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Mutual Funds: Does the Performance Erosion Effect Exist? Evidence from the Czech Republic, Hungary and Poland*

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Abstract

The main aim of this paper is to examine whether the performance of mutual funds in the 2000-2015 period in the Czech Republic, Hungary and Poland was related to net asset value under management. The study is also to verify the hypothesis regarding the fund size at which performance decreases, causing the erosion effect in the three analyzed markets. The obtained results show a slightly positive relationship between asset size and returns. After dividing the total samples of Czech, Hungarian and Polish funds into subsamples consisting of entities with a comparable size of capital bases, it turned out that the main findings can be explained by relations observed in the subsamples of small funds (both Czech and Polish) and partly in Hungarian funds. The presented evidence may be insufficient to confirm or reject the hypothesis about the optimal fund size, but the observed positive influence of assets under management on fund performance suggests that mutual fund industries in the mentioned CEE countries are still in a developing phase and are able to increase the asset size while maintaining efficiency. Hence, the performance erosion effect does not exist in the investigated markets.

1. Introduction

It is assumed that the scale of a financial system is related to the role it plays in the national economy. In spite of certain differences in value of the GDP asset share of financial institutions in the so-called new EU member states – such as the Czech Republic, Hungary and Poland – the mentioned parameter is much lower than in the Western-European countries. Moreover, the structure of financial systems in countries that geographically belong to the Central-Eastern European (CEE) area, named according to Halecki's conception (1980), assigns the systems to the continental model with banks as the main intermediaries. The financial systems have functioned in the above-mentioned CEE countries over a similar period, which enables us to take a closer, cross-sectional look at the development of the chosen financial intermediaries.

As mentioned before, in the countries of the discussed region, the banking sector plays an important role in financial systems. Since funds hold a relatively small share of their assets in the total assets of the financial market, they make up only an

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additional part of the sector. At the end of 2015, mutual fund assets in Poland comprised 12.3% of the value of all local financial intermediaries and only 5% in the Czech Republic and 13.9% in Hungary (NBP, 2016). The Polish financial system is among the least banking-focused in the CEE region due to a relatively strong position of collective investment institutions located there. It should be emphasized, however, that banks hold an impregnable position in all the CEE countries, with more than 70% of market share.

The characteristics of individual financial systems contribute to the fact that the development of this kind of institution should be analysed, for example, with reference to the consequences of changes that took place in the local securities markets. According to the quarterly reports of the European Fund and Asset Management Association (EFAMA, 2016), the rapid growth in the value of assets under management of mutual funds continued in the emerging CEE countries until the onset of the global financial crisis. In the second half of 2007, the collapse in particular industries was observed in the global market as well local markets. The net assets of the European UCITS industry decreased by 25% at that time. In subsequent years, there was a renewed increase in the number of financial intermediaries and assets under management. The mentioned increase in the number of funds in the recent period was accompanied by a simultaneous decrease in the number of fund management companies, which may mean higher industry concentration. However, the total value of fund assets in the analyzed CEE countries compared to the whole European industry still does not exceed 0.5%. The asset value of the Polish UCITS industry at the end of 2015 was EUR 24,176 million; the asset value of Czech mutual funds was EUR 7,497 million and EUR 471 million in the case of Hungarian[1] mutual funds.

The size of fund assets, which may influence the effectiveness of mutual funds, along with the development possibilities of the mutual fund market seems to be an interesting topic requiring further discussion. The fund size belongs to fund attributes that are defined as the organizational characteristics that determine the management profile of fund companies and help funds gain advantage in the market. A portion of the results presented in the U.S. literature on the subject suggests that there is a link between obtaining outperformance and use of organizational fund attributes.

Managing large assets requires extending considerably the spread of an investment portfolio. This, in turn, means limiting the possibilities that could result from the potential stock selection abilities demonstrated by fund managers. Based on the scale of investment, the funds decide to hold less liquid portfolios. Sometimes, the extension of assets results rather in an overwhelming increase in the volume of holdings already purchased by funds than in diversification caused by an increase in the number of investments in their portfolio. Furthermore, the investment decisions by larger funds are more visible in the market, and they could trigger the herding effect. However, the small funds that hold fewer assets might focus their investments in selected securities generating more income.

The main aim of this paper is to examine whether the performance of mutual funds operated in the selected CEE countries is related to fund size. The study will also

[1] In 2015, EFAMA replaced the previous classification of UCITS (publicly-offered, open-ended funds) with a regulatory definition. At the end of 2015, the net assets of the Hungarian alternative investment funds (AIF) industry had amounted to EUR 17,634 million.

verify the hypothesis regarding the fund asset size at which the erosion effect occurs. The analysis of the size-performance relationship is important from the perspective of investors as well as mutual funds. Fund attributes such as size may influence the investment decisions of individual investors suggesting the possibility of outperforming. Moreover, collective investment institutions may use the fact of possessing appropriate attributes to gain an advantage while undertaking marketing actions supporting competitive market strategy.

2. Literature Review

Fund size is one of the basic organizational attributes of collective investment institutions. It can be measured by average net assets under management or by the logarithm of the value of net assets and reflects the market position of a fund. Moreover, the size of a fund represents market acceptance and popularity in the form of asset growth and the possibility to use economies of scale.

The paper by Perold and Salomon (1991) was one of the first studies that analyzed the issue. By means of simulation, showing how bigger funds that use a larger asset base are required to manage portfolio actively – which, at the same time, contributes to an increase in expenses related to a larger number of transactions – the researchers found that middle-sized funds achieved better performance. However, the increase in fund assets was to some extent accompanied by a performance drop.

Economies of scale, which can result, for instance, from apportioning various types of costs (such as legal, administrative and reporting costs) to a greater capital base or from using greater research resources, were obtained by large funds. Similar conclusions were drawn in many studies. Payne et al. (1999), for example, analyzed several factors that could have influenced the performance of U.S. equity and balanced funds in the 1993-1995 period. They found that risk-adjusted and fee-adjusted returns are more substantial in funds with higher value of assets under management.

Another classical study concerning size-performance relationship is the paper by Indro et al. (1999). On the basis of 683 non-indexed U.S. equity funds and mixed funds operated in the 1993-1995 period, where performance was measured by net returns (after deducting the fees), the authors showed that fund size affects fund performance. The analyzed entities, in order to obtain sufficient investment effects, should strive for the minimum asset value, which could legitimize the costs of information acquisition and trading. The discussed paper was one of the first studies covering the issue of optimal size.

Further studies confirmed the negative influence of fund size on fund performance. One of the popular papers on this subject, written by Chen et al. (2004), concerns the effects of scale in the analyzed financial institutions. By using a sample of the US equity funds operating in the 1962-1999 period and by employing the returns from a one-, three- and four-factor CAPM model, they adopted a specific approach to describing regression methods, the so-called Fama-MacBeth model. They presented a relationship whereby performance, whether before or after fees and loads, declines together with the increase in fund assets under management.

The paper by Bodson et al. (2011) aimed at examining the possible relation between fund size and obtained returns. The analyzed entities were equity funds, mixed funds and bond funds functioning in the 2000-2010 period. The authors used linear and quadratic regression models, while the measures of performance consisted of a set of traditional and modern ratios. The linear model revealed a slight dependence of returns on the size of assets. The quadratic model, in turn, showed a concave relationship, which suggests the existence of an optimal size of assets that allows funds to achieve the best performance.

It should be noted that the growth in fund size may be accompanied by the increased frequency of purchases or sales of new securities, which generates higher costs and reduces benefits in less liquid markets. The organizational limitations caused by the growing amount of assets under management and the requirements of numerous investors may contribute also to the loss of efficiency characteristics by asset management companies. The mentioned situation came to be called the 'performance erosion effect', which means that funds with an increased asset value receive worse net returns.

The studies focusing on mutual funds from beyond the US market provide different conclusions, the majority of which favour economies of scale. Lee et al. (2008), for example, were examining the influence of managerial and organizational factors on performance achieved by Taiwan open-end mutual funds. Having analyzed five categories of equity funds that operated between January 2001 and August 2008, they found a significant and positive relationship between fund size and performance. In their analysis, the researchers decided to use raw return, market-adjusted return, Jensen's alpha and Sharpe ratio as measures of performance. Vijayakumar et al. (2012) also investigated the discussed relation. While calculating returns for 14 equity and debt-linked fund of funds functioning in India in the 2004-2008 period, they used the following panel models: common constant method (OLS), fixed effect coefficient (FEM) and random effect coefficient (REM). The obtained results show that the achieved returns are positively related to fund size.

