THE FORECASTING ABILITY OF A MARKET MODEL FOR SHARES ISSUED BY PETROM S.A.

Laura-Mădălina IACOB (PÎRȘCOVEANU)[1], Cornelia-Cristina PÎRȘCOVEANU[2]

[1,2]Bucharest Academy of Economic Studies

Abstract

The scope of this paper is to make an empirical analysis regarding the market model introduced by the American economist Wiliam Sharpe (1963), a research developed based on the idea of portfolio simplification.

In this paper, we tested the ability to predict a market model for shares issued by Petrom S.A. company. The result shows that the market model can be used to predict the profitability of a security, the forecast errors being insignificant. The results of this paper can help the investors to decide when to invest.

Keywords: *market model, diversification, market profitability, share*

JEL classification: *G10, G11, G12*

1. Introduction

This paper is part of the field portfolio management, and it's aims to test the ability to predict the market model in the case of shares issued by Petrom S.A.. The paper is addressed to the academic environment and business environment. The research presented in this article have a particular importance and it’s necessary to know the ability to predict the market model, whether it can be applied as well as whether the application of the model generates forecast errors or not.

[1] *Ph.D. student, Bucharest Academy of Economic Studies, Doctoral School of Economics I, laura.pirscoveanu@yahoo.com*

[2] *Graduate student this year, Bucharest Academy of Economic Studies, Master studies, Advanced research in finance, cristinapirscoveanu30@gmail.com*

The goal of any investor is to maximize the return on invested capital. However, there is a direct relationship between the expected return on investment and the level of risk regarding the investment concerned. In this case, the risk is defined as a measure of uncertainty and can be seen as a maximum loss associated with an investment or can be seen as a variability in profitability.

The current investment practice is strong influenced by the capital market literature of the last two decades, which is based on the market portfolio. As we know that the most appropriate way to build a portfolio is the diversification of this. For each title, there is an index that is correlated with its profitability depending on the perspective of the activity sector. Hal (1993) follows the context in which William Sharpe approaches the market model in the field of portfolio management. He assumes that the yield of each security depends linearly on a single index, considered the profitability of the stock market.

The paper is structured in four chapters as follows: the first chapter refers to the literature (main aspects, currently related to portfolio management). The second chapter makes a brief description of the applied methodology, following that in the third chapter to be presented the data with the help of the linear regression was run. In the last chapter, the authors present the results obtained and draw on the main conclusions of the analysis.

2. Literature review

The founder of the modern portfolio theory is the economist Markowitz (1952) (Nobel prize in economic sciences (1990)). Markowitz's model describes the impact on portfolio diversification by including a large number of securities, analysing the covariance relationships between the included securities. Both theories, the modern portfolio consists of Markowitz's portfolio selection theory (1952) and Sharpe's contributions to financial asset price theory (1964). This model is named in the economic literature the *"Capital Asset Pricing Model"*, known as CAPM. As demonstrated by Fabozii, Gupta, and Markowitz (2002), portfolio theory is an investment framework for the selection and construction of investment portfolios that is based on maximizing expected portfolio returns and simultaneously minimizing investment risk.

The economist Tobin (1958) showed that market investors, regardless of their level of risk tolerance, will maintain the same structure of the stock

portfolio as long as investors maintain their expectations for the future. As a result, Tobin concludes that investment portfolios will be different in terms of the relative proportions of shares and bonds.

The CAPM model represents an evolutionary step in the capital market equilibrium theory, allowing investors to value investment securities according to the associated systematic risk.

Economists like Fabozii, Gupta, and Markowitz (2002) analysed the concept of portfolio diversification. Diversification is a solid foundation of modern portfolio theory and is defined as a concept of risk reduction, which involves the allocation of investments between different financial instruments, industries, and other categories of investments. In simplistic terms, portfolio diversification refers to the saying "Don't put all your eggs in one basket". If the basket is thrown, then all eggs will be broken. If the eggs are placed in different baskets, the risk of all eggs being broken is dramatically reduced. Therefore, diversification can be achieved by investing in different securities from different sectors of activity from different countries.

The goal of diversification is to maximize return and minimize risk by investing in different securities that would react differently to the same event. For example, negative news about the European debt crisis is leading to a decline in the stock market. At the same time, the same news has had a positive impact on the price of certain commodities, such as gold. Thus, portfolio diversification strategies should include different asset classes. Gibson (1990) analyses the diversification effect, which refers to the relationship between correlations and portfolios. When the correlation between assets is positive or negative, the result is given by the diversification effect. Hight (2010) states that diversification is an important and effective risk reduction strategy, as risk can be mitigated without compromising returns. Therefore, an investor characterized by risk aversion will diversify his portfolio to a certain degree.

