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The decision making criteria of a rational investor on the example of an investment portfolio analysis of listed companies and a basket of currencies

1. Introduction

Investing is the activity of engaging in something in the hope of obtaining future benefits. The Accounting Act defines investments, in accordance with general regulations, as assets acquired in order to achieve economic benefits resulting from the increase in the value of these assets, obtaining income from them in the form of interest, dividends or other benefits, including also from a commercial transaction, in particular financial assets and those real estate and intangible assets that are not used by the entity, but were acquired in order to obtain benefits (Ustawa z 29 września 1994 r. o rachunkowości).

The increase in access to information has contributed to the emergence of a growing range of opportunities in the field of multiplying wealth. Currently, of course, depending on the volume of capital held, one can invest in shares, cryptocurrencies, gold, real estate, among others. All investing should focus on selecting diversified assets while maintaining appropriate asset values in the portfolio.

All investment decisions on stock exchanges are conditioned by a wide range of factors. Among them, psychological determinants are of great importance, constituting the area of behavioral finance research. One of the premises of the classical theory of finance is based on the idea of rational choices made by economic agents. A rational investor generally acts in such a way as to maximize her profits, and at the same time does not succumb to emotions or pressure from the environment. In her decisions, such an investor is only guided by information obtained from solid financial analysis. All her decisions should be reduced

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to minimizing the risk with the assumed, expected rate of return or with the simultaneous assumption of maximizing the expected rate of return (Wasilewski, Juszczyk, 2016). A rational investor should strive to maximize the expected rate of return on investment (Markowitz, 1952).

In 1952, Harry Markowitz, later a Nobel laureate, proposed the portfolio theory, which is widely used today. This is one of the most useful discoveries in the field of modern finance. Among the conditions for the correct interpretation and application of the portfolio theory is the treatment of the investment portfolio as an integral whole. The correlation between portfolio elements is important (Stepaniuk, 2015). Consistent with the above theory, the law of average covariance illustrates how the reduction in dispersion that is achieved through diversification is constrained by this tendency (Markowitz, 1976). Markowitz's theory says that higher rates of return on an investment portfolio involve taking more risk. Before selecting a specific investment portfolio, the level of risk for a specific entity intending to make investments must first be determined. In the case of a private investor, the choice of risk is directly related to their age, financial and family situation, and therefore she selects the risk level that is comfortable for her. Cash and bonds have the lowest level of risk, and the highest is related to stocks and derivatives. It is safer to keep funds in a bank deposit than to invest them in the stock market. However, in the situation of the SARS-CoV-2 pandemic, in which low interest rates occurred, with the simultaneous increase in inflation, it is worth rethinking broadly understood investing. Investors are rational when they are risk averse, i.e. they strive to obtain the highest possible rates of return with the lowest possible risk (Kontek, 2011).

The next independent theory, which was developed by William Sharpe and Jan Mossin, as another extremely important theory of capital markets, was an outgrowth of earlier work by Markowitz and Tobin – The Capital Asset Pricing Model – CAMP (Megginson, 1996). The CAMP model was the next step in the development of the equilibrium theory of capital markets. Investors have found its use in the valuation of securities as a function of statistical risk. Sharp won the Nobel Prize in Economics for his groundbreaking contribution to its development (Myles, 2013). The above presentation of theories and their authors motivates the choice of methodology used in this article.

2. Purpose of the work

The aim of the work is to present a portfolio of listed companies, in which entities from the property development, mining and metallurgical industries, as well as the energy industry, were selected in a collision with a portfolio consisting of purchased currencies. The first observation is December 30, 2019, and the last one is December 30, 2020. Of course, the observation period for the analyzed data, both in

terms of companies and currency purchases, coincides in order to maintain the ability to compare rates of return. The period that should be examined using the methods cited depends on the individual preferences of the investor, as well as the availability of historical data and forecasts. For the purposes of this article, a period of one year was examined. However, in most cases, examining historical data over many years can provide better information on asset behavior and risk ratios.

Studying a portfolio of companies from various industries and a portfolio of currencies based on the theories of Markowitz and CAPM is valuable as it aims to understand portfolio diversity, manage risk, and assess expected returns.

The portfolio was built using tools such as: standard deviation, variance, covariance, correlation, rate of return, coefficient of volatility, beta coefficient and rate of return base. The selection of the research sample, in the form of companies from the development industry, mining and metallurgical industries, as well as the energy industry, in relation to the basket of currencies, was used to diversify assets in the investment portfolio.

