# POTENTIAL FOR PORTFOLIO DIVERSIFICATION ACROSS EASTERN EUROPEAN STOCK MARKETS.

by

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Abstract

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This study provides an empirical analysis of portfolio diversification potential of transitional Eastern European and former Soviet Union equity markets. The claim is that although these economies tend to move at the same direction, the return series from these markets are not fully integrated. The existence of far from positive unitary correlations and the absence of cointegration between returns in most markets, indicate that these markets are independent to the extent that there exist profitable opportunities from diversification across them. But as an analysis of the actual patterns of portfolios flows into these countries demonstrates, international investors tend to fail to exploit all benefits. The paper gives some explanations for this phenomenon on the basis of institutional factors, as well as using theories of bias and agglomeration. Some implications for economic policies for «offended» countries are derived, with the goal to improve the effectiveness of their signaling about investment attractiveness.

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# GLOSSARY

**Cointegration**. An association between two time series which measures the extent to which fluctuations in one series offset fluctuations in another. Time leads or lags may be used, but a perfectly cointegrated and weighted pair of time series will sum to a straight line.

**Cointegration test.**. Test to determine whether a linear combination of the variables under consideration is stationary.

**Efficient frontier.** A continuum of portfolios that have the highest expected returns for their given levels of standard deviation plotted in dimensions of expected return and standard deviation**.**

**Efficient portfolio.** A portfolio that provides the greatest expected return for a given level of risk, or equivalently, the lowest risk for a given expected return. Also called optimal portfolio.

**Integrated variable (of order *d*)**. A variable that must be differenced *d* times to be made stationary.

**Markowitz diversification**. The portfolio construction technique to minimize overall portfolio variance for a given level of expected returns using security correlations (covariances).

**Modern portfolio theory**. A variety of portfolio construction, asset valuation, and risk measurement concepts and models that rely on the application of statistical and quantitative techniques.

**Risk diversification**. Reduction in the portfolio risk level that comes from the inclusion of different assets in portfolio. Diversification usually reduces portfolio risk (measured by return variability) because the returns (both positive and negative) on various asset are not perfectly correlated.

**Portfolio.** A collection of different investment instruments owned by one individual or institution.

**Unit root test.** Test o determine whether data series are nonstationary, that is they are characterized by a random walk.

**Volatility.** A measure of the fluctuation in market price of a security. A volatile issue has frequent and large swings in price. Mathematically, volatility is calculated as standard deviation of returns.

*Chapter 1*

# INTRODUCTION AND SURVEY OF LITERATURE.

The concept of international portfolio diversification is central to the international finance literature. Segmented market approach states that since countries around the world exhibit different performance due to unique characteristics operating in them, investment in international assets can offer attractive risk reduction opportunities. The purpose of my work is to empirically analyze the portfolio diversification potential of transitional Eastern European equity markets. Although numerous researchers in the field devoted much efforts to studying Latin American, Asian, and Pacific Basin developing economies, the transitional markets are still somewhat overlooked, and one of the goals of my study is to fill this gap in the empirical finance literature.

According to portfolio selection theory, the degree to which diversification can reduce risk depends upon the correlations between security returns. If the returns are not correlated, diversification could eliminate risk without affecting adversely the portfolio return. The theory proposes rules for construction of efficient portfolios (portfolios with the lowest risk for a given return level, or equivalently, with the highest return for a given risk level). At the same time, in measuring the diversification potential of different assets, we should distinguish between short-term and long-term correlations, which are not always the same. Long-term comovements of national markets, that reduce diversification benefits, play very important role but are not easy to identify. The claim is that although transitional economies tend to move at the same direction, the return series from these markets are not fully integrated,

and thus the diversification potential is likely to persist over the longer-run. My work will demonstrate whether these diversification benefits are available and how international investors can exploit them.

The second direction of my interest is to examine the existent patterns of portfolio investment by foreign investors in these countries, and to explain biases that I expect to find there. The theory states that markets that are characterized by low correlations of stock indexes should benefit from diversification of portfolio flows across them. In reality we find that instead of spreading across different markets, most of these capital flows tend to concentrate in only a few of them. My work analyzes these portfolio patterns and finds explanations for them.

The importance of the problem for transitional economies, especially for Ukraine, which suffers from significant under-investment, lies in the undesirable «distortions» of capital flows to these countries. If the gains from diversification are not realized, it means that some other factors, not associated with stock market developments straightforwardly, influence decisions of investors. Thus, policy corrections by governments might be necessary to eliminate the impact of these negative factors and improve effectiveness of their signaling about investment attractiveness.

The numerous studies that analyze gains and prospects of international portfolio diversification can be divided into two main groups: the first concentrates on measuring international financial integration while the second is based on a segmented market approach. These are in fact two possible (and basically competing) interpretations of the international capital market.

As mentioned earlier, the Markovitz portfolio selection model, which provides a positive explanation and normative rules for the diversification of risky assets, states that the extent of risk reduction through diversification depends upon the correlations between the returns of different assets. If the returns are not perfectly correlated, diversification is effective for risk

reduction purposes. The theory will be expounded in more details in the next section.

Grubel (1968) was one of the first to point out that distinctive factors that operated in individual countries around the world made it possible for investment in international assets to demonstrate attractive risk reduction opportunities. At that time, markets were relatively isolated, with limited (if compared with contemporary situation) international trade, restricted foreign currency movements, and not fully developed global communication system. The unique monetary and fiscal policies conducted in different countries, combined with the above mentioned features made correlations between international assets lower than between exclusively domestic assets. The conclusions of early empirical studies, including Levy and Sarnat (1970), Grubel and Fardner (1971), Solnik (1974), Ripley (1973), Agmon (1972), and Lessard (1973), were consistent with Grubel's (1968) predictions. Despite the diverse empirical methods used, these studies generally found that: i) correlations between returns in national stock markets were surprisingly low, and ii) national factors played an important role in the return-generating process. These findings are often cited as evidence supporting international, as opposed to purely domestic, diversification of investment portfolios.

At the same time, the question of stock markets integration became crucial to studies of many researchers as technological advances and higher openness of domestic economies to foreign capital flows made the economies more responsive to each other's movements. When markets are integrated, assets of identical risk command the same expected return, regardless of location. Moreover, integrated markets are very sensitive to disturbances in each other, which means that their market portfolio returns are highly correlated. The links of world exchange indices and stocks has been addressed, among others, by Eun and Shim (1989), Agmon (1972), and Dekker, Sen and Young (1998). Higher integration of the world equity

markets greatly undermines incentives for international portfolio diversification.

