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Fundamentals and stock returns on the Warsaw Stock Exchange. The application of panel data models

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Fundamentals and stock returns on the Warsaw Stock Exchange. The application of panel data models

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Abstract

This study examines the relationship between the future stock returns and the fundamental indices for companies listed on the Warsaw Stock Exchange in Poland. The fundamental exogenous variables were constructed following the previous research of Lev and Thiagarajan [1993], Abarbanell and Bushee [1997], Piotroski [2000] and Mohanram [2004], while the endogenous variable is defined as a one-year-ahead stock return. Empirical analysis based on a panel data model for 187 companies in years 1999 – 2003 finds that the future stock returns are significantly related to three fundamental variables, i.e. gross margin, sales and administrative expenses and return on assets. Stock returns are also strongly associated with price-earnings ratio. Most of the relationships do no longer hold in case of short-term future stock returns.

Keywords: stock returns, fundamental analysis, panel data models
JEL codes: G1, G12

1. Fundamental analysis on the capital market

Stock markets' vast potential to generate profits resulted in the rising popularity of stock valuation methods among both investors and capital markets researchers. One of the tools that assist market participants in their investment decisions is fundamental analysis. This method of valuation focuses mainly on the issuer's condition and its environment and is used for mid- to long-term investments. It assumes that stocks quotations are not solely connected to the stock market itself, but rather result from the whole economic situation of the companies and their environment. Correspondingly, to forecast future stock prices, fundamental analysis combines economic, industry, and company analysis to derive a stock's current fair value and forecast future quotations. It is assumed that prices do not accurately reflect all available information and markets reveal a weak form of efficiency. The main sources of information for fundamental analysis are financial statements, prospectus, branch reports, current news items relating to the issuer and the forecast of future cash flows. Unfortunately, data regarding the future strategy of the company are rarely available and fundamental analysis often focuses only on the evaluation of the company's current financial condition.

2. Econometrics and fundamental analysis

The econometric research in the area of fundamental analysis has been conducted so far mainly in the United States, focusing attention on the companies listed on the American stock exchanges. Models explaining either stock returns or earnings are based on the financial data from companies' reports and market data regarding stock prices. Some researchers tried also to incorporate into their models the macroeconomic data, such as inflation or economic growth, but generally the "econometric" fundamental analysis concentrates on the evaluation of financial data. At least two approaches can be distinguished among studies in this field.

Firstly, Fama and French [1992, 1993] initiated the studies of the risk factors that determine the value of stock returns. They refined the traditional Capital Asset Pricing Model (Sharpe [1964]) by adding new explanatory variables: company's size (measured by its market capitalization), financial leverage, earnings to price ratio and book-to-market equity (book value of a firm's common stock to its market value). They found that the role of the beta coefficient in the CAPM is decreasing in favour of new variables. What is more, firm's size and book-to-market equity account for much of the variability in average stock returns in the

United States in years 1963-1990. Many researchers followed Fama and French approach, carrying out similar studies in UK and Japan (see Chan, Hamao, Lakonishok [1991]).

Another approach in fundamental analysis initiated by Ou and Penman [1989] deviates from the classical CAPM. Instead, it is suggested that fundamental variables referring to financial categories can be explanatory for the future earnings and stock returns. Ou and Penman [1989] show that an aggregated measure constructed out of financial ratios can be used to predict the sign of the future earnings. The explanatory variables are composed of 68 financial ratios with the use of statistical methods. Their followers, including Lev and Thiagarajan [1993], Abarbanell and Bushee [1997, 1998], Piotroski [2000] and Mohanram [2004], refine the methodology by introducing a so-called "guided search" procedure for variables. On the basis of the professional commentaries on corporate financial reporting and analysis Lev and Thiagarajan identify 12 fundamental signals and show that these variables are correlated with contemporaneous returns. The other researchers utilize similar context-specific financial performance and show significant relations between the fundamentals and stock returns or firm's earnings mostly for the American stock exchange.

