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LONG-TERM RELATIONSHIPS BETWEEN MUTUAL FUNDS AND EQUITY MARKET

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Abstract

Investment funds are an attractive form of investment, especially for those investors who do not want to invest on their own, but rather entrust their funds to professional managers. However, the question arises as to whether the fund managers can diversify the asset portfolio, or whether it is only a passive investment policy that largely imitates the stock market index. In this context, it becomes important to examine the long-term relationships between open-ended equity funds and the funds' benchmarks (stock exchange indices). This study analyses series of weekly quotations for 15 FIOs and 4 indices of the Warsaw Stock Exchange (WSE) from 2004 to 2021. The Johansen method was used as the main tool. The results indicate a lack of long-term relationships between the quotations of the selected indices and the valuation of the vast majority of funds. This result may be due to the analysis covering quite a long period in which the stock exchange situation changed more than once. In the long-term, this may result in disturbances of the long-term balance to such an extent that the relation can no longer return to its long-term path, so the vast majority of the analysed funds do not follow the indices (their benchmarks). This observation can apply to both developed and emerging capital markets.

Keywords: *financial market, funds, long-run relationships, cointegration*

JEL Classification: *C22, G23, E22*

1. Introduction

Investment funds are one vehicle for investors to invest their financial surpluses (Nanda et al. 2000). Equity mutual funds are often considered as a form of long-term investment (Wang and Wang 2010). However, such investments are also subject to varying degrees of risk (Zhou et al. 2010). Depending on the profile of the market participant and their willingness to bear risk, there are different types of funds. This makes it possible to choose the most appropriate one for an investor's profile and risk abilities (Jagric et al. 2007). Funds can also be treated as an instrument for diversifying investments (Bello 2005; Shy and Stenbacka 2003) because purchasing assets in domestic and foreign markets minimises the risk (Zaimović and Berilo

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2015; Zaimović et al. 2017).

Regarding an aggressive investment policy, hence a high risk one, equity funds are the most appropriate. They invest up to 100% of their assets in stocks. Most often, however, management decisions are focused on following the appropriate benchmark, which is the index indicated in the prospectus. Therefore, there is a relationship between the value of fund participation units and the rates of return of stock indices. This relationship is two-way, often with various types of time shifts. Such short-term relationships between equity funds and market indices have been published for the period 2003-2017 (Matuszewska-Janica et al. 2019). The results clearly showed that the valuation of equity fund units is influenced by changes in stock indices (which are the basis for the fund's benchmark). This is in line with expectations, as movement in stock prices on the stock market drives the fund's portfolio value. On the other hand, there are also opposite relationships - changes in the prices of fund units may also contribute to changes in index quotations. It is related, among other things, however, many funds (especially those with high capitalization) have little flexibility regarding market changes. Witkowska and Kompa (2010) note that significant changes in the composition of portfolios are recorded by investors, which results in swings in the prices of securities and market turmoil. This is especially evident in short-term relationships.

Therefore, the question arose: What are the long-term relationships between the valuation of fund units and the benchmark represented by the stock exchange index? The analysis bases on the example of the Polish capital market (Warsaw Stock Exchange - WSE). This market is treated as one of the most developed and largest in the Central and East Europe (Pop 2020). Therefore, trends on this stock exchange can be considered as a benchmark for the other stock exchanges in the region, in particular the increased integration of financial markets as indicated by Hung (2020).

Often, due to the aforementioned inability to move assets quickly we expect no common trend, especially because the analysis covers quite a long period (18 years) that included several shifts in the stock market conditions. Maintaining a common long-term path in times of change is very difficult, particularly if there were several such changes. The importance of this can be considered in two aspects: cognitive and practical. A common long-term path means that a fund's portfolio flexibly adjusts to market movements over the long term. From an investment perspective, when assessing the management of a fund, we also look at the fund in terms of risk diversification. Portfolios that do not follow (or not have) a common long-term path may be of interest to those seeking risk diversification. Of course, other criteria should also be considered in such a search.

The analysis used the most popular method for studying long-term relationships, the Johansen procedure (Johansen 1988). The data included end of week quotations of fund units from 2004 to 2021 (940 observations). The cointegration results can give indications about the local market and can be used to diversify an investment by linking it to an international market. International diversification among the markets under analysis brings additional risk reduction (Zaimović and Berilo 2015).

The article has the following structure. The introductory part is followed by a literature review in section 1. Section 2 is devoted to the market of investment funds in Poland and the characteristics of the analysed funds. Section 3 describes the methods used in the study. Sections 4 and 5 contain the presentation and the discussion of the results. The study ends with the conclusion.

2. Literature review

The relationship characterizing the capital market can be divided into short-term and long-term ones. Concerning the study of short-term relationships, the Granger causality test and its various variants is primarily used. In addition, a regression model and correlation analysis are also considered. Long-term research is based on the concept of cointegration (see Granger 1981; Engle and Granger 1987 and 1991).

