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THREE-FACTOR MARKET-TIMING MODELS WITH FAMA AND FRENCH'S SPREAD VARIABLES[1]

The traditional performance measurement literature has attempted to distinguish security selection, or stock-picking ability, from market-timing, or the ability to predict overall market returns. However, the literature finds that it is not easy to separate ability into such dichotomous categories. Some researchers have developed models that allow the decomposition of manager performance into market-timing and selectivity skills. The main goal of this paper is to present modified versions of classic market-timing models with Fama and French's spread variables *SMB* and *HML*, in the case of Polish equity mutual funds.

Keywords: *mutual funds, performance evaluation, market-timing, selectivity, mimicking portfolios*

1. Introduction

FAMA and FRENCH [6] found that two variables, the market value (*MV*) and the book value to market value ratio (*BV*/*MV*) capture much of the cross-section of average stock returns. They report that "(...) *firms that have high BV/MV (a low stock price relative to book value) tend to have low earnings on assets, and the low earnings persist for at least five years before and five years after book-to-market equity is measured. Conversely, low BV/MV (a high stock price relative to book value) is associated with persistently high earnings. Size is also related to profitability. Controlling for book-to-market equity, small firms tend to have lower earnings on assets than big firms*" [7, pp. 7–8].

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In 1993, FAMA and FRENCH [7] formed portfolios meant to mimic the underlying risk factors in returns related to size and book-to-market equity. These mimicking portfolios are introduced as explanatory variables into regressions of stock excess returns. Fama and French examined regressions that use the following explanatory variables:

- $R_{m.} - R_F$ – the *market* factor (i.e. the excess return on market portfolio *M*) or suitable orthogonalized market factor,
- *SMB* (*small minus big*) – the *size* factor,
- *HML* (*high minus low*) – the *book-to-market* factor.

In 1972 FAMA [5] suggested that the portfolio manager's forecasting ability could be split into two separate activities: microforecasting (which is referred to in the literature as selectivity) and macroforecasting (which is referred to in literature as market-timing). Classical performance measurement literature has attempted to distinguish security selection, or stock-picking ability, from market-timing, or the ability to predict overall market returns. However, the literature indicates that it is not easy to separate ability into such dichotomous categories. The goal of this paper is to present modified market-timing models with Fama and French's spread variables *SMB* and *HML*.

The paper is organized as follows. Chapter 2 provides a brief overview of the Fama and French procedure of constructing a mimicking portfolio based on Polish companies listed on the Warsaw Stock Exchange. In Chapter 3 the classic parametric T–M (TREYNOR–MAZUY [27]) and H–M (HENRIKSSON–MERTON [11]) market-timing models are tested in the case of 15 Polish equity open-end mutual funds. In Chapter 4 modified three-factor versions of the T–M and H–M models are presented. The additional factors are Fama and French's mimicking portfolios *SMB* and *HML*. The market-timing and selectivity abilities of fund managers are evaluated for the period January 2003–December 2009. In Chapter 5 we compare the regression results of the models and investigate their statistical properties.

2. Fama and French's mimicking portfolios *SMB* and *HML*

We construct the size (*SMB*) and book-to-market (*HML*) mimicking portfolios using the Fama and French procedure [7]. We sort all the firms listed on the Warsaw Stock Exchange according to the following conditions:

1. Firms must have existed on the Warsaw Stock Exchange for two years before we use them, that is from December 31, 2001 (when the end of calendar year book value per share is available based on the annual report);

2. The database of the stock "closing" prices must not have too many missing values (for example, Optimus does not meet this condition);

3. We do not use negative *–BV* firms (for example, Atlantis, Bytom, Mostostal Zabrze, Netia, Polnord, Próchnik, Stalexport, Swarzędz are negative *–BV* firms);

4. All of the firm's annual reports must be available (for example, Advadis and Getin do not meet this condition).

Finally, the 61 Warsaw Stock Exchange companies that complied with conditions 1–4 were entered into the database. The stock "closing" prices were obtained from http://bossa.pl. Annual reports were obtained from www.bankier.pl (based on *Notoria Service*).

We sort all firms according to their market capitalization at the end of June each year, beginning in June 28, 2002. We take the market capitalization *MV* to be the number of shares as of the end of June (per WSE) multiplied by the end of June WSE share price. We also sort these same firms according to their end of calendar year book-to-market ratio *BV*/*MV*.

In June of each year *t* from 2002 to 2009, all stocks are ranked according to the size of *MV*. The median size is then used to divide these stocks into two groups, *S – Small* and *B – Big*, where the big group includes all the firms with market capitalization greater than or equal to the median.

Next we divide the stocks into three book-to-market equity groups based on the breakpoints for the bottom 30% (*Low*), middle 40% (*Medium*) and top 30% (*High*) of the ranked values of *BV*/*MV* for stocks.

The decision to sort firms into three groups according to *BV*/*MV* and only two according to *MV* follows Fama and French's observation that book-to-market equity has a stronger role in average stock returns than size.

Table 1. The number of firms contained in the auxiliary portfolios (at the end of June each year)

index	2002	2003	2004	2005	2006	2007	2008	2009
BH	0	0	1	1	0	3	2	5
BM	12	13	14	12	15	13	12	12
BL	18	17	15	17	15	14	16	13
SH	18	18	17	17	18	15	16	13
SM	12	11	10	12	9	11	12	12
SL	1	2	4	2	4	5	3	6
∑	61	61	61	61	61	61	61	61

Source: Author's calculations.