A traditional approach to examine changes in the degree of integration between international stock markets is to analyze shifts in the pairwise correlations of international stock indexes over time. An increased correlation is usually interpreted as a rise in the degree of integration, and therefore a higher tendency that a shock in one country will be transmitted to another. But a straightforward use of this approach may sometimes give misleading conclusions due to the fact that simple correlation coefficients incorporate information on both long-term relations between markets and short-term trading noises. Such short-term deviations of prices can significantly distort the picture of the structure of long-term market linkages. To resolve this problem, Kasa (1992) proposed to use cointegration tests and error-correction model to compute common stochastic trends for equity markets. He applied this technique to five developed economies: the U.S., Japan, England, Germany, and Canada. This seminal paper was followed by Chou *et al* (1994), who extended the sample with the French market, Chauhuri (1996) with the analysis of seven Asian markets, Masih and Masih (1998) and others. These works demonstrated that the sampled stock market indexes are cointegrated with the consequence of limited gains from diversification of portfolio across them.

The degree of integration was found to rise during periods of financial crises. Hilliard (1979) confirmed this in his study of markets during the 1973-1974 OPEC crisis. The world-wide impact of the October 1987 stock market crash emphasized for investors just how integrated financial markets had become. It shifted the interest of researchers from exploring the benefits of diversification outside domestic markets, to determining the actual structure of linkages between markets and the transmission of innovations (information) between world equity markets. Eun and Shim (1989) conducted a formal

analysis of linkages amongst markets. They utilized the Vector Autoregression (VAR) methodology that focuses on return series to study the long-term interaction between markets and the efficiency with which innovations are transmitted. The U.S. market was found to be the dominant market. The recent article of Ammer and Mei (1996) presents evidence of lags in the international transmission of economic shocks, so that contemporaneous output correlation may understate the magnitude of integration. In many studies it is also argued that the longer the time period, the greater the degree of stability among international stock markets of developed countries.

Thus, the hypothesis of international markets being integrated as well as the competing one of their segmentation were broadly analyzed by financial researchers, with substantial evidence that confirms elements of both of them. My work will be concentrated on gains from international diversification, emphasizing the validity of the second hypothesis. But at the same time the findings that are in compliance with the alternative claims should be taken into account, defining the limits of reliability and applicability of results.

In recent years the opportunities for equity investment in developing countries have increased remarkably, which explains the growing interest of financial researchers in these markets. From the perspective of international investors, these rapidly expanding markets offer potentially high rates of return and an important mean of diversifying portfolio risk. It was found that stock returns of developing countries tend to have lower correlations with those of industrial countries, than inter-industrial correlations. Participation in developing countries is thus likely to lower overall unconditional portfolio risk. This fact is by now well established. Divecha, Drach, and Stefak (1992), for example, find that by investing up to about 20 percent of an international portfolio in developing countries, the risk-return trade-off can be notably improved, in which case the unconditional mean-variance frontier shifts upwards dramatically.

Moreover, some recent studies on emerging stock markets (Chan, Gup, and Pan 1993, Defusco, Geppert, and Tsetseks 1996[1], and Chatterjee, Ayadi, and Dufrene, 1998) conclude that these markets are characterized by the lack of cointegration (no long-run equilibrium relationship), so that there are gains from diversifying not only across developed and developing countries as groups, but also across different individual developing countries.

The important warning concerning these diversification benefits, as noted by Claessens (1995), is whether these gains can be attained. The benefits of diversification might exist mainly due to barriers that restrict investment in these markets. (Another obstacle is transaction costs.) Without barriers, capital markets tend to be almost fully integrated; and assets with identical risk characteristics yield identical expected returns. Alternatively, with barriers, markets may propose different returns even if their basic risk characteristics are the same. Claessens (1995) argues that as a result of opening up, the emerging markets become increasingly integrated with world financial markets. To profit fully from increased equity flows and diversification of sources of external finance, they should lower barriers to foreign capital flows.

Tesar and Werner (1995) analyze the pattern of international portfolio of U.S. investors. They find that the U.S. portfolio remains strongly biased toward domestic equities (home bias), despite the recent increase of the share of foreign equities (including emerging markets) in it. At the same time, of the international fraction of investment, the share invested in emerging stock markets is roughly proportional to the share of the emerging markets in the global market capitalization value. But, in my opinion, the comparison of shares of markets in portfolio with their shares in global market capitalization does not reveal an important issue of whether this actual portfolio structure complies with optimally diversified portfolio predictions.

[1] Based on Chatterjee, Ayadi, and Dufrene, 1998.

The goal of my research is to investigate diversification potential of transitional stock markets, somewhat overlooked by researchers . The research will consist of several parts. First, I want to analyze gains from portfolio diversification amongst Eastern European and Former Soviet Union economies. Similar to many works concentrated on Latin American, African, Asian, and Pacific Basin countries (Chatterjee, Ayadi, and Dufrene 1998, Dekker, Sen, and Young 1999, and others), my analysis will demonstrate whether the benefits from diversification exist in this region. Inferences for diversification potential from simple analysis of correlation coefficients of stock market indexes are valid only in the short run, and might be quite misleading for longer periods. Stock prices tend to move closely together and trend upward over time. The long-run relationships of stock market movements can be investigated using the cointegration technique. Existence of cointegrating equations in a system of several sock market indices implies that these markets are characterized by some long-term relationship (even though there could be significant deviations from it over the short-term), which in theory leaves only limited space for gains from diversification .

The second direction of my interest is to explore the existent patterns of portfolio investment by foreign investors in these countries, and to explain biases that I expect to find there. The home bias phenomena in equities, noted by numerous researchers (see, for example, Lewis 1998) is not crucial for me, because my aim is to discover how efficient is distribution of actual portfolio investment flows among transitional economies given the total amount of flows in this region. Thus, what attracts my attention is country-biased investment patterns of the share of portfolio dedicated to foreign assets. It would be interesting to explain what determines the fact that different markets do not benefit from approximately «fair» (in the sense of being in line with efficient portfolio diversification predictions) attention of foreign investors, and most of these capital flows are concentrated in one country. Some

possible explanation of this phenomenon can be found in the literature on home-bias, as well as in the economies of agglomeration theory. Some other valid explanations, which seem to be very appropriate, include institutional problems that are still unresolved in most transitional markets. These problems make investments in these economies very risky and expensive, and thus put obstacles to portfolio flows. Since the resolution of these problems depends primarily on national governments actions, I will try to derive some policy recommendations from my analysis.