The paper by Dahlquist et al. (2000) aimed at determining the relation between the performance and attributes of mutual funds operating in the Swedish market in the 1992-1997 period. The measures of return applied to 210 equity, bond and money market funds were alphas estimated from conditional and unconditional regression models. The obtained results showed that larger equity funds achieved worse returns than their smaller competitors. In the case of bond funds, however, the conclusion was the opposite; it follows, therefore, that the influence of fund size depends on fund type.

The functioning of mutual funds in the CEE countries receives relatively scant scholarly attention. The popular papers by Swinkels and Rzezniczak (2009) address the issue of mutual funds operating in Poland. Bóta and Ormos (2013, 2016) analyze Hungarian funds, Filip (2013) focuses on Czech funds, and Podobnik et al. (2007) are interested in Croatian, Slovenian and Bosnian mutual funds.

As far as the performance of mutual funds in the CEE region is concerned, the issue is rarely explored by scholars. The most well-known paper discussing that subject is the one by Białkowski and Otten (2011) about the influence of several organizational fund characteristics on mutual fund performance. Having analyzed 140 equity, mixed and bond funds (both domestic and international ones) operating in the 2000-2008 period, they found that Polish funds were unable to outperform. This was confirmed by the negative values of Carhart's alphas from the four-factor CAPM model, especially after including management fees. The influence of fund attributes on performance turned out to be statistically significant and indicates the existence of economies of scale.

The observations discussed above, concerning the size-performance relationship among mutual funds and made for the samples of equity funds from the U.S. and non-U.S. markets, have been summarized and presented in Table 1. A careful analysis of these observations may lead to several conclusions:

- the samples from the U.S. market show that fund size positively affects fund performance in relatively short-term horizons; however, the analysis of extended horizons conducted with more advanced methods has revealed the so-called erosion effect, attributed to the level of market development;
- the samples from emerging markets (e.g., Taiwan, India) show a positive size-performance relation;
- the results from the European markets vary depending on the level of development of the markets.

As far as the CEE region is concerned, Lemeshko and Rejnuš (2015) examined the factors conditioning the size of the mutual fund industry in 11 post-transition countries and compared them with the values of macroeconomic factors. The analyzed industry was composed of 5 000 open-end equity, fixed income and money market mutual funds operating in the 2000-2014 period. The study showed that the size of the mutual fund industry is positively related to the openness to trade and capital inflows, to the development and stability of local financial markets and to the factors connected with the quality of legal framework.

The development of mutual fund industries in the CEE countries is identified by an increase in the number of entities in the market, the growth of net asset value managed by funds and their investment effects, which are important from the perspective of clients. Addressing the issue mentioned above seems to be crucial from the cognitive point of view. Furthermore, the lack of actual research on the discussed subject, particularly in view of several crises that occurred in the financial market, makes the analysis of the relation between performance and fund attributes – such as fund size – not only interesting but also necessary. Thus, the study contributes to the financial literature by analyzing the CEE region and answers the question about future mutual fund asset growth in the CEE countries and the question about the existence of a performance erosion effect observed in developed markets.

Table 1 A Summary of the Results Presented in Selected Studies on Size- performance Relationship among Equity Funds

Authors	*Publication year*	*Geographical area*	*Study period*	*Analysed fund attributes*	*Values of size-performance regression coefficients*
Payne et al.	1999	United States	1993-1995	Size, Expense ratio, Load Fee, Turnover, Minimum initial purchase, Age, Management structure	1.94E-5 in overall sample, from 0.55E-6 to 7.21E-6 depending on the investment style
Indro et al.	1999	United States	1993-1995	Size, Turnover, Expense ratio, Risk, Market Factors	From 0.69 to 0.72 depending on the estimation model
Chen et al.	2004	United States	1962-1999	Size, Family Size, Turnover, Age, Expense Ratio, Load Fee, Flow, Past performance	From -0.018 to -0.028 depending on the measure of returns
Bodson et al.	2011	United States	2000-2010	Size	From -0.00113 to 0.00128 depending on the measure of returns
Lee et al.	2008	Taiwan	2001-2008	Size, Age, Management Fee, Turnover, Style	From 0.02 to 0.17 depending on the measure of returns
Vijayakumar et al.	2012	India	2004-2008	Size, Risk, Turnover, Income ratio, Expense ratio	0.015 (OLS), 0.023 (REM), 0.047 (FEM)
Dahlquist et al.	2000	Sweden	1992-1997	Size, Administration Fee, Load Fee, Turnover, Commission Fee, Flow	-0.08 (smaller funds) and -0.88 (larger funds)
Białkowski and Otten	2011	Poland	2000-2008	Expense Ratio, Size, Age	0.00368

Source: Own compilation.

3. Methodology

In order to conduct the study on performance erosion effect, we based the choice of measures of mutual fund returns and tools for analyzing the size-performance relation on the reviewed literature. Given that the results are sensitive to the applied methodological approach, we decided to use four popular measures of returns. Moreover, having in mind the fact that many of the previous studies have arrived at different conclusions, we decided to analyze the mentioned relation by employing the methods used in the studies concerning developing markets.

3.1 Data Sources

The database constructed for the purposes of this study consists of the unit prices of mutual funds operating in the Czech Republic, Hungary and Poland registered at the end of a month. The mentioned data served to calculate yearly returns and net asset values under management of funds at the end of the calendar year. It has to be noted that the collected dataset concerning Polish mutual funds does not include information about the dissolved entities, which means that the study sample was not survivorship-bias free. However, the bias in the sample of Polish funds should not distort the results (cf. Dawidowicz, 2013; Jackowicz and Filip, 2009). In the case of the analysed Czech and Hungarian funds, the database includes survivors as well as non-survivors.

Because of a relatively small number of entities in the selected segment of funds, especially in the Czech Republic, we chose not to divide equity funds into uniform groups depending on their investment styles. On the one hand, this approach means a unique possibility to adopt the econometric procedures presented in the subsequent sections; on the other, it may potentially distort the findings due to permanent differences in risk profiles between uniform fund groups. Taking the above-mentioned into account, the author acknowledges the fact that investment styles may have an influence on the optimal fund size. The empirical results to date give evidence of considerable differences in the optimal amount of assets under management of various funds operating in the more developed markets (cf. Collins and Mack, 1997; Shawky and Li, 2006). However, due to the specificity of the available data concerning mutual funds in the CEE countries, it was impossible to extract homogeneous subgroups of funds comprised of high-conviction funds or index funds. As a result, the interpretation of the obtained results has to be limited only to entities investing in assets with the same risk characteristics.

Furthermore, due to the necessity of verifying the hypothesis about the optimal size of assets, the mutual funds of each of the analysed countries were grouped based upon the value of managed assets into small funds (below EUR 50 million), medium funds (from EUR 50 million to EUR 200 million) and large funds (above EUR 200 million). This procedure enables analyzing the obtained results in terms of the achieved economies of scale or erosions in the performance of funds at various stages of their functioning, measured by the value of assets. It should also be noted that the analysed markets are perceived as emerging ones, comprising mostly small funds.

Table 2 is based on information from the organizations collecting data about mutual funds operating in the Czech Republic (*AKAT ČR*), Hungary (*BAMOSZ*) and Poland (*Analizy Online*) and presents the number of equity funds included in the study. This number may differ from the total number of entities operating in the CEE markets registered by the European Fund Asset Management Association (EFAMA). Outliers were excluded from the sample.