The analysis of short and long-term dependencies takes place at multiple levels, i.e. between markets of different countries (Pynnonen and Knif 1998; Gilmore and McManus 2002; Égert and Kočenda 2007; Golab et al. 2018) or of the same country (Patra and Poshakwale 2008; Ning et al. 2019). The relationship between capital markets is also examined in the framework of market integration (Maneschiöld 2006; Horobet and Lupu 2009).

Within a country, the relationship between individual sectors or between sectors and the market is also examined. An analysis of correlations between sectors was conducted by Fasnacht and Loeberge (2007), Meric et al. (2008) or Cao et al. (2013), among others. The results of Fasnacht and Loeberge (2007) and Meric et al. (2008) pointed to the existence of greater stability between sectors of different countries than between sectors of the same country. On the other hand, Cao, Long and Yang (2013) did not notice any correlation while studying the Chinese and international markets.

Research on the relationship between sectors in a given market or between a market index and sectors has been carried out by Nagendra et al. (2014) and Kurisetti et al. (2018), for example. The former group studied the Indian market from 2006 to 2010. Research for the NSE market was conducted by the latter group using the Granger test and the error correction model (ECM).

Regarding investment funds, much less research is available on short- or long-term relationships. The study of long-term relationships between funds and the market using the cointegration analysis can be found by Pojanavatee (2014), Hossain et al. (2012), (Matallin and Niero 2002) or (Low and Ghazali, 2007). Pojanavatee (2014), while examining equity mutual funds in Australia, points to the existence of a long-term relationship between funds and the S&P / ASX All Ordinaries Index, which includes the 500 largest companies. The Johansen and Juselius procedure and the VECM model were used in the research. Their results lead to the conclusion that investing in equity funds on the Australian market is tantamount to investing in the stock exchange. Hossain et al. (2012), studing the daily rates of return of fund participation units and the Dhaka Stock Exchange index also indicates the existence of cointegration. They applied the Johansen procedure in their research. On the other hand, Matallin and Nieto (2002) did not find a long-term relationship when examining the relationship between the Spanish stock exchange and investment funds. Similarly, Low and Ghazali (2007), who found no long-term relationship between the Malaysia stock index and investment funds.

Concerning the Polish equity market, the research mainly provides analysis of the dependence of the Polish market on European markets or the American market. Such studies have been carried out by Dudek (2009), Augustyński (2011), and Gluzicka (2013), among others. Short-term relationships between the WSE indices can be found in Żebrowska-Suchodolska and Karpio (2019). They only observed a correlation between the food sector and the market represented by small companies (sWIG80). This is also confirmed by a multiple regression model of the WIG-food index using the WIG, WIG20, mWIG40 and sWIG80 indices. Regarding research on funds, it is worth mentioning the study by Bołt and Zamojska (2007). They carried out an analysis of monthly assets of investment funds in the period 1997-2006. The Johansen procedure and VECM models were used in the research.

In research on the Polish market, funds are mainly analysed in the context of their efficiency (Witkowska 2009; Perez 2012; Zamojska 2012; Miziołek and Trzebiński 2018) or market timing (Olbryś 2008, 2010; Węgrzyn 2015; Witkowska et al. 2009; Jamróz 2011; Żebrowska-Suchodolska and Karpio 2020).

Due to the lack of research on the existence of long-term correlations for equity mutual funds on the Polish market, the authors wanted to fill the existing gap in the literature. It is also a continuation of the authors research on the existence of short-term dependencies (Matuszewska-Janica et al. 2019).

3. The characteristics of the investment fund market in Poland and analysed funds

Investment funds have been operating in Poland for 28 years. The first fund was established in 1992, called the First Polish-American Pioneer Trust Fund. Over the past 18 years, investment fund units accounted for approximately 10% of Poles financial assets. Comparing the fund market in Poland to the European market, this share is not large and amounts to approximately 0.5%. In 2018, however, it fell to 0.41% from 0.44% in 2017. This decline was noticeable despite the overall decline in fund assets in most European countries. Concerning Poland, the decrease in the share was caused by the depreciation of the currency and the relatively small proportion of shares among the funds assets. The value for assets *per capita* in Poland, which amount to EUR 1.600, is the second highest among the so-called New Europe countries. The dynamics of this indicator have been close to the European average and over the last five years assets have increased on average by 5.7% which is close to the nominal GDP growth rate.

The Act on investment funds and the management of alternative investment funds of 27 May 2004 divides funds into open investment funds, specialised open investment funds and closed funds. A more detailed division was made by the Fund and Asset Management Chamber, which divided the funds according to the target criterion into equity funds, mixed (balanced) funds, debt funds, money market funds, absolute rate of return, raw materials, non-public assets, real estate and securitisation funds. Equity funds invest up to 100% of their assets in equities, while mixed funds balance both equities and bonds in their portfolio. The proportion of shares in the portfolio of balanced funds is in the range of 40%-60%. Debt funds mainly invest in bonds, while money market funds invest mainly in money market securities, i.e. treasury bills. Non-public asset funds are closed-end funds or specialised open-ended investment funds investing in assets other than securities offered to

the public or traded on a regulated market as well as money market instruments.

