economies

MDPI

Article

Costs, Growth and Performance Persistence in Hungarian Equity Mutual Funds: A Quantile Panel Analysis

László Vancsura [1], Tibor Tatay [2,*], Tivadar Zakár [3] and Tibor Bareith [3,4,5]

1 Department of Marketing and Supply Chain Analytics, Institute of Agricultural and Food Economics, Hungarian University of Agriculture and Life Sciences, 7400 Kaposvár, Hungary; vancsura.laszlo@uni-mate.hu
2 Department of Statistics, Finances and Controlling, Széchenyi István University, 9026 Győr, Hungary
3 Doctoral School of Management and Business Administration, John von Neumann University, 1117 Budapest, Hungary; zakar.tivadar@hallgato.nje.hu (T.Z.); bareith.tibor@krtk.elte.hu or bareith.tibor@nje.hu (T.B.)
4 HUN-REN, Centre for Economic and Regional Studies, Institute of Economics, 1097 Budapest, Hungary
5 Economic Geography and Urban Marketing Centre, John von Neumann University, 1117 Budapest, Hungary
* Correspondence: tatay@sze.hu

Abstract

The value-creation capacity of active asset management remains one of the most debated issues within modern portfolio theory. While the relationship between costs and performance is typically negative in developed markets, in smaller and less liquid markets—where information asymmetry is more pronounced—higher fees may also be interpreted as signals of managerial ability. This study investigates this apparent contradiction in the context of the Hungarian equity mutual fund market, using a panel dataset covering 79 funds over the period 2017–2024, with a particular focus on identifying non-linear effects among performance determinants. The methodological framework combines fixed-effects panel regression with Driscoll-Kraay robust standard errors, complemented by quantile regression estimates to examine different segments of the return and alpha distributions. The results indicate that growth dynamics (NAV_change) and cumulative historical performance (Yield_from_start) consistently enhance fund performance, while the negative effect of past returns suggests the dominance of mean reversion. The impact of the total expense ratio (TER) proves to be non-linear and specification-dependent—a finding con-firmed by an extensive battery of robustness checks—thereby rejecting the cost-signalling hypothesis with respect to risk-adjusted excess returns (Jensen's alpha). Quantile estimates further reveal that the effects of economies of scale and cost structure differ significantly between underperforming and top-performing funds, confirming that analyses based on average effects obscure the heterogeneity of market dynamics. By jointly modelling returns and risk-adjusted performance across the full conditional distribution, the study contributes a distribution-sensitive theoretical account of active management's limitations in a small, less liquid market, showing that these limitations are conditional on fund size and cost structure rather than uniform across the fund population.

Keywords: equity funds; TER; panel econometrics; quantile regression; Hungarian markets

Academic Editor: Robert Czudaj

Received: 8 July 2026
Revised: 30 July 2026
Accepted: 10 August 2026
Published: 24 August 2026

1. Introduction

The analysis of mutual fund performance constitutes a central area of research within financial economics, holding fundamental importance for the efficiency of capital allocation, investor welfare, and the functioning of the financial intermediation system. Whether fund managers are capable of consistently generating excess returns has long been a defining question in both the academic literature and practical investment decision-making. Classical empirical findings suggest that active fund management does not, on average, produce persistent positive risk-adjusted performance (Jensen, 1968; Fama & French, 2010), particularly after accounting for costs (Carhart, 1997). At the same time, more recent empirical research presents a more nuanced picture. An increasing body of evidence indicates that mutual fund performance exhibits substantial heterogeneity, and that analyses based on average effects may obscure differences across various segments of the performance distribution (Revelli & Viviani, 2015; Kacperczyk et al., 2016). The most recent studies suggest that the determinants of performance—such as past returns, fund ratings, or capital flows—affect underperforming and outperforming funds differently, and that short-term return persistence may be observed in certain cases (Ben-David et al., 2024; Brown & Davies, 2024). Furthermore, recent findings indicate that highly rated funds may deliver significantly superior performance in the short term, even if long-term persistence remains inconclusive (Song, 2020; Aasheim et al., 2022). The majority of the international literature, however, focuses on developed markets, while the specific operating mechanisms of emerging markets are receiving increasing attention. Recent research highlights that information asymmetries, lower liquidity, and weaker institutional environments in emerging markets may generate market inefficiencies that can, under certain conditions, favour active management (Lemeunier, 2021). According to these findings, for instance, the performance of smaller funds tends to be more sensitive to liquidity factors, and in some cases positive abnormal returns can be identified in emerging market environments.

Empirical evidence on emerging markets remains, however, far from uniform. Some studies suggest that average performance underperforms benchmarks, particularly over longer time horizons, while short-term performance differences are primarily driven by the weak results of underperforming funds (Charteris et al., 2025). Other research emphasises that investor behaviour—such as return-chasing or the "smart money" effect—also plays a significant role in shaping fund performance (Zhang et al., 2024). Overall, the determinants of performance in emerging markets are more complex and more strongly context-dependent. The Central and Eastern European (CEE) region provides a particularly relevant research setting in this regard. Markets in the region are smaller, less liquid, and more exposed to external shocks; however, owing to higher growth potential and lower levels of market efficiency, the role and performance of mutual funds may differ from patterns observed in developed markets. Previous empirical studies indicate that investment funds operating in emerging economies often exhibit distinct return dynamics and diversification benefits compared to those in developed markets (Letho et al., 2022; Shaekh et al., 2024).

The Hungarian mutual fund market has undergone significant development over the past decade; nevertheless, comprehensive analyses of performance determinants employing modern econometric techniques remain limited (Vancsura & Bareith, 2025). In particular, there is a scarcity of studies that jointly examine returns, risk-adjusted performance, and their distributional heterogeneity within the context of a small open emerging economy. The present study aims to empirically identify the key determinants of the performance of Hungarian equity mutual funds, with particular emphasis on annual returns and risk-adjusted performance, measured by Jensen's alpha within the CAPM framework (Jensen, 1968).

The analysis is based on a panel dataset covering 79 funds over the period 2017–2024, enabling the simultaneous examination of individual heterogeneity and temporal dynamics. The methodological contribution of the study lies in complementing traditional panel econometric models with a quantile regression approach (Koenker & Bassett, 1978). This approach allows for the identification of how the effects of explanatory variables differ across various points of the performance distribution, which is particularly relevant in the presence of non-normal and asymmetric return distributions.

The study seeks to address the following research questions:

- Is heterogeneity observable in the effects of explanatory variables across different segments of the performance distribution?
- How do fund-specific characteristics influence performance in an emerging market environment characterised by high friction costs?
- Is there a significant difference in the impact of costs (TER) and economies of scale between underperforming and top-performing funds?

The study contributes to the literature in several respects. First, it provides new empirical evidence from an under-researched Central and Eastern European market, addressing the scarcity of studies that jointly examine returns, risk-adjusted performance, and their distributional heterogeneity in a small, less liquid emerging economy. Second, from a methodological perspective, it integrates the toolkits of panel econometrics and quantile regression, and validates the resulting inferences through an extensive set of robustness checks applied consistently across both frameworks. Third, and most importantly from a theoretical standpoint, by jointly examining returns and risk-adjusted performance across the conditional distribution, the study advances a distribution-sensitive account of the limits of active management: rather than treating the cost-performance relationship as a single average effect, it demonstrates that this relationship is conditional on fund size and on a fund's position within the performance distribution, refining the cost-signalling hypothesis for smaller, less liquid markets. The findings are relevant not only from a theoretical perspective but also carry practical implications. For investors, they may support more informed portfolio allocation decisions, while for fund managers they provide guidance in identifying the key drivers of performance. More broadly, the research contributes to a better understanding of the functioning and efficiency of the financial intermediation system in a small, open emerging economy.

2. Literature Review

The analysis of mutual fund performance represents one of the most intensively researched areas within financial economics, evolving along several interrelated dimensions: the measurement of risk-adjusted performance, the identification of fund-specific determinants of performance, the examination of performance persistence, and, more recently, the exploration of non-linear and heterogeneous effects. The present study is situated at the intersection of these strands of the literature, with particular emphasis on the specific characteristics of the Central and Eastern European region.

2.1. Risk-Adjusted Performance Measurement

The recent empirical literature increasingly addresses the interpretation of mutual fund performance by emphasising the distinction between active and passive components. Traditional alpha-based approaches often fail to fully disentangle value creation arising from managerial decisions from passive returns driven by portfolio composition (Matallín-Sáez & de Mingo-López, 2024). Such approaches suggest that active trading activity does not necessarily lead to positive abnormal performance in the short term; indeed, in some cases a negative relationship can be observed between the intensity of active management and alpha. With the expansion of the set of performance determinants, growing attention has been directed towards the organisational and behavioural aspects of fund management decision-making. Recent studies indicate that the external assets managed by fund managers—namely, parallel management responsibilities in other funds or portfolios—may exert a significantly negative effect on the performance of a given fund. This effect operates through the so-called "attention constraint" mechanism, according to which the division of managerial capacity reduces the information-processing and decision-making resources allocated to individual funds (Evans et al., 2024). The findings suggest that managing non-overlapping assets has a particularly strong negative impact, supporting the view that performance deterioration stems primarily from attention allocation constraints rather than portfolio synergies. This effect may be especially pronounced in emerging markets, where shortages of human capital are more prevalent. As a consequence, this phenomenon introduces a structural inefficiency, effectively embedding underperformance within the system. In parallel, the growing prominence of passive investment vehicles—particularly the increasing dominance of index-tracking funds and exchange-traded funds (ETFs)—places the evaluation of active management performance into a new perspective. Owing to their low cost structures and transparency, passive strategies serve as increasingly stringent benchmarks for active funds, while global capital market trends indicate a rapid expansion in the share of passive assets, especially in developed markets (Joshi & Dash, 2024). This trend not only reshapes the competitive environment but also affects the methodology of performance evaluation, as cost efficiency and relative performance are becoming increasingly important alongside traditional alpha-based measures. The classical approach to evaluating mutual fund performance is based on the application of risk-adjusted metrics. Jensen's alpha, interpreted within the CAPM framework, remains one of the most widely used indicators, capturing excess returns generated by fund managers while accounting for market risk. The majority of the international empirical literature concludes that active management does not, on average, produce persistent positive alpha, particularly after accounting for costs (Ajadi, 2024). Recognising the limitations of the CAPM, some studies have employed multifactor models—such as Fama–French and Carhart-type specifications—which more accurately capture cross-sectional variation in returns. However, a substantial body of research indicates that even these models are unable to fully disentangle managerial skill from market exposures, especially in smaller and less liquid markets (Chahuán-Jiménez et al., 2025; Ji, 2020).

Taken together, these findings suggest that the interpretation of mutual fund performance increasingly requires a multidimensional framework, in which active management, organisational structure, and the dynamic interactions of market conditions jointly determine achievable returns. This is particularly relevant in emerging and smaller markets, where liquidity constraints, institutional concentration, and limitations in managerial resources may exert a more pronounced influence on performance outcomes.

2.2. Determinants of Performance

A substantial part of the literature focuses on the empirical identification of factors influencing mutual fund performance. One of the most frequently examined variables is the cost level, typically measured by the Total Expense Ratio (TER). The majority of empirical findings identify a negative relationship between costs and net returns, which is consistent with the theoretical expectation that higher fees reduce the returns These divergent findings are not merely inconsistent but appear to be systematically related to context: studies reporting a negative cost-return relationship typically rely on developed-market samples with high fund-market competition and benchmark-hugging incentives, whereas the positive cost-performance association reported by Sheng et al. (2023) emerges specifically in less efficient, less liquid market segments where active management has more scope to add value net of fees. Similarly, the mixed evidence on fund size is best reconciled not by treating it as contradictory but as evidence of a genuinely non-monotonic relationship, in which the economies-of-scale advantage documented by Adams et al. (2022) dominates at small-to-medium fund sizes while the liquidity constraints identified by

Shaekh et al. (2024) dominate beyond a certain size threshold—a pattern that average-effect regression models are structurally unable to detect, and which motivates the quantile-based approach adopted in this study. Realised by investors (Livingston et al., 2019; Mansor et al., 2015; Sofi & Yahya, 2020). At the same time, some studies suggest that in certain market segments higher costs may be associated with a greater degree of active management and potentially superior gross performance (Sheng et al., 2023). Fund size (assets under management) also represents a key determinant. Through economies of scale and related scale effects, larger funds may achieve lower cost levels (Adams et al., 2022); however, excessive size may lead to liquidity constraints and reduced flexibility (Shaekh et al., 2024). Empirical findings in this regard are mixed, suggesting that the effect of size may be non-linear. The literature examining the role of past performance primarily focuses on the issue of performance persistence. Although a certain degree of persistence can be observed in the short term, longer-term results tend to support the efficient market hypothesis, according to which past returns have limited predictive power with respect to future performance.

