

Four-Factor Models of Technical Portfolio Returns on the Warsaw Stock Exchange, 1999–2009

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1. Introduction

Profitability of investment strategies based on technical analysis is one of the basic practical problems in asset management. Standard multifactor models of portfolio returns in current use are based mainly on a combination of fundamental factors (e.g. Fama and French model [1996]), a momentum factor (see e.g. [Jegadeesh and Titman, 2001]) and asset class type factors [Sharpe, 1992]. Except the momentum factor these factors have no direct links to technical analysis. Two areas of investigation seem therefore important: the examination of profitability of technical portfolios i.e. portfolios of assets formed using criteria based on technical analysis with the existing multifactor models, and the construction of technical factors i.e. benchmark technical portfolios, for possible inclusion in factor models.

A further interesting problem related to the factor models is the frequency of portfolio rebalancing. While Fama and French use annual rebalancing, it may be argued that more frequent rebalancing could be more appropriate to incorporate information arrival (e.g. quarterly company reports).

In our earlier paper [Grabowski et al., 2011] we initiated the investigation of the returns of the technical portfolios and factors on an emerging market, the Warsaw Stock Exchange (WSE). We examined five technical factors formed using Fama and French methodology as well as the returns on portfolios of stocks formed using technical indicators with the standard four-factor model. The main results obtained were the following: the factors and over-sold portfolios exhibited negative relationship with the momentum factor; both oversold and overbought portfolios were positively related to the returns of the *SMB* and market factors. We hypothesized that factor construc-

tion based on more frequent rebalancing could help analyze the nature of technical portfolios. Below we present some results of such research.

2. Data and methods

We investigated technical factors and portfolios as well as Fama and French factors based on monthly rather than annual rebalancing for the period July 1999—April 2009.

The Fama and French *SMB* and *HML* factors were formed using the standard procedure at the end of each month rather than annually and returns for the month following the portfolio rebalancing were computed to obtain the series of returns on the monthly factors *SMBM* and *HMLM*. The *WML* factor was computed using the standard procedure (see [Jegadeesh and Titman, 2001]).

Using the methods and data described in our earlier paper for the annual factors [Grabowski et al., 2011] the monthly technical factors *FACTM* were constructed here at the end of each month, using five technical indicators *FACT* (see e.g. [Pring, 1991]): 20-day moving average ($FACT = SR$), 20-day volume-adjusted moving average ($FACT = SRVOL$), 14-day *RSI* ($FACT = RSI$), 14-day *ROC* ($FACT = ROC$) and the Stochastic indicator (3-day average of 5-day %K line, $FACT = STS$). Similarly, technical sorted portfolios $FACTx$, $x = 1, \dots, 5$, were formed at the end of each month using the same indicators with 20% stocks with the lowest value of *FACT* in the *FACT1* portfolio (the oversold portfolio) and 20% of stocks with the highest values of *FACT* in the *FACT5* portfolio (the overbought portfolio). $FACTx$ portfolios were further adjusted with the risk-free rate to obtain $FACTxR$ series of monthly returns.

We examined the descriptive statistics of the returns on the monthly rebalanced Fama and French and technical factors and technical portfolios. Next, we investigated the returns of the oversold and the overbought portfolios using two versions of the four-factor model: first, using the standard annually rebalanced Fama and French *SMB* and *HML* factors and then using the monthly-rebalanced factors *SMBM* and *HMLM*:

Model A ($x = 1, \dots, 5$):

$$FACTxR_t = \alpha + \beta_{MKT}MKT_t + \beta_{SMB}SMB_t + \beta_{HML}HML_t + \beta_{WML}WML_t + \varepsilon_t$$

Model B ($x = 1, \dots, 5$):

$$FACTxR_t = \alpha + \beta_{MKT}MKT_t + \beta_{SMBM}SMBM_t + \beta_{HMLM}HMLM_t + \beta_{WML}WML_t + \varepsilon_t$$

3. Results

The descriptive statistics and correlations for the monthly factors are presented in Tables 1 and 2. Of particular interest is the difference between the features of the monthly and the standard annual Fama and French factors. The average return on the monthly *SMBM* factor is 5.43% and is almost double

the 2.27% return on the standard *SMB* factor. The *HMLM* and *HML* returns are similar. This means that the high capitalization premium on the WSE visible in the standard factor is even much higher if monthly rebalancing is performed. The variability of the returns is much higher for the monthly factors. The *SMBM* and *HMLM* correlations with each other and with the market factor are lower and the correlations with the *WML* factor are higher in absolute value than for the *SMB* and *HML*. As with the annual technical factors, there are no technical premiums on the WSE based on the indicators we analyzed, and the basic statistics are surprisingly similar for the monthly and annual factors.