The work is organized as follows: the next chapter gives basic notions of modern portfolio theory and explains how diversification works. The data, methodology of cointegration tests, and theoretical predictions are presented in Chapter 3. This is followed by a discussion of empirical results, and analysis of actual portfolio investment flows. The final section deals with the conclusions and policy implications.

*Chapter 2*

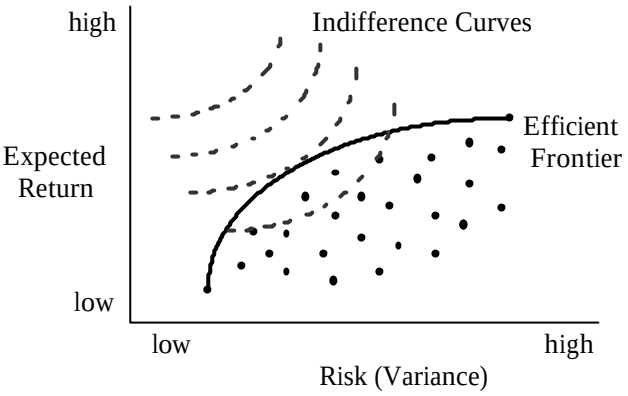
# PORTFOLIO THEORY AND DIVERSIFICATION.

The modern portfolio theory states that investors choose among all possible investments on the basis of their risk and return. Returns are simply gains expected from holding an asset or portfolio. The forecasts of returns are rarely perfectly accurate. In order to measure the forecast uncertainty or the potential forecast error, which define the risk of an asset, we analyze variance of returns, or, more precisely, their standard deviation. The important assumption of the model is that returns should be normally distributed. In this case we need only two summary measures, mean and variance, to describe the entire distribution. Even though this assumption does not always hold, analysts often resort to this approximation of reality in order to simplify their analysis.

The two characteristics of risk and return can be plotted graphically for a group of investments. Figure 1 shows one such graph. Each dot represents a possible investment. Some of the dots are single assets, while other dots are combinations of different assets. The problem for an investor is to choose among all possible portfolios. A quite natural assumption would be that investors get additional utility from greater return, but they get disutility from greater risk. If presented with an opportunity to increase return without undergoing greater risk, investors should choose to do so. Similarly, if various options earning the same rate of return are available, investors should choose the alternative with the lowest risk. To summarize, rational investors will try to construct efficient portfolios - the best-return combinations of assets with a given risk level, or, alternatively, the least-risk investments with a given

return. The thick curved line in Figure 1 links all these efficient portfolios together and is called the efficient frontier.

Figure 1. **The Efficient Frontier**

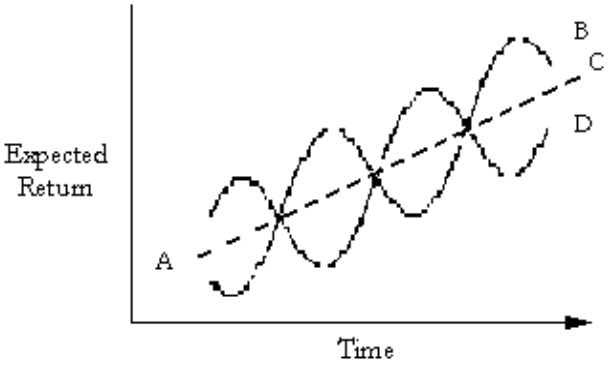



Even though we have now a theoretical guide to construction of efficient frontier, it is not enough if we want to determine which portfolio the investor would prefer. To do so, we should impose a set of investor's indifference curves (trade-offs between risk and return) on the efficient frontier. Following the general microeconomic logic, in order to determine graphically the optimal choice, the point of tangency between the highest indifference curve and the efficient frontier would give the preferred portfolio.

Now, to demonstrate how diversification actually works and why it is important for efficient portfolio construction, we should note that when we move from evaluating a single asset to evaluating a portfolio, some additional characteristics of assets (along with their risk and return) should be taken into consideration. Return on a portfolio is simply the average return from all assets held in portfolio, but standard deviation, or risk, of a portfolio is calculated quite differently. Along with standard deviations of individual assets, their correlations should be taken into account. To demonstrate the difference, we can look at the expected returns from a portfolio composed of only two assets.

Suppose that the returns from both assets are expected to follow a cyclical pattern and vary over time. Line AB in Figure 2 represents the returns expected on asset 1, and line AC represents expected returns on asset 2. The return of the portfolio that consists of both assets is the sum of those from the two assets. However, the risk (variance) of the portfolio would be much smaller than that from either asset. In Figure 2, dashed line AD represents the expected return on the portfolio containing equal amounts of both assets. A negative correlation of returns allows the counterbalancing of movements of individual assets, ending up in lower overall variance of portfolio returns than the variance of either asset's returns.

Figure 2. **Variability of Returns Over Time**




If we turn now to symbol notation, the expected return on a portfolio of $n$ assets can be given by

$$\overline{R}_p = \sum_{i=1}^{n} x_i \overline{R}_i$$

where $\overline{R}_p$ is the expected return on the portfolio

$\overline{R}_i$ is the expected return on asset $i$

$x_i$ is the fraction of the portfolio held in asset $i$.

In addition, we require that the investor should be fully invested, or

$$\sum_{i=1}^{n} x_i = 1$$

The standard deviation of the return on the portfolio is given by

$$\sigma_p = \left(\sum_{i=1}^{n}\sum_{j=1}^{n} x_i x_j \rho_{ij} \sigma_i \sigma_j\right)^{1/2} \quad (1)$$

where $\sigma_p$ is the standard deviation of the return of portfolio

$\sigma_i, \sigma_j$ are the standard deviations of the returns on securities *i*, *j*

$\rho_{ij}$ is the correlation coefficient between assets *i* and *j*.

From the last formula the importance of correlations between individual components of the portfolio becomes evident. It shows that the riskiness of a portfolio is largely determined by the similarities in the return behavior of these components. The lower the correlation coefficients are, the smaller the interactive risk is (the risk that arises from the interaction between securities), and, consequently, the smaller the total portfolio risk is. Ideally, securities with negative correlations should be chosen for portfolio, since they reduce total portfolio risk rather than add to it. The problem is that they can be only rarely found in the security universe.