As far as Warsaw Stock Exchange (WSE) is concerned, the research in the area of financial microeconometrics is still limited, mainly due to the short history of the market and correspondingly due to short time series of available data. Fundamental research has been carried out by Tarczyński [2002] who constructed a synthetic measure to evaluate possible stock investments. Additionally, his research showed that Warsaw Stock Exchange reveals many features of an inefficient market and thus it may be concluded that fundamental analysis may give satisfying results on the Polish stock exchange. In the next section an attempt is made to relate the fundamental signals with the future stock returns.

3. Fundamental determinants of stock returns versus Fama and French factors

In line with the findings of Tarczyński [2002] it can be stated that the current prices on the Warsaw Stock Exchange do not reflect all available information and thus it is possible to find mispriced securities and earn abnormal returns. In particular, fundamental analysis can be used to assist investors in their decisions. Accordingly, a model of future stock returns for the WSE stocks may be based on fundamental signals as explanatory variables.

Fundamental signals for Polish WSE companies were constructed according to formulas developed by Lev and Thiagarajan [1993], Abarbanell and Bushee [1997], Piotroski [2000] and Mohanram [2004]. Exogenous variables were chosen so as to not duplicate infor-

mation. Furthermore, due to the fact that some data used by the researchers was unavailable for Polish companies, the set of explanatory variables has been finally restricted to nine signals. The signals refer to Inventory, Accounts Receivable, Gross Margin, Sales and Administrative Expenses, Labour Force, Return on Assets, Cash Flow from Operations, Leverage and Liquidity. As it was mentioned earlier, signals reflect appropriate empirical relationships ("guided" search procedure) and certain hypotheses regarding each of the signals and stock returns can be drawn. Table 1 presents definitions of the variables as well as their expected relations with stock returns.

Table 1. Fundamantal signals used as explanatory variables for stock returns

Fundamental signal	Symbol	Calculation method	Expected relationship with stock returns
Inventory	inventory	Δ Inventory$_t$ – Δ Sales$_t$	negative
Accounts Receivable	acc_receiv	Δ Accounts Receivable$_t$ – Δ Sales$_t$	negative
Gross Margin	grossmargin	Δ Sales$_t$ - Δ Gross Margin$_t$	negative
Sales & Administrative Expenses	expenses	Δ Sales and Administrative Expenses$_t$ – Δ Sales$_t$	negative
Labour Force	labour	Δ (Sales$_t$ / No of Employees$_t$)	positive
Return on Assets	ROA	Net income$_t$ / Total Assets$_t$	positive
Cash Flow from Operations	cashflow	Cash Flow from Operations$_t$ / Total Assets$_t$	positive
Leverage	leverage	Δ (Long-term Debt$_t$ / Equity$_t$)	negative
Liquidity	liquidity	Δ (Current Assets$_t$ / Current Liabilities$_t$)	positive
Δ - percentage annual change in the variable from the average of prior two years			

Source: Lev and Thiagarajan [1993], Abarbanell and Bushee [1997], Piotroski [2000] and Mohanram [2004]

As already mentioned, one-year-ahead stock returns are the endogenous variable in the model. Since the analysis is carried out from the investor's point of view, it focuses on the future, instead of current, stock returns. The aim is to examine whether or – alternatively – on which fundamental indices an investor can found future decisions regarding the purchase of stock assets. The length of the return period could however be argued. It is assumed that one year is sufficient to realize the forecasted profits from the shares. Such a conjecture is in line with the commonly held theory that fundamental analysis is meant to assess the profitability of the long-term assets.

Still, it cannot be excluded that investors can make a profit on their investment even in a shorter time. Hence to compare the relations between fundamental indices and stock returns of different horizons, two alternative endogenous variables were constructed: one-month-ahead and three-month-ahead stock returns. Furthermore, in analogy to Piotroski [2000], half-year lag in the calculation of the stock return was introduced, i.e. the initial stock price was

registered six months after the end of the financial year for which the relevant fundamentals were calculated. Such a delay ensures that the necessary annual financial information is available to investors at the time of portfolio formation. Consequently, the formulas for the dependent variables are as follows:

$$stockreturn_t = \frac{p_{t+1/2+1}}{p_{t+1/2}} \qquad monthreturn_t = \frac{p_{t+1/2+1/12}}{p_{t+1/2}} \qquad 3monthreturn_t = \frac{p_{t+1/2+3/12}}{p_{t+1/2}}$$