Table 1.

Descriptive statistics for the monthly rebalanced fundamental and technical factor monthly returns for the stocks listed on the Warsaw Stock Exchange in the period July 1999–April 2009, 118 observations

Variable	Mean	Std. Dev.	Min	Max
<i>MKT</i>	-.0010216	.0733501	-.196344	.212919
<i>SMBM</i>	.0543363	.1312888	-.2211451	.736746
<i>HMLM</i>	.0058593	.1235562	-.4769552	.4512902
<i>WML</i>	.0131528	.0716653	-.2920572	.2569392
<i>SRVOLFM</i>	-.0098212	.052157	-.2078265	.1462448
<i>RSIFM</i>	-.008195	.0545727	-.2858765	.1958323
<i>ROCFM</i>	-.0096184	.0488219	-.1387257	.1344242
<i>SRFM</i>	-.0077597	.0533654	-.1776527	.204128
<i>STSFM</i>	-.0018484	.0404403	-.0795717	.1348425

Table 2.

Correlations for the monthly rebalanced fundamental and technical factor monthly returns for the stocks listed on the Warsaw Stock Exchange in the period July 1999–April 2009, 118 observations

	<i>MKT</i>	<i>SMBM</i>	<i>HMLM</i>	<i>WML</i>	<i>SRVOLFM</i>	<i>RSIFM</i>	<i>ROCFM</i>	<i>SRFM</i>	<i>STSFM</i>
<i>MKT</i>	1.0000								
<i>SMBM</i>	0.0485	1.0000							
<i>HMLM</i>	0.0844	0.0954	1.0000						
<i>WML</i>	-0.2638	0.0975	-0.2600	1.0000					
<i>SRVOLFM</i>	0.1152	-0.0954	0.2350	-0.2929	1.0000				
<i>RSIFM</i>	0.0872	0.0363	0.3205	-0.3126	0.8139	1.0000			
<i>ROCFM</i>	0.1144	0.0108	0.2325	-0.3394	0.7165	0.7651	1.0000		
<i>SRFM</i>	0.1163	-0.0079	0.2327	-0.2619	0.9072	0.8841	0.8471	1.0000	
<i>STSFM</i>	0.3617	-0.0441	0.1332	-0.2822	0.6091	0.5267	0.4410	0.5772	1.0000

The descriptive statistics for the sorted portfolios $FACTx$, $x = 1, \dots, 5$ are presented in Table 3. In contrast to the annual portfolios investigated earlier, the monthly technical portfolios, except $STSx$, exhibit visible monotonicity, with the mean returns on the oversold portfolios much lower than the mean returns on the overbought portfolios. The range for mean returns of the overbought portfolios $FACT5$ is 1.5–2.35% indicating a high premium.

Table 3.

Descriptive statistics for the monthly rebalanced technical portfolio monthly returns for the stocks listed on the Warsaw Stock Exchange in the period July 1999–April 2009, 118 observations

Variable	Mean	Std. Dev.	Min	Max
<i>STSM1</i>	.0140565	.0884406	-.2247235	.2928759
<i>STSM2</i>	.0122623	.0830388	-.2068436	.2564633
<i>STSM3</i>	.0156827	.086524	-.2027445	.2800661
<i>STSM4</i>	.0129925	.0802807	-.1857708	.2311417
<i>STSM5</i>	.0150738	.0772844	-.2103485	.2345908
<i>SRM1</i>	.0126305	.0915065	-.1872605	.2579206
<i>SRM2</i>	.0088251	.0828403	-.2443223	.2124323
<i>SRM3</i>	.0135215	.0806314	-.229133	.2631404
<i>SRM4</i>	.0164761	.0809885	-.1786165	.3167551
<i>SRM5</i>	.0186381	.0872224	-.1862518	.2615703
<i>SRVLM1</i>	.0098299	.0923253	-.1987159	.2520334
<i>SRVLM2</i>	.0108418	.083459	-.2299089	.239977
<i>SRVLM3</i>	.0156065	.0818626	-.2415549	.2607979
<i>SRVLM4</i>	.0142202	.0781077	-.1697022	.3103639
<i>SRVLM5</i>	.0191641	.0857764	-.1851312	.2321063
<i>RSIM1</i>	.008643	.0858095	-.2043555	.2251747
<i>RSIM2</i>	.0123922	.0853331	-.2275489	.2926697
<i>RSIM3</i>	.011422	.0823214	-.2480392	.2392936
<i>RSIM4</i>	.0162908	.0858121	-.1549967	.3314438
<i>RSIM5</i>	.0210153	.0811077	-.1898277	.2515488
<i>ROCM1</i>	.0099921	.0921716	-.2059404	.3013406
<i>ROCM2</i>	.0096211	.0851617	-.2418664	.2428901
<i>ROCM3</i>	.0117335	.077488	-.2255789	.2541948
<i>ROCM4</i>	.0151746	.0792596	-.1829881	.2892096
<i>ROCM5</i>	.0235773	.088947	-.1703412	.2879431

We estimated Models A and B for the monthly technical factors. In contrast to the annual factors, which were found earlier to be significantly related to both the market factor and the *WML* factor, the monthly factor regressions proved to be weak with only some evidence for the negative relationship with the *WML* factor and in the case of *STSM* a low positive relationship with the market.