Proceeding in this way, we construct six portfolios for each year: *BH*, *BM*, *BL*, *SH*, *SM*, *SL* from the intersections of the two *MV* and the three *BV*/*MV* groups. For example, the *BH* portfolio contains the stocks in the *B – Big* size group that are also in the *H – High* book-to-market value group. The daily value-weighted returns on the six

portfolios are calculated from July of year t to June of (t + 1), and the firms associated with each portfolio are updated – according to the data from the end of June of (t + 1). We calculate returns beginning in July of year t so that book equity for the year (t – 1) is known [6].

In the next step we form the size mimicking portfolio *SMB* by taking the difference between an equally weighted combination of three small market capitalization indices and three big market capitalization indices. The rate of return on this portfolio is equal to (1):

$$R_{SMB} = \frac{1}{3} \cdot (R_{SH} + R_{SM} + R_{SL} - R_{BH} - R_{BM} - R_{BL}) . \tag{1}$$

In the last step we form the book-to-market mimicking portfolio *HML* by taking the difference between an equally weighted combination of two high book-to-market indices and two low book-to-market indices. The rate of return on the *HML* portfolio is equal to (2):

$$R_{HML} = \frac{1}{2} \cdot (R_{BH} + R_{SH} - R_{BL} - R_{SL}) . \tag{2}$$

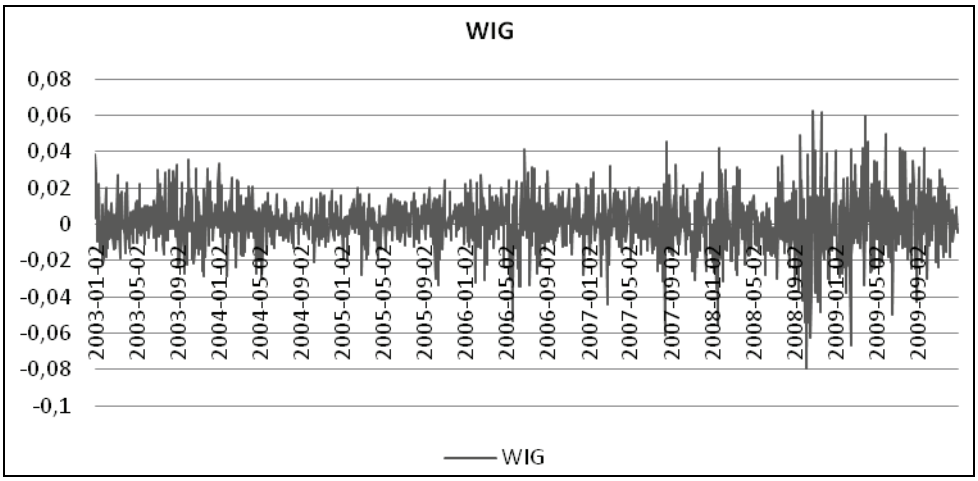

Fig. 1. Daily rates of return on the WSE stock index (*WIG*) in the period January 2, 2003–December 31, 2009
Source: Author's calculations.

Figures 1, 2, 3 present daily rates of return on the WSE stock index (*WIG*), the mimicking portfolio *SMB* and the mimicking portfolio *HML* respectively, in the period investigated January 2, 2003–December 31, 2009.

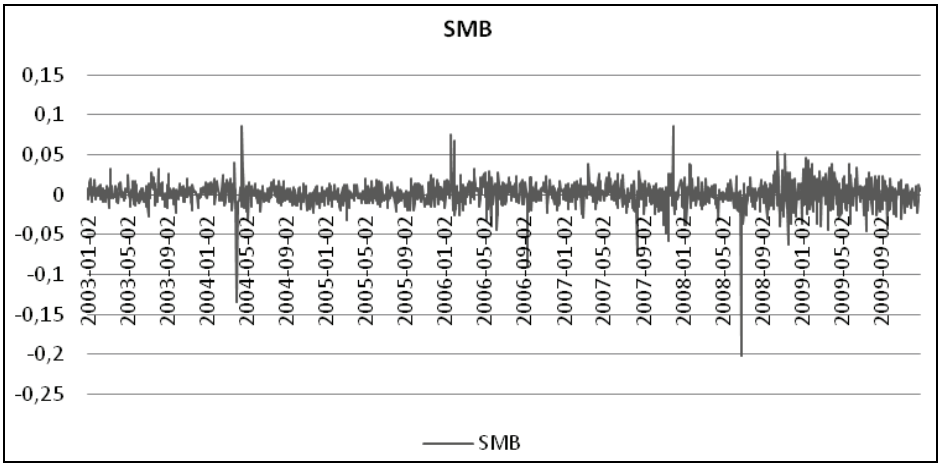

Fig. 2. Daily rates of return on the mimicking portfolio *SMB* in the period January 2, 2003–December 31, 2009
Source: Author's calculations.

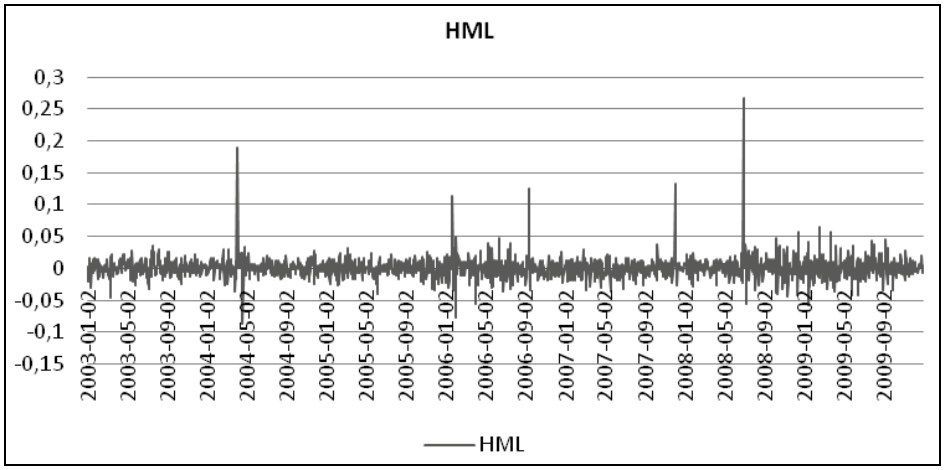

Fig. 3. Daily rates of return on the mimicking portfolio *HML* in the period January 2, 2003–December 31, 2009
Source: Author's calculations.