2.3. Heterogeneity and Nonlinearity

Traditional regression models typically estimate average effects, which may obscure differences arising at various points of the performance distribution. In response to these limitations, quantile regression has gained increasing prominence in financial analysis. The original model of Koenker and Bassett (1978), for instance, demonstrated that parameter estimates may differ substantially at the median and at extreme quantiles, which is particularly relevant in heterogeneous samples. In the development of panel quantile regression, Galvao (2011) showed that, within a dynamic panel framework, quantile-based estimates provide a more stable representation of heterogeneous effects. Empirical findings indicate that the impact of explanatory variables systematically varies across the distribution. Based on an analysis of more than 3000 US mutual funds, Fama and French (2010) found that a large proportion of alpha in the upper performance quantiles is not statistically significant, highlighting the role of luck. In contrast, Cremers and Petajisto (2009), using the so-called "active share" measure, demonstrated that the most actively managed funds achieve average excess returns of approximately 1.3–1.5 per cent per annum in the upper quantiles. This suggests that different mechanisms operate at the tails of the performance distribution, and that the effects of costs or strategies are non-linear. The application of panel data allows for the treatment of individual heterogeneity; however, the complexity of the error structure poses a significant challenge. Powell (2016) showed that ignoring non-additive fixed effects may bias quantile regression estimates, particularly in heterogeneous samples. Furthermore, Kim and White (2004) demonstrated that the kurtosis and skewness of financial returns deviate substantially from the normal distribution, thereby justifying the use of robust estimation methods. Accordingly, the methodological literature increasingly advocates the application of robust estimation procedures. Simulation results by Driscoll and Kraay (1998) indicate that conventional standard errors may underestimate variance by up to 40 per cent in the presence of cross-sectional dependence. Through empirical applications, Hoechle (2007) demonstrated that the use of the Driscoll-Kraay correction yields more stable and consistent results, particularly in panel structures characterised by short time dimensions (T) and large cross-sectional units (N). This approach is therefore essential for the reliable estimation of mutual fund performance.

2.4. Research Gap and Contribution

Based on the above literature review, several research gaps can be identified. First, empirical analysis of the Central and Eastern European region—and particularly the Hungarian market—remains limited. Second, relatively few studies employ multiple, complementary methodological approaches simultaneously in the analysis of mutual fund performance. Third, the joint examination of returns and risk-adjusted performance, especially within a quantile framework, is also underdeveloped. The present study addresses these gaps by analysing the performance of Hungarian equity mutual funds within an integrated methodological framework that combines panel econometric models with quantile regression. In doing so, it not only provides new empirical evidence but also contributes to a more comprehensive and nuanced understanding of mutual fund performance.

Theoretically, the contribution of this study lies in refining the cost-signalling hypothesis of active management. While the existing literature typically evaluates the cost–performance relationship as a single, distribution-averaged effect (Livingston et al., 2019; Mansor et al., 2015), the present analysis shows that this relationship is heterogeneous both across the performance distribution and across performance metrics: it is more pronounced among underperforming funds and largely disappears among top-performing funds, and it diverges depending on whether performance is measured in raw or risk-adjusted terms. This distribution-sensitive perspective extends the information-asymmetry framework proposed by Lemeunier (2021) and the attention-constraint mechanism identified by Evans et al. (2024) by specifying the conditions—fund size, cost level, and position within the performance distribution—under which these mechanisms are more or less likely to bind.

3. Methodology

3.1. Data

The analysis focuses specifically on equity mutual funds rather than the full universe of Hungarian investment funds. Equity funds were selected for three reasons. First, they represent the largest and most actively benchmarked segment of the Hungarian retail fund market, making them the most policy-relevant category for questions of cost efficiency and active management value creation. Second, restricting the sample to a single, homogeneous asset class ensures a consistent risk-return benchmark: computing Jensen's alpha via the CAPM requires a well-defined market portfolio, and mixing equity funds with flexible, mixed, or bond funds—which differ substantially in their equity exposure and benchmark sensitivity—would confound the interpretation of alpha across the sample. Third, equity funds exhibit the highest cross-sectional variation in both TER and realised returns among Hungarian fund categories, which is a methodological precondition for identifying non-linear, quantile-dependent effects with adequate statistical power. The empirical analysis is based on a panel dataset of Hungarian equity mutual funds. The sample comprises a total of 79 publicly available funds, for which annual frequency data are available over the period 2017–2024. The panel is balanced, resulting in a total of 632 observations.

Descriptive statistics indicate (Table 1) substantial dispersion in the returns of Hungarian equity funds. The average annual return is 9.24%; however, the high standard deviation (16.77%), along with extreme values ranging from −43.04% to 117.01%, points to significant heterogeneity. Skewness is positive (0.54), while kurtosis (6.21) exceeds that of the normal distribution, indicating fat tails and frequent extreme observations. A similar pattern is observed in the case of Jensen's alpha. The average value is 1.36%, yet the standard deviation (13.77%) and high kurtosis (8.25) suggest that risk-adjusted performance is also highly volatile and that its distribution deviates markedly from normality. The positive skewness (1.21) indicates that exceptionally high alpha values occur more frequently than extreme negative ones. Among the explanatory variables, particularly strong distortions are observed in NAV-related indicators. NAV_actual_year (skewness = 4.54; kurtosis = 34.26) and especially NAV_change (skewness = 10.96; kurtosis = 186.52) exhibit extreme distributional characteristics, indicating the presence of substantial outliers. In contrast, fund age (Age_in_months) follows an approximately symmetric distribution (skewness = 0.37), with kurtosis (2.28) close to that of a normal distribution. The cost measure (TER) appears relatively stable, with an average value of 2.01%, low dispersion (0.54%), and a near-symmetric distribution (skewness = 0.10), although kurtosis (5.07) still indicates a certain degree of peakedness. Overall, the descriptive statistics suggest that most of the examined variables are not normally distributed and, in several cases, exhibit substantial skewness and extreme values. This justifies the application of robust estimation techniques and a quantile regression approach in the empirical analysis.

Table 1. Descriptive statistics of the examined equity investment funds for the period between 2017 and 2024.

Variable	N	Mean	StD	Min	Max	Skewness	Kurtosis
Annual_yield	632	9.2426	16.7690	−43.0400	117.0100	0.5369	6.2051
Jensen_alpha	632	1.3615	13.7674	−43.5257	91.0537	1.2114	8.2504
NAV_actual_year	632	5.5258	8.6583	0.0072	100.7602	4.5378	34.2649
NAV_change	632	0.2823	0.9827	−0.9412	18.3702	10.9552	186.5192
Previous_yield	632	7.9144	16.2923	−43.0400	117.0100	0.7466	7.0595
Yield_from_start	632	4.5074	4.2073	−8.8500	33.6500	1.3480	10.5260
Age_in_months	632	179.5016	73.116	26.0000	372.0000	0.3727	2.2849
TER	632	2.0137	0.5365	0.5061	4.2471	0.1041	5.0697

Source: authors' research.

No adjustment for outliers was performed, which constitutes a deliberate methodological decision. On the one hand, mutual fund returns inherently exhibit considerable fluctuations, particularly during turbulent market periods; therefore, extreme observations form an integral part of the phenomenon under investigation rather than representing measurement errors or distortive anomalies. On the other hand, the removal of extreme values would entail a potential loss of information, especially in the analysis of the upper and lower segments of the performance distribution, which are of particular relevance from an investor perspective. The quantile regression framework employed in this study is inherently robust to the presence of extreme values, as it does not estimate average effects but instead focuses on different points of the distribution. As a result, the estimates are not substantially biased by extreme observations, while their informational content is preserved. Similarly, the use of robust standard errors in the panel models further mitigates the risk of potential bias. Overall, retaining extreme values is not only justified but also contributes to a more accurate and nuanced representation of real market dynamics.

The data are drawn from multiple sources. Information on net asset value (NAV), returns, and costs was compiled from databases specialising in Hungarian mutual funds (Hungarian National Bank and the Association of Hungarian Investment Fund and Asset Management Companies (BAMOSZ)), while market risk indicators (e.g., beta) were calculated relative to the benchmark index of the Hungarian equity market (BUX). The sample includes exclusively equity funds, ensuring relatively homogeneous investment strategies and enabling the application of CAPM-based performance measures.

3.2. Variables

Two dependent variables were employed in the analysis:

- Annual_yield: the annual return of the fund (%), capturing nominal performance.
- Jensen_alpha: the CAPM-based risk-adjusted performance measure, expressing the fund's excess return relative to market risk.

Jensen's alpha was calculated as follows:

$$\alpha_i = R_i - \left(R_f + \beta_i\left(R_m - R_f\right)\right) \tag{1}$$

where R_i denotes the return of the fund, R_f the risk-free rate, R_m the market return, and β_i the market risk of the given fund.

The empirical model includes the following main explanatory variables:

- NAV_actual_year: the net asset value of the fund in a given year (proxy for size)
- NAV_change: the change in net asset value (growth dynamics)
- Previous_yield: the return in the previous year
- Yield_from_start: cumulative return since inception
- Age_in_months: the age of the fund in months
- TER (Total Expense Ratio): the annual cost indicator of the fund

Additional specifications include:

- L.TER: the lagged value of the cost indicator
- Interaction terms (e.g., TER × NAV, TER × Age), capturing the heterogeneity in the effect of costs

No multicollinearity issues are detected among the variables.

3.3. Panel Regression Model

The empirical analysis is based on a linear panel regression model, which allows for the simultaneous treatment of individual (fund-specific) effects and temporal dynamics. The general form of the estimated model is as follows:

$$Y_{it} = \beta X_{it} + \mu_i + \varepsilon_{it} \tag{2}$$

where Y_{it} denotes the performance measure of fund i in period t, X_{it} represents the vector of explanatory variables, μ_i captures time-invariant unobserved individual effects, and ε_{it} is the stochastic error term. A key issue in panel modelling concerns the treatment of individual effects. The choice between fixed-effects (FE) and random-effects (RE) specifications was determined on the basis of the Hausman test.

3.4. Diagnostic Tests and Robust Estimation

A fundamental requirement for the reliability of panel regression models is the validity of classical assumptions. However, in the case of financial panel data, these assumptions are frequently violated, necessitating the application of multiple diagnostic tests. First, heteroskedasticity is examined, assessing whether the variance of the error term is homogeneous across panels. For this purpose, the modified Wald test is employed, which is particularly suitable for detecting groupwise heteroskedasticity in panel structures. Second, the presence of autocorrelation is tested. The Jochmans portmanteau test evaluates temporal dependence in the error terms and is capable of detecting higher-order serial correlation. Third, cross-sectional dependence is examined, assessing whether the error terms of individual cross-sectional units (in this case, mutual funds) are independent of one another. The Pesaran CD test is a widely used procedure for this purpose, particularly in financial contexts where common macroeconomic shocks or market factors may simultaneously affect all observations. The importance of these diagnostic tests lies in the fact that conventional standard errors may be biased and inconsistent under such conditions. The integrated nature of financial panel data—where movements in the BUX index or common macroeconomic shocks affect all funds simultaneously—renders the rigorous treatment of cross-sectional dependence indispensable. Based on simulation evidence by Driscoll and Kraay (1998), conventional standard errors may underestimate variance by up to 40 per cent in such environments, potentially leading to spurious statistical significance and incorrect inferences. For this reason, the study employs Driscoll–Kraay robust standard errors, which, according to the literature, provide a consistent approach for simultaneously correcting for heteroskedasticity, autocorrelation, and spatial dependence. This approach ensures that the estimated coefficients remain reliable even in panel structures characterised by short time dimensions and large cross-sectional units (large N, small T).

