#### A. Data

This study employs the end-of-month value-weighted Morgan Stanley Capital International (MSCI) market indices (denominated in local currencies) for eight countries. Data between January 1999 and December 2008 are collected for Canada, the USA, Japan, the UK, Germany, France, Switzerland, and Poland. The end-of-month exchange rates expressed in terms of domestic currency/foreign currency (DC/FC) are retrieved. For Polish investors, exchange rates expressed in terms of Polish zloty (PLN)/foreign currency are collected from National Bank of Poland (NBP). Similarly, exchange rates expressed in terms of \$/foreign currency for US investors are collected from Federal Reserve Bank of St Louis. There are a total of 120 monthly observations. The whole sample period is then divided into two equal-length sub-periods: the formation period covering January 1999-December 2003, and the evaluation period stemming from January 2004 to December 2008.

Different national interest rates are used as proxies for risk-free rates. In the case of the USA, three-month T-bill rates are collected at the end of each month from Federal Reserve Bank of St Louis. Similarly, three-month T-Bill rates or money market rates are collected from central bank of Canada, Japan, the UK, Germany, France, and Switzerland[1]. For Poland, time deposit rates with agreed maturities of up to two years are retrieved from NBP. These rates are reported monthly based on averaged monthly rates[2]. The Polish interest rates had been very volatile over our sample period, with higher rates ranging from 11 to 15 percent at the beginning of the sample period and lower rates around 3 percent in July 2007. After that, interest rates in Poland started rising again till the end of the period[3].

Monthly forward rates, expressed as DC/FC, are forecasted based on the covered interest rate parity (IRP) theorem. According to the parity theorem, a Polish (or US) investor would be indifferent between strategy A that he invests the foreign currency locally at the foreign risk-free rate for a specific time period while simultaneously entering into a forward rate agreement to convert the proceeds from the investment into PLNs (or \$s) and strategy B that he converts the foreign currency to PLNs (or \$s) at the spot exchange rate, then invest the PLNs (or \$s) for the same amount of time at Polish (or US) risk-free rate. When no arbitrage opportunities exist, the cash flows from both strategies are equal. As a result, the Polish (or US) forward rates against any foreign country's currency can be obtained from the equation:

$$F_t^{DC/FC} = S_t^{DC/FC} * \left( \frac{1 + r_t^{DC}}{1 + r_t^{FC}} \right)$$

where F – forward rate, S – spot rate, r – periodic risk-free rate, DC – \$ for US investors and DC – PLN for polish investors. And the monthly forward premiums are calculated as:

$$f d_t^{DC/FC} = \left( \frac{F_t^{DC/FC}}{S_t^{DC/FC}} \right) - 1$$

### B. Methodology

The benefits of global portfolio and currency hedging are evaluated from the perspectives of two investors: a Polish investor representing an emerging-market-based investor and an US investor portraying a developed-country-based investor. This approach will allow us to investigate whether investors from different stages of economic development experience the same benefits from global diversification or maybe emerging-markets-based investors are the only ones that can still gain from international diversification in the face of growing financial markets integration.

From a Polish investor's viewpoint, the return of his/her foreign stock investment comes from two sources: monthly stock returns denominated in foreign currency:

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

where  $P_t^{FC}$  is the stock index at time period t, and currency returns computed as:

$$e_t = \left( \frac{S_t^{PLN/FC}}{S_{t-1}^{PLN/FC}} \right) - 1.$$

If the investor chooses not to hedge, his/her PLN returns of the unhedged foreign stock investments are defined as:

$$\begin{aligned} R_t^{PLN} &= (1 + R_t^{FC})(1 + e_t) - 1 \\ &= R_t^{FC} + e_t + R_t^{FC} * e_t \end{aligned}$$

In addition, the excess return  $ER_t^{FC} = R_t^{FC} - r_t^{FC}$  is computed for future comparison.

Hedging a particular currency exposure means establishing an offsetting currency position such that any gain or loss on the currency exposure is offset by the change in value of the hedged position. In case of Polish investors investing abroad, their underlying positions are long in the foreign currency. Therefore, to hedge this position, investors could take a short position in the foreign currency with currency forward contracts. If so, the total return at the end of the investment horizon on such a hedged foreign investment is calculated as:

$$\begin{aligned} {}_H R_t^{PLN} &= R_t^{PLN} + h^* \left( f d_{t-1}^{PLN/FC} - e \right) \\ &= R_t^{FC} + e_t + R_t^{FC} * e_t + h^* \left( f d_{t-1}^{PLN/FC} - e \right) \end{aligned}$$

with a fully hedging strategy, the hedge ratio  $h = 1$  and:

$${}_H R_t^{PLN} = R_t^{FC} + f d_{t-1}^{PLN/FC} + R_t^{FC} * e_t.$$

Since the cross product  $R_t^{FC} * e_t$  is small and ignorable over short period of time, the fully hedged return can be expressed as:

$${}_H R_t^{PLN} \approx R_t^{FC} + f d_{t-1}^{PLN/FC}.$$

The performance of the unhedged international portfolio, comprised of investments in eight stock markets, is evaluated as follows:

$$R_{p,t}^{PLN} = \sum_{i=1}^8 w_i * R_{i,t}^{PLN}$$

where  $w_i$  represents the fraction of the investment in a particular stock market index. The hedged portfolio return is estimated as:

$$\begin{aligned} {}_H R_{p,t}^{PLN} &= R_{p,t}^{PLN} + \sum_{i=1}^8 h_i * w_i * \left( f d_{i,t-1}^{PLN/FC} - e_{i,t} \right) \\ &= \sum_{i=1}^8 w_i * R_{i,t}^{PLN} + \sum_{i=1}^8 w_i * (1 - h_i) * e_{i,t} + \sum_{i=1}^8 h_i * w_i * f d_{i,t-1}^{PLN/FC} + \Delta \end{aligned}$$

For a fully hedging strategy, the performance of international portfolio is reduced to the following form:

$${}_H R_{p,t}^{PLN} = \sum_{i=1}^8 w_i * R_{i,t}^{PLN} + \sum_{i=1}^8 w_i * f d_{i,t-1}^{PLN/FC} + \Delta$$

In order to evaluate different investment and hedging strategies, not only the return but also risk of the portfolio has to be accounted for. A typical risk-averse investor uses volatility of returns (variance or standard deviation) as a measure of risk. The variance of portfolio return is given by:

$$\begin{aligned} \text{Var} \left( {}_H R_{p,t}^{PLN} \right) &= \sum_{i=1}^8 \sum_{j=1}^8 w_i w_j \text{cov} \left( R_{i,t}^{FC}, R_{j,t}^{FC} \right) + 2 \sum_{i=1}^8 \sum_{j=1}^8 w_i w_j (1 - h_j) \text{cov} \left( R_{i,t}^{FC}, e_{j,t} \right) \\ &+ \sum_{i=1}^8 \sum_{j=1}^8 w_i w_j (1 - h_i)(1 - h_j) \text{cov}(e_{i,t}, e_{j,t}) + \Delta \text{Var} \end{aligned}$$

where  $\text{cov} \left( R_{i,t}^{FC}, R_{j,t}^{FC} \right)$  is the covariance between the return of the  $i$ th and  $j$ th local stock market,  $\text{cov} \left( R_{i,t}^{FC}, e_{j,t} \right)$  is the covariance between the  $i$ th local stock market return and the  $j$ th currency return,  $\text{cov}(e_{i,t}, e_{j,t})$  is the covariance between the currency returns of the  $i$ th and  $j$ th currency and  $\Delta \text{Var}$  represents the contribution of the cross product terms. When fully hedging the portfolio ( $h = 1$ ), the variance of the portfolio represents only the covariance between local stock markets' returns (as  $\Delta \text{Var}$  is relatively small).

The out-of-sample analysis helps to determine whether the benefits of internationally diversified portfolio accrue if investment decisions are solely based on prior information. Three portfolio forming strategies are used to evaluate the out-of-sample performance. They are equally-weighted portfolio (EWP), minimum variance portfolio (MVP) and tangency portfolio (TP). The EWP approach is often referred as the naïve diversification as it does not involve the information on the security returns, risks, or co-movements. The strategy relies on investing an equal fraction of a budget into each of the stock markets. The MVP aims to identify the investments' weights in order to achieve the lowest risk of the portfolio for a given return. In the case of the TP, the weights of the different stock markets are determined in order to maximize the risk-adjusted performance measured by the sharpe ratio (the ratio of excess return over the risk-free rate to volatility)[4]. Only this strategy fully incorporates the information on the expected return and covariance matrix of the different investments.

#### IV. Empirical results – *ex post* analysis

##### A. Risk and return characteristics of stock markets

Table I reports average returns and standard deviations for stock and currency markets during the period covering January 1999-December 2008 from different investors' perspectives. The local returns ( $R^{FC}$ ) are stock returns denominated in foreign currencies while the currency returns ( $e^{DC/FC}$ ) are the percentage changes in S expressed in terms of domestic currency against foreign currency. In this case, the domestic currency is the US\$ and Polish zloty for US and Polish investors, respectively. The unhedged returns ( $R^{DC}$ ) composed of both the local returns and currency returns are then reported. Finally, the fully hedged returns ( ${}_H R^{DC}$ ) involving the fully forward hedging strategy of foreign investments are documented. Several observations are noted in Table I. First, the results of local returns suggest that Canadian and Polish stock markets outperform other markets during this period. The average stock return is 0.45 and 0.42 percent for Canada and Poland, respectively, while all the other markets experience negative local returns. However, the standard deviation of returns reveals that the gains in Polish stock market are accompanied by relatively high volatility (8 percent). Once the risk-free rate is taken into account, only the Canada stock market fares a positive excess return.