We use daily data following BOLLEN and BUSSE'S observation [1] that daily data provide better opportunity for inference regarding timing ability than monthly data. This evidence has been examined in the case of Polish equity mutual funds by OLBRYŚ [20]. Table 2 reports summarized return statistics for the *SMB*, *HML* and *WIG* portfolios. The *SMB* and *HML* portfolios exhibit higher excess kurtosis than the *WIG* index.

Table 2. Summarized statistics for market portfolios' daily returns (Jan. 2, 2003–Dec. 31, 2009)

	Mean	Min	Max	Standard deviation	Skewness	Kurtosis
SMB	0.0005	–0.201	0.086	0.015	–1.956	28.403
HML	0.0007	–0.086	0.267	0.016	3.904	55.965
WIG	0.0007	–0.080	0.063	0.014	–0.259	2.686

Source: Author's calculations.

Table 3 presents Pearson coefficients of correlation. We can observe that the Pearson correlations between pairs of variables are negative and rather weak.

Table 3. Pearson coefficients of correlation (Jan 2, 2003–Dec 31, 2009)

(*X*, *Y*)	(*SMB*, *HML*)	(*SMB*, *WIG*)	(*HML*, *WIG*)
r(*X*, *Y*)	–0.370	–0.165	–0.121

Source: Author's calculations.

3. Classical parametric market-timing models

TREYNOR and MAZUY [27] (the T–M model) developed a procedure for detecting timing ability that is based on a regression analysis of the realised returns of managed portfolio, which includes a quadratic term, as follows:

$$r_{P,t} = \alpha_P + \beta_P \cdot r_{M,t} + \gamma_P \cdot (r_{M,t})^2 + \varepsilon_{P,t} \tag{3}$$

where:

$r_{P,t} = R_{P,t} - R_{F,t}$ is the simple excess return on portfolio *P* in period *t*,

$r_{M,t} = R_{M,t} - R_{F,t}$ is the simple excess return on portfolio *M* in period *t*,

$R_{P,t}$ is the one-period return on portfolio *P*,

$R_{M,t}$ is the one-period return on market portfolio *M*,

$R_{F,t}$ is the one-period return on riskless securities,

Jensen's α_P [13] measures the selectivity skills of the manager of portfolio *P*,

β_P is the systematic risk measure of portfolio *P*,

γ_P measures the market-timing skills of the manager of portfolio *P*,

$\varepsilon_{P,t}$ is a residual term, with the following standard CAPM conditions: $E(\varepsilon_{P,t}) = 0$, $E(\varepsilon_{P,t} \mid \varepsilon_{P,t-1}) = 0$.

If the portfolio manager has the ability to forecast security prices, the intercept α_P in equation (3) will be positive [13, pp. 394]. Indeed, it represents the average incremental rate of return on the portfolio per unit time which is due solely to the manager's ability to forecast future security prices. On the one hand, a passive strategy (random buy-and-hold policy) can be expected to yield a zero intercept. On the other hand, if the manager is doing worse than a random selection buy-and-hold policy, α_P will be negative.

If a mutual fund manager increases (decreases) the market exposure of the portfolio prior to a market increase (decrease) then the portfolio return will be a convex function of the market return and γ_P will be positive. The size of the estimate $\hat{\gamma}_P$ informs us about the manager's market skills.

The parametric T–M test examined the performance of 15 selected equity open-end mutual funds using daily data. We have studied daily ordinary excess returns from Jan. 2003 to Dec. 2009. Daily returns on the main index of Warsaw Stock Exchange companies are used as the returns on the market portfolio. The daily average of returns on 52-week Treasury bills are used as returns on riskless assets.

Table 4. Classic T–M model (3) (Jan 2, 2003–Dec 31, 2009)

	Equity funds	$\hat{\alpha}_P$	$\hat{\beta}_P$	$\hat{\gamma}_P$	R^2	*DW*	*AIC*
1	Arka BZ WBK Akcji FIO	0.0007*	0.711*	-2.34*	0.617	2.42	-12008.2
2	Aviva Investors FIO Polskich Akcji	0.0005*	0.748*	–1.92*	0.690	2.56	–12403.0
3	BPH FIO Akcji	0.0002	0.709*	–1.02*	0.715	2.69	–12820.8
4	DWS Polska FIO Top 25 Małych Spółek	0.0005*	0.396*	–2.47*	0.240	2.47	–11123.5
5	DWS Polska FIO Akcji	0.0002	0.621*	–1.44	0.372	2.75	–10732.8
6	DWS Polska FIO Akcji Plus	0.0003*	0.534*	–1.66*	0.346	2.75	–11055.9
7	ING FIO Akcji	0.0001	0.741*	–0.96*	0.694	2.71	–12495.6
8	Legg Mason Akcji FIO	0.0003*	0.690*	–1.13*	0.698	2.61	–12774.1
9	Millennium FIO Akcji	0.0001	0.670*	–1.22*	0.669	2.64	–12635.1
10	Pioneer Akcji Polskich FIO	0.0001	0.809*	–1.53	0.696	2.66	–12196.2
11	PKO/CREDIT SUISSE Akcji FIO	0.0003	0.550*	–2.33*	0.420	2.71	–11481.0
12	PZU FIO Akcji KRAKOWIAK	0.0002	0.698*	–1.39*	0.686	2.66	–12631.8
13	SEB 3 – Akcji FIO	0.0005*	0.504*	–1.20*	0.307	2.68	–10930.9
14	Skarbiec – Akcja FIO	0.0004*	0.443*	–0.81	0.273	2.64	–11130.1
15	UniKorona Akcja FIO	0.0005*	0.499*	–1.44*	0.300	2.70	–10926.6