It should be noted that the asymptotic properties of the Driscoll–Kraay estimator are formally derived for panels with a large time dimension, whereas the present sample spans only eight annual periods (T = 8). While Driscoll–Kraay standard errors remain a defensible choice given the pronounced cross-sectional dependence documented above, the short time dimension warrants caution in interpreting exact significance levels. To address this concern, Section 4.5 reports two additional checks: two-way clustered standard errors (by fund and year), which impose weaker asymptotic requirements on T, and a specification with explicit year fixed effects. The results show that the study's core findings—the positive effects of NAV_change and Yield_from_start and the negative effect of Previous_yield—are unaffected by this choice, whereas the significance of the TER coefficient is sensitive to it, a pattern discussed in de-tail in Sections 4.5 and 5.

3.5. Stationarity and Cointegration

The examination of the time-series properties of the panel is essential for ensuring the validity of the empirical results. In this context, unit root and cointegration tests are applied. To test for the presence of unit roots, Fisher-type panel unit root tests are employed, which combine the results of individual tests conducted on each cross-sectional unit. These tests allow for the determination of whether the variables under consideration are stationary or contain unit roots, which could otherwise lead to spurious regression results. If certain variables are found to be non-stationary, the existence of long-run relationships is examined using panel cointegration tests. The Kao test assumes a homogeneous cointegrating vector and is suitable for assessing whether a stable long-run equilibrium relationship exists among non-stationary variables. The methodological role of these tests is twofold: on the one hand, they ensure that the model specification does not result in spurious regression; on the other hand, they allow for the determination of whether differencing of variables is required or whether estimation in levels is justified.

3.6. Quantile Regression

Traditional panel regression approaches primarily estimate average effects and are therefore limited in their ability to capture heterogeneity across the performance distribution. In the case of mutual funds, however, returns and risk-adjusted performance often exhibit strongly asymmetric and heavy-tailed distributions, which justifies the application of methods that examine the impact of explanatory variables at different points of the distribution. Accordingly, the study employs a quantile regression framework based on the methodology introduced by Koenker and Bassett (1978).

Quantile regression allows for parameter estimation at different quantiles of the conditional distribution of the dependent variable, thereby providing a more detailed understanding of the relationships under investigation compared to conventional OLS-based approaches. This is particularly important in the analysis of mutual fund performance, where underperforming and top-performing funds may follow distinct dynamics (Abdelsalam et al., 2014; Matallín-Sáez et al., 2019; Duong & Meschke, 2020; Ahmed & Doukas, 2021; Agoraki et al., 2023; Paudel & Naka, 2023). An additional advantage of the method is that it does not require strict distributional assumptions regarding the error term, making it more robust to extreme observations. Which is an important consideration in financial data.

Formally, quantile regression specifies the conditional quantile function as follows:

$$Q_\tau(Y_{it} \mid X_{it}) \ = \ \beta_\tau X_{it}, \tau \in (0,1) \tag{3}$$

where τ denotes the quantile level, Y_{it} is the dependent variable (return or Jensen's alpha), and X_{it} is the vector of explanatory variables. The parameters are quantile-specific, meaning that β_τ may take different values across different points of the distribution.

Estimation involves solving the following optimisation problem:

$$\min_{\beta_\tau \in \mathbb{R}^p} \sum_{t\,=\,1}^{T} \rho_\tau\left(Y_{it} - X_{it}'\beta_\tau\right) \tag{4}$$

where the loss function is the so-called "check" or Pinball Loss function:

$$\rho_\tau(u) \ = \ u \cdot (\tau - \mathbb{I}(u < 0)) \tag{5}$$

This asymmetric penalty structure ensures that the model treats positive and negative deviations differently, thereby directly optimising the estimation of conditional quantiles. In contrast, OLS relies on the minimisation of squared loss, making it more sensitive to extreme values.

The analysis considers multiple quantiles (τ = 0.1, 0.2, …, 0.9), allowing for the simultaneous examination of the lower, central, and upper regions of the performance distribution. This is particularly relevant in the context of mutual funds, where the impact of costs (e.g., TER) may differ between underperforming and top-performing funds. In this way, quantile regression contributes to uncovering performance heterogeneity and provides valuable insights from a risk management perspective (Eissa et al., 2024).

To enhance the robustness of the estimates, a bootstrap procedure (with 1000 replications) is applied to compute standard errors, which is particularly appropriate in small-sample and heteroskedastic environments.

4. Results

4.1. Exploratory Data Analysis

Figure 1 illustrates the relationship between the total expense ratio (TER) and annual returns (Annual_yield) in the form of a scatter plot, providing important complementary visual evidence for the interpretation of the econometric results. Based on the distribution of observations, it can first be noted that TER values are concentrated within a relatively narrow range, typically between 1 and 3 per cent, which is consistent with the low dispersion reported in the descriptive statistics. In contrast, annual returns exhibit substantial variability, spanning a wide interval (approximately −43 per cent to 117 per cent), reflecting the inherent volatility of fund performance. The structure of the point cloud does not indicate a clear linear relationship between TER and returns. Most observations are dispersed horizontally, suggesting that similar levels of returns can be observed across different cost levels. This visual pattern is consistent with the regression results, which indicate that the effect of TER is not stable or statistically significant across all specifications. At the same time, certain more subtle patterns can be identified. Observations corresponding to higher returns (particularly above 50 per cent) are relatively sparse and do not cluster clearly around either low or high TER values, implying that exceptional performance cannot be directly attributed to the level of costs. Moreover, a number of extreme observations appear in both the return and TER dimensions, further justifying the application of robust and quantile-based methods in subsequent analyses. Overall, the scatter plot suggests that the relationship between costs and returns cannot be adequately described as a simple linear association, but is instead likely driven by more complex, potentially non-linear mechanisms. This supports the relevance of the methodological approach adopted in the study, particularly the use of quantile regression, which is capable of capturing such complex patterns.

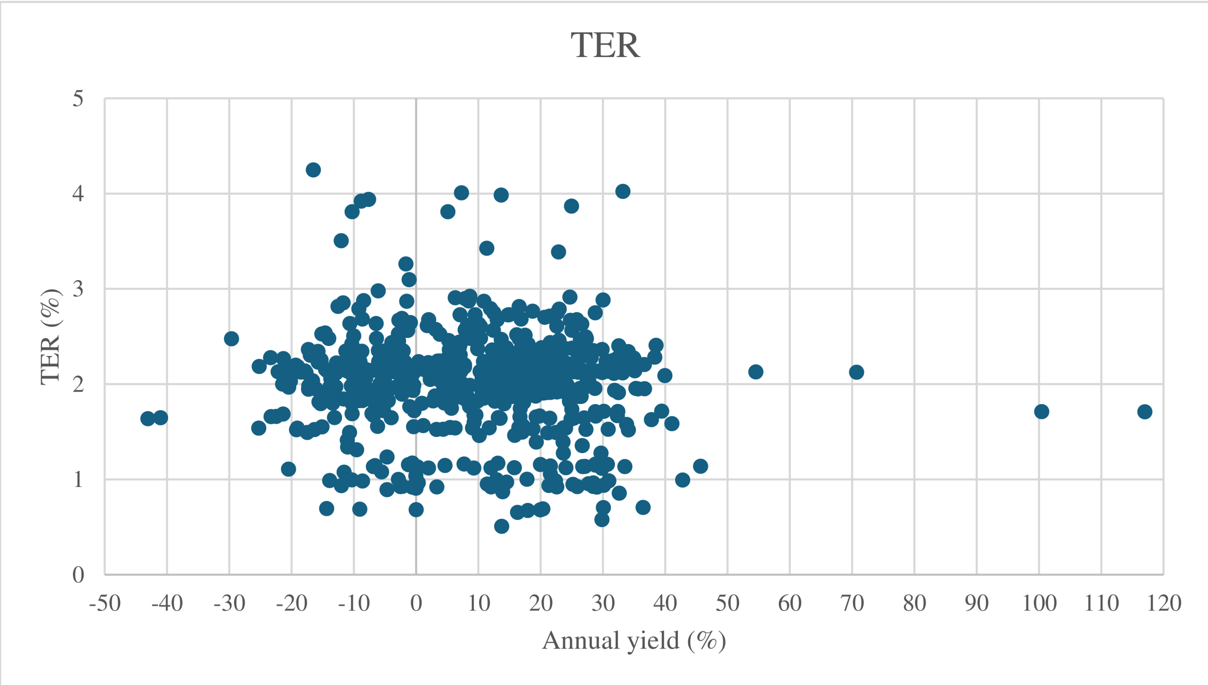

Figure 1. Relationship between annual yield and total expense ratio (TER). Source: authors' research.

Figure 2 presents the distribution of annual returns in the form of boxplots for each year over the analysed period (2017–2024), allowing for a comparative assessment of the temporal dynamics and volatility of performance. The evolution of median values clearly reveals the cyclical nature of returns. The year 2017 is characterised by a moderate, positive median, followed by a marked decline in 2018, with a negative median return and a relatively narrow interquartile range. This period may reflect the impact of market corrections. Subsequently, a significant improvement is observed in 2019: the median return increases substantially and the upper range of the distribution expands, indicating a favourable market environment. The year 2020 is characterised by exceptionally high volatility. The wide interquartile range and the presence of extreme values suggest that fund performance was highly differentiated, consistent with the turbulence observed in global financial markets. In 2021, returns become more stable again, with a higher median, although dispersion remains considerable. The year 2022 is again characterised by a negative median and a relatively narrower distribution, indicating a general market downturn. At the same time, the presence of upper outliers suggests that certain funds were able to achieve outstanding performance even in an unfavourable environment. In 2023 and 2024, returns return to positive territory, medians increase, and the distribution becomes more balanced, which may indicate a partial consolidation of markets. A further important feature of the figure is the consistent presence of outliers in almost every year. These are particularly pronounced in the positive range, suggesting that certain funds periodically achieve exceptionally high returns. This phenomenon reinforces the assumption that the return distribution is asymmetric and characterised by fat tails, which is also supported by the previously reported skewness and kurtosis measures. Overall, the boxplot indicates that the returns of Hungarian equity mutual funds exhibit substantial temporal variability and heterogeneity. The distribution of returns varies from year to year, reflecting both cyclical effects of the macroeconomic and market environment and differences in fund manager performance. This heterogeneity justifies the application of quantile regression, as average effects alone are insufficient to capture variations across different segments of the distribution.

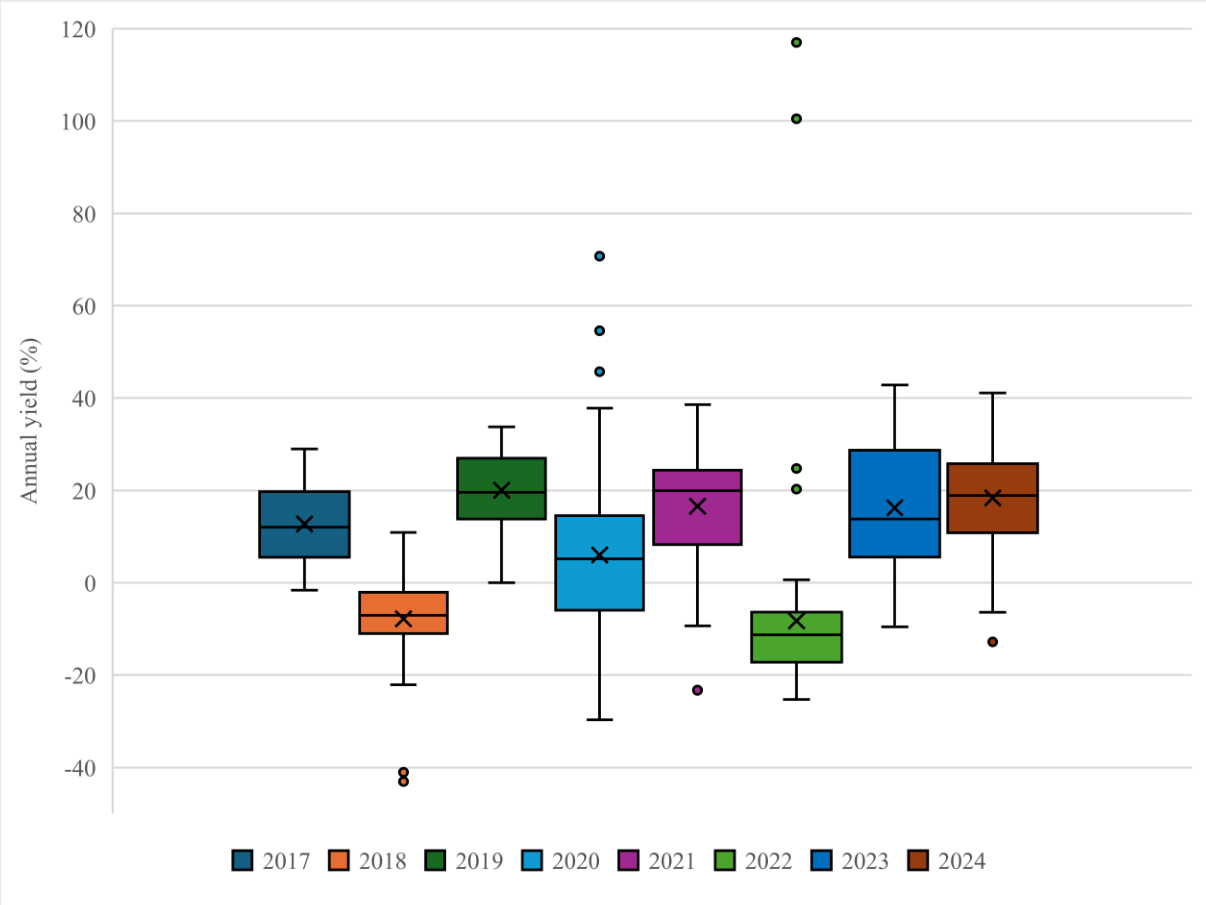

Figure 2. Distribution of annual yield across the periods 2017–2024 (boxplot). Source: authors' research.