The aim is also to confront the model of future stock returns based on fundamental indices with the earlier mentioned approach of Fama and French [1992, 1993]. In particular, three additional variables representing (according to Fama and French) omitted risk factors, were introduced to the model. The idea is to check whether the additional variables can enhance the model with the additional information that influences the value of future stock returns. Risk factors were constructed according to formulas suggested by Fama and French. They are presented in Table 2, along with the expected direction of their relationship with stock returns.

Table 2. Fama and French risk factors used as additional explanatory variables

Fama and French risk factors	Symbol	Calculation method	Expected relationship with stock returns
Earnings to price ratio	EP	Earnings per share$_t$ / Share price$_t$	positive
Market equity	marketequity	Number of outstanding shares$_t$ * Share price$_{t+5/12}$	negative
Book-to-market equity	BVMV	Book value of firm's stock$_t$ / Market value$_t$	positive

Source: Fama and French [1992, 1993]

4. Panel data models

To analyse thoroughly the relations between future stock returns and fundamentals for companies on the Polish stock exchange within a few years, panel data models are employed. Panel data provide a set of rich information that can be used to model the changes both in time and in cross-sectional dimension. Moreover, the dynamic or unobserved factors influencing the explanatory variables can be identified. The construction of panel data models follow several stages. The starting point is the estimation of the Fixed and Random effects models. The fixed effect model can be written as follows:

$$stockreturn_i = e\alpha_i + FUNDAMENTALS'\beta + \varepsilon_i \qquad \text{for } i = 1, \ldots, 187 \text{ and } t = 1, \ldots, 5$$

In the formula above, $stockreturn_i$ is a vector of one-year ahead stock returns. α_i represents the vector of fixed effects. e is a matrix of size $(N \cdot T) \times N$ constructed as follows:

$$e = \begin{bmatrix} \iota & 0 & \ldots & 0 \\ 0 & \iota & \ldots & 0 \\ \cdot & \cdot & \ldots & \cdot \\ 0 & 0 & \ldots & \iota \end{bmatrix}_{(N \cdot T) \times N} \quad \text{where } \iota = \begin{bmatrix} 1 \\ 1 \\ \cdot \\ 1 \end{bmatrix}_{T \times 1}$$

FUNDAMENTALS is a matrix of fundamental indices calculated according to the formulas in Table 1. The parameters β measure the influence of the change of fundamentals on the stock returns. ε_i is the vector of error terms. The fixed effect approach assumes that individual effects are constant over time and specific for each unit. Moreover, ε_i is uncorrelated with exogenous variables and has an identical distribution for all units over time with the mean equal zero and variance of σ_ε^2. Fixed effect method should be applied for samples where the units are one of a kind, not randomly drawn from a population. Forecasts based on this model will refer to a certain unit not to a population as a whole. Since the values of α_i can be estimated, the model can account for the unobservable differences among units in the sample (Greene [2004]).

Alternatively, random effects approach assumes that the values of individual effects are not constant but randomly drawn from the distribution with a given mean μ and standard deviation σ_α^2. The formula of the model is as follows:

$$stockreturn_i = \mu + FUNDAMENTALS'\beta + \alpha_i + \varepsilon_i$$

The essential assumption of the model, on top of the assumptions for the fixed effect model, is the lack of correlation between random effects and explanatory variables.

In this approach, the importance is not attached to the value of an individual effect for a certain unit (company), but the parameters of the distribution of the random effects are estimated. Hence the conclusions drawn upon this model refer not to single units from a sample but to the population in general. Since fixed and random effects models involve different as-

sumptions, the estimation of both models varies. The ordinary least squares method is applied in case of fixed effects model, while generalized least squares estimator is used for random effects model. In both cases, the significance test of individual effects can be carried out.