In the empirical work on the market model, it has been assumed that the systematic risk of an asset or portfolio is constant over time. However, an alternative hypothesis would allow the systematic risk to vary over time. Such variation can occur through the influence of either microeconomic factors (such as changes in the company's operations or changes in the company-specific business environment) or macroeconomic factors (such as inflation rate, general business conditions, expectations about future elements relevant).

This issue is addressed by Rosenberg and Guy (1976). In addition, Jacob (1971), Blume (1975) approach the hypothesis that risk varies over time.

There are also criticisms based on the market model. They focus on inappropriate shares in the portfolio used to represent the sector. Richard Roll (1977) pointed out that the proportion of investments in a market portfolio can be wrongly specified. A representative portfolio may be designated within a single sector. Many market researches have used an equally weighted market portfolio than a capitalized one.

The market model is considered a process of generating profitability for joint actions and occupies a central place in the financial economy. The theory shows that the use of a linear market model with homoscedastic errors is representative of any title in which one invests.

3. Research methodology

The analysis is prepared on daily returns of the Petrom's share and of the stock market index, BET, BETPlus, respectively BET-BK starting from June 6, 2021, until December 8, 2021.

Regarding the application of the market model, we considered as a dependent variable the profitability of Petrom's share, and as an independent variable we considered the market profitability given by the stock market index BET, BETPlus, respectively BET-BK.

We considered the application of the market model in three possible situations, in which the market profitability is represented by each stock index mentioned above. Each stock index has a certain structure, and the Petrom's share has the biggest weighted in each index considered. Also, Petrom's share represent a fairly significant segment of the market.

In fact, a regression analysis is presented between Petrom's return on share and market profitability. To have a clearer picture of the analysis, the formula of the market model is presented in the following form:

$$\mathbf{R_{it} = \alpha + \beta * R_{Mt} + \varepsilon_i}$$

From this perspective, the market model can have two interpretations: one from a financial point of view and the other from a statistical point of view. As a result, from a financial perspective, the return of a share at given moment "t" is made up by three components, as follow:

- Constant parameter (α) - represents the profitability generated by all systematic influencing factors given by the stable characteristics of the securities;

- Market profitability (R_{Mt}) - multiplied by the coefficient β;
- Ɛi - the influence of unsystematic random factors;

From a statistical point of view, the coefficients α and β are constant and the following assumptions need to be met:

- no autocorrelation residues;
- there is homoscedasticity (constant variance of residues);
- residues are not correlated with the independent variable, cov (R_{market} Ɛ) = 0;
- the residues follow a normal distribution, where the average is 0 and constant dispersion.

At the same time, the profitability of Petrom's shares was calculated as the ratio between the logarithm of closing prices on consecutive days. The return on stock index was also calculated according to the following formula:

$$\mathbf{R_i = ln}\frac{Pit}{Pit-1}$$

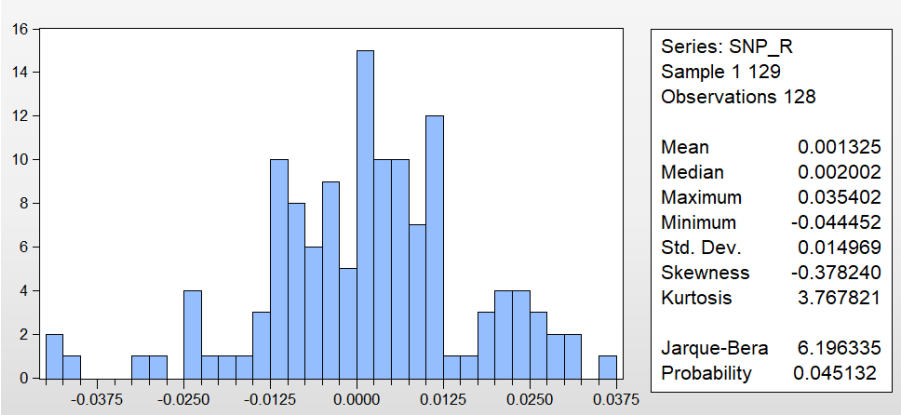
The forecasting ability of the market model was tested by the forecast error. Thus, the forecast error is given by the difference between the actual return on the share and the return obtained using the market model.

$$\textbf{Estimated error} = \mathbf{R_{it\_\ effective} - R_{it\_\ obtained}}$$

To apply the market model for Petrom's share, we used a sample of 129 data over a period of six months. The data were taken from the website of the Bucharest Stock Exchange.