4.2. Panel Diagnostics

Prior to the analysis of the panel data, a comprehensive set of diagnostic tests was conducted in order to select the appropriate econometric specification and to ensure the reliability of the results. As a first step in model selection, fixed-effects and random-effects models were compared. The result of the Hausman test ($\chi^2(6) = 253.14$, $p < 0.001$) clearly rejected the null hypothesis of the random-effects model, indicating that unobserved individual effects are systematically correlated with the explanatory variables. Accordingly, a fixed-effects panel model was employed in the subsequent analysis.

However, several violations of classical assumptions were identified during the evaluation of model reliability. The result of the Modified Wald test ($\chi^2(79) = 1167.40$, $p < 0.001$) clearly indicates the presence of groupwise heteroskedasticity, suggesting that the variance of the error term is not homogeneous across funds. This is further reinforced by the Jochmans portmanteau test ($\chi^2(27) = 76.94$, $p < 0.001$), which reveals significant autocorrelation in the error terms, implying that fund performance follows persistent temporal patterns.

One of the most important characteristics of panel data is cross-sectional dependence, which was examined using multiple tests. The Pesaran CD test (CD = 44.01, $p < 0.001$) indicates strong cross-sectional correlation, further supported by the average absolute correlation (0.43). Extended test statistics (particularly the CDw+ statistic) also yielded significant results, while the estimated exponent of cross-sectional dependence ($\alpha = 0.736$) indicates strong dependence according to the literature. This suggests that mutual fund returns are driven by common market or macroeconomic factors, which is a natural consequence of financial market integration.

The Pesaran–Yamagata test for slope homogeneity did not indicate significant heterogeneity ($\Delta = 0.526$, $p = 0.599$), implying that the effects of the explanatory variables do not differ substantially across funds. This supports the applicability of a homogeneous panel model specification.

In examining long-run relationships, several statistics of the Kao cointegration test were found to be significant (e.g., ADF $= -2.77$, $p = 0.0028$), indicating the presence of a stable long-term equilibrium relationship among the variables. This is a particularly important finding, as financial time series often exhibit co-movement over the long run, and ignoring this may lead to biased estimates.

The stationarity analysis yielded mixed results. Most variables (such as Jensen's alpha, annual return, NAV change, and TER) were found to be stationary ($p < 0.001$); however, in the case of the level of net asset value and fund age, the presence of a unit root could not be unequivocally rejected (e.g., NAV_actual_year: $p = 0.216$). This suggests that certain variables may contain a trend component, which could potentially bias conventional estimators.

Overall, the diagnostic results indicate that the panel data exhibit multiple, interrelated econometric issues, including heteroskedasticity, autocorrelation, and cross-sectional dependence. To address these problems jointly, the final specification employs a fixed-effects panel model with Driscoll–Kraay robust standard errors. This approach ensures that the estimates remain consistent even in the presence of complex error structures, thereby enhancing the reliability of the empirical results.

4.3. Results of Panel Regression

The results of the fixed-effects panel models estimated with Driscoll–Kraay robust standard errors for annual returns are presented in specifications (1)–(4) (Table 2). The different models aim to examine the impact of the total expense ratio (TER) under alternative specifications, including its lagged value and interaction effects. The results exhibit a consistent pattern with respect to the control variables. The change in net asset value (NAV_change) is positive and statistically significant in all specifications ($\beta \approx 4.2$, $p < 0.01$), indicating that an expansion in fund size is associated with higher returns. This relationship is consistent with theoretical considerations related to scale effects. A similarly stable relationship is observed for cumulative returns since inception (Yield_from_start), which is positive and strongly significant in all models ($\beta \approx 5.9$–7.0, $p < 0.01$). This pattern suggests the presence of performance persistence, implying that funds with stronger past performance tend to continue delivering superior results over the analysed period. In contrast, the previous year's return (Previous_yield) is consistently negative and significant ($\beta \approx -0.46$, $p < 0.01$), reflecting the phenomenon of return reversion. In other words, exceptionally high performance is often followed by more moderate returns, indicating the presence of mean reversion in the observed sample. The level of net asset value (NAV_actual_year) exhibits a less clear effect: it is positive and significant in specifications (1) and (4), while in the remaining models it does not appear to be statistically robust. This suggests that the absolute level of size is less important than its change over time. Fund age (Age_in_months) does not show a significant relationship with returns in any specification, indicating that the duration of fund operation is not systematically associated with performance differences. The main explanatory variable, TER, presents a more nuanced picture. In the baseline model (specification 1), a positive and weakly significant relationship is observed ($\beta = 3.353$, $p < 0.1$), suggesting that funds with higher cost levels may achieve higher returns. This finding deviates from the classical cost–return trade-off hypothesis and instead points towards the role of managerial quality underlying higher fees. However, subsequent specifications do not provide consistent support for this relationship. The lagged TER (model 2) is not significant, indicating no evidence of a delayed effect. Similarly, the interaction models (specifications 3 and 4) do not reveal significant relationships in interaction with either size or age, suggesting that the effect of TER does not meaningfully depend on these characteristics. Overall, the results indicate that mutual fund returns are primarily driven by past performance and growth dynamics, while the effect of costs cannot be considered robust. Nevertheless, the positive coefficient of TER remains noteworthy, raising the possibility that higher costs may, in some cases, be associated with more active or more effective portfolio management.

Table 2. Results of panel regression on the determinants of annual yield between 2017 and 2024.

	(1)	(2)	(3)	(4)
	Annual_Yield	**Annual_Yield**	**Annual_Yield**	**Annual_Yield**
NAV_actual_year	0.149 ** (0.051)	0.113 * (0.057)	0.103 (0.195)	0.151 ** (0.054)
NAV_change	4.230 *** (1.204)	3.916 ** (1.268)	4.229 *** (1.203)	4.220 *** (1.199)
Previous_yield	−0.455 *** (0.075)	−0.471 *** (0.082)	−0.455 *** (0.075)	−0.456 *** (0.075)
Yield_from_start	5.892 *** (1.534)	7.040 *** (1.749)	5.894 *** (1.531)	5.897 *** (1.527)
Age_in_months	−0.006 (0.060)	−0.001 (0.087)	−0.006 (0.060)	−0.022 (0.058)
TER	3.353 * (1.766)		3.308 (1.781)	2.255 (2.369)
L.TER		0.450 (1.491)		
TER # NAV_actual_year			0.023 (0.111)	
TER # Age_in_months				0.008 (0.014)
Constant	−21.370 * (9.445)	−21.698 * (9.820)	−21.282 * (9.463)	−19.125 * (9.909)
Observations	632	553	632	632
R2	0.5278	0.5785	0.5278	0.5279

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: authors' research.

The results of the models estimated for Jensen's alpha as a risk-adjusted performance measure are presented in specifications (1)–(4) (Table 3). The objective of the analysis is to examine how costs and fund characteristics influence excess returns generated through active portfolio management. The results indicate that the change in net asset value (NAV_change) is positive and strongly statistically significant in all specifications ($\beta \approx 3.2$–3.6, $p < 0.01$). This relationship suggests that funds experiencing growth not only achieve higher absolute returns but also exhibit superior risk-adjusted performance. Thus, fund growth appears to be a relevant determinant of alpha as well. A similarly robust result is observed for cumulative returns since inception (Yield_from_start), which is positive and significant across all models ($\beta \approx 3.9$–5.3, $p < 0.01$). This pattern confirms the presence of performance persistence also in terms of risk-adjusted measures, indicating that historically well-performing funds tend to generate higher alpha. The effect of the previous year's return (Previous_yield) is weaker and less robust: it is negative and weakly significant in the second specification ($p < 0.1$), while in the remaining models it does not differ significantly from zero. This suggests that short-term mean reversion is more pronounced in raw returns than in risk-adjusted performance. The level of net asset value (NAV_actual_year) is not significant in any of the models, indicating that the absolute size of a fund is not associated with measurable excess performance once market risk is taken into account. Fund age (Age_in_months) yields mixed results: it is negative and significant in the second specification ($p < 0.05$), while in the remaining models it does not exhibit a statistically robust relationship. This may suggest that, under certain specifications, older funds achieve lower alpha, which is consistent with the potential erosion of active management performance over time. The main variable of interest, TER, presents a different pattern compared to the return models. In the baseline specification (model 1), a negative and weakly significant relationship is observed ($\beta = -1.894$, $p < 0.1$), which is also supported by model (3). This result suggests that higher costs are associated with lower risk-adjusted performance, in line with theoretical perspectives emphasising the performance-reducing effect of costs. However, further specifications provide a more nuanced view. The lagged TER (model 2) is not significant, offering no support for delayed cost effects. Similarly, the interaction models (specifications 3 and 4) do not reveal significant relationships in interaction with either size or age, suggesting that the effect of costs is relatively homogeneous across different groups of funds. Overall, the results indicate that risk-adjusted performance is primarily driven by past performance and growth dynamics, while the effect of costs is negative but not robust across all specifications. The contrast between return and alpha results is particularly noteworthy: whereas TER occasionally exhibits a positive coefficient in the return models, its relationship with alpha is predominantly negative, indicating that higher costs are not necessarily associated with genuine risk-adjusted excess performance.

Table 3. Results of panel regression on the determinants of Jensen-alpha between 2017 and 2024.

	(1)	(2)	(3)	(4)
	Jensen_Alpha	**Jensen_Alpha**	**Jensen_Alpha**	**Jensen_Alpha**
NAV_actual_year	−0.121 (0.126)	−0.157 (0.115)	0.104 (0.276)	−0.125 (0.128)
NAV_change	3.214 *** (0.627)	3.582 *** (0.711)	3.219 *** (0.618)	3.239 *** (0.634)
Previous_yield	−0.130 (0.075)	−0.137 * (0.065)	−0.129 (0.074)	−0.129 (0.075)
Yield_from_start	3.892 *** (1.026)	5.254 *** (0.664)	3.887 *** (1.022)	3.880 *** (1.023)
Age_in_months	−0.120 (0.070)	−0.213 ** (0.068)	−0.120 (0.070)	−0.081 (0.059)
TER	−1.894 * (0.878)		−1.677 * (0.843)	0.764 (2.661)

https://doi.org/10.3390/economies14090356

Table 3. *Cont.*

	(1)	(2)	(3)	(4)
	Jensen_Alpha	**Jensen_Alpha**	**Jensen_Alpha**	**Jensen_Alpha**
L.TER		−1.191 (1.644)		
TER # NAV_actual_year			−0.111 (0.173)	
TER # Age_in_months				−0.019 (0.014)
Constant	9.882 (10.099)	20.488 (13.458)	9.451 (10.122)	4.448 (8.770)
Observations	632	553	632	632
R2	0.3102	0.3879	0.3106	0.3112

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: authors' research.

