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FACTORS PREDICTING STOCK RETURNS – ANALYSIS OF TECHNICAL FACTORS IN LITHUANIA EQUITY MARKET

Audrius Dzikevičius[1], Neringa Stabužytė[2]
Vilnius Gediminas Technical University
E-mail: [1]Audrius.Dzikevicius@vgtu.lt; [2]n.stabuzyte@gmail.com

Abstract. Asset management strategies are divided in two main parts: qualitative and quantitative style. The academic literature is showing a growing interest in quantitative equity portfolio management methods. These algorithms vary from the simplest correlation – regression analysis to technically challenging genetic programming algorithms. This paper focuses on the first step of quantitative asset management process – modelling of future stock returns. These models are based on enabling various factors to predict stock returns. The paper provides a detailed analysis of previous researches of forecasting stock returns. It also makes a statistical analysis of some technical factors prediction power of future returns using NASDAQ OMX Vilnius Main List market historical data. Results reveal that historical 3 previous month stock return and 3 previous month historical price volatility are the most significant factors in this research. The prediction power is evaluated by correlation coefficient and coefficients of determination.

Keywords: stock, expected return, quantitative method, correlation analysis, multifactor regression.

Introduction

There are many discussions among portfolio managers which approach is better – quantitative or qualitative. Qualitative style is based on research that focuses on intangibles. It involves evaluating all the economy as a whole, finding some sectors that are believed to expand and then selecting particular companies. The key of this style is expectation. More contrary, quantitative management is rooted in mathematics and statistics. Improvement in computer science and modern programs enable managers to use more sophisticated techniques. These managers use information more mathematically than intuitively. In more developed countries quantitative equity portfolio management (QEPM) is growing in popularity cause of technical advantage, process objectivity and comfort.

The main key of QEPM is that stock returns over time periods are fairly predictable with certain groups of factors (Chincarini, Daehwan 2006). The main four factor groups are: market related (technical) factors, financial statement information (fundamental) factors, external views of the companies (alternative) factors and data external to the stock market (macroeconomic) factors (Nuttall 2007). According to Nuttall J., market data include such technical factors as price of the share, total return, capitalization, trading volume, volatility – everything that can be constructed from past price and volume data. Financial statement information is taken from income statements, balance sheets, such indicators as net income, dividends, interest charge, book value, cash flow and etc. External views about companies can include analysts' expectations, debt and solvency rating. The fourth group, external data to stock market, can be expressed by industrial production, rate of inflation, government bond interest rate and other. The asset manager needs to decide what factors to use and in what way to combine them. There are many different theories and discussions in this field.

One of the greatest advantages is that technical factors update constantly and makes the models more effective. This paper analyzes technical factors effect in Lithuania's equity market. The research includes such historical market factors: 1 previous month stock return, 3 previous month stock return, 1 month stock price volatility (standard deviation), 3 month price volatility, change of trading volume in previous 1 month (change in number of shares traded in the market during a certain period of time) and change of trading volume in previous 3 month. Correlation analysis is used to find whether there is a connection between separate factors and future stock returns and what factors have the strongest effect. Then factors, having biggest influence on stock returns, are included in the multifactor regression model. The task is to find the accuracy of linear approximation containing certain factors.

Multifactor models, including different groups of factors, are widely examined abroad in such markets as NYSE, AMEX and NASDAQ, while in Lithuania there are not so many works. So the aim of this paper is to analyse one of the four factor groups – technical factors – effect and relation with stock returns in Lithuania equity market.

Well-known models of predicting stock returns

There are lots of theories and methods created for valuation of equity securities. The earliest and most known are the arbitrage pricing theory (APT), the capital asset pricing model (CAPM) and the dividend discount model (DDM) based on discounted cash flows (DCF). Despite the fact these models are widely employed, they have a list of drawbacks and are heavily implemented. That leads for investigation of new and more effective methods.

According to APT, this theory makes an assumption that future stock returns can be predicted by few systematic macro-economic factors or market theoretical indices (Roll, Ross 1995). But the main drawback is that macroeconomic or fundamental factors have different power of predicting stock returns and this model does not take into consideration this effect (Mesale, 2008).