In our case, the random effect model is suggested, as the conclusions drawn upon the model should refer to relations between fundamentals and stock returns in general, not only to those specific companies in the sample. However, we apply both approaches in order to compare the results. In the course of estimation, the significance of both individual effects as well as explanatory variables is checked and the insignificant variables are eliminated from the model. Finally, Hausman test allowing for the choice between fixed and random effects model is performed (Greene [2004]).

It needs to be noted that both fixed and random effects models include strong assumptions regarding the error terms. Therefore, before drawing on conclusions regarding fundamentals and stock returns, the validity of error term's features has to be checked. For this, we perform the heteroscedasticity and autocorrelation tests. The estimated error terms matrix is also analysed with respect to the correlation across panels.

If the error terms are autocorrelated or heteroscedastic, fixed and random effects estimators cease to be effective and unbiased. For such cases Parks [1967] suggested the application of generalised least squares. However, such approach requires the data transformation with the use of error covariance matrix and, still, yields effective results only if the number of time series in the sample is greater than the number of panels, which is not our case. Alternatively, Beck and Katz [1995] suggested estimating the parameters of the model by Prais-Winsten method and then adjusting the standard errors for the panel data. Panel Corrected Standard Errors (PCSE) are calculated with the use of following formula:

$$Var\left\{\hat{\beta}_{PCSE}\right\} = \left(X'X\right)^{-1} X'\Omega X (X'X)^{-1}$$

Matrix X represents the explanatory variables, whereas Ω is the covariance matrix for all error terms.

To sum up, if the error terms exhibit heteroscedasticity and autocorrelation, it has to be decided which panel data approach to choose: individual effects model or panel corrected standard errors method. In PCSE model the problem of heteroscedasticity, autocorrelation and correlation across panels will be eliminated, whereas fixed and random effects models allow for including the individual effects.

5. Sample and models

The sample includes companies that were listed at least once during the period 1997 - 2003 on the Warsaw Stock Exchange. Due to the specific characteristics of the financial sector, the banks, investment funds and insurance companies were excluded from the sample. Thus, the analysis is focused on 187 companies.

The explanatory variables were calculated on the basis of financial statements for years 1997 – 2003. The historic stock prices derived from the internet portal PARKIET were used for calculating stock returns. The values of fundamentals were obtained from consolidated financial statements, if available. Otherwise, unit financial statements were taken into account. If a company started publishing consolidated statements during the period of analysis, then such financial statements were the source of information for the model.

Since many companies entered the listing within the analysed period and at the same time other ceased to operate, the sample includes many missing observations. This is, however, common situation for the panel data and the estimators can be modified to account for that. The tests were carried out to confirm the validity of such approach to estimation. The entire analysis was performed with STATA 8.0.

Table 3 displays the estimation results of the two types of panel models with individual effects for one year ahead stock returns: the models with random and with fixed effects. The insignificant variables were excluded from the model.

Table 3. RE and FE model estimation results for one year ahead stock returns

	Model RE		Model FE	
Variable	Coeff.	Prob.	Coeff.	Prob.
grossmargin	-0.1033	0.003	-0.1225	0.002
costs	-0.7560	0.000	-0.8373	0.000
ROA	0.8161	0.001	1.1010	0.001
liquidity	0.1996	0.057	0.2109	0.100
constant	1.4124	0.000	1.4271	0.000
R^2 within	0.0834	-	0.0839	-
R^2 between	0.0452	-	0.0449	-
R^2 overall	0.0757	-	0.0753	-
Joint significance test for all variables	$\chi^2(4)$ = 62.18	0.000	F(4,594) = 13.59	0.000
Significance test for individual effects (H_0: $u_i = 0$)	$\sigma_u = 0$	-	F(165, 594) = 0.64	0.999

Source: own calculations

Both fixed and random effects method yield four significant fundamental variables. The coefficients' signs are coincident with the expectations. The goodness of fit of both models as assessed by R^2 is low. The individual effects are not identified in both cases.

Hausman test performed on the sample revealed that there are no significant differences between both estimation results and hence the random effects estimator is more efficient.

Since the random effects model requires strong assumptions regarding error terms, autocorrelation and heteroscedacticity tests were performed. It was found that error variance matrix reveals autocorrelation, heteroscedasticity and correlation across panels. Therefore, Prais-Winsten estimation with panel corrected standard errors was carried out. The results are shown in Table 4.