In the investment fund market, the largest group is funds of non-public assets (Table 1). However, these are not open-ended funds, they are not within the scope of this paper. Stock funds are ranked fourth here. Over the past six years, their share of overall assets has been falling. The years 2017 and 2021 were exceptions, though. In 2018, the asset value of equity funds fell by 22 percent, bringing their market share to 10.2 per cent. This result was influenced by both net outflows and falling share prices. In 2021, the funds returned to 2018 levels.

Five years in a row, in the case of equity funds, there was a net outflow of resources (Table 2). This was due to the poor results of some companies, the withdrawal of funds from one of the companies and the COVID-19 pandemic. At the start of the pandemic, there was a reduction in net asset value and a shift of funds to less risky assets. The strong initial reaction was followed by a return to riskier assets.

The subject of the research was 15 open share funds in the period from 2004 to 2021 (Table 3). This is how many equity funds existed throughout the study period. Most of them are universal funds, while two are classified as funds of small and medium-sized companies. They are the Investor Top 25 Small Companies and Rockbridge Small and Medium Companies. Additionally. the indices WIG. WIG20. mWIG40 and sWIG80 were adopted for the research. The choice of these indices was dictated by the fact that the aforementioned funds invest mostly in shares from these indices. Table 3 also presents the breakdown of the portfolio of these funds.

The largest share in the portfolio of universal funds were large companies listed in the WIG20 index. The maximum share was 59.81%, held by the Aviva Investors Polish Shares fund. The smallest share in the portfolio was found for equity funds investing in small and medium-sized companies. These were funds from the Investor Top 25 Small Caps and Rockbridge Small and Medium Caps. In this case, it is understandable that the share of assets in the WIG20 index for these funds is small. However, the Investor Shares fund, classified as universal funds, is thoroughly different as it has a different structure of assets in its portfolio

Table 1. The percentage of the share of funds in the structure of assets

Fund type	2013	2014	2015	2016	2017	2018	2019	2020	2021
shares	16.4	14.2	12.8	11.6	12.2	10.2	9.5	9.9	10.3
debt	16.7	19.1	14.9	15.8	16.3	17.3	22.5	22.2	18
mixed	18.8	16.7	14.4	11.4	12.4	12	11.1	12.4	10.6
money market	12.4	14.6	13.1	13.6	15.8	22.7	19.5	18	15.7
absolute rateof return	2.9	2.8	3	4.2	4.3	2.7	2.1	1.9	2.1
raw materials	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.6	0.9
non-public assets	29.9	29.6	38.8	39.9	35.9	32.1	32	32.5	33.7
real estate	1.5	1.9	2	2.3	1.9	1.9	2	1.9	1.5
securitization	1.3	1	0.7	0.8	0.9	0.9	0.8	0.8	0.2

Source: own study based on the Chamber of Fund and Asset Management

Table 2. Annual net inflow of funds to particular types of funds in PLN billion

Fund type	2013	2014	2015	2016	2017	2018	2019	2020	2021
shares	8.60	-0.90	3.90	-4.20	-0.50	-3.60	-2.40	-0.35	7.12
debt	6.80	5.70	-2.30	2.60	3.80	-2.60	8.5	-0.30	-5.68
mixed	5.50	-1.40	1.60	-7.50	3.40	-2.10	-1.4	3.50	4.28
money market	12.60	6.30	2.60	1.00	7.60	13.10	-2.3	-2.41	-2.40
absolute rate of return	2.20	0.10	1.40	2.70	0.60	-4.30	-1.6	-0.14	0.83
raw materials	0.00	0.10	0.20	0.40	-0.10	-0.10	0.032	0.52	1.19

Source: own study.

Table 3. Analysed funds: declared fund benchmark and portfolio composition as of December 2018*