Country	USA	Canada	Japan	UK	France	Germany	Switzerland	Poland
Average returns								
<i>Local perspective</i>								
Local ( $R^{FC}$ ) (%)	-0.22	0.45	-0.12	-0.15	-0.04	-0.03	-0.10	0.42
Excess return (%)	-0.48	0.16	-0.14	-0.54	-0.30	-0.29	-0.24	-0.13
<i>Polish perspective</i>								
Exchange rate ( $e^{PLN/FC}$ ) (%)	-0.11	0.06	0.14	-0.24	0.04	0.04	0.13	0.00
No hedging ( $R^{PLN}$ ) (%)	-0.38	0.49	-0.07	-0.44	-0.06	-0.06	-0.04	0.42
Fully hedging ( ${}_HR^{PLN}$ ) (%)	0.02	0.70	0.33	-0.03	0.19	0.19	0.25	0.42
<i>USA perspective</i>								
Exchange rate ( $e^{USD/FC}$ ) (%)	0.00	0.19	0.25	-0.07	0.17	0.17	0.23	0.24
No hedging ( $R^{USD}$ ) (%)	-0.22	0.68	0.10	-0.21	0.13	0.15	0.12	0.78
Fully hedging ( ${}_HR^{USD}$ ) (%)	-0.22	0.46	0.10	-0.26	-0.04	-0.02	0.01	0.24
SD of returns								
<i>Local perspective</i>								
Local ( $R^{FC}$ ) (%)	4.41	4.83	5.21	4.08	5.29	6.68	4.14	8.00
Excess return (%)	4.40	4.83	5.22	4.08	5.31	6.70	4.16	8.03
<i>Polish perspective</i>								
Exchange rate ( $e^{PLN/FC}$ ) (%)	3.76	3.20	4.81	2.98	2.90	2.90	3.51	0.00
No hedging ( $R^{PLN}$ ) (%)	4.73	5.55	5.66	4.08	4.95	6.16	3.92	8.00
Fully hedging ( ${}_HR^{PLN}$ ) (%)	4.48	4.83	5.49	4.10	5.33	6.69	4.19	8.00
<i>USA perspective</i>								
Exchange rate ( $e^{USD/FC}$ ) (%)	0.00	1.98	2.43	2.21	2.54	2.54	2.49	3.62
No hedging ( $R^{USD}$ ) (%)	4.41	5.90	5.34	4.96	5.83	7.21	4.67	9.83
Fully hedging ( ${}_HR^{USD}$ ) (%)	4.41	4.78	5.27	4.05	5.33	6.75	4.19	7.95

**Note:** The average returns and standard deviation of returns are computed using monthly data

**Table I.**  
Risk and return  
characteristics of local  
stock market  
indices (January  
1999-December 2008)

Second, except for investment in the US and UK markets, Polish investors benefit from weaker value of Polish zloty over this period. Negative currency returns of Polish zloty against US\$ and British pound suggest that Polish zloty appreciates against these two currencies. As a result, Polish investors suffer losses both in the local stock market and the currency market when investing in the US and UK stock markets. As to other foreign investments, positive currency returns due to depreciation of Polish zloty against the respective foreign currencies increase the unhedged returns of Polish investors as compared to those of the local investors.

Meanwhile, it is shown that for Polish investors, returns of a fully hedged foreign investment are higher than those denominated in local currencies, indicating foreign currencies are traded at forward premiums. Based on the IRP theorem, currency with higher interest rate should be traded at forward discount. Given the Polish money market rates have been much higher than those of other countries over the period considered, it is not surprising to find that Polish zloty is traded at forward discount.



For example, the average monthly money market rate for Poland is 0.56 percent which is much higher than 0.26 percent reported in Germany. More interesting is that this forward discount estimated using the IRP theorem is larger than the *ex post* realized currency depreciation; therefore, the fully hedged returns are higher than both the unhedged and local returns. In addition, it can be seen that hedging currency exposure would improve the return while keep volatility (measured in standard deviation) in check. For example, the return and the standard deviation on the UK stock market measured in local currency is  $-0.15$  and  $4.08$  percent, respectively, while from Polish investors' perspective, the return and the standard deviation of a fully hedged UK investment is  $-0.03$  and  $4.10$  percent.

Third, US\$ depreciates against most of the currencies included in the study except for British pound. Consequently, US investors yield positive gains in the currency markets. Although both Polish zloty and US\$ depreciate against other currencies during the sampling period, these positive currency returns for US investors are larger than those for Polish investors. As a result, the unhedged returns for US investors are much higher than those for Polish investors. However, unlike Polish investors, even though currency hedging reduces the volatility in returns, it also decreases US investors' fully hedged returns in foreign investments.