*Significant at the 5% level
Source: Author's calculations (using *Gretl 1.8.5*).

Table 4 provides details on the estimated market-timing T–M models. The Newey–West (1987) procedures have been used to correct for both autocorrelated and heteroskedastic error terms. Results of the T–M tests show that the estimates of JENSEN'S

[13] measure of performance ($\hat{\alpha}_P$) are positive, but not significant at the 5% level in the case of half of the funds. These results suggest that fund managers do not possess selectivity skills, in this way being consistent with most studies on performance evaluation which support the hypothesis of a weakly efficient market [1], [3], [12], [18], [25], [26]. We can observe that the levels of systematic risk ($\hat{\beta}_P$) are significantly positive and high. Unfortunately, almost all of the funds (except DWS Polska FIO Akcji, Pioneer Akcji Polskich FIO and Skarbiec-Akcja FIO) present significantly negative estimates of market-timing skills ($\hat{\gamma}_P < 0$). These empirical results show no statistical evidence that Polish equity fund managers have outguessed the market. Table 4 documents a negative correlation between regression intercepts and timing coefficients, as in other studies [1], [12], [18]–[20], [25], [26].

HENRIKSSON and MERTON [11] (the H–M model) assume that in each period the managers forecast whether stocks will outperform riskless bonds or vice-versa. They can choose between two target levels of systematic risk [12, pp. 76–78]:

- η_1 when they predict that riskless securities outperform the market, $R_{M,t} \le R_{F,t}$
- η_2 when they predict that the market outperforms riskless securities, $R_{M,t} > R_{F,t}$

Since the managers' forecasts are not observable, the risk of the portfolio at time *t*, β_t, should be a random variable for a market-timer, assuming a value of η_1 or η_2 depending on whether the manager forecasts a down market or an up market. If the forecaster is rational, then $\eta_2 > \eta_1$. Under the assumption that beta is not observable, the return on the portfolio *P* in the period *t* is given by:

$$R_{P,t} = R_{F,t} + (b + \theta_t) \cdot r_{M,t} + \lambda + \varepsilon_{P,t} \tag{4}$$

where:

$R_{P,t}$, $R_{F,t}$, $r_{M,t}$, $\varepsilon_{P,t}$ are as in equation (3),

b is the unconditional (on the forecast) expected value of β_t,

$\theta_t = \beta_t - b$ is the unanticipated (dependent on the forecast) expected value of β_t,

λ is the expected excess return from selectivity.

In this form,

$$\eta_1 = b + \theta_t \tag{5}$$

is the target level of systematic risk when the forecaster predicts $R_{M,t} \le R_{F,t}$ and

$$\eta_2 = b + \theta_t \tag{6}$$

is the target level of systematic risk corresponding to a forecast of $R_{M,t} > R_{F,t}$ [12, pp. 77].

Using the return process described in (4), least squares regression analysis can be used to estimate the separate contributions from security analysis and market-timing, as follows:

$$r_{P,t} = \alpha_P + \beta_P \cdot r_{M,t} + \gamma_P \cdot y_{M,t} + \varepsilon_{P,t} \tag{7}$$

where:

$r_{P,t}$, $r_{M,t}$, α_P, β_P, γ_P, $\varepsilon_{P,t}$ are as in equation (3),

$y_{M,t} = \max\{0, R_{F,t} - R_{M,t}\} = \max\{0, -r_{M,t}\}$.

Equation (7) is motivated by Merton's analysis of the value of market-timing [17]. He shows that the returns obtained by a timing strategy would be similar to the returns obtained from an option investment strategy of the put protective type. In this way, $\hat{\alpha}_P$ measures the contribution of security selection to portfolio performance, which corresponds to testing the null hypothesis:

$$H_0 : \alpha_P = 0 \tag{8}$$

i.e., the manager does not have any microforecasting ability [26].

The estimate $\hat{\beta}_P$ represents the proportion invested in the market portfolio when following the option investment strategy. The estimate $\hat{\gamma}_P$ represents the number of "free" put options on the market due to the manager's market-timing skills. In this context, the evaluation of market-timing skills is carried out by testing the null hypothesis:

$$H_0 : \gamma_P = 0 \tag{9}$$

i.e., the manager does not possess any timing ability or does not act on his forecast ($\eta_1 = \eta_2$) [12, pp. 77–78]. A negative value for the regression estimate $\hat{\gamma}_P$ would imply a negative value for market-timing.