Another method, CAPM, into prediction of stock returns includes risk factor to particular benchmark, risk free rate and market risk premium (Black, Jensen, Sholes 1972). It also does not take into account many other factor groups and do not have great empirical success (Fama, French 2004).

The theory of DCF takes most of the attention to the time value of money (Penman, Sougiannis 1995). It requires projection of firm's financial statements and has some serious assumptions about predicting future growth rates and other ratios. Also the company's financial information has a periodicity, so the calculations can be renewed only by quarters, when all financial statements are achieved in public.

Multifactor quantitative models

The key to modelling quantitative equity portfolios is choosing the most important factors in certain markets because every security needs particular investigation. (Mesale 2008). So it needs a detailed analysis of various factors groups that are the most important on every special case.

The first step of QEPM and one of the most important tasks is to construct a model that could explain future stock returns. These models specify a relationship between the stock return and a list of explanatory variables. These variables are called factors (Chincarini, Daehwan 2006).

Suppose that the model specifies that the return of stock *i* at time *t*, r_{it} , is a linear function of the value of *K* factors premiums at time t, that is, $f_{1t},...,f_{Kt}$:

$$r_{it} = \alpha_i + \beta_{i1} * f_{1t} + \beta_{i2} * f_{2t} + ... + \beta_{iK} * f_{Kt} + \varepsilon_{it} \quad (1)$$

Where α_i, β_{i1}, $\beta_{i2},\ldots$, β_{iK} are parameters to be estimated and ε_{it} is the random error-term (the deviation of the stock return from its expected value). This factors model presents, that the average stock return is proportional to the stock's exposure to the risk that the factor represents (the factor exposure) and to the payoff for each unit of exposure to the risk (the factor premium) (Chincarini, Daehwan 2006).

The accuracy of this linear approximation can be measured by the goodness of fit –the coefficient of determination R^2 and adjusted coefficient of determination R^2_{adj} (Čekanavičius, Murauskas 2008).

$$R^2 = 1 - \frac{\sum_i (r_i - \hat{r}_i)^2}{\sum_i (r_i - \bar{r})^2} \quad (2)$$

Where r_i – observed values, $\hat{r}_i$ - modelled values and $\bar{r} = \frac{1}{n}\sum_i^n r_i$ - average of observed values.

$$R^2_{adj} = 1 - \frac{n-K}{n-K-1} * (1 - R^2) \quad (3)$$

Here n is number of observations and K – number of variables. The values of both R^2 and R^2_{adj} vary from 0 to 1 and larger meaning means better approximation. The value of 1 means perfect accuracy.

Previous researches

The academic literature is showing the interest of trying to find the most appropriate factors that could explain future stock returns. Most of attention is focused on fundamental factors, but other groups, including technical factors, are also analysed.

The technical factors power of forecasting stock returns was started to analyse in 1990 by Jegadeesh N. The author analysed previous period stock return effect to

future returns. The period investigated was from 1934 till 1987 and included stocks from NYSE, AMEX and NASDAQ markets. The results revealed that there is a negative serial correlation in monthly returns and significant positive correlation at longer periods, especially in 12 month periodicity. So this paper highlighted strong evidence of stock returns predictability using historical price data (Jegadeesh 1990).

Other important researchers in the field of predicting stock returns are Fama E. F. and French K.R. that in 1992 in Nyse, AMEX and Nasdaq markets implemented a model of multi-factor expected returns. The period of investigation was from 1963 till 1990. The technique they used was a cross-sectional regression (explanatory variables are associated with one period or point in time). They included only fundamental factors: companies size, book-to market ratio (book value of the firm divided by its market value), market β (risk factor), leverage ratio (share price divided by its per share earnings). They revealed that relation between systematic risk factor – market β and stock return is weak. They also found a significant negative relation between firm size and average return and positive relation between book-to-market values and average stock returns (Fama, French 1992).