For companies, daily closing rates for individual days of the year were used, due to the occurrence of holidays and holidays, the number of observations was 252. Data were downloaded from Stooq.com. For the second set of data, referring to the exchange rates of purchased currencies, tables for the euro and the Australian dollar were used from the website of the National Bank of Poland. The conducted analysis is an attempt to estimate the rate of return on invested capital for the described investment portfolios.

3. Characteristics of the analyzed data

The selection of companies in the portfolio was not accidental. Due to the growing interest in the real estate market, entities dealing with development services were selected, i.e. Archicom, Dom Development, Inpro, JW. Construction Holding, Atal, Global Trade Centre. In addition, quotation values for Jastrzębska Spółka Węglowa as the largest producer of high-quality hard coking coal and a leading producer of coke used for steel smelting were adopted for the analysis (JSW, 2021). ArcelorMittal, the largest steel producer, for which we are observing a significant increase in value in 2020, was selected as a company from a related industry. In addition, the portfolio includes companies from the energy sector, i.e. Enea and Energa.

The second portfolio included currencies: the Australian dollar and the euro, which recorded an increase in exchange rates in the analyzed period. Due to different rates for currency exchange in bureaux de change or via a bank account, the cost of currency purchase/sale was not included in the analysis. It is also worth paying attention to the fact that the commission appears in banks from a high balance at the end of 2020 (for most 5 million PLN and 100,000 in a foreign currency). Currently, limits only apply to corporate accounts, while private investors

also need to be aware of such fees in the future and should constantly monitor the tables of fees and commissions for the bank accounts used.

4. Analysis

According to the assumptions of the Markowitz model, investors are rational when they are risk averse, i.e. they strive to obtain the highest possible rates of return with the lowest possible risk. The analysis uses the formula for the simple rate of return of the portfolio, which is presented below.

Pattern 1

$$R = \frac{FV - PV}{PV}$$

Source: (Pera et al., 2014)

In the formula, PV is the purchase price of the stock, while FV is the final value of the investment. The simple rate of return is the base rate and is the least accurate measure of investment return. It is the ratio of the obtained or expected income to the outlays that have been or will be incurred. In addition, it should be noted that the simple rate of return is devoid of additivity. For further analysis, the logarithmic rate of return was used, which is the basic method for calculating the relative return on investment for continuous capitalization. The analytical form of the equation for the logarithmic rate of return is such a transformation of the future value formula for the aforementioned continuous capitalization so that the interest rate is on its left side. Hence, the relationship presented below is true (Pera et al., 2014).

Pattern 2

$$r_{ln} = \ln(FV) - \ln(PV) = \ln\left(\frac{FV}{PV}\right)$$

Source: (Pera et al., 2014)

Therefore, it can be said that each n-period logarithmic rate of return is the sum of single-period logarithmic rates of return, i.e. it is additive (Pera et al., 2014). In further analysis for the indices of the companies mentioned above, the results for the logarithmic rate of return for each day were used to calculate the rate of return and standard deviation.

Standard deviation as a measure of risk was used to estimate the level of volatility in the quotations of the audited entities, as well as to further present the formation of the volatility coefficient in the entities under consideration. The results of the calculations are presented in the Table 1.

Table 1

Expected rate of return, standard deviation and coefficient of variation for portfolio I companies

	Archicom S.A. (ARH)	Dom Development S.A. (DOM)	Inpro S.A. (INP)	JW. Construction Holding S.A. (JWC)	Atal S.A. (1AT)	Global Trade Centre S.A. (GTC)	Jastrzębska Spółka Węglowa S.A. (JSW)	ArcelorMittal S.A. (MT.US)	Energa S.A. (ENG)	Enea S.A. (ENA)
Expected rate of return [%]	0.17	0.11	0.00	–0.01	–0.06	–0.12	0.08	0.12	0.04	–0.08
The standard deviation of the rate [%]	3.38	2. 39	3.18	1.83	2.67	3.02	5.33	4.71	2.10	3.45
Coefficient of variation	20.1968	22.1250	1423.7562	–231.8276	–43.0746	–25.7205	69.3756	40.5265	49.5495	–45.3147

Source: own calculations based on quotations available on https://stooq.pl (access date: 1.08.2021)