Table 5 provides details on the estimated market-timing H–M models. The Newey–West procedures have been used to correct for both autocorrelated and heteroskedastic error terms. We can observe that the null hypothesis (8) is rejected for almost all of the funds (except DWS Polska FIO Akcji), i.e. they present a significant positive estimate of selectivity. According to Jensen's interpretation of the value of $\hat{\alpha}_P$, this measure could be positive for two reasons: (1) the extra returns earned on the portfolio are actually due to the manager's ability, or (2) the positive bias in the estimate of $\hat{\alpha}_P$ resulting from the negative bias in the estimate of $\hat{\beta}_P$ [13, pp. 396]. Results of the H–M parametric tests show that equity fund managers rather do not possess market-timing skills ($\hat{\gamma}_P$). The null hypothesis (9) is rejected for almost all of the funds (except DWS Polska FIO Akcji and Skarbiec – Akcja FIO), i.e. they present a significant estimate of timing ability, but unfortunately none of them exhibit positive estimates of $\hat{\gamma}_P$. We thus find evidence of negative market-timing. Significant negative estimates of market-timing indicate that, contrary to what would be expected of rational investors, managers increase the exposure of their portfolios to the market in down markets and act inversely in up markets [26, pp. 361]. Therefore, our initial conclusions remain unaltered.

Table 5. Classic H–M model (7) (Jan. 2, 2003–Dec. 31, 2009)

	Equity funds	$\hat{\alpha}_P$	$\hat{\beta}_P$	$\hat{\gamma}_P$	R^2	*DW*	*AIC*
1	Arka BZ WBK Akcji FIO	0.0013*	0.617*	–0.20*	0.617	2.43	–12005.5
2	Aviva Investors FIO Polskich Akcji	0.0010*	0.669*	–0.17*	0.689	2.57	–12401.9
3	BPH FIO Akcji	0.0005*	0.664*	–0.09*	0.715	2.70	–12821.5
4	DWS Polska FIO Top 25 Małych Spółek	0.0011*	0.297*	–0.21*	0.239	2.47	–11121.8
5	DWS Polska FIO Akcji	0.0006	0.564*	–0.12	0.372	2.75	–10732.2
6	DWS Polska FIO Akcji Plus	0.0008*	0.464*	–0.15*	0.346	2,75	–11055.9
7	ING FIO Akcji	0.0004*	0.695*	–0.09*	0.694	2.71	–12497.0
8	Legg Mason Akcji FIO	0.0006*	0.639*	–0.11*	0.698	2.61	–12775.3
9	Millennium FIO Akcji	0.0005*	0.611*	–0.12*	0.670	2.64	–12638.0
10	Pioneer Akcji Polskich FIO	0.0005*	0.741*	–0.14*	0.697	2.66	–12197.3
11	PKO/CREDIT SUISSE Akcji FIO	0.0009*	0.452*	–0.20*	0.420	2.71	–11480.8
12	PZU FIO Akcji KRAKOWIAK	0.0006*	0.636*	–0.13*	0.687	2.67	–12633.3
13	SEB 3 – Akcji FIO	0.0009*	0.428*	–0.16*	0.307	2.68	–10928.9
14	Skarbiec – Akcja FIO	0.0007*	0.403*	–0.08	0.273	2.64	–11130.8
15	UniKorona Akcja FIO	0.0009*	0.439*	–0.13*	0.300	2.70	–10926.5

* Significant at the 5% level.
Source: Author's calculations (using *Gretl 1.8.5*).

4. Modified three-factor market-timing models

In 1994 GRINBLATT and TITMAN [9] showed that tests of mutual fund performance are quite sensitive to the chosen benchmark. For this reason, we run three-factor analogs of equations (3) and (7), in which the two new additional spread variables are Fama and French's *SMB* and *HML* factors. Performance evaluation in terms of modified three-factor versions of the T–M or H–M models might allow a better assessment of manager's selectivity and timing skills.

We express the three-factor modified T–M model as:

$$r_{P,t} = \alpha_P + \beta_P \cdot r_{M,t} + \delta_{1P} \cdot r_{SMB,t} + \delta_{2P} \cdot r_{HML,t} + \gamma_P \cdot (r_{M,t})^2 + \varepsilon_{P,t} \tag{10}$$

where:

$r_{P,t}$, $r_{M,t}$, α_P, β_P, γ_P, $\varepsilon_{P,t}$ are as in equation (3),

$r_{SMB,t} = R_{SMB,t} - R_{F,t}$ is the simple excess return on the mimicking portfolio *SMB* in the period *t*,

$r_{HML,t} = R_{HML,t} - R_{F,t}$ is the simple excess return on the mimicking portfolio *HML* in the period *t*,

δ_{1P} is the sensitivity measure of the returns on portfolio *P* to changes in the *SMB* factor returns,

δ_{2P} is the sensitivity measure of the returns on portfolio *P* to changes in the *HML* factor returns.

Table 6. Three-factor versions of the T–M models (10) (Jan. 2, 2003–Dec. 31, 2009)