#### B. Correlations between stock and currency returns

Table II(A) presents the correlations between the stock market returns measured in local currency (local returns) while Table II(B) exhibits the correlations matrix of stock returns measured in Polish zloty (shown in upper triangular of the matrix) and in US\$ (shown in lower triangular of the matrix). For a diversified portfolio, the lower the correlation between returns, the higher the potential risk reduction benefits. In general,

	USA	Canada	Japan	UK	France	Germany	Switzerland	Poland
<i>(A) Returns in local currencies</i>								
USA	1	0.80	0.60	0.84	0.83	0.81	0.76	0.57
Canada		1	0.63	0.68	0.73	0.66	0.60	0.56
Japan			1	0.57	0.58	0.52	0.54	0.49
UK				1	0.85	0.80	0.81	0.53
France					1	0.93	0.82	0.62
Germany						1	0.77	0.59
Switzerland							1	0.51
Poland								1
<i>(B) Returns in Polish zloty and US dollar<sup>a</sup></i>								
USA	1	0.72	0.59	0.81	0.74	0.68	0.66	0.25
Canada	0.78	1	0.56	0.66	0.67	0.60	0.41	0.37
Japan	0.54	0.61	1	0.54	0.45	0.35	0.48	0.14
UK	0.79	0.72	0.56	1	0.78	0.69	0.71	0.22
France	0.77	0.73	0.54	0.86	1	0.92	0.72	0.42
Germany	0.77	0.66	0.48	0.82	0.94	1	0.63	0.45
Switzerland	0.64	0.58	0.47	0.82	0.83	0.78	1	0.12
Poland	0.57	0.59	0.45	0.56	0.61	0.60	0.50	1

**Table II.**

Correlation between stock market returns (January 1999-December 2008)

**Notes:** <sup>a</sup>Returns in upper and lower triangular are measured in Polish zloty and US dollar, respectively; the table presents correlations of unhedged stock markets returns; they are computed using monthly returns from the sample period of January 1999-December 2008

the correlations of stock returns measured in local currency are greater than or equal to 0.49. The unusually larger correlation of 0.93 between German and French stock market implicates significant integration of European Union economies. When the stock returns are measured in terms of Polish zloty, the correlations become slightly lower but remain positive in all cases. Similar results are found when returns are measured in US\$.

Table III(A) and (B) present correlations between currency returns and one-month forward premiums, respectively. Correlations of returns measured in PLN/FC are reported in the upper triangular of the matrix while those measured in \$/FC are in the lower triangular of the matrix. It is found that the correlation between currency returns as well as forward premiums in terms of PLN/foreign currency are positive in all cases. However, a few negative correlations show up sporadically when returns are presented in terms of \$/FC.

Table IV reports correlations between local stock market returns and currency returns. For Polish investors, this correlation is negative for most of the countries studied here. For example, the correlation of Japan stock market and exchange rate of PLN/Yen is  $-0.35$ , indicating that as Japanese stock market increases in value, Japanese Yen depreciates against Polish zloty. This opposite movement of stock markets and exchange rates has an offsetting rather than a reinforcing effect on the exchange rate volatility.

### C. EWP performance

To demonstrate the benefits of international diversification and currency hedging, an EWP is created using monthly returns from January 1999 to December 2008. The performance statistics and the decomposition of risk and return of this EWP are presented in Tables V and VI, respectively. For Polish investors, both the unhedged

	USA	Canada	Japan	UK	France	Germany	Switzerland	Poland
<i>(A) Correlations between spot rates<sup>a</sup></i>								
USA	1	0.73	0.82	0.73	0.60	0.60	0.63	
Canada		1	0.57	0.63	0.56	0.56	0.47	
Japan		0.03	1	0.64	0.65	0.65	0.74	
UK		0.48	0.17	1	0.66	0.66	0.63	
France		0.48	0.33	0.75	1	1	0.92	
Germany		0.48	0.33	0.75	1	1	0.92	
Switzerland		0.35	0.48	0.70	0.93	0.93	1	
Poland		0.36	0.02	0.52	0.46	0.46	0.43	1
<i>(B) Correlations between one-month forward premiums (discounts)<sup>a</sup></i>								
USA	1	0.98	0.93	0.96	0.92	0.92	0.93	0.02
Canada	0.10	1	0.98	0.99	0.97	0.97	0.97	0.02
Japan	0.07	0.82	1	0.99	0.99	0.99	0.98	0.01
UK	0.03	0.77	0.92	1	0.98	0.98	0.98	0.01
France	0.15	0.81	0.88	0.85	1	1	0.99	0.02
Germany	0.15	0.81	0.88	0.85	1	1	0.99	0.02
Switzerland	0.15	0.73	0.83	0.83	0.96	0.96	1	0.02
Poland	0.16	0.19	-0.16	-0.10	0.10	0.10	0.12	1