Table 2 The Number of Equity Funds Included in the Study

Equity funds operated in:	Years	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Czech Republic	**Total sample**	**9**	**18**	**22**	**17**	**13**	**14**	**14**	**18**	**22**	**26**	**26**	**27**	**25**	**25**	**28**	**32**
	Small	8	18	22	17	12	13	12	16	21	15	24	24	22	20	20	21
	Medium	1	0	0	0	1	1	1	1	1	0	1	3	3	5	8	9
	Large	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	2
Hungary	**Total sample**	**25**	**26**	**32**	**33**	**31**	**32**	**34**	**38**	**45**	**63**	**77**	**98**	**115**	**116**	**116**	**101**
	Small	24	25	31	31	28	29	29	34	44	58	74	98	115	115	116	100
	Medium	1	1	1	2	3	2	4	3	1	4	3	0	0	1	0	1
	Large	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0
Poland	**Total sample**	**10**	**12**	**13**	**16**	**17**	**20**	**26**	**38**	**58**	**79**	**89**	**107**	**118**	**135**	**143**	**152**
	Small	8	10	12	14	9	9	6	7	38	55	64	86	95	100	114	121
	Medium	2	2	1	2	8	9	11	16	16	18	17	16	17	27	23	25
	Large	0	0	0	0	0	2	9	15	4	6	8	5	6	8	6	6

Source: Own compilation.

The time span under study is the 2000-2015 period. The beginning of this period is marked by the emergence of an adequately large number of funds in the CEE countries necessary to conduct a verification of the main hypothesis about the existence of a performance erosion effect. The end of the period is the moment in which the works on the database were completed.

3.2 Measurement of Returns

The study employs the most popular measures of fund returns encountered in many studies (e.g., Lee et al., 2008); the measures use the values of units. The first one is simple return. It shows the return on a unit of initial investment and is calculated as follows (e.g., Hudson and Gregoriou, 2015):

$$r_{i,t} = \frac{UP_{i,t} - UP_{i,t-1}}{UP_{i,t-1}}, \tag{1}$$

where $r_{i,t}$ is the raw return of fund *i* in period *t*, $UP_{i,t-1}$ and $UP_{i,t}$ are net unit prices on fund *i* in period *t*-1 and respectively period *t*.

The disadvantage of the above rate is the fact that it disregards the differences in the level of risk undertaken by funds. These differences are included in an approximate way in the Sharpe ratio by means of a standard deviation. The second measure, the so-called reward-to-variability ratio, is calculated as follows (Sharpe, 1966):

$$SR_{i,t} = \frac{r_{i,t} - r_{f,t}}{\sigma(r_{i,t})}, \qquad (2)$$

where: $SR_{i,t}$ is the Sharpe ratio on fund *i* in period *t*; $r_{f,t}$ is the mean risk-free return over period *t*; $\sigma(r_{i,t})$ is the standard deviation of the rate of return on fund *i* in period *t*. The mean rate of return and standard deviation are calculated on the basis of monthly observations.

The next measure of return includes the element representative of securities market, in which given funds invest the managed assets. Because of the range of investments, we decided to separate domestic funds from foreign ones. This was done only for Polish entities as both Czech and Hungarian funds hold portfolios mainly in global or emerging stock markets or have no regional restrictions due to the small size of local securities markets. The raw returns together with returns in the equity market enable calculating the market-adjusted return. The presented measure of returns is described as follows (Lee et al., 2008):

$$rm_{i,t} = r_{i,t} - r_{m,t}, \qquad (3)$$

where $rm_{i,t}$ is the market-adjusted return of fund *i* in period *t*; $r_{m,t}$ is the return on the local equity market benchmark in period *t*.

The measure that confronts the achieved rate of return with the expected returns and takes into account the adjusted market risk is an intercept of regression models. Hence, each fund from the database was ascribed a model specified as follows (Jensen, 1968):

$$r_{i,t} - r_{f.t} = \alpha_i + (r_{m,t} - r_{f,t})\beta_i + \varepsilon_t, \qquad (4)$$

where: α_i is abnormal return of fund *i* (the so-called Jensen's alpha); β_i – is the beta coefficient of fund *i* and ε_t means the random error in period *t*. Since the study analyzes performance dependence on fund size in three markets, the necessary specification of benchmarks, used in equations (3) and (4), was presented in Table 3.

Table 3 The List of Benchmarks Used in the Estimation of Intercepts of Regression Models

Country	*Market benchmark*	*Risk-free rate*
Poland	WIG/MSCI	Weighted average yield on 13-week T-bills sold at auctions
Czech Republic	MSCI	Average rate weighted by volume, on the three-month T-bills sold at auctions
Hungary	MSCI	Weighted average yield on 90-day T-bills sold at auctions

Source: Own compilation.

The data on the risk-free rate values come from the International Financial Statistics quarterly reports conducted by the International Monetary Fund. Moreover, the Morgan Stanley Capital International index (MSCI) served as a market benchmark for all the internationally diversified funds. The global equity index data was collected from the MSCI websites. The values of the main local market index (WIG) for Polish domestic funds were taken from the website of the Warsaw Stock Exchange, as mentioned above.

3.3 Regression Specification

Regression analysis is a tool for investigating the relationships between variables. It is a specific case of dependence investigation whereby some values of one variable are ascribed to the values of the other variable. While examining the analyzed relationship, it is justified to use several methodological approaches in order to improve the statistical conclusion validity. It is, therefore, necessary to apply methods for time-series cross-section (TSCS) data, consisting of time-series data observed on many units. The estimation of parameters taking into account the TSCS dimension will be conducted through the application of the pooled ordinary least squares (OLS) and least-squares dummy variables with fixed-effects (FEM) methods.

The traditional functional model to investigate dependence between variables employs linear regression. The relation between performance and size of assets can be determined on the basis of the following formula (Bodson et al., 2011):

$$PM_i = a_0 + a_1(\log TNA_i) + \varepsilon_i , \tag{5}$$

where: PM_i means the used measure of returns of fund *i*, and $\log TNA_i$ is a natural logarithm of net asset values of the fund.

The verified null hypothesis states that the fund size in a given period does not affect the achieved returns. In this case, the estimated a_1 parameter equals 0, which indicates a lack of the mentioned influence. The statistical significance of the coefficient will be verified by the *t*-test. If the calculated value of statistics *t* is higher than the critical value for a given significance level with the number of degrees of freedom, the null hypothesis will be rejected. The sign of coefficient a_1, in case of its statistical significance, will inform about the character of dependence of fund performance on fund size. The positive parameter a_1 confirms the existence of some economies of scale; the negative value confirms the existence of the erosion effect. Moreover, the study will use the global F-test (Fisher–Snedocor) to verify the significance of the whole regression formula and the heteroskedasticity test (White's test) to check the constant variance of errors in a regression model.

However, the studies on more developed markets measure the optimal asset value of funds by quadratic regression models. The analysis that applies polynomial regression, e.g., the quadratic model, is used in cases where an endogenous variable depends on only one exogenous variable; however, the linear regression model might be inaccurate (Horvath and Reeder, 2013). Similarly to Bodson et al. (2011) or Tang et al. (2012), we adopt the additional approach that enables the curve analysis of the size-performance function. It will be done by means of the following formula:

$$PM_i = a_0 + a_1(\log TNA_i) + a_2(\log TNA_i)^2 + \varepsilon_i . \tag{6}$$

In order to check whether the regression model fits the applied data well, we used a classic parameter, namely, the determination coefficient. Moreover, as in the linear model, the F-test for joint significance of all variables will verify the hypothesis about the significance of the determination coefficient. Furthermore, it should be stressed that with a large number of observations and an endogenous variable with values in some interval, the low values of R^2 are acceptable and should not serve to evaluate the quality of model fit (see Cox and Wermuth, 1992).

The basic features of the analyzed data are presented in a concise summary describing the constructed samples. Table 4 shows the descriptive statistics related to independent variables.

Table 4 Descriptive Statistics for Fund Assets

	Sample	*Observations*	*Mean*	*Median*	*Std. Deviation*	*Minimum*	*Maximum*	*Kurtosis*	*Skewness*	*Jarque-Bera normality test*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
Czech Republic	Total sample	336	26 620 454	14 029 828	37 628 538	36 324	254 631 913	14.93	3.53	2 190
	Small	295	16 021 863	12 135 389	13 224 884	36 324	49 703 652	-0.09	0.94	164
	Medium	35	81 442 840	66 626 411	34 190 287	50 892 781	171 877 808	0.43	1.28	17
	Large	6	227 920 598	222 122 664	17 202 723	206 805 039	254 631 913	-1.39	0.62	5
Hungary	Total sample	982	10 278 500	4 007 419	23 465 390	1 031	324 723 515	80.83	7.72	249 105
	Small	951	7 197 754	3 711 832	9 304 959	1 031	48 761 948	3.73	1.94	329
	Medium	27	79 201 432	58 659 708	32 974 173	50 439 440	154 577 453	0.2	1.17	14
	Large	4	277 496 162	281 747 708	39 081 581	221 765 717	324 723 515	-1.47	-0.42	3
Poland	Total sample	1033	60 937 178	16 903 517	137 975 808	103 528	1 511 485 762	41.29	5.69	64 083
	Small	748	13 422 261	9 057 418	12 785 468	103 528	49 681 217	0.36	1.14	359
	Medium	210	98 036 308	85 789 369	40 342 935	50 079 685	198 256 741	0.05	0.98	111
	Large	75	430 941 710	316 760 748	304 542 844	200 716 486	1 511 485 762	2.76	1.9	24

Notes: Values in column 3-7 are expressed in EUR.
Source: Own compilation.