For having an overview of the data, we performed a synthesis analysis for both, the dependent variable (Petrom's share return) and the independent variable (market profitability). The data series used where tested and it's accomplished the stationary condition at the first level. So, in the annex we presented the results of the Augmented Dickey-Fuller (ADF) test, where we can observe the probability is lower than 0.05%.

Figure 1 – Descriptive statistics – profitability Petrom's share (SNP_R)



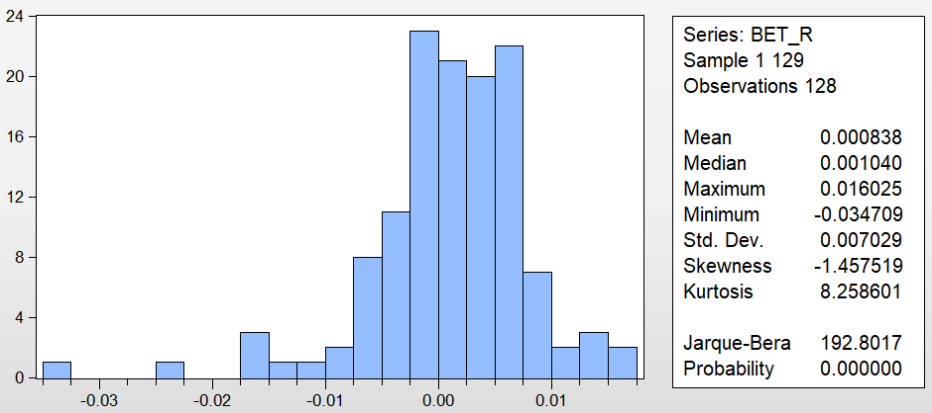
Source: Own calculations

It is noted that the probability associated with the Jarque Bera test is lower than the critical value (0.05), which means that the profitability of Petrom's share follows a normal distribution. Moreover, the asymmetry coefficient, Skewness, is negative, which means that the distribution is not symmetrical, but "left-skewed". To fully analyse the series, we will also take into account the information provided by the flattening coefficient, Kurtosis, which is greater than 3, which means that the series is leptokurtic.

We approached the same principle for the independent variable, in this case, the market profitability represented by the stock market index BET, BETPlus, BET - BK.

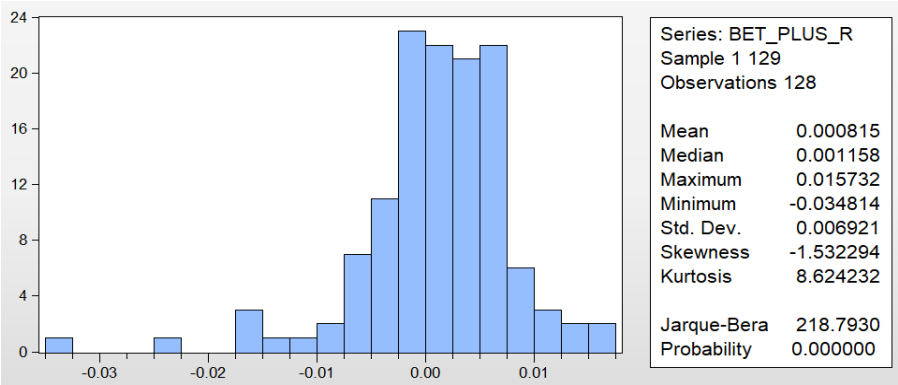
Similar to the Petrom share return series, the market return follows a normal distribution, characterized by a negative asymmetry coefficient and a flattening coefficient higher than its normal value, 3, which means that the distribution is leptokurtic.