No.	Fund name	Declared fund benchmark	Fund Short cut	WIG20	mWIG40	sWIG80	Other assets
1	Aviva Investors Polskich Akcji Aviva Investors Polish Shares	90% WIG + 10% FTSE PLN 3 Month Eurodeposit Local Currency	Aviva	59.81	14.18	11.11	14.90
2	Esaliens Akcji Esaliens Shares	100% WIG	Esaliens	45.04	14.81	5.94	34.21
3	Generali Korona Akcje Generali Korona Shares	90% WIG + 10% WIBID 12M	UniKor	48.73	23.35	6.50	21.42
4	Investor Akcji Investor Shares	90% WIG + 10% WIBID 6M	Investor1	13.97	21.85	11.61	52.56
5	Investor Akcji Spółek Dywidendowych Investor Shares of Dividend Companies	90% WIG + 10% WIBID 6M	Investor2	31.92	23.03	5.20	39.85
6	Investor Top 25 Małych Spółek (Investor Top 25 Small Companies)	80% Investor MS + 20% WIBID 6M	InvestorT	9.12	25.98	22.01	42.89
7	Millennium Akcji Millennium Shares	No benchmark	Millennium	49.21	14.34	8.01	28.44
8	NN Akcji NN Shares	100% WIG	NN	57.31	22.40	6.14	14.15
9	Novo Akcji Novo Shares	100% WIG minus management costs	Novo	41.17	11.30	9.56	37.97
10	Pekao Akcji Polskich Pekao Polish Shares	80% WIG + 10% MSCI Europe + 10% WIBID 1M	Pekao	55.49	16.71	4.29	23.51
11	PZU Akcji Krakowiak PZU Krakowiak Shares	90% WIG + 10% WIBID 1M	PZU	53.80	18.69	4.06	23.45
12	Rockbridge Akcji Rockbridge Shares	95% WIG + 5% WIBID 3M	Rock1	55.34	13.80	10.38	20.48
13	Rockbridge Małych i Średnich Spółek Rockbridge Small and Medium Companies	90% mWIG40 + 10% POLONIA	Rock2	4.21	58.21	21.18	16.40
14	Santander Akcji Santander Shares	95% WIG + 5% WIBID O/N	Santander	56.59	22.64	5.83	14.94
15	Skarbiec Akcja Skarbiec Share	90% WIG20 + 10% WIBID 3M minus fixe cost	Skarbiec	54.75	5.66	0.43	39.16

* Latest available data

Source: Authors' own study based on Analizy.pl and bankier.pl

than other funds in this category. Apart from large companies, equity funds also include medium-sized and small companies in their portfolio. Their share in the portfolio of universal funds was a maximum of 23.35%, and for equity funds of small and medium-sized companies -was 58.21%. The share of funds in small companies amounted to a maximum of 11.61% and 21.18%, for universal funds and small and medium-sized companies, respectively. In addition, the funds' portfolios include stocks that are not included in the indices listed. Their share ranged from 14.15% to 52.56%.

4. Methods

It is worth noting that methods for exploring long-term relationships are widely used in not only financial analysis (e.g. (Fabozzi 2006; Matuszewska-Janica 2011; Witkowska et al. 2012 Gulzar et al. 2019; İskenderoglu and Akdağ 2020), including mutual funds: (Matallin and Nieto 2002; Pojanavatee 2014)) but also in macroeconomic analyses (e.g., Bilas et al. 2017; Pasovic and Efendic 2018; Škare et al. 2020). The Johansen tests constitute one of these tools. It is applied in the analysis of non-stationary time series integrated at the same order (Charemza and Deadman 1992). We also applied the augmented Dickey-Fuller test (Enders 2010) to check the integration level of time series in the analysis.

Johansen's method is based on the vector error correction model (VECM: Charemza and Deadman 1992; Enders 2010; Luthkepohl 2013). The formula of the model is as follows (with the assumption that all variables included in the model are integrated in the first degree):

$$\Delta Z_t = CD_t + \sum_{i=1}^{k-1} \Gamma_i \Delta Z_{t-i} + \Pi Z_{t-k} + \varepsilon_t \quad (1)$$

where: Z_t - is a vector of considered n not-lagged variables, ΔZ_t – is a vector of first differences of Z_t, D_t – deterministic variables; they are usually intercept or/and trend (this type of variable is omitted when deterministic components are absence in the model) C, Γ_i, Π - parameters of the model, ε_t - error terms.

The Π matrix is special because it is the basis for inference about the cointegration of the time series under study. It should also be mentioned that the VECM model is a transformation of the vector autoregression model (VAR: Luthkepohl 2013; Charemza and Deadman 1992). The lag order can be determined based on the information criteria like Akaike (AIC), Schwarz (BIC) or Hannan-Quinn (HQ), (i.e., Pilatowska 2010).

The Johansen method allows the researcher to not only identify long-term relationships, but also to determine the number of co-integrating vectors (r), that is, the number of the linear combinations (in the basic case) of variables whose relation is stationary. The maximum number of co-integrating vectors that can occur in a given system of variables is n (n is also the number of variables in the system). The different potential results are interpreted as follows:

- $r = 0$ – no long-term relationship exists;
- $r = n$ – there is a strict long-term relationship; and
- $0 < r < n$ – there is a long-term equilibrium with disturbance in the short term.

We can use two tests in the Johansen procedure: the trace test and the maximum eigenvalue test. It happens that both tests can give different results. In the analysis presented here we have established, following Enders (2010, p. 392), that we will take the indications of the maximum eigenvalue value test. We start with the verification of the hypotheses $H_0 : r = 0$ vs $H_1 : r = 1$. If we do not reject H_0 we conclude that there is no cointegration between the analysed variables. If we reject H_0 in favour of H_1, the next step is to verify the following hypotheses: $H_0 : r = 1$ vs $H_1 : r = 2$. We repeat the testing procedure until H_0 is not rejected or until we reject H_0 in favour of $H_1 : r = n$. The construction of the test statistics of the maximum eigenvalue value test is as follows:

$$\lambda_{max}(r, r+1) = -Tln(1-\lambda_{r+1}) \quad (2)$$

where: T – number of observations. λ_1. .... λ_n – eigenvalues of Π matrix settled in descending order. Statistics λ_{max} is calculated for each λ_{r+1} (for r+1=1.... n).