Table 4 presents descriptive statistics concerning fund assets in all the included samples. The majority of observations were gathered for Polish and Hungarian funds (1033 and 982 observations respectively); Czech funds will be discussed on the basis of 336 observations. However, it should be noted that following the division of funds, described in section 3.1., into small (below EUR 49 million of assets), medium (from EUR 50 million to EUR 200 million) and large (above EUR 200 million), the largest subsamples were the ones comprised of Hungarian small funds (approx. 97% of all observations in Hungary), Polish small funds (approx. 72% of Polish observations) and Czech small funds (approx. 88% of Czech observations), which indicates the dominance of small entities in the CEE markets. In nearly all the analyzed size-related subsamples, the funds functioning on the Polish market exceed Hungarian and Czech funds in terms of value of assets and median value of assets.

In regard to the concentration of assets around the mean, the kurtosis calculated for the total samples of Czech, Hungarian and Polish funds was relatively high, which means a leptokurtic distribution of independent variables. However, for the subsamples of small, medium and large funds, the distribution was similar to normal distribution; this result receives confirmation also from the Jarque-Bera test for normality of residuals. The values of skewness coefficient, in turn, showing the asymmetry of the probability distribution, indicated a positive skew in the distribution of variables in total samples and a slight deviation from the normal bell curve characteristic of the subsamples.

At this point, it seems crucial to present the results from the basic statistical analysis of fund performance data. This necessity stems from the fact that asymmetric returns may be perceived as an attribute characterising the distribution of variables (see Kraus and Litzenberger, 1976). Thus, Table 5 shows the values of descriptive statistics for the endogenous variables used.

Table 5 Descriptive Statistics for Performance Metrics

	Measure	Observations	Mean	Median	Std. Deviation	Minimum	Maximum	Kurtosis	Skewness	Jarque-Bera normality test
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Czech Republic	Raw Return	336	0.00736	0.03067	0.23535	-0.67478	1.56358	6.09	0.57	166
	Market-adj. Return	336	-0.04597	-0.00834	0.21745	-0.75636	1.26167	3.82	0.01	10
	Sharpe Ratio	336	-0.05577	-0.02518	0.11387	-0.82304	0.06981	20.99	-4.27	4 289
	Jensen's Alpha	335	-0.00003	0.00097	0.01323	-0.07748	0.06783	5.71	-0.46	77
Hungary	Raw Return	982	0.05106	0.03353	0.21771	-0.51460	1.07467	2.29	0.74	141
	Market-adj. Return	982	-0.03676	-0.00982	0.25175	-0.76905	1.00790	0.55	-0.5	164
	Sharpe Ratio	982	-0.04439	-0.03633	0.41903	-4.06507	1.17764	13.33	-1.75	4 082
	Jensen's Alpha	982	-0.00111	-0.00047	0.02043	-0.09055	0.09278	3.13	-0.45	-72
Poland	Raw Return	1033	0.05078	0.06376	0.24922	-0.67267	0.87089	0.68	-0.15	207
	Market-adj. Return	1033	-0.00994	-0.01495	0.13726	-0.67588	0.55313	2.06	0.12	58
	Sharpe Ratio	1033	-0.00613	0.06296	0.42268	-1.56246	1.16409	-0.07	-0.48	322
	Jensen's Alpha	1029	-0.00067	-0.00052	0.01140	-0.06320	0.04613	2.91	-0.41	-70

Source: Own compilation.

Table 5 presents the values of descriptive statistics for dependent variables in the form of performance metrics. The highest values of dispersion, measured by standard deviation, have been observed for Sharpe ratios, particularly for Polish and Hungarian funds. The lowest values, in turn, have been noted for Jensen's alphas, which could be caused by their specific method of calculation. The level of asymmetry in the distribution of returns, measured by skewness, indicates a negatively skewed distribution of returns calculated by Sharpe ratio and Jensen's alpha. The skewness of the two remaining performance metrics is ambiguous. The values of kurtosis, for measuring the concentration of values around the mean, provide evidence indicating that the distribution of returns is similar to the one normal for the majority of measures. The same applies to the effects of asset management, except for the Sharpe ratios, achieved by Polish and Hungarian funds. The returns of Czech funds have much more leptokurtic distribution with heavier tails. The values of Jarque-Bera statistics, which test normality, suggest that the distribution of residuals is close to the normal distribution.

4. Empirical Results

As mentioned before, the study analyzes the data of Czech, Hungarian and Polish mutual funds based on a time-series cross-sectional approach. In order to verify the hypotheses mentioned above, we will use two research methods. A linear regression is the first method used in this study and will serve for verifying the hypothesis about the influence of fund size on performance. The second method, a quadratic regression, will allow for addressing the convexity or concavity of the size-performance function, which refer to a decline in returns until a particular size of assets under management is reached and to growth in returns until a moment of increasing capital resources, respectively.

The gathered data are related to the three CEE markets mentioned above. All of the analyzed funds have been divided into three subsamples of small, medium and large funds; the subsamples include 44 Czech funds, 137 Hungarian funds and 152 Polish funds. The number of observations made with regard to the entire period under study, i.e., the number of yearly returns by all the analyzed funds recorded for the 2000-2015 time horizon, was 336 (Czech funds), 982 (Hungarian funds) and 1033 (Polish funds). The obtained results will be presented side by side in successive panels for all of the selected CEE markets.

4.1 The Analysis of Linear Relation between Fund Size and Performance

In order to verify the first hypothesis, it is necessary to examine the influence of fund size on performance. The analysis of the dependence of asset management effects upon fund size will be conducted also for the subsamples. As such, it should allow for determining the strength of the analysed relationship in the groups of funds with similar scale of functioning. As mentioned before, the obtained results concerning the analyzed markets will be confronted in three successive panels. Table 6 presents the sign and the values of parameter a_1 estimated for the model (5) by using four measures of return within two regression methods.