A very important investigation of the multifactor expected returns model was done in 1996 by R.A. Haugen and N.L. Baker (Haugen, Baker 1996). This multifactor model included fundamental and technical factors, as the authors call them factors relative to the risk (fundamental factors) and factors related to the bias in the market's pricing. The model took into account factors connected to the risk, liquidity, price level, growth potential and technical history of stock returns. Authors used cross – sectional regression to find coefficients of the factors and find the most important of them. The same investigation of the same period from 1979 till 1993 was done in five countries markets: Russel 3000 Index, Japan, France, Germany and UK. The conclusion was made that future stock returns can be explained by both fundamental and technical factors. The most significant factors were found: one – month excess return (return above benchmark measure), book to price ratio (current closing price of the stock divided by the latest known book value per share), twelve – month excess return, cash flow to price ratio, earnings to price ratio (current share price divided by earnings per share) and sales to price ratio (share price divided by revenue per share). So both fundamental and technical factors were found significant in forecasting stock returns.

One of the first researchers in Eastern Europe were Lyn E.O. and Zynchowitz E.J. that in 2004 implemented a multifactor model in developing markets of this Europe part (Lyn, Zynchowitz 2004). Analysed factors were based only on fundamental data. Authors used correlation and regression analysis. The results showed that E/P (earnings to price ratio) is in a negative relation with longer than 6 month stock returns. The ratio of dividend yield was found to be positively related with stock returns, but just in the weak form. Also it was found a statistically significant relation between stock return and market liquidity and systematic risk factor (Lyn, Zychowicz 2004).

One of the newest analyses of stock returns predictability power based on various factors in the Baltic equity market is Raimonds Lieksnis's article of 2010. The analysis goes through monthly returns of 8 Latvian, 13 Estonian and 27 Lithuanian company stocks. The period investigated is from June 2002 till February 2010. The factors included are based only on fundamental data. The author uses Fama and French methodology and includes only fundamental data factors: market index, book – to – market ratio and market capitalization. The author used cross – sectional analysis to find whether these factors are significant. Analysis reveals that relative capitalization and book-to-market ratio are significant factors in predicting future stock returns and book-to-market ratio is the most significant factor of analysed factors in the Baltic stock market. Despite the fact this model gives a good approximation of reality, the model as a whole is not statistically acceptable that leads for further investigations (Lieksnis, 2010).

The question of whether stock returns can be predicted by fundamental factors also was investigated in more narrow Lithuania equity market. The link between stock return and companies financial ratios was analyzed during the period from 2010-2011. The results revealed that fundamentals factors can be used as stock returns predictors in Lithuania equity market but there is no one the most significant ratio that could explain all stocks returns, so every company needs a specific analysis (Dzikevičius, Šaranda 2011). The investigation also highlighted a problem of data collecting because quarterly published information can be fallacious.

The problem of using misleading and inaccurate financial data can be avoided by choosing market related – technical factors which can be renewed according to the particular needs. The analysis of relation based only on technical factors and stock returns was done in 2006 in NYSE and NASDAQ markets. During the investigation

over the period of 1962 – 2002 the relation between stocks return and trading data was found. Using econometric analysis it was tested that the most extreme price changes are more usual for stocks that have low liquidity and high turnover. Negative autocorrelation (relation between stock price return and its previous period return) was found of weekly periodicity in stocks with high turnover while the impact of monthly turnover was found to be opposite (Avramov, Chordia, Goyal 2006).

Nevertheless the most researches are based on US market data there are some evidence of analysing technical factors in other markets too. The relationship between trading volume and stock returns was analyzed in India stock market during the period from 2005 till 2010. The results revealed that daily trading volume has an explanatory power for Indian stock market returns (Tripathy 2010). German stock market was analyzed in 2010 by implementing various combinations of multifactor models to find the most important factors. It combined both fundamental and technical data. Results revealed that during the period of 1960-2006 in German stock market momentum (previous period return) was the most significant factor in explaining stock returns. No evidence was found analyzing such fundamental factors as book-to-market ratio and companies' size. So the historical data was found to be more accurate in predicting stock returns than fundamental factors at this case (Artmann, Finter, Kemph, Theissen 2010).