Table 4. Prais-Winsten estimation results with panel corrected standard errors for one year ahead stock returns

	Prais-Winsten model with PCSE and common AR (1) for all panels	
Variable	Coeff.	Prob.
grossmargin	-0.1190	0.000
costs	-0.8695	0.012
ROA	0.9460	0.068
constant	1.4600	0.000
R^2	0.0727	-
Joint significance test for all variables	$\chi^2(3) = 18.14$	0.000
rho	0.1715	-

Source: own calculations

Only three variables are found significant. Goodness of fit remains on the similar level as before. Hausman test shows that there is no sample selection bias, i.e. missing observations do not negatively affect the estimation results.

In the next step, Fama and French risk factors were included into the model. The same procedure of estimation was repeated for one-month-ahead and three-month-ahead stock returns. The estimation results are presented in Table 5.

Table 5. Prais-Winsten estimation results with panel corrected standard errors including Fama and French factors as explanatory variables for one-year-, one-month- and three-month-ahead stock returns

	Prais-Winsten estimation with PCSE and AR(1) common for all panels					
	one-year-ahead returns		one-month-ahead returns		three-month-ahead returns	
Variable	Coeff.	Prob.	Coeff.	Prob.	Coeff.	Prob.
acc_receiv	-	-	-0.0140	0.249	-	-
grossmargin	-0.0912	0.006	-	-	-0.0364	0.001
costs	-0.5618	0.039	-	-	-	-
ROA	0.8813	0.185	-	-	-	-
leverage	-	-	-0.0002	0.001	-0.0002	0.014
liquidity	-	-	-	-	-	-
EP	0.8563	0.000	0.0241	0.417	0.0698	0.379
marketequity	-1.44e-08	0.192	-1.61e-09	0.345	-6.44e-09	0.196
BVMV	0.0029	0.541	0.0008	0.340	0.0027	0.140
constant	1.2333	0.000	1.0136	0.000	1.0304	0.000
R^2	0.1856	-	0.0218	-	0.0145	-
Joint significance test for all variables	$\chi^2(6)$ = 47.92	0.000	$\chi^2(5)$ = 28.16	0.000	$\chi^2(5)$ = 141.15	0.000
rho	0.0650	-	-0.0192	-	0.0680	-

Source: own calculations

In terms of goodness of fit, the one-year-ahead stock returns model seems to be the best. Generally, Fama and French factors are found insignificant, except the earnings to price ratio in case of one-year-ahead stock returns. The nature of the relationships between fundamentals and stock returns varied for different time frames.

6. Conclusions

The study confirms that statistically significant associations can be found between some fundamental factors and future stock returns for companies listed on the Warsaw Stock Exchange. The importance of the fundamental variables is more evident in the long term.

Three fundamentals (indices referring to gross margin, sales and administrative expenses, return on assets) were found significant in case of one-year-ahead stock returns. Two variables (gross margin and leverage) are significant in case of three-month-ahead returns and only one (leverage) in case of one-month-ahead stock returns. Such findings support the hypothesis that fundamental analysis is aimed at assessing long term investments.

Out of the Fama and French risk factors, only one (earnings to price ratio) appears significant in explaining future stock returns. However, its influence on the one-year-ahead stock returns is strong.

Neither in random nor in fixed effects approach it was possible to identify individual effects specific for units in the sample. This indicates that companies listed on the Warsaw

Stock Exchange did not have any specific unobservables (or the characteristics not included in the model) that would allow to achieve constantly a certain level of stock returns.

In general, the goodness of fit of the model was low, which is however a common feature of panel data models (Wooldridge [2000]).

Finally, the panel data model was developed jointly for all companies, with no regard to the area of business they run. The aim was to benefit from the quantity of data, as the history of the Warsaw Stock Exchange is relatively short. Yet, the influence of the fundamental indices and correspondingly of Fama and French factors may vary within industries. With the larger data sets available, it might be worth continuing the panel research into the associations between long term stock returns and fundamental factors for industrial sectors.

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