**Note:** <sup>a</sup>Returns in upper and lower triangular are measured in terms of PLN/FC and USD/FC, respectively

**Table III.**  
Correlations between  
currency returns (January  
1999-December 2008)

**Table IV.**  
Correlation between stock market returns (in local currencies) and currency returns (January 1999-December 2008)

	USA	Canada	Japan	UK	France	Germany	Switzerland	Poland
<i>(A) Currency returns of PLN/FC</i>								
USA	-0.33	-0.38	-0.27	-0.23	-0.24	-0.26	-0.21	-0.38
Canada	-0.03	-0.09	0.02	-0.01	-0.04	-0.06	-0.09	-0.22
Japan	-0.34	-0.36	-0.35	-0.30	-0.34	-0.35	-0.30	-0.41
UK	-0.30	-0.30	-0.21	-0.37	-0.31	-0.35	-0.27	-0.44
France	-0.33	-0.35	-0.28	-0.28	-0.39	-0.39	-0.37	-0.41
Germany	-0.33	-0.35	-0.28	-0.28	-0.39	-0.39	-0.37	-0.41
Switzerland	-0.43	-0.44	-0.41	-0.39	-0.48	-0.48	-0.48	-0.48
Poland	0	0	0	0	0	0	0	0
<i>(B) Currency returns of USD/FC</i>								
USA	0	0	0	0	0	0	0	0
Canada	0.38	0.44	0.3	0.4	0.28	0.25	0.25	0.28
Japan	-0.10	-0.01	-0.19	-0.04	-0.06	-0.08	-0.15	-0.07
UK	0.25	0.29	0.19	0.02	0.14	0.16	0.15	0.17
France	0.04	0.12	-0.02	0.11	-0.01	0.02	0.03	0.05
Germany	0.04	0.12	-0.02	0.11	-0.01	0.02	0.03	0.05
Switzerland	-0.06	0.05	-0.10	0.03	-0.10	-0.07	-0.08	-0.03
Poland	0.32	0.36	0.24	0.23	0.23	0.26	0.20	0.38

(- 0.02 percent) and fully hedged returns (0.26 percent) of the EWP are lower than the return of the domestic investment (0.42 percent) during this particular period. Nevertheless, the standard deviation of the portfolio returns, either unhedged (4.08 percent) or fully hedged (4.53 percent), is much lower than that of the Polish domestic stock market (8.00 percent). It appears that fully hedging the currency risk results in slightly higher portfolio variance as compared to the case when no hedging is incorporated. Decomposition of portfolio returns shows that the negative unhedged returns are mainly caused by the negative cross-term of local stock market returns and currency returns while the positive fully hedged portfolio returns are consequently determined by forward premiums on foreign currencies. As for the volatility of returns, the large portion of the portfolio risk originates from the local stock market volatility.

Contrary to the portfolio return results for Polish investors, US investors benefit from investing globally. The average return in the US stock market is - 0.22 percent while the unhedged and fully hedged returns of the EWP are 0.19 and 0.03 percent, respectively. Meanwhile, the standard deviation of the EWP, 5.02 percent for unhedged returns and 4.48 percent for fully hedged returns, is marginally higher than that of the US domestic stock market (4.41 percent). Decomposition of portfolio return indicates

**Table V.**  
Performance statistics of the equally weighted portfolio (January 1999-December 2008)

Strategy	Polish perspective			USA perspective		
	Mean (%)	STD (%)	Sharpe ratio	Mean (%)	STD (%)	Sharpe ratio
Domestic stock market	0.42	8.00	-0.016	-0.22	4.41	-0.109
EWP	-0.02	No hedging 4.08	-0.140	0.19	No hedging 5.02	-0.014
EWP	0.26	Fully hedging 4.53	-0.064	0.03	Fully hedging 4.48	-0.051