The importance of equity's price history data in forecasting future market movements in the Baltic market is analyzed by previous researches of using simple moving average (SMA) and exponential moving average (EMA) techniques. The results revealed that EMA method is suitable to forecast stock market fluctuations of OMX index in the Baltic States market (Dzikevičius, Šaranda 2011). So there is some evidence that historical market data has a power of predicting future price and movements in Lithuania equity market.

Correlation analysis of technical factors in Lithuania stock market

Gathering historical data of equity market information in Lithuania is quite time consuming and complex task because we do not have a common database suck as Compustat that combines data of financial, statistical and market information on active and inactive throughout the world.

Lithuania equity market, NASDAQ OMX Vilnius, belongs to the world's largest exchange company – NASDAQ OMX Group. Shares that are listed in Vilnius equity market are divided into two groups: Main list and Secondary list. All historical data is taken from the official equity market internet site. The period selected is all available data on the official internet site from 2000.01.04 till 2011.11.29. Investigation includes seventeen companies' equities that consist Vilnius Main List at the moment and were included to the list not earlier than two years before. Table 1 gives a brief summary of equities that were included to the research in order to calculate weighted average results of the research as a whole. Every stock's monthly returns are calculated during this period of almost 11 year. Other data is also calculated from the certain period stock price and volume market history.

Table 1. Composition and weights of companies included in analysis

Company	Bloomberg	Amount of shares	Last price 2011.11.29, EUR	Capitalization 2011.11.29 , EUR	% of capitalization
Apranga	APG1L	55.291.960	1,417	78.348.707,32	3,86%
City Service AB	CTS1L	31.610.000	1,93	61.007.300,00	3,00%
Grigiškės	GRG1L	60.000.000	0,485	29.100.000,00	1,43%
Invalda	IVL1L	51.659.758	1,825	94.279.058,35	4,64%
Lietuvos dujos	LDJ1L	469.068.254	0,59	276.750.269,86	13,62%
Lesto AB	LES1L	603.944.593	0,547	330.357.692,37	16,26%
Linas Agro Group	LNA1L	158.940.398	0,405	64.370.861,19	3,17%
Panevėžio prekybos trestas	PTR1L	16.350.000	1,112	18.181.200,00	0,89%
Pieno žvaigždės	PZV1L	54.205.031	1,633	88.516.815,62	4,36%
Rokiškio sūris	RSU1L	35.867.970	1,229	44.081.735,13	2,17%
Šiaulių bankas	SAB1L	234.857.533	0,256	60.123.528,45	2,96%
Sanitas	SAN1L	31.105.920	10,06	312.925.555,20	15,40%
Teo LT	TEO1L	776.817.518	0,595	462.206.423,21	22,75%
Ūkio bankas	UKB1L	295.824.000	0,183	54.135.792,00	2,66%
Utenos trikotažas	UTR1L	19.834.442	0,199	3.947.053,96	0,19%
Vilniaus baldai	VBL1L	3.886.267	10,007	38.889.873,87	1,91%

Vilkyškių pieninė	VLP1L	11.943.000	1,2	14.331.600,00	0,71%
			sum:	2.031.553.466,53	

Previous researches revealed that historical market data factors, such as past stock performance, trading volume or volatility can be used for prediction of future stock returns. The question arises, are such technical factors important in Lithuania equity market that could be used as predictors for future stock returns and what are the most important ones.

In order to find out the prediction power of technical factors for future stock returns, the analysis includes six factors that could be calculated from historical market data:

- previous 1 month stock return;
- previous 3 month stock return;
- volatility of 1 month stock price;
- volatility of 3 month stock price;
- change in 1 month trading volume;
- change in 3 month trading volume.

Every seventeen stocks monthly returns were calculated. Correlation coefficients were estimated between 1 month stock return and each of six factors above. Results are presented graphically.