When we construct a VECM, the deterministic variables can influence the results. Therefore, five cases are considered: P1 - no intercept and no trend in the model; P2 - the model contains the intercept that is represented in the co-integrating vector (restricted intercept); P3 - the model contains an intercept that is not represented in the co-integrating vector (unrestricted intercept); P4 - the model contains the linear trend that is represented in the co-integrating vector (restricted trend); and P5 - the model contains a linear trend that is not represented in the co-integrating vector (unrestricted trend).

When the deterministic variables are included in the model, the cases P2 and P3 as well as P4 and P5 should be distinguished. For this purpose, both versions of the model should be estimated - with the deterministic factor outside the cointegrating vector and the deterministic factor included in the co-integrating vector. Then we calculate the eigenvalues of the matrix Π for both models and use the LR test (Enders 2010. p. 393), where the hypotheses are as follows:

H_0: The deterministic component is restricted to the cointegrating vector (we include trend in the co-integrating vector [the preferred model is P4] /or we include the intercept in the co-integrating vector P2).

H_1: The deterministic component is not restricted to the co-integrating vector (trend is outside the co-integating vector P5 / and the intercept is outside co-integating vector P3).

When we consider a trend in the model, the hypotheses are reported in Table A2 as follows: H0:P4 vs.

H1:P5. In turn, when we consider the intercept, the hypotheses are reported in the following form: H0:P2 vs. H1:P3. The test statistic is calculated using formula (3):

$$LR_1 - T \sum_{i=r+1}^{n} [ln(1-\lambda_i^*) - ln(1-\lambda_i)] \quad (3)$$

where: λ_1. .... λ_n – eigenvalues of unrestricted Π matrix (taken from model P5 or P3) settled in descending order; λ_1^*. .... λ_n^* – eigenvalues of restricted Π matrix (taken from model P4 or P2 – the deterministic component is restricted to the co-integrating vector) settled in descending order.

Statistics LR_1 is $\chi^2(n\text{-}r)$ distributed. In the test, we assume that values $\ln(1\text{-}\lambda_i^*)$ and $\ln(1\text{-}\lambda_i)$, should be equal if the restriction can be rejected.

While selecting a model (P5/P4/P3/P2/P1), the choice between models P4 and P3 and P2 and P1 is also considered. This means that we test the restriction on the deterministic component present in the co-integrating vector.

H_0: Restriction concerning deterministic component is not binding (trend in the co-integrating vector - the preferred model is P4/ intercept in the co-integrating vector (P2)

H_1: Restriction concerning deterministic component is binding (we remove trend from the co-integrating vector - P3/or we remove the intercept from the co-integrating vector (P1)

In Table A2, the results for these tests are labelled H0:P4 vs H1:P3 when comparing models P4 and P3 and H_0:P2 vs H_1:P1 when comparing models P2 and P1. The test statistic is as follows (see Enders 2010, p. 394):

$$LR_2 - T \sum_{i=1}^{r} [ln(1-\lambda_i^*) - ln(1-\lambda_i)] \quad (4)$$

where: λ_1. .... λ_n – eigenvalues of Π matrix in unrestricted model (taken from model P4 or P2) settled in descending order; λ_1^*. .... λ_n^* – eigenvalues of Π matrix in restricted model (taken from model P3 or P1) settled in descending order.

We use R package for VAR lag selection and to conduct the Johansen test. In turn, model selection tests (among P5/P4/P3/P2/P1) are performed using Excel.

5. Results

As mentioned earlier, the main aim of the analysis is to test whether there is a long-term relationship (using Johansen's method) between mutual funds and the stock market indices which are benchmarks for these funds. As funds are generally considered long-term investments, our analysis covered a long period: from 2004 to 2021 (weekly data over 18 years, totalling 940 observations). We analyse the logarithmic values of index quotations and fund unit valuations from the end of each week. All series analysed were non-stationary and integrated at level one I(1).

We estimated the parameters of five types of models, P1/P2/P3/P4/P5 (*Methods* section) for each pair of series (FIO - Index, 60 pairs of time series in total) in order to automate the analysis in the first stage. The results (p-values obtained for the Johansen maximum eigenvalue test with $H_0 : r = 0$) are presented in Tables A1 and A2. The next step was the selection of cases (pairs of series), where $H_0 : r = 0$ was rejected at the significance level of 0.05 (for at least one of the model). These cases are bolded in the Tables A1 and A2. In cases we rejected $H_0 : r = 0$, the next step was to test the following set of hypotheses: $H_0 : r = 1$ and $H_1 : r = 2$. In our analysis we did not have to reject $H_0 : r = 0$, so for the analysed pairs of series we are dealing with at most one cointegrating vector.