Table 6 Linear regression models for the CEE mutual funds

Panel A: Czech funds		*pooled OLS*				*FEM*			
		(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Sample	***Variables***	***Raw Return***	***Market-adjusted Return***	***Sharpe Ratio***	***Jensen's Alpha***	***Raw Return***	***Market-adjusted Return***	***Sharpe Ratio***	***Jensen's Alpha***
Total sample	log(TNA)	0.05328 ***	0.06314 ***	0.01502 **	0.00424 ***	0.07874 ***	0.11181 ***	0.01227	0.00584 ***
		(0.00593)	(0.00787)	(0.00726)	(0.00068)	(0.01707)	(0.01406)	(0.00776)	(0.00105)
No. Obser.	constant	-0.86387 ***	-1.07838 ***	-0.30136 **	-0.06945 ***	-1.33952 ***	-1.81207 ***	-0.26627 **	-0.10158 ***
336		(0.10100)	(0.13220)	(0.12070)	(0.01117)	(0.24910)	(0.20520)	(0.11330)	(0.01534)
No. Funds	F-statistic	37.77	67.02	11.93	80.29	60.02	159.32	118.78	177.77
44	R-square	0.10	0.17	0.03	0.19	0.15	0.32	0.26	0.35
	White test	3.26	2.69	0.05	326.86	2.98	15.99	0.03	29.83
Small funds	log(TNA)	0.05472 ***	0.06231 ***	0.01596 **	0.00435 ***	0.08113 ***	0.11446 ***	0.01639 ***	0.00621 ***
		(0.00719)	(0.00974)	(0.00716)	(0.00083)	(0.02007)	(0.01516)	(0.00331)	(0.00120)
No. Obser.	constant	-0.88541 ***	-1.06628 ***	-0.31645 ***	-0.07096 ***	-1.37451 ***	-1.85077 ***	-0.32641 ***	-0.10700 ***
295		(0.11950)	(0.15890)	(0.11990)	(0.01365)	(0.29300)	(0.22140)	(0.04839)	(0.01751)
No. Funds	F-statistic	31.98	49.05	10.16	66.62	55.81	149.04	102.83	169.15
41	R-square	0.10	0.14	0.03	0.19	0.16	0.34	0.26	0.37
	White test	4.05	5.51	0.90	286.23	5.09	3.07	0.90	39.43
Medium funds	log(TNA)	-0,03678	-0.05278	-0,09270	-0.00700	0.01791	-0.01251	0.01635	-0.00385
		(0.04614)	(0.05765)	(0.09630)	(0.00490)	(0.03715)	(0.06071)	(0.01161)	(0.00288)
No. Obser.	constant	0.73340	1.02578	1.65091	0.13270	-0.30739	0.22225	-0.28630	0.07140
35		(0.81480)	(1.01900)	(1.72400)	(0.08664)	(0.65930)	(1.07700)	(0.20600)	(0.05108)
No. Funds	F-statistic	0.14	0.64	2.09	2.18	5.77	34.45	1002.55	35.09
12	R-square	0.00	0.02	0.06	0.06	0.15	0.51	0.97	0.52
	White test	1.85	0.30	2.76	27.22	1.16	0.42	2.25	0.39
Large funds	log(TNA)	-4.11997 ***	-3.52577 ***	-0.31010 **	-0.15194 ***	-4.21640 ***	-3.84109 ***	-0.42751 ***	-0.16373 ***
		(0.28960)	(0.40550)	(0.10260)	(0.01666)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
No. Obser.	constant	79.56920 ***	68.02920 ***	5.96564 **	2.93553 ***	81.49880 ***	74.12900 ***	8.21576 ***	3.16421 ***
6		(5.63500)	(7.82300)	(1.96800)	(0.32180)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
No. Funds	F-statistic	1.63	1.70	2.85	1.00	2.31	2.20	5.90	1.31
3	R-square	0.29	0.30	0.42	0.20	0.37	0.35	0.60	0.25
	White test	5.71	5.84	3.39	4.66	5.91	5.96	0.36	5.97

Panel B: Hungarian funds		pooled OLS				FEM			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	***Variables***	***Raw Return***	***Market-adjusted Return***	***Sharpe Ratio***	***Jensen's Alpha***	***Raw Return***	***Market-adjusted Return***	***Sharpe Ratio***	***Jensen's Alpha***
Total sample	log(TNA)	0.00540 ***	-0.00149	0.00900 *	0.00008	0.03863 ***	-0.00177	0.07477 ***	0.00372 ***
		(0.00183)	(0.00196)	(0.00477)	(0.00015)	(0.00983)	(0.00876)	(0.01858)	(0.00092)
No. Obser.	constant	-0.02649	-0.01529	-0.17369 **	-0.00222	-0.65586 ***	-0.08401	-1.31719 ***	-0.06607 ***
982		(0.02725)	(0.03029)	(0.07544)	(0.00227)	(0.14940)	(0.13330)	(0.28260)	(0.01399)
No. Funds	F-statistic	4.54	0.26	3.40	0.11	108.13	91.64	186.09	94.91
137	R-square	0.00	0.00	0.00	0.00	0.10	0.09	0.16	0.09
	White test	0.83	6.66	2.70	581.90	69.92	7.74	0.13	87.80
Small funds	log(TNA)	0.00367 **	-0.00074	0.00699	-0.00007	0.03492 ***	0.00184	0.07401 ***	0.00356
		(0.00187)	(0.00208)	(0.00485)	(0.00016)	(0.01036)	(0.00940)	(0.02002)	(0.00095)
No. Obser.	constant	-0.00488	-0.02465	-0.14838 *	-0.00043	-0.59942 ***	-0.13897	-1.30564 ***	-0.06375
951		(0.02751)	(0.03142)	(0.07588)	(0.00228)	(0.15750)	(0.14300)	(0.30440)	(0.01441)
No. Funds	F-statistic	1.98	0.06	1.92	0.07	102.63	92.13	182.59	95.87
137	R-square	0.00	0.00	0.00	0.00	0.10	0.09	0.16	0.09
	White test	0.64	3.09	3.69	943.01	51.59	4.39	43.55	79.81
Medium funds	log(TNA)	0.02528	0.03153	0.21015	-0.00738	0.14122	0.11132	0.36668	0.00748
		(0.09072)	(0.05042)	(0.19350)	(0.00848)	(0.11700)	(0.07194)	(0.23280)	(0.01133)
No. Obser.	constant	-0.31120	-0.66075	-3.72587	0.13881	-2.25396	-2.06686	-6.30439	-0.11792
27		(1.63100)	(0.89890)	(3.52500)	(0.15210)	(2.08400)	(1.28100)	(4.14500)	(0.20170)
No. Funds	F-statistic	0.04	0.12	0.79	0.31	9.57	6.85	15.42	8.25
9	R-square	0.00	0.00	0.03	0.01	0.28	0.22	0.38	0.25
	White test	2.05	0.70	0.19	20.14	1.57	0.12	0.55	1.88
Large funds	log(TNA)	-1.16163 **	0.00168	-1.52576 **	-0.08625 *	-0.89907 ***	0.04554 ***	-1.36709 ***	-0.06277 ***
		(0.26950)	(0.04502)	(0.16290)	(0.02409)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
No. Obser.	constant	22.84230 **	-0.09503	29.82420 **	1.69420 *	17.61770 ***	-0.96772 ***	26.66700 ***	1.22718 ***
4		(5.36300)	(0.89590)	(3.24100)	(0.47940)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
No. Funds	F-statistic	1.29	0.00	5.78	0.88	795.29	24.17	129.88	132.76
2	R-square	0.39	0.00	0.74	0.30	1.00	0.92	0.98	0.99
	White test	2.62	3.56	2.14	3.26	2.70	2.74	2.73	2.71

Panel C: Polish funds		pooled OLS				FEM			
		(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Sample	***Variables***	***Raw Return***	***Market-adjusted Return***	***Sharpe Ratio***	***Jensen's Alpha***	***Raw Return***	***Market-adjusted Return***	***Sharpe Ratio***	***Jensen's Alpha***
Total sample	log(TNA)	0.02329 ***	0.00820 ***	0.03643 ***	0.00071 ***	0.05764 ***	0.02647 ***	0.12131 ***	0.00231 ***
		(0.00286)	(0.00254)	(0.00593)	(0.00019)	(0.00876)	(0.00643)	(0.01572)	(0.00053)
No. Obser.	constant	-0.33631 ***	-0.14620 ***	-0.61161 ***	-0.01241	-0.87759 ***	-0.38449 ***	-2.02951	-0.03357 ***
1033		(0.04841)	(0.04249)	(0.10120)	(0.00323)	(0.13740)	(0.10080)	(0.24660)	(0.00829)
No. Funds	F-statistic	26.77	10.77	22.68	11.64	102.90	188.25	165.41	179.16
153	R-square	0.03	0.01	0.02	0.01	0.09	0.15	0.14	0.15
	White test	5.66	14.38	4.10	331.92	5.83	1.04	1.40	0.68
Small funds	log(TNA)	0.02610 ***	0.01250 ***	0.04367 ***	0.00096 ***	0.08174 ***	0.04074 ***	0.17279 ***	0.00366 ***
		(0.00535)	(0.00408)	(0.01039)	(0.00031)	(0.01121)	(0.00765)	(0.01858)	(0.00069)
No. Obser.	constant	-0.37775 ***	-0.21286 ***	-0.72133 ***	-0.01626 ***	-1.25549 ***	-0.60831 ***	-2.83679 ***	-0.05477 ***
748		(0.08527)	(0.06512)	(0.16750)	(0.00500)	(0.17570)	(0.12000)	(0.29130)	(0.01078)
No. Funds	F-statistic	13.34	8.71	12.52	7.10	125.54	183.38	184.53	172.26
149	R-square	0.02	0.01	0.02	0.01	0.14	0.20	0.20	0.19
	White test	4.01	2.80	1.54	718.56	1.65	1.71	15.09	2.18
Medium funds	log(TNA)	0.11060 ***	-0.00337	0.15652 **	0.00104	0.25547 ***	0.03839	0.34918 ***	0.00460 **
		(0.04253)	(0.02740)	(0.06215)	(0.00185)	(0.05848)	(0.03863)	(0.08498)	(0.00243)
No. Obser.	constant	-1.94256 **	0.06791	-2.81667 **	-0.01852	-4.54418 ***	-0.75328	-6.31676 ***	-0.08541 **
210		(0.78200)	(0.50500)	(1.14600)	(0.03426)	(1.05800)	(0.69870)	(1.53700)	(0.04394)
No. Funds	F-statistic	5.54	0.02	4.05	0.36	52.18	102.05	62.80	112.36
48	R-square	0.03	0.00	0.02	0.00	0.20	0.33	0.23	0.35
	White test	1.95	0.70	6.04	144.18	0.38	1.93	3.26	5.77
Large funds	log(TNA)	0.05620	0.01809	0.05972	0.00080	0.20359 ***	0.03656 ***	0.31500 ***	0.00335 ***
		(0.04607)	(0.01131)	(0.07165)	(0.00096)	(0.03607)	(0.01126)	(0.06631)	(0.00109)
No. Obser.	constant	-0.99607	-0.36161	-1.10555	-0.01536	-3.97314 ***	-0.73553 ***	-6.28595 ***	-0.06693 ***
75		(0.92270)	(0.22740)	(1.44100)	(0.01936)	(0.71970)	(0.22460)	(1.32300)	(0.02166)
No. Funds	F-statistic	1.17	1.28	0.54	0.41	15.93	78.83	19.45	63.99
20	R-square	0.02	0.02	0.01	0.01	0.18	0.52	0.21	0.47
	White test	0.71	2.94	2.05	62.96	2.19	3.86	9.15	4.78