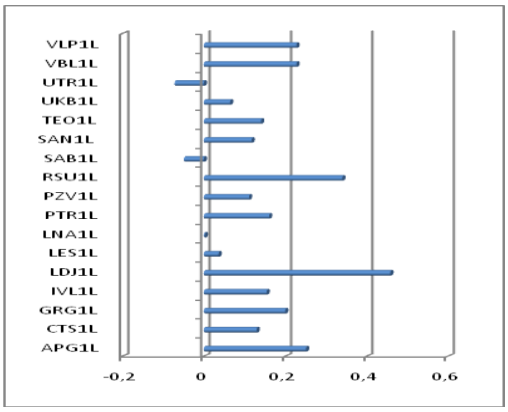

Fig. 1. Correlation between 1 month return and previous 1 month return

As it is seen from the Figure 1, correlation between 1 month stock price return and previous 1 month return almost on all cases is positive and varies in a weak relation from 0 to 0,4 correlation coefficient. So we could say it is a weak form autocorrelation between 1 month period stock returns.

In comparison to this case in Figure 2 is represented the relationship between 1 month return and previous 3 month returns. On all seventeen companies the correlation seems to be positive and also stronger because distribution on higher correlation values is denser. So the first simple conclusion arises that 3 month previous stock return factor is more significant than previous 1 month return factor. The assumption can be made that longer period aligns some short-term deviations and can lead to stronger relation.

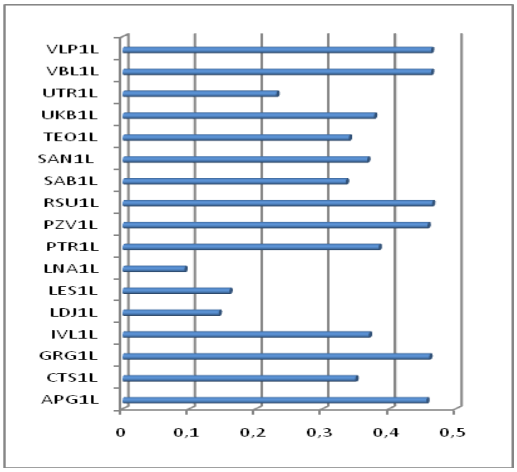

Fig. 2. The correlation between 1 month price return and previous 3 month returns.

The Figure 3 presents negative relation between 1 month price return and previous 1 month volatility. It is fairly positive only in two cases. The Figure 4 is on the case of 3 month price volatility and this case also shows that longer period factor of price volatility is more significant than 1 month price volatility according to the absolute value of correlation coefficient. At both cases of analysing relation between 1 month return and previous period return or standard deviation the periodicity of 3 month variables had a stronger effect. According to the results, larger price fluctuation causes a negative effect on stock return.

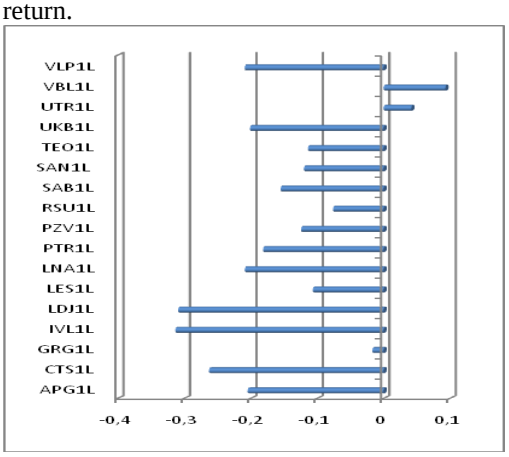

Fig. 3. Correlation between 1 month price return and previous 1 month price volatility

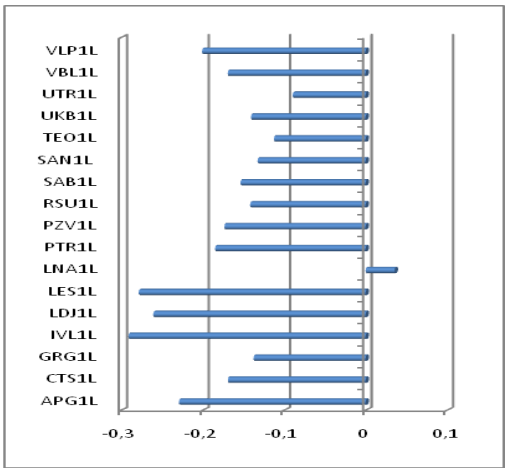

Fig. 4. Correlation between 1 month stock return and previous 3 month price volatility.