**Note:** The returns and variance of return is reported in per month terms

	Polish perspective				USA perspective			
	$R^{PLN}$	$R^{FC}$	No hedging $e^{PLN/FC}$	$\Delta$	$R^{\$}$	$R^{FC}$	No hedging $e^{\$/FC}$	$\Delta$
Return %	-0.02	0.03	0.01	-0.05	0.19	0.03	0.15	0.02
Contribution (%)	100	-150	-50	250	100	16	79	11
Variance % <sup>2</sup>	$Var(R^{PLN})$ 16.63	$Var(R^{FC})$ 20.08	$Var(e^{PLN/FC})$ 6.61	$2\text{cov}(R^{FC}, e^{PLN/FC}) + \Delta$ -10.07	$Var(R^{\$})$ 25.22	$Var(R^{FC})$ 20.08	$Var(e^{\$/FC})$ 2.81	$2\text{cov}(R^{FC}, e^{\$/FC}) + \Delta$ 2.33
Contribution (%)	100	121	40	-61	100	80	11	9
			Fully hedged $fd^{PLN/FC}$				Fully hedged $fd^{\$/FC}$	
Return %	$H^R^{PLN}$ 0.26	$R^{FC}$ 0.03	0.29	$\Delta$ -0.05	$H^R^{\$}$ 0.03	$R^{FC}$ 0.03	-0.01	$\Delta$ 0.01
Contribution (%)	100	12	112	-19	100	100	-33	33
Variance % <sup>2</sup>	$Var(H^R^{PLN})$ 20.54	$Var(R^{FC})$ 20.08	$Var(fd^{PLN/FC})$ 0.08	$2\text{cov}(R^{FC}, fd^{PLN/FC}) + \Delta$ 0.37	$Var(H^R^{\$})$ 20.13	$Var(R^{FC})$ 20.08	$Var(fd^{\$/FC})$ 0.01	$2\text{cov}(R^{FC}, fd^{\$/FC}) + \Delta$ 0.04
Contribution (%)	100	98	0	2	100	100	0	0

**Table VI.**  
Decomposition of return  
and risk of equally  
weighted portfolio  
(January 1999-December  
2008)

that when there is no currency hedging, portfolio returns are determined mostly by currency returns and when a fully hedging strategy is applied, portfolio returns are determined by local stock market returns. From an US investor's viewpoint, the variance of the returns of the EWP also comes mostly from the local stock market risk.

In summary, the *ex post* analysis suggests that global portfolio either reduces risk or improves return. Compared to the domestic portfolio, the international portfolio reduces the portfolio risk while maintains certain level of portfolio return for Polish investors who experience unusual high volatility in domestic market. On the other hand, an international portfolio yields higher portfolio return with similar risk level, as compared to the domestic portfolio, for US investors who suffer losses in the domestic market. A fully currency hedging strategy benefits Polish but not US investors. Hedging or not, the risk of the local stock market is the major contributor to the risk of the EWP for both Polish and US investors.

### V. Empirical results – out-of-sample analysis

The out-of-sample analysis allows us to evaluate the performance of different investments and hedging strategies under more realistic conditions. First, the whole sampling period is divided into two sub-periods: the formation period beginning from January 1999 to December 2003 and the evaluation period starting from January 2004 to December 2008. Table VII(A) presents the descriptive statistics of eight stock market returns during the formation period. It is clear that in general, the world markets experience a bear market during the formation period as most of the Sharpe Ratios are negative. The table shows that for both Polish and US investors, the Canadian stock market outperforms the other markets after adjusting for risks. For example, from Polish investors' perspective, the Sharpe Ratio of unhedged and fully hedged returns of the Canadian stock market is 0.015 and 0.044, respectively. Therefore, one should not be surprised to see the Canadian stock market with a heavy weight in the TP. For the purpose of comparison, Table VII(B) presents the descriptive statistics of stock returns during the evaluation period. It seems that during the evaluation period, Polish and Canadian stock markets report better risk-adjusted performance.

Second, a total of 60 monthly stock returns for each country in the formation period are then used to estimate individual country weights in order to form the internationally diversified portfolio at the end of December 2003. The portfolio weights for different strategies are presented in Table VIII. Panels A and B report the portfolio weights without and with short-selling, respectively[5]. Recall that there are three portfolio formation strategies, the EWP, MVP, and the TP together with two currency hedging strategies, no hedging and fully hedging strategy. When short-selling is prohibited, the Canadian stock market has a 100 percent weight in the TP for both Polish and US investors due to the fact that Canadian stock market dominates other markets in terms of risk-adjusted performance. For the MVP, the weights differ depending on the hedging strategies and the investor's perspective. The portfolio weights for the TPs change significantly when short-selling is allowed. For the Polish investors, they are recommended to short sell the US, Japan, UK, France, Germany and the Switzerland stock markets while constructing a TP with no currency hedging. Similar observations are found for the US investors except that they will short sell the Polish instead of the Swiss stock market. The weight composition varies slightly when currency hedging is adopted.