	Equity funds	$\hat{\alpha}_P$	$\hat{\beta}_P$	$\hat{\delta}_{1P}$	$\hat{\delta}_{2P}$	$\hat{\gamma}_P$	R^2	*DW*	*AIC*
1	Arka BZ WBK Akcji FIO	0.0006*	0.730*	0.070*	0.046*	–2.03*	0.623	2.43	–12030.9
2	Aviva Investors FIO Polskich Akcji	0.0005*	0.751*	–0.002	0.021	–1.92*	0.691	2.56	–12403.5
3	BPH FIO Akcji	0.0001	0.716*	0.011	0.031*	–0.96*	0.716	2.69	–12826.1
4	DWS Polska FIO Top 25 Małych Spółek	0.0002	0.445*	0.216*	0.070*	–1.54*	0.297	2.61	–11257.6
5	DWS Polska FIO Akcji	0.0002	0.630*	0.033	0.017	–1.30	0.373	2.74	–10731.4
6	DWS Polska FIO Akcji Plus	0.0002	0.555*	0.092*	0.025	–1.27	0.355	2.75	–11075.4
7	ING FIO Akcji	0.0001	0.746*	0.009	0.027*	–0.92*	0.695	2.70	–12497.5
8	Legg Mason Akcji FIO	0.0003*	0.698*	0.017	0.035*	–1.05*	0.700	2.60	–12781.8
9	Millennium FIO Akcji	0.0000	0.683*	0.033*	0.050*	–1.07*	0.673	2.63	–12653.3
10	Pioneer Akcji Polskich FIO	0.0000	0.814*	–0.001	0.035*	–1.52*	0.698	2.65	–12202.1
11	PKO/CREDIT SUISSE Akcji FIO	0.0003	0.559*	0.029	0.028	–2.20*	0.422	2.71	–11481.7
12	PZU FIO Akcji KRAKOWIAK	0.0001	0.702*	–0.003	0.035*	–1.39*	0.689	2.65	–12641.5
13	SEB 3 – Akcji FIO	0.0004	0.522*	0.085*	0.017	–1.64	0.315	2.68	–10945.9
14	Skarbiec– Akcja FIO	0.0003	0.457*	0.068*	0.013	–0.52	0.279	2.64	–11139.8
15	UniKorona Akcja FIO	0.0004*	0.519*	0.091*	0.019	–1.06	0.309	2.70	–10944.2

* Significant at the 5% level.
Source: Author's calculations (using *Gretl 1.8.5*).

We have detected (based on the Augmented Dickey–Fuller test) that the analysed series $r_{M,t}$, $r_{SMB,t}$ and $r_{HML,t}$ (see equations (10) and (11)) are stationary. The Newey–West procedures HAC (heteroskedasticity and autocorrelation consistent covariance method) have been used to correct for both autocorrelated and heteroskedastic error terms. We have used the Akaike Information Criterion (AIC) to compare the T–M models (see Table 4) and their three-factor versions (see Table 6). The lowest value of the AIC index indicates the preferred model, that is, the one with the fewest parameters that still provides an adequate fit to the data. The evidence is that in the case of 14 funds (all except DWS Polska FIO Akcji), the addition of the regressors caused a (small) decrease in the AIC index.

The results for the three-factor versions of the T–M models, given in Table 6, reveal that the determination coefficients are larger than for the classical T–M models (Table 4). Seven out of the fifteen coefficients of the *SMB* variable ($\hat{\delta}_{1P}$) are positive and statistically significant. Moreover, eight out of the fifteen coefficients of the *HML* variable

($\hat{\delta}_{2P}$) are positive and statistically significant. As for timing, all the funds exhibit negative timing coefficients ($\hat{\gamma}_P$) and ten of them are statistically significant.

In a way analogous to (10), we express the three-factor modified H–M model as:

$$r_{P,t} = \alpha_P + \beta_P \cdot r_{M,t} + \delta_{1P} \cdot r_{SMB,t} + \delta_{2P} \cdot r_{HML,t} + \gamma_P \cdot y_{M,t} + \varepsilon_{P,t} \tag{11}$$

where:

$r_{P,t}$, $r_{M,t}$, $r_{SMB,t}$, $r_{HML,t}$, $y_{M,t}$, α_P, β_P, γ_P, δ_{1P}, δ_{2P}, $\varepsilon_{P,t}$ are as in equations (7) or (10), as appropriate.

Table 7. Three-factor versions of the H–M models (11) (Jan. 2, 2003–Dec. 31, 2009)

	Equity funds	$\hat{\alpha}_P$	$\hat{\beta}_P$	$\hat{\delta}_{1P}$	$\hat{\delta}_{2P}$	$\hat{\gamma}_P$	R^2	*DW*	*AIC*
1	Arka BZ WBK Akcji FIO	0.0010*	0.650*	0.071*	0.046*	-0.17*	0.623	2.43	-12028.3
2	Aviva Investors FIO Polskich Akcji	0.0010*	0.672*	–0.002	0.021	–0.17*	0.690	2.57	–12402.3
3	BPH FIO Akcji	0.0004*	0.673*	0.011	0.031*	–0.09*	0.716	2.69	–12826.7
4	DWS Polska FIO Top 25 Małych Spółek	0.0005	0.387*	0.217*	0.071*	–0.12*	0.297	2.61	–11256.2
5	DWS Polska FIO Akcji	0.0005	0.579*	0.034	0.017	–0.11	0.373	2.74	–10730.8
6	DWS Polska FIO Akcji Plus	0.0005	0.501*	0.092*	0.025	–0.11	0.355	2.76	–11075.3
7	ING FIO Akcji	0.0004	0.702*	0.008	0.026*	–0.09*	0.695	2.71	–12498.7
8	Legg Mason Akcji FIO	0.0006*	0.651*	0.016	0.035*	–0.10*	0.700	2.61	–12782.8
9	Millennium FIO Akcji	0.0004	0.631*	0.032*	0.049*	–0.11*	0.674	2.64	–12655.8
10	Pioneer Akcji Polskich FIO	0.0005	0.746*	–0.001	0.034*	–0.14*	0.698	2.65	–12203.2
11	PKO/CREDIT SUISSE Akcji FIO	0.0008*	0.467*	0.029	0.028	–0.19*	0.422	2.71	–11481.4
12	PZU FIO Akcji KRAKOWIAK	0.0005*	0.640*	–0.003	0.035*	–0.13*	0.689	2.66	–12642.9
13	SEB 3 – Akcji FIO	0.0007	0.462*	0.085*	0.017	–0.13	0.314	2.68	–10944.1
14	Skarbiec – Akcja FIO	0.0005	0.429*	0.067*	0.012	–0.06	0.279	2.64	–11140.3
15	UniKorona Akcja FIO	0.0007	0.475*	0.091*	0.019	–0.09	0.309	2.70	–10944.1

* Significant at the 5% level.
Source: Author's calculations (using *Gretl 1.8.5*).