The results indicate that most of the funds are not co-integrated with the indices, so there is no long-term relationship between them. We separately analysed each FIO-index pair for which at least in one case $H_0 : r = 0$ was rejected in order to select one model applying the LR_1 and LR_2 tests.

For the 15 analysed FIO-WIG pairs, $H_0 : r = 0$ was rejected in five cases. The results (p-values) used for the model comparisons (P4 vs P5, P4 vs P3, P2 vs P3 and P2 vs P1) are presented in Table A2. When, in the model defined by formula (1), the parameter at the trend was statistically significant, we started comparing the models by verifying the hypotheses H0:P4 vs H1:P5. This refers to pairs Novo-WIG, Pekao-WIG and PZU-WIG. In all these cases, the LR_1 test indicated model P4. In the next step, the hypotheses H0:P4 vs H1:P5 (with statistic LR_2) were verified. The results indicated P4 for all mentioned pairs. It should be noted that in the LR_1 and LR_2 tests, the result depends on how many potential cointegrating vectors may be found in the tested models. We followed the rule that if in both tested models $H_0 : r = 0$ was rejected in the maximum eigenvalue test, then in the LR_1 and LR_2 tests we adopted the version for $r = 0$. In turn, when at least for one of the verified models we reject $H_0 : r = 0$ in the maximum eigenvalue test, we verified the hypotheses for r=1 in the LR_1 and LR_2 tests. The results used in the selection process are bolded in Table A2. As mentioned, for the pairs Novo-WIG, Pekao-WIG and PZU-WIG, the LR_1 and LR_2 tests indicated the model P4. In turn, the results presented in Table A1 precluded

rejection of the hypothesis of lack of co-integration for these models and the above-mentioned FIO-WIG pairs. In other words, these pairs of time series are not co-integrated. For the other two FIO-WIG pairs Rock2-WIG and UniKor-WIG, in model 1 the parameter at the trend was not significant. Therefore, we started the model comparison by testing the hypotheses H_0:P2 vs H_1:P3 (the comparison of models P4 and P5 and P4 and P3 is omitted).

For Rock2-WIG, the preferred model was P1, while for UniKor-WIG, the preferred model was P2. Looking at the results presented in Table A1, at a significance level of 0.05 only for Rock2-WIG can we conclude the existence of a cointegrating relationship.

The selection of results for the remaining pairs of time series (FIO-WIG20, FIO-mWIG40 and FIO-sWIG80) was performed by analogy. The results considered in the selection process are bolded in Table A2. Finally, the existence of co-integration relationships was confirmed for pairs of series: Rock2-WIG20, Rock2-mWIG40, Rock2-sWIG80 and Pekao-sWIG80. It is worth noting that the Rockbridge Small and Medium Companies fund (Rock2) was co-integrated with all four analysed indices. In turn, Pekao demonstrated a long-term relationship only with the sWIG80 index.

6. Discussion of results

We observed many changes in the situation on the stock market during the period under review (2004-2021). Adjusting to a benchmark is difficult in times of economic fluctuations. It is worth noting the fact that the compositions of FIO portfolios do not reflect the composition of the market portfolio. Funds' selection strategies are individual and do not have to imitate the benchmark portfolio, which may result in a slightly different reaction in the long run than those seen on the main market. Moreover, funds, especially those with high capitalization, are characterised by little flexibility in adjusting portfolio changes to market changes, as noted by Witkowska and Kompa (2010). They indicate that significant changes in the composition of the portfolio are recorded by investors, which results in swings in the prices of securities and market turmoil. It is especially visible in short-term relationships (see e.g., Matuszewska-Janica et al. 2019), where the relation between fund and index is bidirectional. Changes in index quotations are the cause of changes (in Granger's meaning) in the prices of funds units and vice versa: changes in the prices of funds units contribute to changes in index quotations. In turn, this may result in imbalances in long-term relationships, to such an extent that the disturbed relationship can no longer return to its long-term path. It is also worth noting that in the analysed period this equilibrium could have been disturbed several times (in periods of changes in the trend structure, such as economic changes or the pandemic; see (Okičić 2014 or Sitima and Hlatywayo 2014).

The only fund that shows a strong relationship with the equity market of Poland is the Rockbridge Small and Medium Companies. In this case, we find that during the study period it demonstrated long-term relationships with all four analysed indices: the WIG, WIG20, mWIG40 and sWIG80. It is worth noting that according to the latest available data (see Table 3) almost 80% of the fund's portfolio consisted of shares of medium-sized and small companies (listed respectively in the mWIG40 index (over 58%) and in the sWIG80 index (over 21%), and only 4.2% of the companies listed in the WIG20 (the lowest among all funds). The second of the funds with a large proportion of shares of medium-sized and small companies was the Investor Top 25 Small Companies, though it comprised only about 48% of such companies, substantially than the corresponding percentage of the Rockbridge Small and Medium Companies. The presence of a long-term relationship (co-integration) between this fund (Rocks) and the market can be explained by the fact that this fund can respond more flexibly to market changes. Firstly, it is much smaller (its net asset value was less than PLN 60 million in March 2022, see also data presented in Matuszewska-Janica et al. 2019, Figure 1). Secondly, its portfolio is based on the medium-sized and small companies listed in the mWIG40 and sWIG80 indices. It may be easier and more efficient to reallocate a smaller proportion of capital in segments of the WSE other than those in which the largest companies are listed. The ability of this fund's managers to respond to market changes has been confirmed by market-timing analysis (see Żebrowska-Suchodolska and Karpio 2020).