4.4. Results of Quantile Regression

The results of the quantile regressions (Figure 3 and Appendix A—Table A1) make it possible to examine how the effects of the explanatory variables vary across different points of the return distribution. This approach is particularly relevant in the context of investment funds, where the determinants of performance may differ between low- and high-performing funds. The results indicate pronounced heterogeneity in the effects of the variables. The level of net asset value (NAV_actual_year) is positive and statistically significant in the lower quantiles of the return distribution (e.g., $\beta = 0.369$, $p < 0.05$). However, its effect gradually diminishes as one moves towards higher quantiles, eventually disappearing and even turning negative in the upper range. This pattern suggests that larger fund size is associated with higher returns primarily among underperforming funds, whereas this relationship does not hold for top-performing funds. By contrast, the effect of changes in net asset value (NAV_change) strengthens across the quantiles. While it is not always significant in the lower quantiles, increasingly larger and statistically significant positive coefficients are observed above the median (with β increasing from approximately 3.1 to 5.2). This indicates that growth dynamics play a particularly important role among higher-performing funds. The effect of Previous_yield is highly stable: it is negative and strongly significant across all quantiles ($p < 0.01$), with only a slight decline in magnitude towards the upper quantiles. This consistent pattern provides strong evidence of mean reversion across the entire distribution of returns. Yield_from_start is also positive and significant in all quantiles, with coefficients showing a gradual increase (from $\beta \approx 5.65$ to $\beta \approx 6.10$). This suggests that the advantage of historically successful funds is especially pronounced in the higher-return segment. Fund age (Age_in_months) exhibits a non-linear pattern. In the lower quantiles, the effect is negative and weakly significant; it disappears in the middle range, and becomes positive and significant again in the upper quantiles. This implies that older funds may be at a disadvantage among underperformers, while representing an advantage among top-performing funds. The key variable, TER, displays a clearly quantile-dependent effect. In the lower and middle quantiles, it is positive and in several cases statistically significant ($\beta \approx 3.3$–4.2). However, in the upper quantiles the effect gradually weakens and loses statistical significance. This pattern suggests that higher costs are associated with higher returns primarily among low- and mid-performing funds, whereas for top-performing funds the role of costs is negligible. The quantile regression results clearly demonstrate that the determinants of returns are not homogeneous across the distribution. Substantial heterogeneity is particularly evident in the case of TER and

NAV_change, which justifies the use of a quantile-based approach over traditional models focusing solely on average effects.

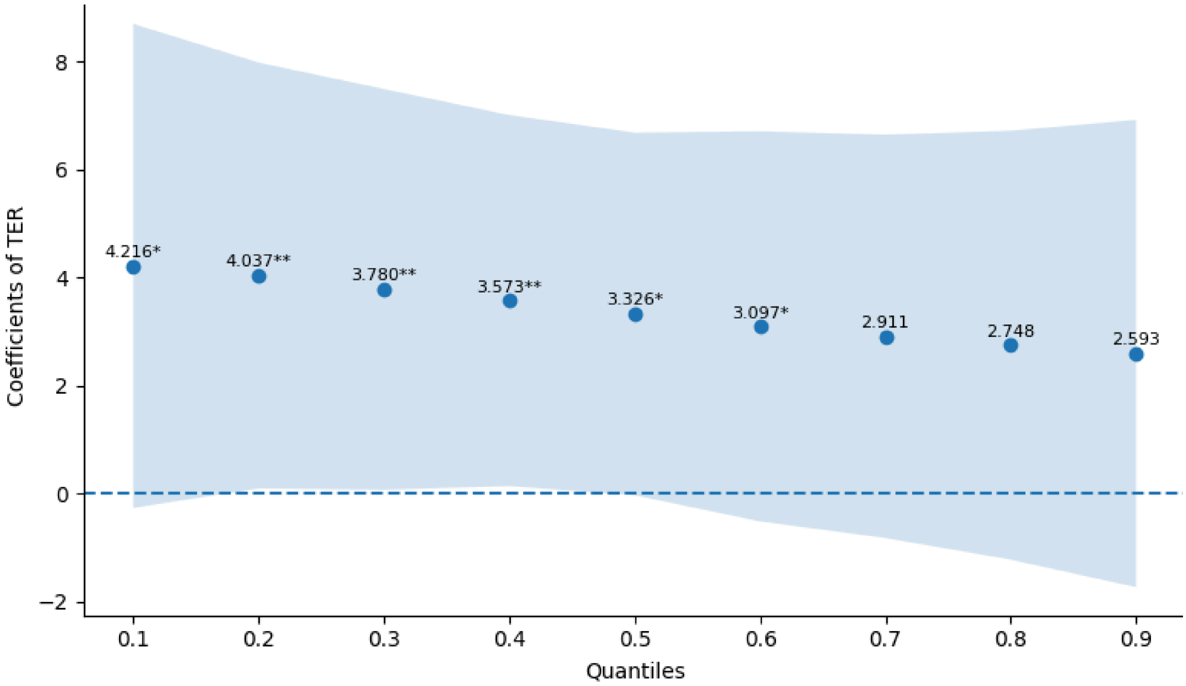

Figure 3. Estimates of Quantile Regression of TER Effect on Annual_yield. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: authors' research.

The quantile regression estimates for Jensen's alpha (Figure 4 and Appendix A—Table A2) provide a detailed picture of how the determinants of risk-adjusted performance vary across different points of the distribution. The results reveal pronounced heterogeneity, particularly with respect to the effects of fund size and past performance. The effect of the level of net asset value (NAV_actual_year) changes along the quantiles. It is not statistically significant in the lower quantiles, while it becomes negative in the upper quantiles and reaches statistical significance at the highest quantiles ($\beta \approx -0.25$ to -0.30, $p < 0.1$). This pattern suggests that larger fund size may constitute a disadvantage in terms of risk-adjusted performance among top-performing funds, consistent with potential diseconomies of scale. In contrast, the change in net asset value (NAV_change) is positive and statistically significant across all quantiles, with coefficients increasing along the distribution (from $\beta \approx 2.5$ to $\beta \approx 4.0$). This indicates that dynamically expanding funds are particularly capable of generating excess performance in the higher-alpha segment. The effect of Previous_yield is also quantile-dependent. It is weak or not significant in the lower quantiles, but becomes increasingly negative and statistically significant above the median (from $\beta \approx -0.07$ to $\beta \approx -0.22$, $p < 0.01$). Thus, mean reversion in risk-adjusted performance appears to be primarily driven by higher-performing funds. Yield_from_start is positive and significant across all quantiles, with coefficients displaying a monotonic increase (from $\beta \approx 3.1$ to $\beta \approx 4.7$). This confirms that the advantage of historically successful funds is especially pronounced in the upper segment of the alpha distribution. A markedly different pattern emerges for fund age (Age_in_months) compared to the return models: it is negative and strongly significant across all quantiles ($p < 0.01$), with the absolute magnitude of the coefficients slightly decreasing towards the upper quantiles. This result suggests that older funds consistently exhibit lower risk-adjusted performance, potentially reflecting a gradual erosion in the effectiveness of active management over time. The main variable of interest, TER, exhibits a uniformly negative sign across the entire quantile distribution, yet it is not statistically significant at any quantile. At the same time, the magnitude of the coefficients shows a gradual decline (from $\beta \approx -2.3$ to $\beta \approx -1.4$), indicating that the negative impact of costs may be more pronounced among lower-alpha funds, even if this relationship is not consistently significant. The quantile regression results demonstrate that the determinants of Jensen's alpha vary substantially across the distribution. Fund size and past performance play particularly differentiated roles in the upper quantiles, while the effect of costs is consistently negative but not robust. These findings further reinforce the relevance of the quantile-based approach, as analyses based solely on average effects would entail a considerable loss of information when examining different levels of performance.

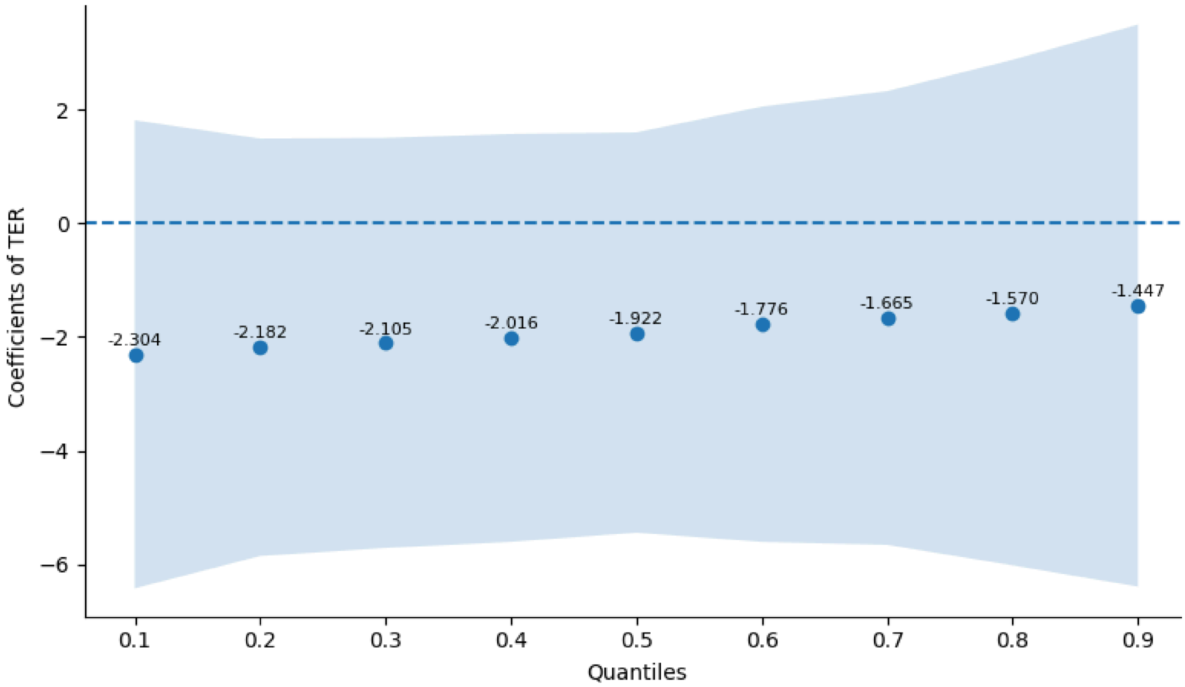

Figure 4. Estimates of Quantile Regression of TER Effect on Jensen-alpha. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: authors' research.

Beyond the cost variable, it is informative to visualise the quantile-dependence of NAV_change—the model's strongest and most robust determinant (see Section 4.5). Figure 5 presents the quantile regression estimates of the NAV_change effect on Annual_yield. The coefficient of NAV_change rises monotonically across the distribution, from 3.109 (not significant) at $\tau = 0.1$ to 5.217 ($p < 0.05$) at $\tau = 0.9$, and reaches conventional significance from the second decile onward. This pattern indicates that fund growth is not merely a generic positive predictor of returns, as the panel estimates alone would suggest, but one whose importance increases specifically among top-performing funds: strong NAV growth is both a stronger and a more reliably significant driver of returns for funds already in the upper part of the performance distribution than for underperforming funds, consistent with growth momentum reinforcing, rather than merely accompanying, superior performance.

Figure 6 presents the analogous pattern for Jensen's alpha. For Jensen's alpha, the NAV_change coefficient is significant at the 1% level across almost the entire distribution ($\tau = 0.1$ to $\tau = 0.8$) and remains significant at the 5% level at $\tau = 0.9$, rising from 2.529 to 3.959. Unlike the TER effect, which weakens and loses significance towards the upper quantiles (Figures 3 and 4), the NAV_change effect on risk-adjusted performance is significant throughout the distribution and, if anything, strengthens towards the top. This asymmetry reinforces the paper's central message: growth dynamics, not cost levels, are the more reliable and universally significant driver of risk-adjusted performance among Hungarian equity funds, regardless of where a fund sits in the performance distribution.