The subsequent chapters of this paper will be devoted to the analysis of return correlations of transitional stock market indexes. Even though correlation coefficients alone are of limited use for portfolio choice (expected returns and risk should also be investigated), their analysis is helpful in deciding about the diversification potential of different markets. Besides, it is difficult to reveal expected stock index returns. The usual practice is to look at historical returns and approximate expectations by these realized values. This widely accepted approach may be valid for matured markets with long history, but give quite misleading results for fledgling transitional markets. Moreover, the recent financial crisis in Russia caused collapses in most markets of the

region, and led to negative historical performance of most of them. Since we do not expect such situation to persist over time, other proxies for expected returns should be developed. This task is out of scope of this paper and constitutes one of the directions of author's future work. Bekaert *et al* (1996) analyzed the behavior of emerging market returns and offered some explanations of forces that underlie their characteristics.

Another stock market characteristic that is important for efficient frontier construction is asset risk. A conventional measure of risk, returns variance (or standard deviation), also seems to be more appropriate for developed markets. Most transitional economies are characterized by low liquidity and shallowness of their stock markets, which add to their risks, but might be only partially reflected in the variability of returns. Even though variance of returns seem to be much more reliable measure of risk than historical returns - of expectations, some additional research should be done in the direction of improving its descriptiveness of actual market risk.

Taking into account everything stated above, I will leave the problem of efficient frontier construction from transitional stock market indexes for future research, and now will concentrate on the analysis of correlation coefficients as measures of diversification potential across different markets. These coefficients are much less likely to suffer from the shortcomings noted above about the conventional risk and return measures, and I assume that they reflect the similarities of returns behavior in different markets quite precisely.

*Chapter 3*

# DATA AND METHODOLOGY.

The empirical part of the paper is based on weekly data of the stock market indices for ten transitional economies (Ukraine, Lithuania, Estonia, Latvia, Poland, Hungary, Slovenia, Russia, Czech Republic and Slovakia) for a period from April 1997 till January 2000. The choice of the period and countries was driven primarily by the availability of data. Index series for five countries are taken from the Emerging Market Data Base (EMBD) formerly compiled by the International Finance Corporation (IFC), and recently acquired by Standards &Poors. Like many industrial market indexes, indexes from EMDB are biased toward local blue-chip stocks, and this sometimes diminishes their representativeness. Perceived advantages of the IFC indexes over the locally calculated market indexes are that they offer greater comparability across markets and are, according to many researchers, more carefully calculated.

IFC indexes for some countries have quite a short history (for Ukraine, for example, their calculation began only in 1999) or are not easily accessible, which means that other sources of data should be addressed. For countries which fall into this category, indexes constructed and reported by national agencies (PRO-U index for Ukraine, TALSE Index for Estonia etc.) are taken. Weekly values for the indexes are collected, and, when appropriate, are converted to U.S. dollar equivalents. The description of the data series is provided in Table 1. A careful examination of data is conducted to insure their final integrity and absence of apparent anomalies.

Table 1. Indexes Used.

| *Country* | *Index* | *Country* | *Index* |
|---|---|---|---|
| Ukraine | PRO-U | Slovakia | IFC-investable |
| Estonia | TALSE | Hungary | IFC-investable |
| Slovenia | SBI | Czech Republic | IFC-investable |
| Latvia | DJRSE | Poland | IFC-investable |
| Lithuania | LITIN | Russia | IFC-investable |

The stock indexes are converted into rates of return by taking the difference between natural logarithms of two consecutive weekly index prices. That is,

$$R_{it} = \ln I_{it} - \ln I_{i(t-1)},$$

where $I_{it}$ is the stock price index of the $i$-th country at time $t$ and $R_{it}$ is the corresponding rate of return on the index. For indexes quoted in national currencies the above formula is transformed as follows:

$$R_{it} = \ln\left(\frac{I_{it}}{I_{i(t-1)}} * \frac{e_{i(t-1)}}{e_{it}}\right),$$

where $e_{it}$ is the exchange rate of the $i$-th country per American dollar at time $t$. The transformation of raw data by taking their natural logarithm is consistent with convention, as most economic and financial time series follow curvilinear trends.

First, the correlation coefficients of the returns are computed. The existence of low correlations is indicative of potential diversification gains from investments in the sampled markets. But in measuring diversification potential, we should distinguish between short-term and long-term correlations. The fact that short-term correlations among stock returns are low may not capture long-term comovements. One solution to this is to use a cointegration technique to examine whether in the long-run index series follow common trends. The assertion that national equity indexes are cointegrated implies that there are linear combinations of these indexes that are stationary

and form long-run equilibrium relationships.

A precondition for cointegration of time series is for none of the series to be integrated of order higher than one. A method to test for stationarity in a particular variable is Philips-Perron test (P-P test). This test method is preferred to the traditional approach of Dickey and Fuller, as it adjusts for error autocorrelations.

The cointegration test assumes that if any two variables contain a common stochastic trend, each can be described as an integrated variable. Also, if a linear combination of these two variables is observed stationary, the two variables are said to be cointegrated. Under the bivariate framework, the cointegrating regression equations between any two market indexes with reverse specifications can be described as follows:

$$\ln I_{1t} = \alpha_0 + \alpha_1 \ln I_{2t} + e_t$$

$$\ln I_{2t} = \beta_0 + \beta_1 \ln I_{1t} + v_t \quad ,$$

where $I_{1t}$ is the weekly index value of market 1, $I_{2t}$ is the index from stock market 2, and $e_t$, $v_t$ are the stochastic error terms. The cointegration equations are estimated by ordinary least squares (OLS) to investigate whether these two returns are cointegrated[2]. I will use the cointegration test proposed by Johansen (1991). The advantage of this procedure lies in its use of maximum likelihood estimation within both bivariate and multivariate frameworks. The model calculates and tests the number of cointegrating vectors in an OLS setup. If the null hypothesis that the residuals are integrated cannot be rejected, the two series are said to be cointegrated. If $I_{1t}$ and $I_{2t}$ are cointegrated (the number of cointegrating equations is less than two), the two return series cannot drift apart indefinitely. This limits the diversification possibilities of these two markets.

Using a similar argument, the multivariate cointegration equation with

reverse specifications for any number of series can be represented by

$$\ln I_{1t} = \gamma_0 + \sum_{i=2}^{n} \lambda_1 \ln I_{it} + u_t ,$$

where $I_{it}$ represents the value of the $i$-th index and $\lambda_i$ is the corresponding regression coefficient. In this case the complete system will be represented by $n$ equations.

For diversification potential in $n$ different markets to exist, the number of common trends have to be equal to the number of index series (i.e., $n$ index series will be dominated by $n$ different stochastic trends). Consequently, the correlations between these market return series are likely to be independent upon the length of the investment horizon and profitable diversification would be possible.