The unexpected result here is the co-integration of Pekao with the sWIG80 index, which is surprising because over 50% of Pekao's shares are listed in the WIG20 index, while only about 4.3% are listed in sWIG80 index. However, we should treat this result with caution because the p-value for the Johansen maximal eigenvalue test was 0.043, meaning that the value only slightly exceeds the critical value. Therefore, we consider the question of the actual co-integration of the Pekao fund and the sWIG80 index to remain open.

7. Conclusion

The aim of the analysis is to determine whether there are long-term relationships (co-integration) between the valuation of investment fund units and stock market indices, which most often are the benchmarks of these funds. The Johansen method is applied as the main tool. The empirical analysis covers weekly data for the funds and the main stock indices (representing benchmarks) quoted on the Warsaw Stock Exchange (WSE) in years 2004-2021. As mentioned before, WSE is one of the biggest and most developed stock exchanges in the CEE region (Pop 2020). Moreover, considering the fact of significant integration of financial markets of this region (Hung 2020), we can treat the processes observed on the WSE (including the formation of long-term relations) as a benchmark for other stock exchanges of the region.

The results indicate the lack of long-term relationships between the quotations of the selected indices and the vast majority of the funds under study. The findings are similar to those obtained by Matallin and Niero (2002) or Low and Ghazal (2007). Such a result may be because a very long period was included in the analysis, during which the stock market trends changed more than once. In long-term relationships, this may result in imbalances from which a relationship disturbed to such an extent can no longer return to its long-term path. On the other hand, when examining the relationship between funds and indices, the prevalence of co-integration was noted only in the case of two funds. While the long-term relationship between one fund (Rockbridge Small and Medium Companies) and the four main indices of the WSE was strongly confirmed by the results of Johansen's test, the significance of the relationship between the second one (Pekao Polish Shares) and the WIG80 was on the verge of significance. It should be mentioned that the fund that demonstrates significant cointegration with the equity market is one of the funds with the smallest capitalization and to the greatest extent (of all those analysed) investing in small and medium-sized companies. Thus, it may be perceived as more flexible in responding to market changes.

It is worth pointing out that the compositions of these funds' portfolios do not reflect the composition of the market portfolio. The funds portfolio selection strategies are individual and do not have to imitate the benchmark portfolio. This may result in a slightly different reaction in the long run than those seen on the main market. Moreover, funds (especially large ones) are characterised by little flexibility in adjusting portfolio changes to the changes taking place in the main market (see e.g., Witkowska and Kompa 2010). Related to smaller company markets, funds can react more flexibly, mainly due to their ability to move assets faster than the largest companies. This is confirmed, for example, by the lack of market timing from 2003 to 2017 for most of the equity funds studied by Żebrowska-Suchodolska and Karpio (2020). Even in those cases where the coefficients responsible for market timing and selectivity were statistically significant, they had low values. Therefore, the managers showed only a negligible ability to selectively select assets for the portfolio.

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Appendix

Table A1. Results of Johansen maximum eigenvalue test – *p*-values obtained under H_0:r=0 verification