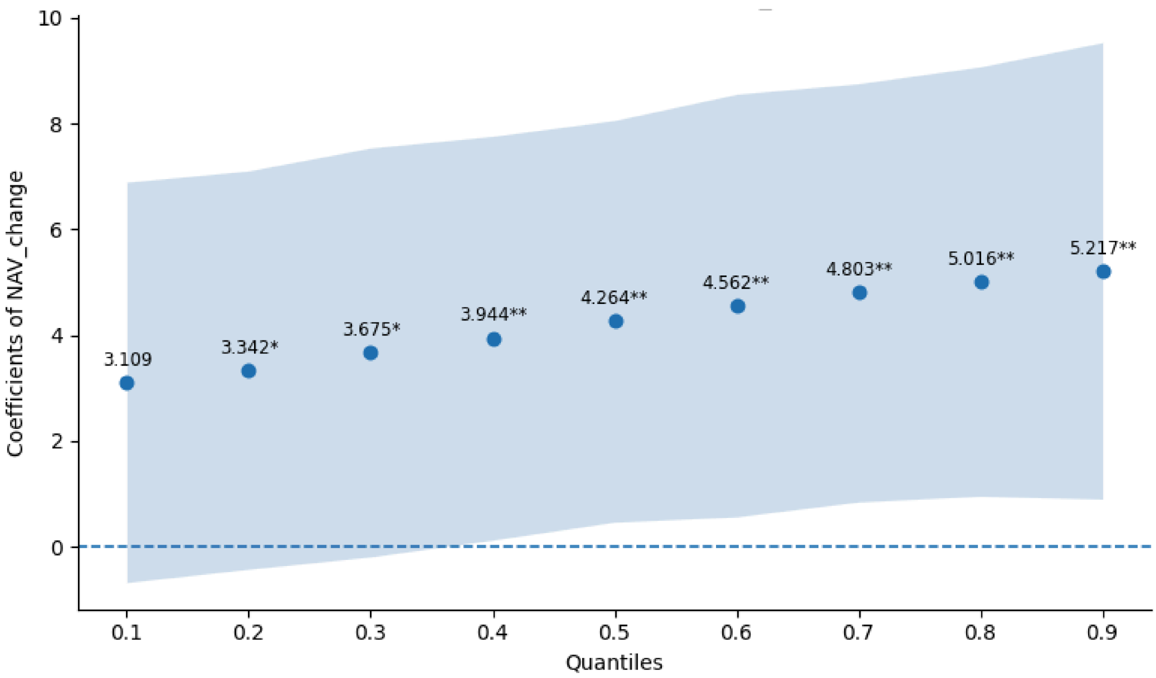

Figure 5. Estimates of Quantile Regression of NAV_change Effect on Annual_yield. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: authors' research.

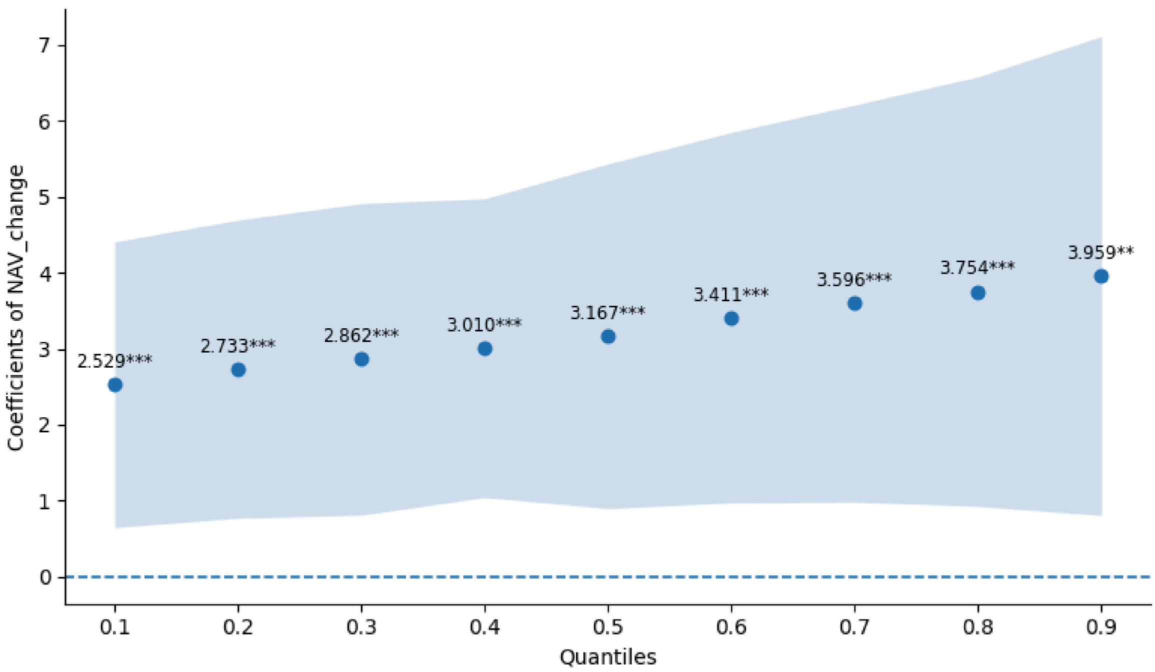

Figure 6. Estimates of Quantile Regression of NAV_change Effect on Jensen's Alpha. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: authors' research.

4.5. Robustness Checks

4.5.1. Robustness of the Panel Regression Estimates

To assess the sensitivity of the baseline panel estimates to outlier influence, alternative variance–covariance assumptions, and unobserved time-varying shocks, the baseline models for both dependent variables (Annual_yield and Jensen_alpha) were re-estimated under eight alternative specifications: (1) the original fixed-effects model with Driscoll–Kraay standard errors; (2) two-way clustered standard errors (by fund and by year), which do not rely on the large-T asymptotics underlying the Driscoll–Kraay correction; (3) the addition of year fixed effects to the entity fixed-effects specification, controlling explicitly for common macroeconomic and market-wide shocks; (4) and (5) winsorisation of all model variables at the 1st/99th and 5th/95th percentiles, respectively; (6) log-transformation of the two most heavily skewed variables, NAV_change (log(1+x), as its minimum value exceeds −1) and NAV_actual_year; (7) exclusion of the top and bottom 1% of NAV_change, the variable with the most extreme skewness and kurtosis in the sample; and (8) exclusion of the top and bottom 1% of the dependent variable itself. Table 4 reports the coefficient, standard error, and significance level of TER (the manuscript's principal variable of interest) under each specification; full coefficient tables for all control variables are available from the authors upon request.

Table 4. Robustness of the TER coefficient across alternative specifications.

Specification	Annual_Yield: TER Coef.	Jensen_Alpha: TER Coef.
(1) Baseline, Driscoll–Kraay SE (original)	3.353 * (1.767)	−1.894 ** (0.879)
(2) Two-way clustered SE (fund & year)	3.353 ** (1.636)	−1.894 (1.739)
(3) Entity + year fixed effects, DK SE	1.705 (1.358)	0.638 (1.131)
(4) Winsorised at 1%/99%	2.724 (2.384)	−2.753 ** (1.277)
(5) Winsorised at 5%/95%	3.805 (2.778)	−3.466 * (1.990)
(6) Log-transformed NAV_change & NAV_actual_year	3.600 (2.233)	−2.270 ** (1.110)
(7) Excluding top/bottom 1% of NAV_change	3.594 * (2.147)	−2.457 *** (0.906)
(8) Excluding top/bottom 1% of dependent variable	2.754 (2.365)	−2.698 ** (1.080)

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: authors' research.

Two clear patterns emerge. First, the core control variables (NAV_change, Yield_from_start, and Previous_yield) retain their sign and statistical significance across all eight specifications (full results available on request), confirming that the central findings on growth dynamics and mean reversion are not artefacts of outlier influence or model choice. Second, the effect of TER displays a markedly different robustness profile depending on the dependent variable. For Annual_yield, the positive TER coefficient is only weakly significant in the baseline model and loses significance under every alternative specification, most notably once year fixed effects are introduced—reinforcing the manuscript's conclusion that the cost–return relationship for raw returns cannot be regarded as robust. For Jensen's alpha, the negative TER coefficient is robust to outlier treatment: it remains significant, and in some cases strengthens, after winsorisation, log-transformation, and exclusion of extreme observations. However, it loses statistical significance both under two-way clustered standard errors and once year fixed effects are added. This pattern indicates that part of the negative TER–alpha relationship identified in the baseline model may be attributable to common time-varying shocks affecting costs and risk-adjusted performance simultaneously across funds in certain years, rather than to a purely within-fund cost effect. This finding refines rather than undermines the manuscript's central argument: it suggests that the rejection of the cost-signalling hypothesis should be interpreted with appropriate caution regarding the temporal dimension of the relationship, a point elaborated further in the Discussion.

4.5.2. Robustness of the Quantile Regression Estimates

To ensure that the robustness analysis follows (Table 5) a consistent logic across the panel and the quantile models, the fixed-effects quantile regression (Canay, 2011) was re-estimated at three representative quantiles (τ = 0.1, 0.5, 0.9) under the same five outlier- and transformation-related specifications applied to the panel models in Table 4: (2) winsorisation at the 1st/99th percentiles; (3) winsorisation at the 5th/95th percentiles; (4) log-transformation of NAV_change and NAV_actual_year; (5) exclusion of the top and bottom 1% of NAV_change; and (6) exclusion of the top and bottom 1% of the dependent variable. The two specifications addressing the short-T limitation of the Driscoll–Kraay estimator (two-way clustering and year fixed effects) were not repeated here, as the quantile estimates already rely on a fund-level block bootstrap (1000 replications) for inference, which serves an analogous role. Standard errors are reported in parentheses.

Table 5. Robustness of the TER and NAV_change coefficients across representative quantiles (Canay fixed-effects quantile regression, block-bootstrap SE).

Dependent Variables	τ	Specification	TER Coef.	NAV_Change Coef.
Annual_yield	0.1	(1) Baseline	4.674 ** (1.923)	2.981 * (1.705)
		(2) Winsorised 1%/99%	3.363 * (1.856)	7.632 *** (1.915)
		(3) Winsorised 5%/95%	5.636 *** (2.084)	13.440 *** (1.717)
		(4) Log-transformed	5.453 *** (1.677)	15.791 *** (2.953)
		(5) Excl. NAV_change extremes	5.879 *** (1.865)	9.062 *** (2.897)
		(6) Excl. dep. var. extremes	3.065 * (1.656)	5.447 *** (1.730)
	0.5	(1) Baseline	3.363 * (1.812)	7.828 *** (2.424)
		(2) Winsorised 1%/99%	3.105 ** (1.572)	9.453 *** (1.367)
		(3) Winsorised 5%/95%	4.434 ** (2.116)	14.344 *** (1.625)
		(4) Log-transformed	4.148 *** (1.499)	16.666 *** (2.475)
		(5) Excl. NAV_change extremes	4.159 ** (1.805)	11.388 *** (1.901)
		(6) Excl. dep. var. extremes	2.597 (1.760)	9.384 *** (1.515)
	0.9	(1) Baseline	2.171 (2.054)	5.839 *** (2.131)
		(2) Winsorised 1%/99%	2.388 (1.790)	5.573 *** (1.237)
		(3) Winsorised 5%/95%	2.031 (2.045)	10.777 *** (2.494)
		(4) Log-transformed	1.981 (1.968)	9.832 *** (2.837)
		(5) Excl. NAV_change extremes	2.379 (2.250)	8.161 ** (3.287)
		(6) Excl. dep. var. extremes	1.323 (1.426)	5.030 *** (1.154)
Jensen_alpha	0.1	(1) Baseline	−4.375 ** (2.187)	2.487 * (1.269)
		(2) Winsorised 1%/99%	−3.781 (2.478)	2.624 ** (1.284)
		(3) Winsorised 5%/95%	−4.289 (2.653)	6.403 *** (1.400)
		(4) Log-transformed	−3.263 (2.183)	8.545 *** (1.909)
		(5) Excl. NAV_change extremes	−4.977 ** (1.975)	4.157 ** (1.941)
		(6) Excl. dep. var. extremes	−4.597 * (2.344)	2.951 ** (1.226)
	0.5	(1) Baseline	−2.314 (1.744)	3.371 ** (1.495)
		(2) Winsorised 1%/99%	−2.959 (1.893)	5.099 *** (1.257)
		(3) Winsorised 5%/95%	−4.097 * (2.419)	8.652 *** (1.526)
		(4) Log-transformed	−2.851 (1.931)	9.124 *** (1.934)
		(5) Excl. NAV_change extremes	−2.257 (1.865)	5.270 *** (1.674)
		(6) Excl. dep. var. extremes	−3.402 ** (1.593)	4.213 *** (1.456)
	0.9	(1) Baseline	−1.725 (2.628)	5.641 *** (1.941)
		(2) Winsorised 1%/99%	−2.668 (2.045)	5.564 *** (1.087)
		(3) Winsorised 5%/95%	−3.753 (2.318)	7.122 *** (1.778)
		(4) Log-transformed	−1.268 (2.911)	8.494 *** (2.526)
		(5) Excl. NAV_change extremes	−2.339 (2.096)	7.461 *** (2.565)
		(6) Excl. dep. var. extremes	−2.485 (2.312)	5.964 *** (2.084)

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: authors' research.