We have used the Akaike Information Criterion (AIC) to compare the H–M models (see Table 5) and their three-factor versions (see Table 7). In a manner comparable to the T–M models, the evidence is that in the case of 14 funds (all except DWS Polska FIO Akcji), the addition of regressors caused a decrease in the AIC index, i.e. indicate that the three-factor versions of the H–M models should be preferred.

The results for the three-factor versions of the H–M models, given in Table 7, reveal that the determination coefficients are larger than for the classical H–M models (Table 5). By analogy to Table 6, seven out of the fifteen coefficients of the *SMB* variable ($\hat{\delta}_{1P}$) are

positive and statistically significant and eight out of the fifteen coefficients of the *HML* variable ($\hat{\delta}_{2P}$) are also positive and statistically significant. Furthermore, all the funds exhibit negative timing coefficients ($\hat{\gamma}_P$) and ten of them are statistically significant.

5. Comparison of empirical results

Table 8 presents a brief summary of the results on selectivity and market-timing for 15 equity open-end mutual funds using daily data from Jan. 2, 2003 to Dec. 31, 2009 (based on Tables 4–7).

Table 8. Summary of selectivity and market-timing (Jan. 2, 2003–Dec. 31, 2009)

	Equity funds	T–M model (3)		H–M model (7)		3-factor T–M model (10)				3-factor H–M model (11)			
		$\hat{\alpha}_P$	$\hat{\gamma}_P$	$\hat{\alpha}_P$	$\hat{\gamma}_P$	$\hat{\alpha}_P$	$\hat{\gamma}_P$	$\hat{\delta}_{1P}$	$\hat{\delta}_{2P}$	$\hat{\alpha}_P$	$\hat{\gamma}_P$	$\hat{\delta}_{1P}$	$\hat{\delta}_{2P}$
1	Arka BZ WBK Akcji FIO	++	– –	++	– –	++	– –	++	++	++	– –	++	++
2	Aviva Investors FIO Polskich Akcji	++	– –	++	– –	++	– –	–	+	++	– –	–	+
3	BPH FIO Akcji	+	– –	++	– –	+	– –	+	++	++	– –	+	++
4	DWS Polska FIO Top 25 Małych Spółek	++	– –	++	– –	+	– –	++	++	+	– –	++	++
5	DWS Polska FIO Akcji	+	–	+	–	+	–	+	+	+	–	+	+
6	DWS Polska FIO Akcji Plus	++	– –	++	– –	+	–	++	+	+	–	++	+
7	ING FIO Akcji	+	– –	++	– –	+	– –	+	++	+	– –	+	++
8	Legg Mason Akcji FIO	++	– –	++	– –	++	– –	+	++	++	– –	+	++
9	Millennium FIO Akcji	+	– –	++	– –	0	– –	++	++	+	– –	++	++
10	Pioneer Akcji Polskich FIO	+	–	++	– –	0	– –	–	++	+	– –	–	++
11	PKO/CREDIT SUISSE Akcji FIO	+	– –	++	– –	+	– –	+	+	++	– –	+	+
12	PZU FIO Akcji KRAKOWIAK	+	– –	++	– –	+	– –	–	++	++	– –	–	++
13	SEB 3 – Akcji FIO	++	– –	++	– –	+	–	++	+	+	–	++	+
14	Skarbiec – Akcja FIO	++	–	++	–	+	–	++	+	+	–	++	+
15	UniKorona Akcja FIO	++	– –	++	– –	++	–	++	+	+	–	++	+

Notes: – negative, – – significantly negative at the 5% level, + positive, ++ significantly positive at the 5% level.
Source: Author's calculations.

The results presented in Tables 4–8 show that equity fund managers rather do not posses security selection. The null hypothesis (8) is only rejected for some of the

funds, i.e. only some of the funds present a significant positive estimate of selectivity ($\hat{\alpha}_P$). As was mentioned above (in Chapter 3), the $\hat{\alpha}_P$ measure could be positive for two reasons: (1) the extra returns earned on the portfolio are actually due to the manager's ability, or (2) the positive bias in the estimate of $\hat{\alpha}_P$. With respect to systematic risk, all of the funds present significant estimate of $\hat{\beta}_P$ at the 5% level.

Another important finding of the analysis in Tables 4–7 is the negative correlation between selectivity ($\hat{\alpha}_P$) and timing ($\hat{\gamma}_P$). In fact, almost all of the funds exhibit opposite signs for these two measures. A negative correlation between the measures of selectivity and timing has also been found in other studies [12], [18], [26]. This type of evidence is consistent with the majority of studies on timing and selectivity and supports the hypothesis of a weakly efficient market.

6. Conclusions

In this paper we have presented modified market-timing models with Fama and French's spread variables *SMB* and *HML* and we have examined the usefulness of these models in the evaluation of investment managers' performance. Although some groups argue, that the Fama and French model is controversial [25, pp. 259], the results in Tables 6, 7 and 8 suggest, that the *SMB* and *HML* variables have significant explanatory power for our sample of funds.