The analysis shows that the estimated parameters of linear regression models in general became statistically significant for Czech, Hungarian and Polish mutual funds. The positive values of slope coefficients indicate a positive, though not always high, influence of fund size on performance in the total samples. The fixed effects regression, which is dedicated to panel data, provided much stronger results than the pooled ordinary least squares method. The empirical results were also different, depending on the measure of return used. Some of the strongest evidence confirming economies of scale was offered for Polish funds, especially by means of the Sharpe ratio. In this particular case, the values above 0.12 mean that an increase in the level of assets by circa 10% allows for achieving results higher by about 1.20%. The results obtained in total samples of Czech funds, but only for raw and market-adjusted returns, seem to be also relatively high in comparison to the average quantities (see tab. 1). The findings obtained through the remaining performance metrics, presented in the panels of Table 6, can be described with relatively lower values of regression parameters. In other words, the size of assets (e.g., Hungarian assets) has a weak but positive and statistically significant impact on their performance. For instance, with an increase in assets of Hungarian funds by about 10%, the mean raw return rises by about 0.38%. The models for Polish as well as Czech equity funds verified by the F-Snedecor test were statistically significant in all the cases concerning total samples. The evaluation of models for Hungarian funds gave similar results with the exception of models estimated by pooled OLS method, where market-adjusted return and Jensen's alpha served as endogenous variables. However, the obtained low values of the determination coefficient could suggest the lack of a model fit to the empirical data. It should be noted that a dependent variable is calculated as a kind of ratio or index, which means achieving standardized values and limited values of R^2.

The above conclusions about the total samples are generalized. A more detailed analysis, focusing on the impact of asset size on the performance of funds with comparable capital bases, will allow for answering the question whether there exists an interval of fund size that influences performance more significantly. The panels included in Table 6 inform about the parameters of the formula mentioned earlier for models that have been applied also to subsamples. The results obtained for small funds may largely explain the general findings mentioned above. The values of coefficients, the levels of significance and other parameters describing a given model are closely comparable among small funds and the total sample of Czech funds for both methods of estimations used, among Polish funds for the OLS method and among Hungarian funds for FEM regression. In other cases, there were some slight discrepancies. This means that the total samples were mainly dominated by small entities, and the results may be similar. Statistically significant evidence for positive dependence between the size of assets and performance among medium entities emerged only for Polish funds. Interestingly, the analyzed relation was generally stronger in the subsample than in small funds, which may suggest that Polish funds with a value of assets between EUR 50 million and EUR 200 million along with growing capital bases achieve increased returns more frequently than their competitors in the remaining subsamples (this conclusion is valid only for some performance metrics). A positive size-performance relationship exists also among Polish large funds, i.e., funds with an asset value above EUR 200 million, but has been recorded only for fixed effect regression. The results for Czech and Hungarian large funds should be treated carefully since they are based on an extremely low number of observations.

4.2. The analysis of Quadratic Relation between Fund Size and Performance

The second of the analysed hypotheses is that there exists a size of assets under management at which performance decreases or, to put it differently, at which the so-called erosion effect occurs. The phenomenon will be examined by means of a quadratic regression. Including the subsamples in the analysis will make it possible to determine whether the mentioned nonlinear relation exists in groups of funds with similar asset values. The results of polynomial regression models for all of the three analyzed markets are presented in Table 7.

Table 7 Quadratic regression models for the CEE mutual funds

Panel A: Czech funds		***pooled OLS***				***FEM***			
		(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Sample	***Variables***	***Raw Return***	***Market-adjusted Return***	***Sharpe Ratio***	***Jensen's Alpha***	***Raw Return***	***Market-adjusted Return***	***Sharpe Ratio***	***Jensen's Alpha***
Total sample	log(TNA)^2	-0.00056	-0.00189	0.00023	-0.00052 **	0.00438	-0.00771	-0.00278	-0.00056
		(0.00209)	(0.00296)	(0.00209)	(0.00025)	(0.00565)	(0.00807)	(0.00491)	(0.00040)
	log(TNA)	0.07079	0.12244	0.00792	0.02065 ***	-0.06236	0.35989	0.10177	0.02396 *
		(0.06470)	(0.09454)	(0.06223)	(0.00808)	(0.17890)	(0.26350)	(0.15130)	(0.01281)
No. Obser.	constant	-0.99953 **	-1.53787 **	-0.24635	-0.19765 ***	-0.21411	-3.79075 *	-0.98009	-0.24609 ***
336		(0.49660)	(0.75170)	(0.46230)	(0.06549)	(1.41600)	(2.13100)	(1.16300)	(0.10210)
No. Funds	F-statistic	18.84	33.63	5.96	44.16	30.13	80.62	59.69	90.46
44	R-square	0.10	0.17	0.03	0.21	0.15	0.33	0.26	0.35
	White test	16.02	16.04	1.47	47.39	16.23	33.75	1.54	107.52
Small funds	log(TNA)^2	-0.00074	-0.00388	0.00176	-0.00024	0.00883	-0.01054	0.00091	-0.00057
		(0.00295)	(0.00485)	(0.00263)	(0.00050)	(0.00791)	(0.01137)	(0.00254)	(0.00050)
	log(TNA)	0.07718	0.17962	-0.03735	0.01167	-0.19660	0.44593	-0.01216	0.02428
		(0.08684)	(0.14760)	(0.07597)	(0.01571)	(0.23690)	(0.36560)	(0.07923)	(0.01559)
No. Obser.	constant	-1.05349	-1.94404 *	0.08241	-0.12570	0.79675	-4.44219	-0.10318	-0.24824 **
295		(0.62900)	(1.11500)	(0.53940)	(0.12260)	(1.78100)	(2.91700)	(0.61690)	(0.12060)
No. Funds	F-statistic	15.95	24.92	5.34	33.75	28.31	75.55	51.27	85.38
41	R-square	0.10	0.15	0.04	0.19	0.16	0.34	0.26	0.37
	White test	10.41	7.08	1.35	34.06	11.99	33.38	1.36	124.29
Medium funds	log(TNA)^2	0.52526	0.35028 **	0.10973	0.02600 **	0.75827	0.44533 **	0.07774	0.02920 ***
		(0.36910)	(0.14290)	(0.08392)	(0.01240)	(0.47910)	(0.19460)	(0.05469)	(0.00960)
	log(TNA)	-19.26240	-12.87380 **	-4.10898	-0.95884 **	-27.74490	-16.31740 **	-2.82983	-1.07286 ***
		(13.55000)	(5.26700)	(3.10200)	(0.45780)	(17.59000)	(7.16000)	(2.00700)	(0.35450)
No. Obser.	constant	176.57500	118.29000 **	38.38480	8.83844 **	253.57600	149.32700 **	25.74140	9.84722 ***
35		(124.20000)	(48.48000)	(28.66000)	(4.22100)	(161.30000)	(65.78000)	(18.39000)	(3.26800)
No. Funds	F-statistic	1.42	1.63	1.15	2.54	5.10	22.02	521.98	21.22
12	R-square	0.08	0.09	0.07	0.14	0.24	0.58	0.97	0.57
	White test	3.39	3.09	5.76	7.05	4.43	3,65	5.33	5.62
Large funds	log(TNA)^2	107.49200 ***	85.44410 **	3.42467	4.75788 **	140.57100 ***	118.77900 ***	7.33212 ***	6.75528 ***
		(16.74000)	(16.28000)	(1.63500)	(1.03800)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
	log(TNA)	-4143.930 ***	-3294.220 **	-132.204	-183.391 **	-5418.830 ***	-4579.050 ***	-282.850 ***	-260.368 ***
		(645.1000)	(627.5000)	(63.0400)	(40.0000)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
No. Obser.	constant	39937.900 ***	31751.000 **	1275.850	1767.170 **	52221.200 ***	44130.900 ***	2727.790 ***	2508.780 ***
6		(6214.0000)	(6044.0000)	(607.6000)	(385.2000)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
No. Funds	F-statistic	7.79	5.45	1.89	4.44	18.71	16.13	81.25	14.11
3	R-square	0.84	0.78	0.56	0.75	0.93	0.91	0.98	0.90
	White test	1.91	1.10	2.83	1.63	5.01	5.31	5.72	4.73