While examinations of bivariate relationships may provide additional insight, they are not entirely informative for portfolio construction purposes and serve at best as a precondition for further analysis in a multivariate setting. The absence of a cointegrating relationship between two stock market prices does not preclude the possibility that the two markets are integrated. It is possible that these two markets are related to other stock markets so that equilibrium price relationship must involve multiple stock prices.

I would like to stress that the theory hardly provides us with any clear-cut real world predictions about the cointegration coefficients in a multivariate setting. In the ideal world of perfect information, full capital mobility, no uncertainty about stock price and exchange rate movements, no transaction costs, perfect arbitrage, and continuous portfolio rebalancing, we would assume equal expected (as well as risk-adjusted and expressed in one currency) returns in different markets, which follows from the rate of return parity condition. To keep the analysis simple, we will first start with a two-country

[2] Chatterjee, Ayadi, and Dufrene (1998)

case.

Using the previously introduced notation, we can define that

$$R_t^{country\,1} = R_t^{country\,2},$$

or, equivalently,

$$\ln I_t^{country\,1} - \ln I_{t-1}^{country\,1} = \ln I_t^{country\,2} - \ln I_{t-1}^{country\,2}$$

By rearranging the terms, we get

$$\ln I_t^{country\,1} = \ln I_t^{country\,2} + \ln I_{t-1}^{country\,1} - \ln I_{t-1}^{country\,2}$$

Since this relationship should hold every period, we obtain

$$\ln I_{t-1}^{country\,1} = \ln I_{t-1}^{country\,2} + \ln I_{t-2}^{country\,1} - \ln I_{t-2}^{country\,2}$$

$$or \quad \ln I_{t-1}^{country\,1} - \ln I_{t-1}^{country\,2} = \ln I_{t-2}^{country\,1} - \ln I_{t-2}^{country\,2}$$

…

$$\ln I_2^{country\,1} = \ln I_2^{country\,2} + \ln I_1^{country\,1} - \ln I_1^{country\,2}$$

$$or \quad \ln I_2^{country\,1} - \ln I_2^{country\,2} = \ln I_1^{country\,1} - \ln I_1^{country\,2}$$

By substituting $C = \ln I_1^{country\,1} - \ln I_1^{country\,2}$, we get

$$\ln I_t^{country\,1} - \ln I_t^{country\,2} = \ln I_{t-1}^{country\,1} - \ln I_{t-1}^{country\,2} =$$

$$= \ln I_2^{country\,1} - \ln I_2^{country\,2} = \ln I_1^{country\,1} - \ln I_1^{country\,2} = C$$

So, we can write the general expression as

$$\ln I_t^{country\,1} - \ln I_t^{country\,2} = C$$

This equation gives us the long-run (and short-run in a perfect world) relationship between stock price indexes of different countries. We would expect that if our assumptions hold and such relationship exists, it is exactly what the cointegration technique should reveal. The cointegration coefficients predicted by the theory in this case are (1, -1).

If we turn to a multivariate case now, and still assume a perfect world situation (with rate of return parity between all individual markets), we can show that

$$\ln I_t^{country\ 1} - \frac{1}{n-1}\ln I_t^{country\ 2} - \frac{1}{n-1}\ln I_t^{country\ 3} - \ldots - \frac{1}{n-1}\ln I_t^{country\ n} = C.$$

The predicted by the theory cointegration coefficients now would be

$$[1, -1/(n-1), -1/(n-1), -1/(n-1), ..., -1/(n-1)].$$

Having in mind these results, if we turn to a more general case and allow for some market imperfections, we can assume that the cointegrating equation would look as follows:

$$\ln I_t^{country\ 1} - \alpha_1 \ln I_t^{country\ 2} - \alpha_2 \ln I_t^{country\ 3} - \ldots - \alpha_{n-1} \ln I_t^{country\ n} = C,$$

where $\alpha_1 + \alpha_2 + \ldots + \alpha_{n-1}$ is expected to be close to 1, and $0 \le \alpha_i \le 1$ for each *i*. The simplified interpretation would be that the rates of return in different markets (measured as the difference between stock price indexes in subsequent periods) do not reflect accurately the gains that investors obtain from investing in these markets, and in order to transform them into realized gains, they should be corrected by some coefficient. Some types of transaction or other costs may make arbitrage activity unprofitable even though straightforwardly measured returns in different markets are not equal. The prediction of $\alpha_1 + \alpha_2 + \ldots + \alpha_{n-1}$ being close to 1, as well as that of $0 \le \alpha_i \le 1$, depend crucially on the magnitude of these costs, and can be violated if measured returns are far from actually realized gains.

Further departures of cointegration coefficients values from predictions may arise if we assume that in the case of small developing stock markets investors' behavior is not really guided by rate of return parity condition. Since most of these markets are small and shallow, large investors are limited in their decisions about portfolio rebalancing by liquidity considerations. So, it might happen that quite large departures from the rate of return parity will be allowed until investors decide to assume additional risk of low liquidity and enter into this more profitable market with more investments. Another cause of non-typical cointegration coefficients might

constitute barriers on international portfolio flows imposed by individual countries (this might still be true to some extent for the markets under consideration even though the countries that I chose for the analysis have no explicit barriers to international portfolio flows). Such barriers would complicate portfolio rebalancing task and allow persistent violations of the rate of return parity.

*Chapter 4*

# RESULTS AND DISCUSSION.

The correlation coefficients of stock index returns and other basic stock market characteristics of the sampled economies are presented in Table 2 from Appendix 1. Along with ten Eastern European indexes described earlier, the table contains two additional ones - European aggregated index Dow Jones STOXX and NYSE Industrial index representing European and U.S. stock markets respectively. The temporary inclusion of these two indexes into the analysis is done for purely demonstrational purposes in order to have a better understanding of the relationships between transitional and developed stock market returns. The coefficients range from -0.089 to 0.681, and in most cases are quite low, indicating that there should be benefits from diversification across these markets, at least in the short run. If we concentrate only on transitional stock markets, the lowest correlation (0.032) is observed between Lithuania and Slovenia, which can probably be explained by the fact that Slovenia, which is one of the most successful economies in the region, does not belong to the Former Soviet Union group of countries (the countries from this group have much higher correlation coefficients with Lithuania), and its market movements are mostly influenced by factors not relevant and in general only weakly transmitted to the Lithuanian market. The highest correlation coefficient of 0.67 belongs to Hungary and Poland: these two markets, often referred to as "converging", have extensive trade and financial linkages, which determine their close interrelationships.