Figure 2 – Descriptive statistics – profitability market (BET_R)



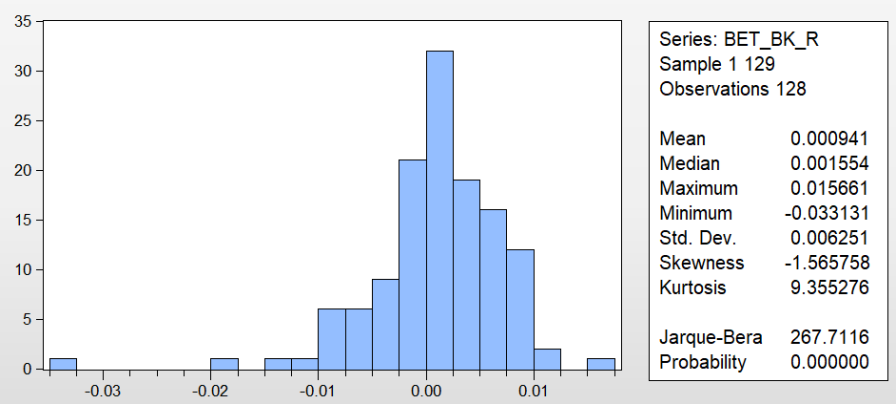
Source: Own calculations

Figure 3 – Descriptive statistics – profitability market (BET_PLUS_R)



Source: Own calculations

Figure 4 – Descriptive statistics – profitability market (BET_BK_R)



Source: Own calculations

4. Results

Further, we elaborate three linear regressions (one with the BET index, other with the BETPLUS index and the last with BET-BK index) and the results obtained is the follow:

Figure 5 – Linear regression with BET index

Dependent Variable: SNP_R
Method: Least Squares
Date: 12/11/21 Time: 14:24
Sample (adjusted): 1 128
Included observations: 128 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BET_R	1.529940	0.131974	11.59275	0.0000
C	4.32E-05	0.000931	0.046379	0.9631

R-squared	0.516114	Mean dependent var	0.001325
Adjusted R-squared	0.512274	S.D. dependent var	0.014969
S.E. of regression	0.010454	Akaike info criterion	-6.268174
Sum squared resid	0.013770	Schwarz criterion	-6.223611
Log likelihood	403.1631	Hannan-Quinn criter.	-6.250067
F-statistic	134.3919	Durbin-Watson stat	1.969332
Prob(F-statistic)	0.000000		

Source: Own calculations

The regression resulted: $\mathbf{R_{SNP} = 0.0000432 + 1.529940 * R_{BET}}$

It is noted that there is a direct or positive relationship between the profitability of Petrom's share and the profitability of the market index. In this respect, a 1% increase of the market will lead to a 1.52% increase in Petrom's profitability. The market profitability coefficient is also statistically significant.

In addition, the adjusted R-squared and R-squared coefficients show the extent to which Petrom's profitability is explained by the independent variable. The closer the values of the two coefficients are to 1, the better the model. Thus, 51% of the change in profitability of the share is explained by the change in market profitability.

For this regression, we can calculate the prediction error. We observed that the values of the prediction error is quite low, which means that the market model can be applied.

Figure 6 – Linear regression with BET_PLUS index

Dependent Variable: SNP_R
Method: Least Squares
Date: 12/11/21 Time: 14:34
Sample (adjusted): 1 128
Included observations: 128 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BET_PLUS_R	1.548901	0.134501	11.51588	0.0000
C	6.32E-05	0.000934	0.067726	0.9461

R-squared	0.512790	Mean dependent var	0.001325
Adjusted R-squared	0.508923	S.D. dependent var	0.014969
S.E. of regression	0.010490	Akaike info criterion	-6.261328
Sum squared resid	0.013864	Schwarz criterion	-6.216765
Log likelihood	402.7250	Hannan-Quinn criter.	-6.243222
F-statistic	132.6154	Durbin-Watson stat	1.966659
Prob(F-statistic)	0.000000		

Source: Own calculations

The regression resulted: $\mathbf{R_{SNP} = 0.0000632 + 1{,}548901 * R_{BETPlus}}$

It is worth noting that there is a direct or positive relationship between the profitability of Petrom's share and the profitability of the market index, BETPlus. In this respect, the growth of the market by 1% will lead to an

increase in the profitability of Petrom's share by 1.54%. Also, the coefficient associated with market profitability is statistically significant.
In addition, the adjusted R-squared and R-squared coefficients show the extent to which Petrom's profitability is explained by the independent variable. The closer the values of the two coefficients are to 1, the better the model. Thus, 51% of the change in profitability of the share is explained by the change in market profitability.

Table 2 in the Appendices section shows the prediction error for this regression. It can be seen that the forecast error is quite small.