	WIG					WIG20				
	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5
Aviva	0.291	0.572	0.457	0.735	0.571	0.253	0.284	0.240	0.516	0.343
Esaliens	0.108	0.392	0.390	0.598	0.429	0.085	0.355	0.262	0.664	0.444
Investor1	0.945	0.367	0.264	0.675	0.629	**0.038**	0.109	0.253	0.574	0.378
Investor2	0.852	0.455	0.343	0.690	0.541	0.382	0.317	0.273	0.582	0.396
InvestorT	0.856	0.361	0.352	0.534	0.437	0.969	0.569	0.410	0.487	0.362
Millenium	**0.049**	0.091	0.390	0.465	0.346	0.824	0.470	0.329	0.528	0.359
NN	0.598	0.349	0.449	0.569	0.369	0.394	0.231	0.244	0.486	0.306
Novo	**0.023**	**0.025**	0.179	0.524	0.336	0.664	0.380	0.283	0.593	0.399
Pekao	**0.000**	**0.000**	0.326	0.709	0.533	0.615	0.225	0.134	0.479	0.294
PZU	**0.000**	**0.002**	0.350	0.763	0.655	0.910	0.389	0.260	0.583	0.398
Rock1	0.592	0.421	0.331	0.700	0.514	0.380	0.364	0.296	0.479	0.310
Rock2	**0.020**	**0.035**	0.102	0.237	0.291	0.200	0.588	0.445	0.401	0.388
Santander	0.157	0.378	0.249	0.647	0.499	**0.007**	**0.048**	0.082	0.318	0.235
UniKor	**0.020**	0.089	0.086	0.296	0.287	**0.005**	**0.012**	0.183	0.567	0.421
Skarbiec	0.162	0.355	0.262	0.680	0.524	0.250	0.186	0.192	0.441	0.281
	mWIG40					sWIG80				
	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5
Aviva	0.352	0.514	0.476	0.738	0.542	0.367	0.237	0.274	0.640	0.539
Esaliens	0.596	0.401	0.368	0.762	0.553	0.050	0.115	0.094	0.384	0.299
Investor1	0.954	0.765	0.676	0.935	0.830	0.354	0.186	0.192	0.587	0.644
Investor2	0.833	0.706	0.572	0.902	0.806	0.896	0.205	0.206	0.611	0.639
InvestorT	0.868	0.382	0.405	0.569	0.477	0.214	**0.005**	**0.018**	0.120	0.372
Millenium	0.636	0.497	0.391	0.596	0.399	0.087	0.155	0.308	0.639	0.588
NN	0.547	0.515	0.391	0.743	0.523	0.110	0.188	0.250	0.635	0.618
Novo	0.364	0.195	0.273	0.602	0.405	0.439	0.051	0.103	0.318	**0.000**
Pekao	**0.039**	0.071	0.547	0.912	0.776	**0.043**	**0.034**	0.258	0.634	0.621
PZU	0.122	0.272	0.405	0.621	0.534	0.167	**0.044**	0.172	0.490	0.372
Rock1	0.922	0.444	0.357	0.645	0.494	0.598	0.255	0.259	0.685	0.517
Rock2	**0.005**	**0.031**	0.113	0.116	0.124	**0.001**	**0.001**	**0.008**	**0.046**	0.135
Santander	0.259	0.307	0.245	0.594	0.463	0.219	0.216	0.224	0.587	0.425
UniKor	0.102	0.197	0.179	0.448	0.347	0.250	0.284	0.344	0.519	0.387
Skarbiec	0.893	0.290	0.228	0.643	0.477	0.331	0.159	0.160	0.531	0.379

Source: Own calculation in the R package.

Table A2. Results of model selection – *p*-values of LR_1 and LR_2 tests

Funds	For	H0:P4 vs H1:P5	H0:P4 vs H1:P3	H0:P2 vs H1:P3	H0:P2 vs H1:P1	Trend / Model selection
WIG						
Novo	r=0	**0.4757**	**0.5116**	0.0032	0.0328	Yes
	r=1	0.2650	0.0607	0.0325	0.0129	P4
Pekao	r=0	**0.0854**	**0.4588**	0.0000	0.0977	Yes
	r=1	0.0348	0.4499	**0.0567**	**0.0107**	P4
PZU	r=0	**0.1172**	**0.6213**	0.0000	0.8232	Yes
	r=1	0.0715	0.1262	**0.0124**	**0.0179**	P4
Rock2	r=0	0.2088	0.1413	0.0932	0.0627	No
	r=1	0.7718	0.2056	**0.6090**	**0.0202**	P1
UniKor	r=0	0.2928	0.3587	**0.3839**	0.3086	No
	r=1	0.5810	0.2580	0.5545	**0.1073**	P2
WIG20						
Inv_Dyw	r=0	**0.0175**	**0.3122**	**0.0301**	0.1706	Yes
	r=1	0.0050	0.1182	0.0935	**0.0097**	P5
Rock2	r=0	0.3053	0.0280	0.8562	0.8250	No
	r=1	0.6096	0.0855	**0.8572**	**0.0270**	P1
Santander	r=0	**0.5211**	**0.5079**	0.1138	0.5196	Yes
	r=1	0.6819	0.0960	0.2567	0.1668	P4
mWIG40						
Pekao	r=0	0.6888	0.8150	**0.0029**	0.0783	No
	r=1	0.4778	0.5872	0.0650	**0.0320**	P3
Rock2	r=0	0.2868	0.0279	0.0517	0.4002	No
	r=1	0.9219	0.0646	**0.3420**	**0.0917**	P2
sWIG80						
InvestorT	r=0	0.0191	0.9450	0.0912	0.0002	No
	r=1	0.2077	0.4281	**0.8538**	**0.0007**	P1
Novo	r=0	0.5793	0.2999	0.0624	0.0013	Yes
	r=1	**0.8331**	**0.0668**	0.1559	0.0018	P4
PZU	r=0	**0.5829**	**0.4238**	0.0138	0.0049	Yes
	r=1	0.7727	0.0706	**0.0747**	**0.0037**	P4
Rock2	r=0	0.0654	0.3812	0.0334	0.0371	No
	r=1	0.9164	0.6002	**0.7026**	**0.0097**	P1
Pekao	r=0	0.2316	0.4783	0.0112	0.0222	No
	r=1	0.3451	0.5086	**0.2003**	**0.0096**	P1

Source: Own calculation.