Country	Polish perspective			USA perspective		
	Mean (%)	STD (%)	Sharpe ratio	Mean (%)	STD (%)	Sharpe ratio
<i>(A) For formation period (January 1999-December 2003)</i>						
	No hedging			No hedging		
USA	-0.12	5.27	-0.180	-0.17	5.02	-0.088
Canada	0.92	6.04	0.015	0.85	5.91	0.098
Japan	0.17	6.42	-0.103	0.10	5.53	-0.031
UK	-0.17	4.35	-0.230	-0.12	4.93	-0.079
France	0.14	5.53	-0.125	0.19	6.51	-0.012
Germany	-0.09	7.39	-0.124	-0.02	8.54	-0.034
Switzerland	-0.04	4.11	-0.212	-0.02	5.23	-0.055
Poland	0.43	9.04	-0.044	0.53	10.37	0.025
	Fully hedging			Fully hedging		
USA	0.35	4.95	-0.097	-0.17	5.02	-0.088
Canada	1.06	5.26	0.044	0.54	5.28	0.051
Japan	0.73	4.96	-0.020	0.18	4.96	-0.018
UK	0.06	4.51	-0.171	-0.44	4.51	-0.157
France	0.43	6.21	-0.064	-0.06	6.27	-0.053
Germany	0.20	8.21	-0.077	-0.26	8.33	-0.064
Switzerland	0.32	4.59	-0.111	-0.16	4.61	-0.093
Poland	0.43	9.04	-0.044	-0.03	9.05	-0.033
<i>(B) For evaluation period (January 2004-December 2008)</i>						
	No hedging			No hedging		
USA	-0.64	4.15	-0.224	-0.26	3.76	-0.136
Canada	0.08	5.05	-0.042	0.52	5.93	0.046
Japan	-0.30	4.83	-0.122	0.10	5.19	-0.029
UK	-0.70	3.81	-0.260	-0.30	5.03	-0.109
France	-0.26	4.34	-0.127	0.07	5.13	-0.035
Germany	-0.03	4.72	-0.068	0.31	5.68	0.011
Switzerland	-0.05	3.75	-0.091	0.25	4.09	0.000
Poland	0.41	6.89	0.017	1.02	9.34	0.082
	Fully hedging			Fully hedging		
USA	-0.30	3.98	-0.148	-0.26	3.76	-0.136
Canada	0.35	4.38	0.014	0.39	4.28	0.033
Japan	-0.05	5.98	-0.057	0.03	5.61	-0.039
UK	-0.11	3.69	-0.108	-0.08	3.57	-0.092
France	-0.04	4.33	-0.076	-0.03	4.26	-0.066
Germany	0.19	4.82	-0.021	0.21	4.77	-0.008
Switzerland	0.17	3.80	-0.032	0.18	3.77	-0.019
Poland	0.41	6.89	0.017	0.50	6.78	0.037

**Table VII.**  
Descriptive statistics of  
monthly stock indices  
returns – out-of-sample  
analysis

Third, measurements of portfolio performance for different strategies during the evaluation period are presented in Table IX. Panels A and B report the performance statistics without and with short-selling, respectively. For Polish investors, none of the international portfolios offers superior risk-adjusted performance than holding a domestic portfolio when short selling is prohibited. However, when the short-selling constraint is lifted, TP outperforms the domestic portfolio. For US investors, it is clear that they would benefit from an internationally diversified portfolio, especially when short-selling is allowed. It is also evident that a full currency hedging reduces the risks and returns of the portfolio simultaneously. Yet, the decrease in portfolio returns is accompanied with an even larger reduction in risks. As a result,

**Table VIII.**  
Portfolio weights –  
out-of-sample analysis

Strategy	Polish perspective					USA perspective										
	USA	Canada	Japan	UK	France	Germany	Switzerland	Poland	USA	Canada	Japan	UK	France	Germany	Switzerland	Poland
<i>(A) Without short selling</i>																
EWP	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	No hedging		0.125	0.125	0.125
MVP	0	0	0.082	0.263	0	0	0.536	0.119	0.258	0	0.324	0.121	0	0	0.297	0
TP	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
EWP	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	Fully hedging		0.125	0.125	0.125
MVP	0	0	0.362	0.336	0	0	0.242	0	0	0.005	0.371	0.337	0	0	0.244	0
TP	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>(B) With short selling limited to -100 percent</i>																
No hedging																
EWP	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	No hedging		0.125	0.125	0.125
MVP	-0.052	0.036	0.020	0.510	0.034	-0.274	0.545	0.179	0.504	-0.084	0.248	0.228	0.098	-0.424	0.403	0.026
TP	-1.000	5.306	-1.000	-1.000	-0.400	-1.000	-0.068	0.164	-1.000	3.444	-0.764	-1.000	1.121	-1.000	0.256	-0.056
Fully hedging																
EWP	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	Fully hedging		0.125	0.125	0.125
MVP	-0.021	0.164	0.281	0.519	0.010	-0.340	0.360	0.024	-0.077	0.181	0.283	0.562	0.020	-0.342	0.354	0.018
TP	-1.000	3.752	0.245	-1.000	0.642	-1.000	-0.303	-0.336	-1.000	3.330	0.096	-1.000	0.742	-1.000	0.063	-0.232

**Notes:** Different portfolio strategies were used: EWP is the equally weighted portfolio, TP is the tangency portfolio, MVP is the minimum variance portfolio; the (arithmetic) mean returns and standard deviation (STD) of returns are reported in per month basis