The results confirm the two central patterns reported in Section 4.4. First, the positive effect of NAV_change is virtually unaffected by outlier treatment: it is statistically significant—mostly at the 1% level—in 34 of the 36 specification–quantile combinations across both dependent variables, and its magnitude, if anything, increases under winsorisation and log-transformation. Second, the quantile-dependence of the TER effect is preserved under every alternative specification. For Annual_yield, the TER coefficient is positive and significant at the lower and median quantiles in five of the six specifications, but never reaches significance at the upper quantile ($\tau = 0.9$) under any of the six specifications—a striking confirmation that cost levels are unrelated to performance among top-performing funds. For Jensen's alpha, the negative TER coefficient is significant in about half of the lower- and median-quantile specifications but, as with Annual_yield, is not significant at the upper quantile under any specification. Taken together, these results indicate that the heterogeneous, quantile-dependent role of fees documented in Section 4.4 is a robust empirical pattern rather than an artefact of extreme observations or a particular data transformation.

5. Discussion

The empirical results contribute to a deeper understanding of the performance of Hungarian equity mutual funds in several respects. Based on the panel regression estimates, two key determinants of both returns and risk-adjusted performance (Jensen's alpha) stand out: changes in net asset value (NAV_change) and cumulative returns (Yield_from_start), both of which exhibit robust and consistently positive effects across all specifications. This suggests that fund growth dynamics and past performance are closely associated with future performance, in line with the international literature on performance persistence. At the same time, the negative coefficient of Previous_yield consistently indicates the presence of mean reversion. This is a particularly important finding in the domestic context, as it suggests that short-term outperformance is not necessarily sustainable, which has clear implications for investor decision-making. The effect of fund size (NAV_actual_year) presents a more nuanced picture. While it is partially positive in the classical panel models, the quantile regression results show that its effect weakens and eventually turns negative towards the upper quantiles. This implies that larger fund size may reduce efficiency among top-performing funds, pointing to a trade-off between economies of scale and liquidity constraints. The impact of costs (TER) is particularly noteworthy. While the effect on raw returns is positive and partially significant in several models, the results for Jensen's alpha are predominantly negative, albeit less robust. This duality suggests that higher costs may, in some cases, be associated with higher gross returns—potentially reflecting more active portfolio management—yet this advantage does not clearly translate into superior risk-adjusted performance. These findings cast a critical light on the "cost-quality" paradox. While the positive coefficient of TER in return models may indicate that higher fees finance more active risk-taking, the negative (though not uniformly robust) relationship observed for Jensen's alpha suggests that such activity does not translate into net managerial value added. This is consistent with the theory of information asymmetry proposed by Lemeunier (2021): in emerging markets, managers may effectively "sell" superior information at higher fees, but the exploitation of market inefficiencies ultimately erodes excess profits. Beyond information asymmetry, managerial capacity constraints may also provide an important explanation for the results. In the Hungarian market, fund managers frequently oversee multiple funds or portfolios simultaneously, raising the relevance of the "attention constraint" mechanism described by Evans et al. (2024). This theoretical framework highlights that the allocation of managerial attention and information-processing capacity across multiple mandates can have a significant negative impact on fund performance. In light of the present findings, this suggests that although higher fees may theoretically finance more active management, limited managerial capacity prevents this additional investment effort from being transformed into risk-adjusted alpha. An additional key insight from the quantile regressions is that the effects of the explanatory variables differ substantially across the distribution. In particular, the impact of NAV_change and Yield_from_start becomes stronger in higher quantiles, indicating that these factors are especially important for top-performing funds. Conversely, the negative effect of Previous_yield is also more pronounced in the upper quantiles, signalling stronger mean reversion dynamics among top performers. Finally, the panel diagnostic tests clearly revealed violations of classical assumptions. The Hausman test (χ^2 = 253.14, p < 0.001) justified the use of a fixed effects model, while the joint presence of heteroskedasticity (χ^2 = 1167.40, p < 0.001), autocorrelation (χ^2 = 76.94, p < 0.001), and cross-sectional dependence (Pesaran CD = 44.01, p < 0.001) confirmed the necessity of robust estimation techniques. Accordingly, the application of Driscoll-Kraay standard errors represents a methodologically sound and well-justified choice.

The economic mechanism underlying this quantile-dependent pattern warrants further discussion. Among underperforming funds (lower quantiles), higher TER is associated with weaker risk-adjusted performance, consistent with a setting in which such funds lack the scale or managerial capacity to convert additional fee income into offsetting active returns—the "attention constraint" described by Evans et al. (2024) is likely to bind more tightly for these funds. Among top-performing funds (upper quantiles), by contrast, the cost effect disappears entirely, for both raw returns and Jensen's alpha. This is consistent with two, not mutually exclusive, explanations: first, top-performing funds may al-ready operate close to their efficient scale, so that fee levels no longer differentiate performance outcomes; second, outperformance in this segment may be driven predominantly by idiosyncratic managerial skill or favourable security selection that operates independently of the cost structure. The asymmetry is therefore informative in itself: it implies that cost discipline matters most where performance is weakest, while for the best-performing funds, costs are essentially uninformative about future performance—a nuance that average-effect models cannot reveal.

The robustness analysis presented in Section 4.5 adds an important qualification to this interpretation. While the negative association between TER and Jensen's alpha sur-vives outlier-related perturbations of the data, it does not survive the introduction of year fixed effects or two-way clustered standard errors in the panel setting. This suggests that at least part of the apparent cost penalty on risk-adjusted performance may reflect years in which cost levels and market-wide performance shocks moved together across the fund population, rather than a stable, fund-level mechanism through which higher fees erode alpha. Consequently, the rejection of the cost-signalling hypothesis advanced in this study should be understood as an average, sample-period-specific finding rather than as evidence of a structurally invariant relationship. This nuance does not overturn the paper's central conclusion—under no specification does TER emerge as a reliable positive predictor of risk-adjusted performance—but it does call for caution when extrapolating the magnitude of the estimated cost effect beyond the 2017–2024 period.

6. Conclusions

The primary objective of the study was to examine how costs—particularly the Total Expense Ratio (TER)—affect the returns and risk-adjusted performance of Hungarian equity mutual funds. The role of TER cannot be regarded as unequivocally negative, which partially contradicts traditional financial theoretical expectations: panel estimates indicate a positive, weakly significant association between TER and raw returns, whereas the relationship with Jensen's alpha is predominantly negative but not uniformly robust. The quantile regression results, confirmed by the robustness analysis in Section 4.5, refine this picture further by showing that the cost effect is concentrated among underperforming funds and disappears among top performers. With regard to control variables, changes in net asset value (NAV_change) and cumulative returns since inception (Yield_from_start) exhibit a stable positive relationship with both returns and alpha, while the negative effect of previous returns points to the presence of short-term mean reversion. The practical and theoretical implications of these findings are elaborated below.

The study is subject to several limitations. First, the analysis is restricted to a relatively short time horizon (eight annual observations) and a specific asset class, which may affect the generalisability of the results beyond the Hungarian equity mutual fund segment; extending the analysis to other CEE markets or to bond and mixed funds represents an important avenue for future research. Second, the TER variable is an aggregate measure that does not distinguish between different cost components (e.g., management fees, performance fees, transaction costs), and a more detailed examination of underlying mechanisms would require richer, decomposed cost data. Third, performance is evaluated relative to the CAPM-based Jensen's alpha; while this choice is consistent with the majority of the domestic and regional literature on Hungarian and CEE funds and keeps the framework directly comparable to prior studies, it does not control for size, value, or momentum exposures captured by multifactor models (e.g., Fama–French, Carhart), and part of the estimated alpha may therefore reflect systematic risk exposures rather than managerial skill; future work could usefully extend the analysis with multifactor benchmarks as more granular holdings-based data become available. Fourth, macroeconomic and institutional variables (e.g., interest rate cycles, regulatory changes, distribution channel effects) were not included in the model; while fund and, in several specifications, year effects absorb part of this variation, the specific channels through which macroeconomic conditions affect the cost–performance relationship remain outside the scope of this study. Fifth, several explanatory variables—particularly NAV_change and Yield_from_start—are potentially endogenous with respect to fund performance, as growth and past returns may themselves be partly driven by unobserved managerial actions correlated with future performance; the reported associations should therefore be interpreted as robust conditional correlations rather than strictly causal effects, and the results of the robustness analysis in Section 4.5 indicate that these associations are stable across a wide range of alternative specifications. Sixth, while the use of a balanced panel ensures methodological consistency, the potential presence of survivorship bias must be acknowledged, as the sample includes only funds that operated throughout the entire observation period; however, given the relatively low rate of fund closures in the Hungarian equity market during the sample period, this bias is unlikely to materially affect the validity of the results.

Several avenues for future research emerge from the findings. First, a more granular analysis of cost structures would be valuable, particularly with respect to performance-based fees and differences between passive and active management strategies. Second, a regional comparative analysis incorporating other Central and Eastern European markets could help assess whether the observed effects of TER are specific to Hungary. Third, the application of non-linear modelling techniques or dynamic panel models could contribute to a deeper understanding of the relationship between costs and performance.

The findings suggest that the relationship between costs and performance in Hungarian equity funds is far from straightforward. Three main conclusions can be drawn for the international asset management industry:

1. Non-linearity in the size–performance relationship: The quantile results indicate that economies of scale improve performance only up to a certain point (in the lower quantiles); among top-performing funds, size increasingly acts as a liquidity constraint.

https://doi.org/10.3390/economies14090356

2. Failure of cost signalling: In emerging markets, investors cannot interpret high TER as a reliable signal of quality, as there is no significant positive relationship between costs and risk-adjusted excess returns (alpha).
3. Return persistence vs. mean reversion: The negative effect of past returns highlights the dominance of short-term luck, cautioning investors against extrapolating past performance into the future.

The results also carry important implications for regulatory authorities. The lack of a clear relationship between costs and performance in emerging markets may justify enhanced transparency in fee structures, particularly for high-fee funds, where investors may pay unjustifiably high premia for non-existent alpha. More specifically, since the cost penalty on risk-adjusted performance is concentrated among underperforming funds (Section 5), disclosure regimes and fee caps—such as those already used in several EU markets under the UCITS framework—could usefully be calibrated to a fund's historical performance quantile rather than applied uniformly across the market, targeting oversight where the cost-performance mismatch is empirically largest. Regulators and industry bodies (e.g., the Hungarian National Bank, MNB) could also consider requiring standardised, quantile-based performance disclosure (rather than average-return comparisons alone) to help retail investors distinguish funds whose fees are justified by demonstrated top-quantile performance from those that are not.