Figure 7 – Linear regression with BET_BK index

Dependent Variable: SNP_R
Method: Least Squares
Date: 12/11/21 Time: 15:14
Sample (adjusted): 1 128
Included observations: 128 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BET_BK_R	1.475776	0.167997	8.784538	0.0000
C	-6.33E-05	0.001058	-0.059867	0.9524

R-squared	0.379824	Mean dependent var	0.001325
Adjusted R-squared	0.374902	S.D. dependent var	0.014969
S.E. of regression	0.011835	Akaike info criterion	-6.020019
Sum squared resid	0.017648	Schwarz criterion	-5.975457
Log likelihood	387.2812	Hannan-Quinn criter.	-6.001913
F-statistic	77.16811	Durbin-Watson stat	2.098008
Prob(F-statistic)	0.000000		

Source: Own calculations

The regression resulted: $\mathbf{R_{SNP} = -0.0000633 + 1{,}475776 * R_{BET-BK}}$

Also, in this case, the relationship between market profitability and profitability of share is positive. Thus, a 1% increase in the market will increase Petrom's profitability by 1.47%.

In addition, the adjusted R-squared and R-squared coefficients show the extent to which Petrom's profitability is explained by the independent variable. In 37%, the change in the return on the share is explained by the change in the return on the market.

5. Conclusions

The market model proposes a risk quantification approach. The use of the market model has increased significantly, most investors study the profitability and risk of a portfolio in relation to market behaviour in general. The model explains changes in index prices based on market profitability. The shares issued by Petrom show a high degree of liquidity, representing a large part of the market sector. This is due to the fact that the traded product is a commodity of strict necessity, which is found in all sectors of activity.

An alternative approach to testing the predictability of the market model is to remove the influence of Petrom's action from the structure of the stock market index. Thus, the application of the market model may reflect possible influences on the profitability of the share.

In conclusion, the study presents the ability to predict the market model in terms of stock indices BET, BETPlus, BET - BK used as dependent variables in the model.

6. References

- Fabozzi, F., Gupta, F., & Markowitz, H. (2002), The legacy of modern portfolio theory, *Journal of Investing*, p. 7-22;
- Gibson, R.C. (1990), *Asset allocation: Balancing financial risk*, Homewood: Dow Jones-Irwin;
- Hal V. (1993) A portfolio of Nobel Laureates: Markowitz, Miller and Sharpe, *Journal of Economic Perspectives*, 7 (1), p. 159–169;
- Hight, G., (2010), Diversification effect: Isolating the effect of correlation on portfolio risk, *Journal of Financial Planning*;
- Jacob N. L. (1971), The measurement of systematic risk for securities and portfolios: Some empirical results., *Journal of Financial and Quantitative Analysis*,
- Markowitz H. (1952), Portfolio Selection, *The Journal of Finance* 7(1), p. 77-91;
- Richard R. (1977), A critique of the asset Pricing Theory's Tests, *Journal of Financial Economics*, p. 129 – 176;
- Rosenberg B., Guy, J. (1976) Prediction of beta from investment fundamentals *Financial Analysts Journal*, p. 60-72;
- Sharpe, W. (1964), Capital asset prices: A theory of market equilibrium under conditions of risk, *Journal of Finance*, 19, p. 425-442.

- Tobin J. (1958), Liquidity preference as behaviour toward risk, *Review of Economic Studies*, p. 65-85;

Web source:

- Bucharest stock exchange web-site, the dates used for elaborate the econometric model is available on the following link: *http://www.bvb.ro/FinancialInstruments/Details/FinancialInstrumentsDetails.aspx?s=SNP*, *accessed on December 8, 2021*

7. Annex - Results of the ADF test

Figure 8. ADF Test - SNP

Null Hypothesis: SNP_R has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.18428	0.0000
Test critical values:	1% level	-3.482453	
	5% level	-2.884291	
	10% level	-2.578981	

Source: Own calculations

Figure 9. ADF Test – BET_R

Null Hypothesis: BET_R has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.39211	0.0000
Test critical values:	1% level	-3.482453	
	5% level	-2.884291	
	10% level	-2.578981	

Source: Own calculations

Figure 10. ADF Test – BET_PLUS_R

Null Hypothesis: BET_PLUS_R has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.28000	0.0000
Test critical values:	1% level	-3.482453	
	5% level	-2.884291	
	10% level	-2.578981	

Source: Own calculations

Figure 11. ADF Test – BET_BK_R

Null Hypothesis: BET_BK_R has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.38922	0.0000
Test critical values:	1% level	-3.482453	
	5% level	-2.884291	
	10% level	-2.578981	

Source: Own calculations