As noted earlier, a straightforward interpretation of correlation coefficients might be quite misleading, since they are determined not only by

long-term fundamental relationship among the markets, but also include some short-term noise. So, the next step in my analysis is to look directly at the long-run relationships using the concept of cointegration.

The first step is to check each index series for stationarity. The null hypothesis for the presence of unit root (the series is non-stationary) has been tested using Phillips-Perron test with intercept and time trend. The test results (for both levels of the series and their first differences) are presented in Table 3.

Table 3. Results of Unit-Root Tests for Stationarity of Stock Indexes.

| | *levels* | *first differences* | | *levels* | *first differences* |
|---|---|---|---|---|---|
| **Ukraine** | -0.9606 (-4.0250) | -8.1152 (-4.0254) | **Poland** | -2.4854 (-4.0250) | -11.8591 (-4.0254) |
| **Estonia** | -1.7712 (-4.0250) | -10.2723 (-4.0254) | **Lithuania** | -1.6710 (-4.0250) | -10.6396 (-4.0254) |
| **Hungary** | -2.9205 (-4.0250) | -13.4842 (-4.0254) | **Slovenia** | -2.0596 (-4.0250) | -12.3576 (-4.0254) |
| **Russia** | -0.760250 (-4.0250) | -10.53539 (-4.0254) | **Latvia** | -0.5947 (-4.0250) | -9.8026 (-4.0254) |
| **Czech Republic** | -2.7536 (-4.0250) | -12.57386 (-4.0254) | **Slovak Republic** | -1.8227 (-4.0250) | -12.2462 (-4.0254) |

*Notes:*
P-P test option with trend and intercept is used.
The *levels* column contains the Phillips-Perron test statistics for index series in level form.
The *first differences* column contains the Phillips-Perron test statistics for index series in first-difference form.
1% MacKinnon critical values for the rejection of hypothesis of a unit-root are provided in parentheses.

For series levels, the null hypothesis of non-stationarity (unit root) cannot be rejected. However, for the first differences of all index series this null hypothesis is rejected. The conclusion is that the index series are non-stationary in levels but stationary in the first differences, which gives us a necessary precondition to continue with cointegration analysis.

Results from the multivariate cointegration tests appear in Table 4. The chosen test option is linear trend in the VAR and intercept but no trend in the cointegrating equation. The decision about the lag order (no lags included) was driven mainly by the limited sample size of 143 observations (according to the rule of thumb, the number of estimated coefficients - in my case, $10 \times 10 = 100$ when no lags are included and $10 \times 20 = 200$ with one lag - should not be greater than the sample size). Besides, if the evidence of cointegration is found in the setting with no lags, the inclusion of lags usually allows to claim with even more grounds the existence of long-run relationship between variables.

Table 4 reports that in the system of ten equations at most two cointegrating vectors (or eight common trends) are observed. This implies that these markets are likely to be connected by some long-run relationships, and there exist two distinct linear combinations of indexes that are stationary. It should be noted that the assumption implicitly built into the cointegration procedure is that the stability of the system (in terms of the number of common stochastic trends) is not affected by shocks and some specific events. The intuitive interpretation of cointegrating (long-run) relationships between several variables is that the short-term deviations from this long-term equilibrium will feed back on the changes in the variables in order to force their adjustment towards the long-term equilibrium.

The cointegrating equation, normalized on Poland (the choice of normalization variable was driven by the size and activity of this market), is as follows:

$$1.00\,POL + 0.70\,UKR - 1.42\,SLV - 0.70\,SLK - 0.54\,RUS + 1.15\,LIT -$$
$$\underset{(0.13946)}{} \quad \underset{(0.66086)}{} \quad \underset{(0.25595)}{} \quad \underset{(0.12231)}{} \quad \underset{(0.27636)}{}$$
$$-0.45\,LAT - 1.06\,HUN - 0.82\,EST - 1.35CR - 1.48 = \varepsilon_t,$$
$$\underset{(0.14638)}{} \quad \underset{(0.23374)}{} \quad \underset{(0.33230)}{} \quad \underset{(0.23879)}{}$$

where $\varepsilon_t$ is white noise (standard errors are given in parentheses).

Table 4. Results for Multivariate Johansen Cointegration Test.

| *Eigenvalue* | *Likelihood Ratio* | *5 Percent Critical Value* | *1 Percent Critical Value* | *Hypothesized No. of Cointegrating Equations* |
|---|---|---|---|---|
| 0.4877 | 305.2798 | 233.13 | 247.18 | None** |
| 0.3299 | 210.3153 | 192.89 | 205.95 | At most 1** |
| 0.2725 | 153.4583 | 156.00 | 168.36 | At most 2 |
| 0.1975 | 108.2731 | 124.24 | 133.57 | At most 3 |
| 0.1504 | 77.0286 | 94.15 | 103.18 | At most 4 |
| 0.1450 | 53.8803 | 68.52 | 76.07 | At most 5 |
| 0.0870 | 31.6342 | 47.21 | 54.46 | At most 6 |
| 0.0821 | 18.7091 | 29.68 | 35.65 | At most 7 |
| 0.0373 | 6.5494 | 15.41 | 20.04 | At most 8 |
| 0.0081 | 1.1566 | 3.76 | 6.65 | At most 9 |

*Notes:* *(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 2 cointegrating equation(s) at 5% significance level

As we can see, the signs of most of cointegrating coefficients comply with our theoretical predictions (with the exception of Ukraine and Lithuania), but the absolute values of coefficients deviate from our expectations of their summing up to zero. Along with the possible explanations of these deviations offered in the previous section, several additional issues that might lead to such violations of theoretical predictions are:

- the rates of return series used in the tests are not expected, but historical rates of return;
- the rates of return series are not risk-adjusted;
- the exchange rate data imperfections used for transformation of stock indexes calculated in national currencies into dollar terms may add to both risk and expectations problems.

To gain some insight on the robustness of results for all ten indexes, cointegration tests for systems including less than ten countries are

conducted[3]. The findings are that the cointegration hypothesis cannot be rejected for any combination of nine or eight markets (even though the number of cointegrating relationships changes), but there exist several mixes of seven markets that do not cointegrate.