Two last figures 5 and 6 presents the connection between 1 month stock return and change in trading volume of 1 month and also 3 month periodicity. From the graphical view any trend is noticed.

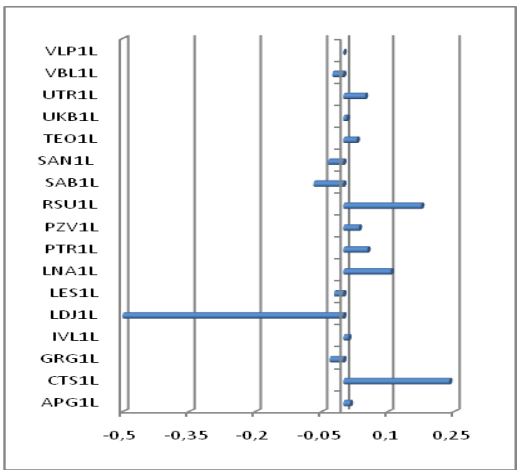

Fig. 5. Correlation between 1 month price return and change in previous 1 month trading volume

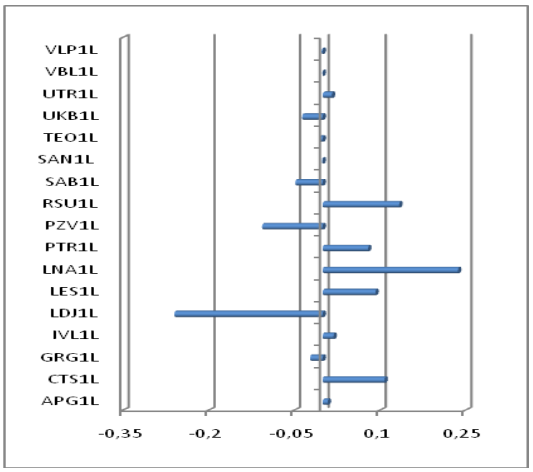

Fig. 6. Correlation between 1 month price return and change in previous 3 month trading volume

From seventeen analyzed companies stocks, six stocks had a negative correlation coefficient between 1 month return and change of trading volume during 1 month and eleven of them had a positive coefficient. Only one stock "Lietuvos dujos" was found to have an average form of negative relationship with this variable.

According to the Figure 6, five stocks were found to have a negative connection with trading volume change in 3 month while twelve stocks were in slightly positive relation. So most of the stocks had a positive relation, but averagely the correlation coefficient did not exceed 0, 1.

On both cases of analysing trading volume change in 1 month and in 3 month effect to stock returns more stocks had a positive correlation coefficient than negative. But both positive and negative absolute values were very small so any trend between trading volume and stock returns is found during this investigation.

Table 2. Summary of correlation analysis

Weighted average of correlation coefficient between 1 month stock return and:	Previous 1 month return	Previous 3 month return	Previous 1 month price volatility	Previous 3 month price volatility	Change in 1 month trading volume	Change in 3 month trading volume
	0,1617	0,3005	-0,1593	-0,2105	-0,0134	-0,0679

So from the graphics and empirical results on Table 2 it is seen that from these six analyzed factors most important is the return of previous 3 month and the second is previous 3 month price volatility. Nevertheless, the correlation is in a weak form.

Regression analysis in Lithuania stock market

The simplest approximation of the relation between stock return and predicting factors is linear. According to the formula (1), a linear approximation can be found for three cases incorporating factors that were found to be more effective than others:

- regression based only on 1 factor – previous 3 month price return;
- regression based only on 1 factor – previous 3 month price volatility;
- regression based on 2 factors – previous 3 month price return and previous 3 month price volatility.

On the first case the monthly returns are approximated linearly by previous 3 month price returns factors , then by previous 3 month price volatility factor and thirdly of combination of both factors. Every stock is regressed separately and Tables 3, 4, 5 presents summary of all seventeen stock results as weighted averages of each stock regression parameters. The confidence level is chosen of 95 %.