We examined further the Models A and B for the monthly sorted technical portfolios *FACT_xR*, $x = 1, \dots, 5$. The estimates for the oversold portfolios *FACT₁R* and the overbought portfolios *FACT₅R* for Model A and B are presented in Tables 4 and 5 respectively.

In Model A the *WML* factor turned out to be largely insignificant in contrast to the standard Fama and French factors. The relationship with the market factor appears to be positive but slightly weaker for overbought portfolios than for the oversold ones and the relationship with the *SMB* factor was also positive but weaker for the oversold portfolios. The *HML* coefficient was positive but lower than for the first two factors. The *SMB* and *HML* coefficients were largely lower than for the annually sorted technical portfolios.

In Model B the relationship with the market factor was similar to Model A. The coefficients at the *SMB* factor were also highly significant and positive but about half in value compared to Model A. The coefficients at *HML* were significant and positive only for the oversold portfolios. The coefficient at *WML* was negative and significant for the oversold portfolios for the *RSI*, *ROC* and *SRVOL* factors.

While the standard Fama and French model performs surprisingly well for the monthly sorted technical portfolios it is clear from the estimations that the relationship between technical returns and fundamental ones becomes more complex as we examine the returns with more finely tuned models. In Model B we find that the oversold and overbought portfolio behavior differs considerably from each other. The four-factor model captures the dynamics of the oversold portfolios, while the overbought portfolios seem independent from the *HML* and *WML* factors. Thus for different technical portfolios the dependence on the basic factors may be strikingly different.

To gain more insight into the relationships between fundamental and technical factors an analysis at the level of selected decile/quantile sorted portfolios and not full factors may be appropriate.

4. Conclusion

We have constructed monthly rebalanced size and value factors as well as selected monthly rebalanced technical factors and portfolios with the WSE data from the period 1999–2009 and estimated four-factor models of the technical portfolios with both monthly and annually rebalanced factors. The standard Fama and French model captured the behavior of the oversold and overbought technical portfolios quite well exposing possible links between fundamental and technical investment methods. The four-factor model based

Table 4.

The results of the estimation of the four-factor model with standard factors for the oversold and overbought portfolios on the Warsaw Stock Exchange

Coef.	RS1R	RS15R	ROC1R	ROC5R	STS1R	STS5R	SR1R	SRSR	SRVOL1R	SRVOL5R
β_{MKT}	.837551*** (0.000)	.78996*** (0.000)	.895967*** (0.000)	.846605*** (0.000)	.90277*** (0.000)	.723286*** (0.000)	.904032*** (0.000)	.810798*** (0.000)	.917071*** (0.000)	.833549*** (0.000)
β_{SMB}	.331202*** (0.000)	.435804*** (0.000)	.325429*** (0.001)	.434353*** (0.000)	.389201*** (0.000)	.387281*** (0.000)	.355994*** (0.000)	.488423*** (0.000)	.396967*** (0.000)	.426636*** (0.000)
β_{HML}	.2494667** (0.012)	.113112 (0.215)	.2176764* (0.061)	.1829554* (0.097)	.1731631* (0.070)	.2025985** (0.014)	.209265** (0.048)	.195508* (0.072)	.1784345* (0.077)	.2000943* (0.058)
β_{HML}	-.1978079** (0.023)	.1484734 (0.149)	-.1572325 (0.134)	.134803 (0.249)	-.1447913 (0.200)	-.0043335 (0.965)	-.1222018 (0.271)	.1388297 (0.235)	-.1717659 (0.120)	.1063018 (0.350)
α	-.0037181 (0.435)	.0025838 (0.613)	-.0024978 (0.673)	.0049515 (0.389)	.0002558 (0.952)	-.0009116 (0.846)	-.0009543 (0.857)	-.0013979 (0.795)	-.0038138 (0.477)	.0009562 (0.868)
F statistic	46.65*** (0.0000)	38.55*** (0.0000)	37.83*** (0.0000)	36.30*** (0.0000)	54.93*** (0.0000)	30.85*** (0.0000)	49.14*** (0.0000)	35.59*** (0.0000)	66.93*** (0.0000)	26.04*** (0.0000)