Following [1], [20], we have studied daily ordinary excess returns on the funds from Jan. 2003 to Dec. 2009. The daily data present one notable complication compared to monthly data. DIMSON (1979) [4] describes the problem of a nonsynchronous trading which hampers regression analysis for individual securities. Since they are typically well-diversified stock portfolios, mutual funds are not as susceptible to problems associated with a nonsynchronous trading as individual securities are. However, to study and remedy these problems, we could use Dimson's correction and include lagged values of the factors as additional independent variables in the regressions to accommodate infrequent trading. Therefore, further investigation of modified market-timing models may be needed.

References

[1] BOLLEN N.P.B., BUSSE J.A., *On the timing ability of mutual fund managers*, The Journal of Finance, 2001, Vol. 56, No. 3, 1075–1094.

[2] CARHART M.M., *On persistence in mutual fund performance*, The Journal of Finance, 1997, 52, No. 1, 57–82.

[3] CZEKAJ J., WOŚ M., ŻARNOWSKI J., *Efektywność giełdowego rynku akcji w Polsce*, PWN, Warszawa, 2001.
[4] DIMSON E., *Risk measurement when shares are subject to infrequent trading*, Journal of Financial Economics, 1979, 7, 197–226.
[5] FAMA E.F., *Components of investment performance*, The Journal of Finance, 1972, 27, No. 2, 551–567.
[6] FAMA E.F., FRENCH K.R., *The cross-section of expected stock returns*, The Journal of Finance, 1992, 47, 427–465.
[7] FAMA E.F., FRENCH K.R., *Common risk factors in the returns on stocks and bonds*, Journal of Financial Economics, 1993, 33, 3–56.
[8] FAMA E.F., FRENCH K.R., *Size and book-to-market factors in earnings and returns*, The Journal of Finance, 1995, 50, No. 1, 131–155.
[9] GRINBLATT M., TITMAN S., *A study of monthly mutual fund returns and performance evaluation techniques*, Journal of Financial and Quantitative Analysis, 1994, 29, 419–444.
[10] HAUGEN R.A., *Nowa nauka o finansach. Przeciw efektywności rynku*, WIG-Press, Warszawa, 1999.
[11] HENRIKSSON R., MERTON R., *On market timing and investment performance. II. Statistical procedures for evaluating forecasting skills*, Journal of Business, 1981, 54, No. 4, 513–533.
[12] HENRIKSSON R., *Market timing and mutual fund performance: an empirical investigation*, Journal of Business, 1984, 57, 73–96.
[13] JENSEN M., *The performance of mutual funds in the period 1945–1964*, Journal of Finance, 1968, 23, 389–416.
[14] KUFEL T., *Ekonometria. Rozwiązywanie problemów z wykorzystaniem programu Gretl*, PWN, Warszawa, 2004.
[15] LEHMANN B., MODEST D.M., *Mutual fund performance evaluation: A comparison of benchmarks and benchmark comparisons*, The Journal of Finance, 1987, 42 (June), 233–265.
[16] MADDALA G.S., *Ekonometria*, PWN, Warszawa, 2008.
[17] MERTON R., *On market timing and investment performance. I. An equilibrium theory of value for market forecasts*, Journal of Business, 1981, 54, No. 3, 363–406.
[18] OLBRYŚ J., *Parametric tests for timing and selectivity in Polish mutual fund performance. Optimum*, Studia Ekonomiczne, Wydawnictwo Uniwersytetu w Białymstoku, 2008, 3(39), 107–118.
[19] OLBRYŚ J., *Parametryczne testy umiejętności wyczucia rynku – porównanie wybranych metod na przykładzie OFI akcji*, [in:] Z. Binderman (ed.) *Metody ilościowe w badaniach ekonomicznych*, IX. Wydawnictwo SGGW w Warszawie, Warszawa, 2008, 81–88.
[20] OLBRYŚ J., *Ocena umiejętności stosowania strategii market-timing przez zarządzających portfelami funduszy inwestycyjnych a częstotliwość danych*, Studia i Prace Wydziału Nauk Ekonomicznych i Zarządzania Nr 10, Uniwersytet Szczeciński, Szczecin, 2008, 96–105.
[21] OLBRYŚ J., KARPIO A., *Market-timing and selectivity abilities of Polish open-end mutual funds managers*, [in:] P.Chrzan, T.Czernik (ed.) *Metody matematyczne, ekonometryczne i komputerowe w finansach i ubezpieczeniach 2007*, Wydawnictwo AE im. K. Adamieckiego w Katowicach, Katowice, 2009, 437–443.
[22] OSIŃSKA M., *Ekonometria finansowa*, PWE, Warszawa, 2006.
[23] OSIŃSKA M. (ed.), *Wybrane zagadnienia z ekonometrii*. Wydawnictwo WSIiE TWP w Olsztynie, Olsztyn, 2005.
[24] PETKOVA R., *Do the Fama–French factors proxy for innovations in predictive variables?* Journal of Finance, 2006, 61, No. 2, 581–612.
[25] PRATHER L.J., MIDDLETON K.L., *Timing and selectivity of mutual fund managers: An empirical test of the behavioral decision-making theory*, Journal of Empirical Finance, 2006, 13, 249–273.

[26] ROMACHO J.C., CORTEZ M.C., *Timing and selectivity in Portuguese mutual fund performance*, Research in International Business and Finance, 2006, 20, 348–368.
[27] TREYNOR J., MAZUY K., *Can mutual funds outguess the market?* Harvard Business Review, 1966, 44, 131–136.
[28] URBAŃSKI S., *Wpływ innowacji wybranych czynników na równowagę cenową walorów notowanych na Giełdzie Papierów Wartościowych w Warszawie*, Bank i Kredyt, NBP, 2008, 7, 37–49.