One such combination, reported in Table 5 from Appendix 2, is of particular interest, since it includes the Ukrainian stock index. More or less strong conclusions can be suggested by these particular findings. Since these seven markets are not integrated, gains from portfolio diversification across all of them are likely to persist in the long run, which is reinforced by quite low correlation coefficients between national stock indexes. So, the inclusion of all these markets in one's portfolio is likely to be profitable in terms of overall risk reduction. Still, we should be careful about the generality of interference that can be made from the obtained results. This very appealing fact of no cointegration in the system of seven markets (which in theory implies the possibility of earning virtually abnormal profits in these markets from diversification across them) does not destroy the fact that the inclusion of more markets in our sample does change the situation. The previous results demonstrate that incorporation of additional (and to some extent more attractive[4]) markets into the analysis actually brings important changes. Moreover, even though cointegration technique basically singles out long-term comovements of markets, the structure of these comovements may change with time. Taking into account current trends of accelerating market liberalization and aggressive integration of transitional economies into the world financial community, we might expect that someday hypotheses about cointegration can become much more difficult to reject even for samples that contain reduced number of markets.

The presence of cointegration implies that in these markets there is a

[3] All obtained results are not reported here due to the space limitations, but are available from the author upon request.

common force (like arbitrage activity) that causes adjustments in them and brings them together in the long-run. Even though in the long run the possibility of abnormal profits from diversification is, in theory, eliminated, the short-run opportunities (which may last for some time) are still available. Moreover, since most of these markets are making only the first steps towards their higher openness and integration, and they are still much more responsive to internal disturbances than to external ones, the (long run) equilibrium state is not likely to persist and will be prevailed by short-run deviations from it. This would further enhance profitable opportunities from diversification across them.

To demonstrate the validity of this point, we can refer to the following example. Let's take two cointegrated stock index series (Ukraine and Russia), analyze the correlation of their returns, and then numerically calculate the benefits from diversification across these two markets. The results of cointegration test are presented in Table 6 from Appendix 3. Since we cannot reject the hypothesis that these two price series are cointegrated, there should exist a long-run relationship between the two markets that would theoretically exclude the possibility of benefits from the diversification across them. But, as noted earlier, short-run deviations from this equilibrium relationship are still permissible, and might even prevail over equilibrium state. The correlation coefficients can give us an idea about this. The contemporaneous correlation of returns from Ukrainian and Russian stock markets, given earlier in Table 2, is only about 30 percent, which means that the similarities in the return behavior are not overwhelming. The self-descriptiveness of correlation coefficients can be enlarged if along with contemporaneous analysis, leads and lags will be introduced in calculations. Thus, the correlation of returns falls to approximately 11 percent if the Russian index is assumed to move first, and is followed by the Ukrainian index in the next period. The opposite situation

[4] Under the attractiveness we mean larger size and greater liquidity of markets.

gives the correlation of about 47 percent. This coefficient seems to be the largest, and introduction of greater lags only diminishes the correlation. So, if we approximate by this number the correlation coefficient in diversification benefits calculations, we can compute the risk (variance) of the portfolio constructed from two stock indexes and then compare it to the individual stock index variances. Let's also assume the Ukrainian index constitutes $3/4^{th}$ of our portfolio, while the Russian index has the weight of $1/4$. The portfolio variance in this case is

$$\sigma_p^2 = \frac{1}{16} \times \sigma_{Russia}^2 + \frac{9}{16} \times \sigma_{Ukraine}^2 + \\ + 2 \times \frac{1}{4} \times \frac{3}{4} \times \rho_{Ukraine\&Russia} \times \sigma_{Russia} \times \sigma_{Ukraine} =$$

$$= \frac{1}{16} \times 0.0136 + \frac{9}{16} \times 0.0064 + 2 \times \frac{1}{4} \times \frac{3}{4} \times 0.47 \times 0.1166 \times 0.0802 = 0.0061$$

The standard deviation of this portfolio is then about 0.078. Thus, the overall portfolio risk is less than the risk of any of its components, which demonstrates that diversification works. Besides, we would usually expect that the market with greater risk also proposes greater rate of return (although this statement is not confirmed by the historical return values), which means that the diversification allows not only to reduce risk but also to achieve higher expected return.

Even though the existence of cointegration between all ten markets makes the inclusion of all of them in one's portfolio much less suitable for risk reduction purposes, the cointegration evidence can be used for prediction purposes (Masih and Masih, 1998). After some further analysis of the significance of coefficients with which each market enters into the cointegrating vectors, it is possible to reveal what information about the common stochastic trends each national stock index contains. Then, the predictions about one index behavior can be derived from the information on

other stock indexes.

To summarize, the results obtained from the tests indicate that there exist some combinations of markets are not cointegrated and contain opportunities for international portfolio diversification that are likely to persist over longer-term periods. Besides, even in the markets that are cointegrated, short-run deviations from the equilibrium are likely to make diversification profitable.

*Chapter 5*

# ANALYSIS OF ACTUAL PORTFOLIO PATTERNS.

The next question that naturally arises from the above conclusions is how effectively the existing diversification potential is exploited by international investors. Since there exists no single theory that would be able to incorporate all relevant factors that influence investors' decisions, the judgment about their rationality and effectiveness is not an easy task. Moreover, most of the work that researchers are conducting in the field contain an ex-post analysis, while the theory states that investors expectations (which are utterly difficult to reveal) should play the major role. Thus, normative assessments of actual investment patterns should be provided very cautiously, keeping in mind that they are based on imperfect theoretical models. However deficient, these predictions can be very helpful in deciding by how much actual behavior of economic agents deviate from the "optimal" model.

To gain insight on the actual patterns of foreign portfolio investments into the sampled markets, we make a representative investor assumption. This assumption implies that the structure of aggregate portfolio investments, as reflected by the International Investment Positions of different countries (reported by the International Monetary Fund), is supposed to be representative for individual investors. Even though we would not really expect that all investors have identical structures of their portfolios, this assumption does not distort the general picture, and allows us to make general conclusions. Table 6 contains both absolute values and percentage shares of foreign investors' portfolio positions in different countries.