The results of the estimation of the four-factor Model A, where the dependent variables are *FACT1R* and *FACT5R*, the risk-free rate adjusted monthly returns on *FACT1* (oversold) and *FACT5* (overbought) portfolios for *FACT* = *RSI*, *ROC*, *STS*, *SR* and *SRVOL*. The *SMB* and *HML* factors are rebalanced annually. The tables present the regression coefficients and intercepts as well as F statistics for the individual equations, together with p-values below. All standard errors are estimated using the Newey-West correction for heteroskedasticity and autocorrelation. The data are from the period July 1999–April 2009, 118 monthly observations. The coefficient significance at 1%, 5% and 10% level is denoted by ***, ** and * respectively. For further details see the main text.

Table 5.

The results of the estimation of the four-factor model with monthly rebalanced factors for the oversold and overbought portfolios on the Warsaw Stock Exchange

Coef.	RS1R	RS15R	ROC1R	ROC5R	STS1R	STS5R	SR1R	SRSR	SRVOL1R	SRVOL5R
β_{MIT}	.8471063*** (0.000)	.8433842*** (0.000)	.9053765*** (0.000)	.8841169*** (0.000)	.9563626*** (0.000)	.7510663*** (0.000)	.9215821*** (0.000)	.8560915*** (0.000)	.9512787*** (0.000)	.8686784*** (0.000)
β_{SMB}	.1633294*** (0.000)	.1977794*** (0.014)	.1932508*** (0.000)	.2295733*** (0.026)	.1783278*** (0.000)	.1912242*** (0.002)	.1885774*** (0.000)	.2408546** (0.013)	.1783296*** (0.000)	.2070589** (0.022)
β_{HML}	.0913987** (0.033)	.0156854 (0.687)	.0835349 (0.129)	-.0005734 (0.992)	.0838509** (0.027)	.037716 (0.346)	.115495*** (0.009)	.0356963 (0.419)	.0946796** (0.023)	.0341074 (0.504)
β_{MIL}	-.161946*** (0.007)	.1364514 (0.164)	-.1340213** (0.041)	.1138132 (0.284)	-.1194726 (0.147)	.0000976 (0.999)	-.0834632 (0.217)	.1345558 (0.187)	-.1409937* (0.067)	.1068767 (0.302)
α	-.0043673 (0.390)	.0026482 (0.634)	-.0049056 (0.442)	.0039173 (0.527)	-.000192 (0.963)	-.0013671 (0.810)	-.002849 (0.592)	-.0021489 (0.718)	-.0041839 (0.458)	.0005997 (0.923)
F statistic	62.09*** (0.0000)	27.18*** (0.0000)	53.85*** (0.0000)	23.99*** (0.0000)	99.37*** (0.0000)	22.37*** (0.0000)	88.84*** (0.0000)	27.28*** (0.0000)	94.62*** (0.0000)	24.42*** (0.0000)

The results of the estimation of the four-factor Model B, where the dependent variables are *FACT1R* and *FACT5R*, the risk-free rate adjusted monthly returns on *FACT1* (oversold) and *FACT5* (overbought) portfolios for *FACT* = *RSI*, *ROC*, *STS*, *SR* and *SRVOL*. The *SMB* and *HMLM* factors are rebalanced monthly. The tables present the regression coefficients and intercepts as well as F statistics for the individual equations, together with p-values below. All standard errors are estimated using the Newey-West correction for heteroskedasticity and autocorrelation. The data are from the period July 1999–April 2009, 118 monthly observations. The coefficient significance at 1%, 5% and 10% level is denoted by ***, ** and * respectively. For further details see the main text.

on monthly rebalanced factors uncovered differences between the oversold and overbought portfolios. While for the former relationships with all four factors were evident, the latter were linked only to the market and size factors. In addition to being independent of the value and momentum factors the overbought portfolios were found to exhibit a large return premium in the sample period.

References

- Fama E.F., French K.F., 1996, 'Multifactor explanations of asset pricing anomalies', *Journal of Finance* 51, 55–84
- Grabowski W., Rotuski K., Skrzypczak K., 2011, 'An analysis of technical factor returns on the Warsaw Stock Exchange', 1999–2009. *Ekonomia* 26, in press.
- Jegadeesh N., Titman S., 2001, 'Profitability of momentum strategies: an evaluation of possible explanations', *Journal of Finance* 56, 699–720.
- Pring M.J., 1991, *Technical analysis explained*, 3rd ed. McGraw-Hill.
- Sharpe W., 1992, 'Asset allocation: management style and performance measurement', *Journal of Portfolio Management*, Winter 1992, 18 (2), 7–19.