Panel B: Hungarian funds		*pooled OLS*				*FEM*			
		(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Sample	***Variables***	***Raw Return***	***Market-adjusted Return***	***Sharpe Ratio***	***Jensen's Alpha***	***Raw Return***	***Market-adjusted Return***	***Sharpe Ratio***	***Jensen's Alpha***
Total sample	log(TNA)^2	0.00188 ***	-0.00031	0.00691 ***	0.00020 ***	0.00251	0.00021	0.00386	0.00026
		(0.00064)	(0.00074)	(0.00185)	(0.00001)	(0.00201)	(0.00195)	(0.00345)	(0.00018)
	log(TNA)	-0.04278 ***	0.00641	-0.16799 ***	-0.00497 ***	-0.03277	-0.00786	-0.03476	-0.00369
		(0.01621)	(0.01884)	(0.04576)	(0.00149)	(0.05957)	(0.05884)	(0.10310)	(0.00517)
No. Obser.	constant	0.26305 ***	-0.06281	0.88993 ***	0.02809 ***	-0.15158	-0.04097	-0.54357	-0.01376
982		(0.09778)	(0.11390)	(0.25870)	(0.00883)	(0.45210)	(0.45250)	(0.79080)	(0.03837)
No. Funds	F-statistic	4.79	0.18	11.00	3.17	55.04	45.78	93.70	48.64
137	R-square	0.01	0.00	0.02	0.01	0.10	0.09	0.16	0.09
	White test	1.33	8.91	4.73	7.98	26.58	11.43	19.84	23.14
Small funds	log(TNA)^2	0.00109	0.00014	0.00741 ***	0.00015 **	0.00164	0.00161	0.00435	0.00025
		(0.00079)	(0.00089)	(0.00231)	(0.00001)	(0.00231)	(0.00212)	(0.00393)	(0.00018)
	log(TNA)	-0.02392	-0.00417	-0.17970 ***	-0.00375 **	-0.01063	-0.04291	-0.04689	-0.00347
		(0.01971)	(0.02240)	(0.05651)	(0.00174)	(0.06663)	(0.06260)	(0.11340)	(0.00529)
No. Obser.	constant	0.15815	-0.00436	0.95471 ***	0.02131 **	-0.28629	0.16872	-0.47442	-0.01537
951		(0.11560)	(0.13190)	(0.31560)	(0.01007)	(0.49050)	(0.47010)	(0.84010)	(0.03903)
No. Funds	F-statistic	1.65	0.04	9.12	1.37	51.62	46.26	91.97	48.85
137	R-square	0.00	0.00	0.02	0.00	0.10	0.09	0.16	0.09
	White test	0.72	4.42	5.38	6.38	28.53	6.47	19.60	25.08
Medium funds	log(TNA)^2	0.49826 **	-0.02069	0.72014 *	0.04241	0.75019 *	-0.10112	1.04286 *	0.08230
		(0.22510)	(0.34700)	(0.37010)	(0.02606)	(0.42030)	(0.30540)	(0.56800)	(0.05778)
	log(TNA)	-18.16270 **	0.78674	-26.07700 *	-1.55558	-27.26930 *	3.80603	-37.73740 *	-2.99952
		(8.26700)	(12.70000)	(13.55000)	(0.95880)	(15.29000)	(11.18000)	(20.71000)	(2.10300)
No. Obser.	constant	165.58900 **	-7.54936	236.05000 *	14.26060	247.96300 *	-35.79400	341.52900 *	27.33140
27		(75.85000)	(116.10000)	(124.00000)	(8.81200)	(139.00000)	(102.30000)	(188.80000)	(19.12000)
No. Funds	F-statistic	0.73	0.06	0.76	0.57	7.08	3.35	8.96	6.24
9	R-square	0.06	0.00	0.06	0.05	0.37	0.22	0.43	0.34
	White test	9.19	1.58	3.83	10.58	8.55	2.07	3.25	9.88
Large funds	log(TNA)^2	-11.54560	-1.46516	-7.86217	-1.09071	-1.50364 ***	1.12157 ***	-3.53156 ***	-0.30821 ***
		(3.48000)	(0.89630)	(1.50100)	(0.27110)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
	log(TNA)	446.91900	56.86380	303.60200	42.24370	57.43290 ***	-43.46440 ***	135.63600 ***	11.89400 ***
		(135.00000)	(34.76000)	(58.20000)	(10.52000)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
No. Obser.	constant	-4324.360	-551.7620	-2930.480	-408.9840	-548.0680 ***	420.9790 ***	-1301.950 ***	-114.726 ***
4		(1308.0000)	(337.1000)	(564.3000)	(102.00000)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
No. Funds	F-statistic	2.46	0.31	14.03	2.96	n.a.	n.a.	n.a.	n.a.
2	R-square	0.83	0.39	0.97	0.86	1.00	1.00	1.00	1.00
	White test	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00