The table reports that in 1997 and 1998 about ninety percent of

Table 7. Foreign Portfolio Investments to Eastern European Stock Markets.

| *International Investment Position* | 1997 | | 1998 | |
|---|---|---|---|---|
| | Millions of US Dollars | % | Millions of US Dollars | % |
| **Ukraine*** | 294 | 1.3 | 521 | 1.7 |
| **Hungary** | 15089 | 64.9 | 18242 | 61.3 |
| **Estonia** | 573 | 2.5 | 301 | 1.0 |
| **Latvia** | 9 | 0.0 | 42 | 0.1 |
| **Lithuania** | 1041 | 4.5 | 1625 | 5.5 |
| **Slovak Republic** | 157 | 0.7 | 108 | 0.4 |
| **Poland** | 2672 | 11.5 | 4969 | 16.7 |
| **Czech Republic** | 3028 | 13.0 | 3793 | 12.7 |
| **Slovenia** | 156 | 0.7 | 144 | 0.5 |
| **Russia** | 240 | 1.0 | 36 | 0.1 |
| **Total** | 23259 | 100 | 29739 | 100 |

*Source:* International Monetary Statistics, IMF

*For Ukraine the International Investment Position statistics is not reported, and is approximated by the Balance of Payments data.

aggregated portfolio position of foreigners in these ten markets fell on only three of them: Hungary (that has a lion's share of all investments), Czech Republic and Poland.

The previous analysis would suggest that such portfolio structure does not comply with our expectations. It was demonstrated that these markets can potentially offer benefits from diversification across them, so clustering of investments in only three countries seems to be in conflict with general theoretical predictions.

Several possible explanations of such inconsistencies can be proposed. The most evident ones include uncertainty about future returns from these markets and their high risks, which are among the main factors influencing investors' choice. Historical performance of Eastern European stock indexes is quite discouraging (with negative returns in most cases), but it is very unlikely that such situation can persist over time. On the contrary, rapid development of most transitional economies, an even more rapid growth of their financial markets (that is urged by the need to build previously non-

existent financial infrastructure) makes the possibility of receiving very high returns on portfolio investments quite realizable.

Direct and indirect institutional barriers that foreign investors are likely to encounter when investing in these markets constitute the second set of restraining factors. Such barriers may include huge transaction costs, restrictions on foreign investments, tax burdens, lack of transparency in market participants' actions, undeveloped legislative base, shallowness and low liquidity of the markets, reduced disclosure requirements, possible enforcement problems, etc. Lack of information about the markets and their opportunities in general, as well as high political and currency risks, are likely to add to the problem. These are the barriers that can be addressed and effectively removed by national governments. Their more detailed analysis is out of scope of this paper, and lays down the direction of author's future research.

Another set of relevant factor is probably beyond direct governmental control. It includes so called psychological and behavioral factors. As noted earlier, the theory stresses that in the portfolio choice expected returns play very important role. But there is no clear guidance as to how these expectations are formed. One possible situation that would end up in biases in portfolio flows might originate from return expectations that are systematically more optimistic about one markets than about others, thus determining the direction of portfolio flows (French and Poterba, 1991). Uncertainties associated with expected returns estimation often make it difficult for investors to learn that returns in one markets are not regularly higher than those in other markets, so the adjustment of expectations can be very slow. The same problem may be related to risk evaluation of different markets. Along with historical standard deviations of returns, some "extra" risks may be attributed to individual markets just because the information about them is not very widespread, or some cultural perceptions play an important role. Such

behavior can be quite rational in case of transitional economies with not yet formed economic systems and substantial political risks. But it is also possible that too much weight is devoted to these risks without any well-grounded foundations.

One more behavioral phenomenon may include perceptions that all these economies belong to the same region (or, at most, are grouped into two-three regions - non-Soviet countries, Baltic countries, and Former Soviet Union excluding Baltics). Therefore, "all of them more or less resemble each other" (with the consequence of investing in only a few of them). The problem is especially crucial for Ukraine, since it is still considered by many foreigners as a part of the Russian empire, and thus in most situations is not treated separately.

Herding is another very famous behavioral finance theory. Herding arises if each investor finds it optimal to follow others actions, even if his private information suggests that he should do something different. The problem here is that costs from endangering investor's reputation in case of unconventional investment decisions might outweigh benefits from winning if this unconventional action string is successful. This can be called the incentive-reputation argument, and is closely connected to principal-agent problem. Herding explanation of portfolio flows distortions can also be applied to transitional stock markets. Even though the portfolio flows to most of these markets are still very limited, their reversal might be caused by herding behavior of investment funds managers influenced by the developments in other markets.

The theory of agglomeration, developed primarily for rationalization of business activity concentration, can also propose some explanatory arguments. This theory mostly deals with clustering together of firms in one place, which is largely determined by history. Such behavior of firms displays strategic complementarities, in the sense that an agent is better off when other agents

choose the same action as he does, rather than being worse off due to increased competition. In emerging financial markets, early interest and participation of strong international investors (and, in fact, only these investors can afford a luxury to assume extremely large risks inherent in these markets) may be crucial for their further development. First participants demand and help to create informational and transaction service centers that stimulate both the development of financial infrastructure and interest of other investors to new markets.

To summarize, we can distinguish numerous factors that influence international investors decisions concerning stock markets of transitional economies. Even though behavioral motives may have a very important role, we should not forget about institutional impediments to portfolio inflows, since they can be relatively easily controlled and removed by national governments.

*Chapter 6*

# CONCLUSIONS.

In this work, we have applied simple correlation analysis and cointegration technique with the goal to investigate the relationships between Eastern European stock markets. This approach allows to analyze both short-term and long-term linkages between international markets, and derive important conclusions for portfolio decisions.

In summary, our multivariate analysis established that for the ten sampled markets the hypothesis of non-cointegration cannot be rejected, but the long-term relationship disappears when we reduce the number of markets. The correlation coefficients are quite low for most markets, which, when combined with the previous results, indicates that the benefits from diversification across these markets are available(at least in the short run, when deviations from the long-term equilibrium take place).

Some interesting conclusions can be derived from the analysis of actual portfolio patterns and their comparison with theoretical predictions. Important biases in the behavior of international investors are suggested by the data (at least, if compared to theoretical predictions) . Even though these biases can be caused by behavioral factors which are hardly under the control of national governments, institutional barriers might additionally aggravate the situation. The transitional economies that need a lot of funds for their restructuring and development, can use the stock markets as an additional means for domestic and international investment mobilization. To do so, the governments should develop these markets more

rapidly and efficiently. At the same time, perhaps even more than in other developing countries, for Eastern European transitional economies reform efforts can be identified as the most important determinant of private capital flows. One key policy implication from this is that the sustainability of capital flows is associated with the sustainability of reform efforts.

The increasing liberalization and globalization of the world capital markets intensify the problem of the national stock market development in transitional economies, and open new areas for research. The numerous issues about characteristics and interdependencies of these markets still need to be addressed. Among others, and to continue the general concept of this paper, we can highlight the problems of more appropriate measurement of expected returns and risks, identification of common trends from cointegration results, modeling of the short-run dynamics of markets, prediction issues etc.

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