Table 3. Weighted average of parameters of regression based on 3 month previous return factor

	Previous 3 month return
R Square	0,2933
Adjusted R Square	0,2496
Standard Error	0,1189
Intercept	0,0133
Variable 1 coeff.	0,3116

Table 4. Weighted average of parameters of regression based on 3 month price volatility factor

	3 month price volatility
R Square	0,0416
Adjusted R Square	0,0071
Standard Error	0,1378
Intercept	0,0519
Variable 1 coeff.	-0,7038

Table 5. Weighted average of parameters of regression based on 3 month price volatility and 3 month previous return factors.

	Previous 3 month return and 3 month price volatility	
R Square	0,3897	
Adjusted R Square	0,3356	
Standard Error	0,1118	
Intercept	0,0408	
Variable 1/2 coeff.	0,0301	-0,1546

According to the empirical results presented in tables 3, 4, 5, the best of these three approximations is the one that includes both factors of previous 3 month price return and previous 3 month price volatility. It is seen from the biggest value of R^2 and R^2_{adj} and also the lowest value of standard error. Nevertheless, the goodness fitness coefficients R^2 and R^2_{adj} do not reaches 0,5 while the value 1 means the perfect fitness. So these results leads to futher investigations of icluding more factors, looking more complicated than linear relationships and achieving higher accuracy.

Conclusions

Empirical investigation reveals that from analyzed six historical factors the closest relationship is between 1 month stock return and its previous 3 month stock return. The relationship is positive but the correlation is not strong, only averagely about 0,3. The second factor according to the absolute value of correlation coefficient is previous 3 month stock price volatility (standard deviation) which absolute value of correlation coefficient is about 0,2.

The second conclusion arises that at this case longer period factors are better predictors, in comparison of 1 month and 3 month periodicity. Periodicity can be also analyzed as a separate factor in order to find the most accurate relationship among dependent and independent variables.

Regression approximation on 3 cases reveals that more accurate is the regression based on two factors. Nevertheless the goodness of fit is not big, the average coefficient of determination is about 0,4.

According to the empirical results, the analysis of stocks returns evaluation leads for further investigations - including more factors, not only historical market data, but also fundamental. Better accuracy can be achieved by adding more factors, looking for more complicated relations between stock return and analyzed factors, analyzing effect of different periodicity.

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AKCIJŲ GRĄŽĄ PROGNOZUOJANTYS VEIKSNIAI – TECHNINIŲ VEIKSNIŲ ANALIZĖ LIETUVOS AKCIJŲ BIRŽOJE

A. Dzikevičius, N. Stabužytė

Santrauka

Gali būti išskiriamos dvi pagrindinės lėšų valdymo strategijos: kokybinė ir kiekybinė. Mokslinė literatūra rodo augantį susidomėjimą kiekybinias portfelio valdymo metodais. Šie algoritmai kinta nuo paprastos koreliacinės – regresinės analizės iki sudėtingų genetinio programavimo algoritmų. Šis straipsnis susitelkia ties pirmuoju kiekybinio akcijų portfelio valdymo žingsniu – akcijų ateities grąžos modeliavimu. Šie modeliai pasitelkia įvairius veiksnius, galinčius prognozuoti ateities grąžą. Pateikiama ankstesnių akcijų grąžos prognozvimo tyrimų literatūros apžvalga. Atliekama statistinė analizė naudojant NASDAQ OMX **V**ilnius oficialiaus akcijų sąrašo istorinius duomenis, siekiant išanalizuoti kai kurių techninių veiksnių įtaką akcijų ateities grąžai. Istorinė akcijos 3 praėjusių mėnesių grąža ir 3 praėjusių mėnesių akcijos kainos standartinis nuokrypis išskiriami kaip svarbiausi šiame tyrime. Prognozavimo galia įvertinama koreliacijos koeficientu ir determinacijos koeficientais R^2 ir R^2_{adj}.

Reikšminiai žodžiai: akcija, tikėtina grąža, kiekybinis metodas, koreliacinė analizė, daugiafaktorė regresija.