Panel C: Polish funds		pooled OLS				FEM			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	***Variables***	***Raw Return***	***Market-adjusted Return***	***Sharpe Ratio***	***Jensen's Alpha***	***Raw Return***	***Market-adjusted Return***	***Sharpe Ratio***	***Jensen's Alpha***
Total sample	log(TNA)^2	0,00032	-0.00165 *	-0.00108	-0.00011	-0.00396	-0.00507 ***	-0.01060 **	-0.00039 **
		(0.00132)	(0.00099)	(0.00242)	(0.00008)	(0.00275)	(0.00169)	(0.00476)	(0.00015)
	log(TNA)	0.01278	0.06286 *	0.07237	0.00441 *	0.18801 **	0.19358 ***	0.47047 ***	0.01503 ***
		(0.04465)	(0.03292)	(0.08206)	(0.00256)	(0.09057)	(0.05595)	(0.15580)	(0.00521)
No. Obser.	constant	-0.25017	-0.59396 **	-0.90597	-0.04276 **	-1.94841 ***	-1.75702 ***	-4.89739 ***	-0.13804 ***
1033		(0.37360)	(0.27330)	(0.69280)	(0.02126)	(0.74900)	(0.46600)	(1.28200)	(0.04424)
No. Funds	F-statistic	13.38	6.46	11.38	6.54	52.31	99.81	85.17	94.28
153	R-square	0.03	0.01	0.02	0.01	0.09	0.16	0.14	0.15
	White test	7.22	14.72	7.87	17.87	7.06	5.42	21.11	6.36
Small funds	log(TNA)^2	0.00170	-0.00061	0.00259	-0.00014	0.00289	-0.00273	0.00799	-0.00005
		(0.00388)	(0.00251)	(0.00694)	(0.00022)	(0.00694)	(0.00352)	(0.01165)	(0.00035)
	log(TNA)	-0.02640	0.03142	-0.03642	0.00539	-0.00715	0.12480	-0.07288	0.00531
		(0.11960)	(0.07694)	(0.21380)	(0.00666)	(0.21210)	(0.10840)	(0.35610)	(0.01088)
No. Obser.	constant	0.02449	-0.35780	-0.10767	-0.05023	-0.57293	-1.25374	-0.95029	-0.06746
748		(0.91590)	(0.58740)	(1.63800)	(0.05078)	(1.62300)	(0.83840)	(2.72600)	(0.08456)
No. Funds	F-statistic	6.73	4.38	6.31	3.74	62.82	91.95	92.53	86.03
149	R-square	0.02	0.01	0.02	0.01	0.14	0.20	0.20	0.19
	White test	11.61	3.27	6.72	1.38	7.32	1.53	9.12	2.35
Medium funds	log(TNA)^2	0.04990	0.05301	-0.01079	0.00272	0.04306	0.05696	0.02362	0.00207
		(0.09757)	(0.05306)	(0.14910)	(0.00390)	(0.13020)	(0.05525)	(0.19740)	(0.00385)
	log(TNA)	-1.72581	-1.95403	0.55373	-0.09887	-1.33016	-2.05917	-0.52051	-0.07149
		(3.57900)	(1.95100)	(5.47100)	(0.14320)	(4.78100)	(2.02600)	(7.24300)	(0.14060)
No. Obser.	constant	14.94460	18.00570	-6.46930	0.90029	10.04770	18.54960	1.68659	0.61482
210		(32.81000)	(17.92000)	(50.16000)	(1.31500)	(43.88000)	(18.57000)	(66.44000)	(1.28500)
No. Funds	F-statistic	2.84	0.40	2.01	0.36	26.02	51.44	31.25	56.07
48	R-square	0.03	0.00	0.02	0.00	0.20	0.33	0.23	0.35
	White test	2.19	2.54	6.77	6.19	0.35	2.59	3.55	6.75
Large funds	log(TNA)^2	0.07357	0.02927	0.13246	0.00313 **	0.01389	0.05473 ***	0.03010	0.00440 **
		(0.08052)	(0.01817)	(0.12920)	(0.00152)	(0.09699)	(0.01770)	(0.17070)	(0.00172)
	log(TNA)	-2.88872	-1.15361	-5.24279	-0.12469 **	-0.35224	-2.15423 ***	-0.88999	-0.17281 **
		(3.24900)	(0.73060)	(5.22000)	(0.06098)	(3.89900)	(0.71150)	(6.86600)	(0.06930)
No. Obser.	constant	28.44740	11.35320	51.90930	1.23926 **	1.58410	21.16830 ***	5.76166	1.69429 **
75		(32.75000)	(7.34200)	(52.68000)	(0.61130)	(39.15000)	(7.14300)	(69.00000)	(0.69650)
No. Funds	F-statistic	0.84	1.07	0.61	1.05	7.86	43.29	9.61	35.47
20	R-square	0.02	0.03	0.02	0.03	0.18	0.55	0.21	0.50
	White test	1.51	6.56	3.77	5.21	2.37	7.50	9.09	6.02

In contrast to the findings presented in section 4.1., the analysis of parabolic function provides equivocal conclusions. The results given in Table 7 reveal the statistical significance of regression parameters in models concerning total samples, observed only in a few cases where various measures of return were used as endogenous variables. The negative regression coefficient placed next to the second power of the independent variable for Polish funds may denote concavity of the function. However, the parabolic relation for Hungarian funds might be interpreted inversely. The disparate results are confirmed only partly and on the basis of different methods of estimations as well as dissimilar measures of return; therefore, they should be considered with caution.

The mentioned findings are not substantiated by the convexity analysis of the size-performance function conducted for the particular subsamples. The vast majority of regression coefficients for the analysed small funds (Polish, Czech and Hungarian ones) are statistically insignificant. The regression coefficients of statistical significance have been observed rarely, e.g., for small Hungarian funds, at low values of F-statistic and low level of model fit to the data (see values of R^2). The results obtained for medium Czech and Hungarian funds may partly indicate the U-shape of the parabola but only for market-adjusted return and Jensen's alphas in the case of Czech funds and for raw return and Sharpe ratio in the case of Hungarian funds. Hence, in this particular case, we note that the results may depend on the measures used (cf. e.g. Ding et al. 2009). The statistical significance of quadratic regression parameters noted in the sample of large Czech funds for both estimation methods (OLS and FEM) and in the sample of large Hungarian funds for the FEM method should be interpreted carefully due to the exceptionally small size of the samples and the limited number of observations. In general, any interpretation that refers to study samples comprising entities with comparable size of capital bases should be made with appropriate caution as the analysis of such samples might bring inconclusive results.

5. Conclusions

Fund size is one of the main organizational attributes of collective investment institutions. It reflects the market position of a fund and represents market acceptance as well as popularity in the form of asset growth. The growth in fund size, however, may be related to the increased frequency of purchases or sales of new securities, which generates higher costs, reduces benefits in less liquid markets and sometimes results in the loss of a fund's efficiency characteristics. The mentioned effect is defined as performance erosion. As noted in this paper, the analysis of the size-performance relationship is important for investors as well as mutual funds. Fund attributes such as size may influence investment decisions of individual investors, suggesting the possibility of outperforming. Moreover, collective investment institutions may use the fact of possessing appropriate attributes to gain competitive advantages.

The main aim of this paper was to examine if the performance of the mutual funds operated in the Czech Republic, Hungary and Poland was related to net asset value under management. The study focused on verifying the main hypotheses about the influence of asset size on performance in some groups of funds divided with regard to the scale of their functioning. This examination was possible by using the traditional linear regression approach and the methods for determining the suggested fund size for achieving the most effective performance. The next approach was the polynomial regression approach (the quadratic regression model), used for analysing the direction in which the size-performance function opens. The second hypothesis considered in this study was that there exists a particular size of assets under management at which performance decreases (performance erosion effect). The models contained endogenous variables including raw return, market-adjusted return, Sharpe ratio and Jensen's alpha. The methods for estimating the parameters were pooled ordinary least squares and least-squares dummy variables with fixed-effects for time-series cross-section data. The study analyzed equity funds operated in the Czech Republic, Hungary and Poland between the years 2000 and 2015.

The results obtained from linear regression analysis showed the existence of a slightly positive relationship between the size of assets and returns in all three analysed CEE markets. After restricting the study samples to entities with capital bases of similar size, it turned out that the general findings can be explained by the relations existing among small funds, which was proved by means of all four measures of return for Czech and Polish funds and partly for Hungarian ones. Some of the strongest evidence for economies of scale occurred in the case of Polish funds. In the consecutive subsamples consisting of medium and large Polish funds, the mentioned positive relation was persistent, though only partly. The findings correspond well with the conclusions by Białkowski and Otten (2011) confirming the existence of economies of scale in the operation of Polish financial intermediaries. The conclusions concerning large Czech and Hungarian funds should be drawn carefully due to the limited sample size.

In the analysis of the optimal fund size by quadratic regression model, most of the results were statistically insignificant. Hence, the conducted study brought evidence that was insufficient to confirm or reject the hypothesis about the optimal fund size. The positive influence of assets under management on fund performance suggests that mutual fund industries in the CEE countries are still in the developing phase; they are also likely to expand in size while maintaining efficiency. Accordingly, the performance erosion effect does not exist in the investigated markets. Hence, further studies are necessary to explore the existence of some economies of scale in the performance of mutual funds from the CEE countries.

Existing research capabilities did not make it possible to ring-fence subgroups of funds based on their investment style. Nevertheless, the obtained results justify a need for undertaking further studies in that area because of the prospective increase in the number of entities for analysis and possibilities to sufficiently isolate numerous and homogeneous subgroups of funds. Moreover, the relatively strong sensitivity of the obtained results to the applied measures, mentioned in the empirical section, should be investigated by means of other performance metrics (e.g., analysing managerial skills) based on multifactor models.

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