Strategy	Polish perspective			USA perspective		
	Mean (%)	STD (%)	Sharpe ratio	Mean (%)	STD (%)	Sharpe ratio
<i>(A) For evaluation period (January 2004-December 2008), without short selling</i>						
Local stock market	0.41	6.89	0.017	-0.26	3.76	-0.136
	No hedging			No hedging		
EWP	-0.19	3.63	-0.132	0.21	4.86	-0.008
MVP	-0.19	3.34	-0.144	0.01	3.97	-0.060
TP	0.08	5.05	-0.042	0.52	5.93	0.046
	Fully hedging			Fully hedging		
EWP	0.08	4.20	-0.050	0.12	4.06	-0.032
MVP	-0.01	3.96	-0.076	0.03	3.86	-0.057
TP	0.35	4.38	0.014	0.39	4.28	0.033
<i>(B) For evaluation period (January 2004-December 2008), with short selling limited - 100 percent</i>						
Local stock market	0.41	6.89	0.017	-0.26	3.76	-0.136
	No hedging			No hedging		
EWP	-0.19	3.63	-0.132	0.21	4.86	-0.008
MVP	-0.28	3.26	-0.175	-0.21	3.49	-0.132
TP	2.11	19.24	0.095	2.04	13.04	0.137
	Fully hedging			Fully hedging		
EWP	0.08	4.20	-0.050	0.12	4.06	-0.032
MVP	0.00	3.79	-0.077	0.05	3.64	-0.055
TP	1.30	10.33	0.098	1.30	8.99	0.117

**Notes:** Different portfolio strategies were used: EWP is the equally weighted portfolio, TP is the tangency portfolio, MVP is the minimum variance portfolio; the (arithmetic) mean returns and standard deviation (STD) of returns are reported in per month basis

**Table IX.**  
Portfolio performance

the Sharpe ratio is improved. This observation suggests that short-selling is critical in enhancing portfolio returns whereas currency hedging is valuable in reducing portfolio risks.

## VI. Conclusions

In this paper, we study the stock and currency returns on eight different countries from both Polish and US investors' viewpoints. It is found that Canadian stock market outperforms others during the period from January 1999 to December 2008. Investing in foreign stock market individually, Polish investors would benefit from a fully hedging strategy whereas US investors perform better when no hedging is involved. Empirical results from the *ex post* analysis suggests that the creation of the EWP is beneficial to Polish as well as US investors but offers different advantages to these two groups of investors. Comparing to investing in their domestic stock market, Polish investors could decrease their investment risk by 50 percent forming an EWP with a fully currency hedging strategy. On the other hand, US investors could significantly improve their portfolio performance with the construction of an EWP, regardless whether they hedge or do not hedge their currency exposure. In other words, the *ex post* analysis suggests that without currency hedging, the global portfolio offers risk reduction opportunities for Polish investors and performance improvement potentials for US investors. A fully currency hedging strategy benefits Polish but not the US investors.



Similar to results reported in prior studies, national stock returns are positively correlated. Interestingly, the correlations between stock returns measured in local currencies and currency returns are mostly negative, especially from Polish investors' perspective. It indicates that when local stock market gains, the same country loses its purchasing power in international monetary market. This negative cross-correlation could contribute to a reduction in portfolio return and risk. Nevertheless, the decomposition analysis shows that the risk and return of the EWP originate majorly from the stock markets.

Due to the dominating performance of the Canadian stock market during the formation period, the TP consists entirely of the Canadian stock market index when short-selling is prohibited. The weight matrix changes significantly when short-selling is allowed. It is shown that this TP, hedged or not, still reports better risk-adjusted performance as measured by the Sharpe Ratio. Yet, the best performance is found in the TP when short-selling is allowed and currency risk fully hedged. Our results show that even with increasing correlation in global markets, both Polish and US investors could still benefit from global portfolio diversification. Furthermore, their risk-adjusted portfolio performance could be enhanced by currency hedging.

One criticism of time-series studies is that empirical results may be period specific. Time periods associated with "normal" market conditions generate different data than periods during global financial crises. For example, one may argue that the subprime crisis and the resulting economic recession in late 2007 and 2008 in our sample period could lead to dramatic changes in investment behavior, causing biased results. However, we want to emphasize that the primary benefit of portfolio diversification relies on its ability to weather financial storms in a global setting. Hence, including the financial crisis in the sample period may provide a more realistic evaluation of an international portfolio's performance.

### Notes

1. Average monthly rates are reported for Canada, France and Germany whereas end-of-month rates are reported for Japan, UK, and Switzerland.
2. We also used parity condition to "estimate" three-month risk-free rate for Poland. The forecasted rates differed significantly from the time-deposit rates that were collected from NBP.
3. This seems to be the result of the global financial crisis in 2008.
4. The Sharpe Ratio, calculated as  $(\bar{R} - r_{RF})/SD(R)$ , is a measure of risk-adjusted performance.
5. The weight of short-selling is limited to  $-100$  percent.

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