Author Contributions: Conceptualization, L.V., T.T., T.Z. and T.B.; methodology, L.V.; software, L.V.; validation, L.V., T.T., T.Z. and T.B.; formal analysis, L.V.; investigation, T.T., T.Z. and T.B.; resources, L.V.; data curation, L.V.; writing—original draft preparation, L.V.; writing—review and editing, L.V., T.T., T.Z. and T.B.; visualization, L.V.; supervision, T.T.; project administration, T.T. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

Acknowledgments: During the preparation of this manuscript, the authors used [Claude Sonnet 5 and ChatGPT-5.5] for the purposes of academic text proofreading, translation and language refinement, paraphrasing, academic writing guidance, and conceptual clarifications to improve clarity and coherence. The authors have reviewed and edited the output and take full responsibility for the content of this publication.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. Results of the quantile regression for annual returns.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Annual_Yield	**Annual_Yield**	**Annual_Yield**	**Annual_Yield**	**Annual_Yield**	**Annual_Yield**	**Annual_Yield**	**Annual_Yield**	**Annual_Yield**
NAV_actual_year	0.369 ** (0.187)	0.324 * (0.171)	0.258 * (0.149)	0.205 (0.143)	0.143 (0.136)	0.084 (0.136)	0.037 (0.134)	−0.005 (0.146)	−0.044 (0.157)
NAV_change	3.109 (1.931)	3.342 * (1.922)	3.675 * (1.973)	3.944 ** (1.948)	4.264 ** (1.938)	4.562 ** (2.039)	4.803 ** (2.018)	5.016 ** (2.072)	5.217 ** (2.203)
Previous_yield	−0.467 *** (0.056)	−0.464 *** (0.049)	−0.461 *** (0.044)	−0.458 *** (0.040)	−0.455 *** (0.040)	−0.452 *** (0.042)	−0.449 *** (0.046)	−0.447 *** (0.048)	−0.445 *** (0.058)
Yield_from_start	5.654 *** (0.885)	5.704 *** (0.816)	5.774 *** (0.815)	5.832 *** (0.797)	5.900 *** (0.823)	5.963 *** (0.839)	6.014 *** (0.899)	6.059 *** (0.928)	6.102 *** (0.990)
Age_in_months	−0.067 * (0.035)	−0.055 * (0.031)	−0.036 (0.031)	−0.022 (0.028)	−0.004 (0.027)	0.012 (0.026)	0.025 (0.026)	0.037 (0.027)	0.047 * (0.027)
TER	4.216 * (2.285)	4.037 ** (2.011)	3.780 ** (1.892)	3.573 ** (1.752)	3.326 * (1.712)	3.097 * (1.842)	2.911 (1.904)	2.748 (2.025)	2.593 (2.206)
Observations	632	632	632	632	632	632	632	632	632

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: authors' research.

Table A2. Results of the quantile regression for Jensen-alpha.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Jensen_Alpha	**Jensen_Alpha**	**Jensen_Alpha**	**Jensen_Alpha**	**Jensen_Alpha**	**Jensen_Alpha**	**Jensen_Alpha**	**Jensen_Alpha**	**Jensen_Alpha**
NAV_actual_year	0.045 (0.191)	−0.004 (0.172)	−0.035 (0.160)	−0.071 (0.138)	−0.109 (0.134)	−0.168 (0.135)	−0.213 (0.138)	−0.251 * (0.150)	−0.301 * (0.169)
NAV_change	2.529 *** (0.959)	2.733 *** (1.001)	2.862 *** (1.046)	3.010 *** (1.003)	3.167 *** (1.157)	3.411 *** (1.244)	3.596 *** (1.333)	3.754 *** (1.442)	3.959 ** (1.608)
Previous_yield	−0.047 (0.042)	−0.072 * (0.037)	−0.087 ** (0.036)	−0.105 *** (0.036)	−0.124 *** (0.035)	−0.154 *** (0.037)	−0.176 *** (0.043)	−0.195 *** (0.047)	−0.220 *** (0.053)
Yield_from_start	3.126 *** (0.863)	3.354 *** (0.775)	3.498 *** (0.760)	3.664 *** (0.711)	3.840 *** (0.692)	4.113 *** (0.691)	4.320 *** (0.678)	4.497 *** (0.725)	4.726 *** (0.731)

Table A2. *Cont.*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Jensen_Alpha	**Jensen_Alpha**	**Jensen_Alpha**	**Jensen_Alpha**	**Jensen_Alpha**	**Jensen_Alpha**	**Jensen_Alpha**	**Jensen_Alpha**	**Jensen_Alpha**
Age_in_months	−0.131 ***	−0.127 ***	−0.125 ***	−0.123 ***	−0.120 ***	−0.116 ***	−0.113 ***	−0.111 ***	−0.108 ***
	(0.024)	(0.023)	(0.022)	(0.021)	(0.022)	(0.023)	(0.025)	(0.027)	(0.030)
TER	−2.304	−2.182	−2.105	−2.016	−1.922	−1.776	−1.665	−1.570	−1.447
	(2.103)	(1.875)	(1.842)	(1.833)	(1.798)	(1.956)	(2.038)	(2.271)	(2.525)
Observations	632	632	632	632	632	632	632	632	632

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: authors' research.

References

Aasheim, L. K., Miguel, A. F., & Ramos, S. B. (2022). Star rating, fund flows and performance predictability: Evidence from Norway. *Financial Markets and Portfolio Management*, *36*(1), 29–56. [CrossRef]

Abdelsalam, O., Fethi, M. D., Matallín, J. C., & Tortosa-Ausina, E. (2014). On the comparative performance of socially responsible and Islamic mutual funds. *Journal of Economic Behavior & Organization*, *103*, S108–S128. [CrossRef]

Adams, J., Hayunga, D., & Mansi, S. (2022). Index fund trading costs are inversely related to fund and family size. *Journal of Banking & Finance*, *140*, 106527. [CrossRef]

Agoraki, M. E. K., Aslanidis, N., & Kouretas, G. P. (2023). How has COVID-19 affected the performance of green investment funds? *Journal of International Money and Finance*, *131*, 102792. [CrossRef] [PubMed]

Ahmed, M. S., & Doukas, J. A. (2021). Revisiting disposition effect and momentum: A quantile regression perspective. *Review of Quantitative Finance and Accounting*, *56*, 1087–1128. [CrossRef]

Ajadi, A. (2024). Can equity mutual funds outperform the benchmark and simple passive portfolios? *Business Performance Review*, *2*(1), 8–15. [CrossRef]

Ben-David, I., Li, J., Rossi, A., & Song, Y. (2024). Discontinued positive feedback trading and the decline of return predictability. *Journal of Financial and Quantitative Analysis*, *59*(7), 3062–3100. [CrossRef]

Brown, D. C., & Davies, S. (2024). *Off target: On the underperformance of target-date funds*. Available online: https://www.ssrn.com/abstract=3707755 (accessed on 25 March 2026).

Canay, I. A. (2011). A simple approach to quantile regression for panel data. *The Econometrics Journal*, *14*(3), 368–386. [CrossRef]

Carhart, M. M. (1997). On persistence in mutual fund performance. *The Journal of Finance*, *52*(1), 57–82. [CrossRef]

Chahuán-Jiménez, K., Muñoz-Rojas, L., Muñoz-Pizarro, S., & Schulze-González, E. (2025). Comparison of the CAPM and multi-factor Fama–French models for asset valuation in US industries. *International Journal of Financial Studies*, *13*(3), 126. [CrossRef]

Charteris, A., McCullough, K., & Muguto, L. (2025). Evaluating passive fund performance: Short-term versus long-term metrics. *Applied Economics*, 1–26. [CrossRef]

Cremers, M., & Petajisto, A. (2009). How active is your fund manager? A new measure that predicts performance. *Review of Financial Studies*, *22*(9), 3329–3365. [CrossRef]

Driscoll, J. C., & Kraay, A. C. (1998). Consistent covariance matrix estimation with spatially dependent panel data. *Review of Economics and Statistics*, *80*(4), 549–560. [CrossRef]

Duong, T. X., & Meschke, F. (2020). The rise and fall of portfolio pumping among US mutual funds. *Journal of Corporate Finance*, *60*, 101530. [CrossRef]

Eissa, M. A., Al Refai, H., & Chortareas, G. (2024). Heterogeneous impacts of geopolitical risk factors on stock markets in the Middle East: A quantile regression analysis across four emerging economies. *The Journal of Economic Asymmetries*, *30*, e00374. [CrossRef]

Evans, R., Gil-Bazo, J., & Lipson, M. (2024). Mutual fund performance and manager assets: The negative effect of outside holdings. *Financial Management*, *53*(1), 3–29. [CrossRef]

Fama, E. F., & French, K. R. (2010). Luck versus skill in the cross-section of mutual fund returns. *Journal of Finance*, *65*(5), 1915–1947. [CrossRef]

Galvao, A. F., Jr. (2011). Quantile regression for dynamic panel data with fixed effects. *Journal of Econometrics*, *164*(1), 142–157. [CrossRef]

Hoechle, D. (2007). Robust standard errors for panel regressions with cross-sectional dependence. *Stata Journal*, *7*(3), 281–312. [CrossRef]

Jensen, M. C. (1968). The performance of mutual funds in the period 1945–1964. *The Journal of Finance*, *23*(2), 389–416. [CrossRef]

Ji, Z. (2020). Empirical research on the Fama–French three-factor model. *Sustainability*, *12*(12), 5170. [CrossRef]

Joshi, G., & Dash, R. K. (2024). Exchange-traded funds and the future of passive investments: A bibliometric review and future research agenda. *Future Business Journal*, *10*(1), 17. [CrossRef]

Kacperczyk, M., Van Nieuwerburgh, S., & Veldkamp, L. (2016). A rational theory of mutual funds' attention allocation. *Econometrica*, *84*(2), 571–626. [CrossRef]

Kim, T.-H., & White, H. (2004). On more robust estimation of skewness and kurtosis. *Finance Research Letters*, *1*(1), 56–73. [CrossRef]

Koenker, R., & Bassett, G., Jr. (1978). Regression quantiles. *Econometrica: Journal of the Econometric Society*, *46*, 33–50. [CrossRef]

Lemeunier, S. M. (2021). Information asymmetry and the mutual fund market. *The Quarterly Review of Economics and Finance*, *81*, 440–448. [CrossRef]

Letho, L., Chelwa, G., & Alhassan, A. L. (2022). Cryptocurrencies and portfolio diversification in an emerging market. *China* Finance Review International, *12*(1), 20–50. [CrossRef]

Livingston, M., Yao, P., & Zhou, L. (2019). The volatility of mutual fund performance. *Journal of Economics and Business*, *104*, 105835. [CrossRef]

Mansor, F., Bhatti, M. I., & Ariff, M. (2015). New evidence on the impact of fees on mutual fund performance of two types of funds. *Journal of International Financial Markets.* Institutions and Money, *35*, 102–115. [CrossRef]

Matallín-Sáez, J. C., & de Mingo-López, D. V. (2024). The role of passive effects in the relationship between active management and short-term performance: Evidence from mutual fund portfolio holdings. *Finance Research Letters*, *62*, 105107. [CrossRef]

Matallín-Sáez, J. C., Soler-Dominguez, A., & Tortosa-Ausina, E. (2019). Does active management add value? New evidence from a quantile regression approach. *Journal of the Operational Research Society*, *70*(10), 1734–1751. [CrossRef]

Paudel, K., & Naka, A. (2023). Effects of size on the exchange-traded funds performance. *Journal of Asset Management*, *24*(6), 474–484. [CrossRef]

Powell, D. (2016). Quantile regression with nonadditive fixed effects. *Journal of Econometrics*, *190*(2), 403–414. [CrossRef]

Revelli, C., & Viviani, J. L. (2015). Financial performance of socially responsible investing (SRI): What have we learned? A meta-analysis. *Business Ethics: A European Review*, *24*(2), 158–185. [CrossRef]

Shaekh, A. A., Rabby, S. M., & Hossain, S. A. (2024). *Impact of fund size on performance and risk of closed-end mutual funds: An empirical analysis in the context of Bangladesh*. Available online: https://www.ssrn.com/abstract=4878186 (accessed on 25 March 2026).

Sheng, J., Simutin, M., & Zhang, T. (2023). Cheaper is not better: On the 'superior' performance of high-fee mutual funds. *The Review of Asset Pricing Studies*, *13*(2), 375–404. [CrossRef]

Sofi, M. F., & Yahya, M. H. (2020). Shariah monitoring, agency cost and fund performance in Malaysian mutual funds. *Journal of Islamic Accounting and Business Research*, *11*(5), 945–972. [CrossRef]

Song, Y. (2020). The mismatch between mutual fund scale and skill. *The Journal of Finance*, *75*(5), 2555–2589. [CrossRef]

Vancsura, L., & Bareith, T. (2025). Competitiveness analysis of ESG qualified investment funds available in Hungary. *Public Finance Quarterly*, *71*(2), 50–75. [CrossRef]

Zhang, P., Lv, Z. X., & Liu, J. Y. (2024). Flows, performance, and investor behavior: Evidence from mutual funds in China. *Cogent Economics & Finance*, *12*(1), 2373258. [CrossRef]