The above data show that despite the popularity of the indicated industries, the rates of return vary. It should be remembered that due to the pandemic, there has been reluctance in society to invest in real estate. The fear of losing one's job and a steady source of income caused a decline in investments in this area. It is only in 2021 that we notice an increase in interest in real estate purchases. It is also directly related to rising inflation, as well as low interest rates in banks. To estimate the level of volatility, the basic measure of volatility was used, which is standard deviation. The larger the observed standard deviation, the further the recorded values are away from the average. In the presented period, the lowest standard deviation from the rate of return, compared to historical data, was recorded by JW. Construction Holding. ARE. The calculated rate of return and standard deviation were used to determine the volatility coefficient, which is a relative measure of risk assessment. It informs about the amount of risk per unit of rate of return. It is a measure referring to the characteristics of a rational investor mentioned in the introduction who invests his funds in such a way as to maximize his profits while minimizing the risk taken. According to this theory, the coefficient of variation should be as small as possible (Pera et al., 2014).

Cell fields referring to the coefficient of variation were filled in gray deliberately. The results have been obscured because considering the coefficient in question only makes sense when it takes values greater than zero.

Similarly, the analysis was performed for a basket of currencies. In the same period, i.e. on December 30, 2019, an Australian dollar was purchased, marked later in the essay with the code AUD and euro – EUR. The determined rate of return for the currencies in question is as follows in the Table 2.

Table 2

Expected rate of return, standard deviation and coefficient of volatility for currencies from portfolio II

	Australian dollar [AUD]	Euro [EUR]
Expected rate of return [%]	0.235	0.0243
The standard deviation of the rate [%]	0.66	0.43
Coefficient of variation	27.9182	17.6679

Source: own calculations based on https://www.nbp.pl/home.aspx?f=/kursy/arch_a.html (access date: 20.08.2021)

The next stage of the study was the creation of the Spearman correlation matrix, after calculating the weights for individual companies. This coefficient

applies to any monotonic relationship. The calculation results are presented in the Table 3 (Pera et al., 2014).

Table 3

Spearman's correlation coefficient for companies from portfolio I

	Spearman correlation matrix									
	ARH	DOM	INP	JWC	1AT	GTC	JSW	MT.US	ENG	ENA
ARH	**1.0000**	0.2464	0.0293	0.1247	0.1852	0.1628	0.2450	–0.0019	0.1438	0.2669
DOM	0.2464	**1.0000**	0.0352	0.1687	0.2786	0.2179	0.2769	–0.0499	0.2282	0.2032
INP	0.0293	0.0352	**1.0000**	–0.1062	0.1276	0.0391	0.0528	0.0938	–0.0098	0.1258
JWC	0.1247	0.1673	–0.1062	**1.0000**	0.0437	0.0494	0.2311	0.0293	0.1431	0.1204
1AT	0.1852	0.2796	0.1276	0.0437	**1.0000**	0.1140	0.2036	0.0644	0.0519	0.1637
GTC	0.1628	0.2179	0.0391	0.0494	0.1140	**1.0000**	0.3018	0.1218	0.0528	0.2104
JSW	0.2450	0.2769	0.0528	0.2311	0.2036	0.3018	**1.0000**	0.1228	0.1385	0.4108
MT.US	–0.0019	–0.0499	0.0938	0.0293	0.0644	0.1218	0.1228	**1.0000**	–0.0780	0.0394
ENG	0.1438	0.2282	–0.0098	0.1431	0.0519	0.0528	0.1385	–0.0780	**1.0000**	0.2892
ENA	0.2669	0.2032	0.1258	0.1204	0.1637	0.2104	0.4108	0.0394	0.2892	**1.0000**

Source: own calculations based on https://stooq.pl (access date: 1.08.2021)

The highest correlation, at the level of 0.41, is recorded by Jastrzębska Spółka Węglowa and Enea. The above value fits into the correlation at a moderate level. On the other hand, the remaining observations in the matrix of companies show a weak or even no relationship (Statystyka, 2021).

On the other hand, the Spearman correlation matrix for the values of exchange rates is characterized by a weak relationship (Table 4).

Table 4

Spearman's correlation coefficient for portfolio currencies II

	Spearman correlation matrix	
	AUD	EUR
AUD	**1.00**	0.2642
EUR	0.2642	**1.00**

Source: own calculations based on
https://www.nbp.pl/home.aspx?f=/kursy/arch_a.html (access date: 20.08.2021)

In the vast majority of both portfolios, the ratio shows a weak or no relationship, thanks to which the risk of a sudden decrease in the value of portfolios is low.

Additionally, covariance and correlation matrices were created for all indices, and then the beta coefficient was calculated, the calculation results are shown in the tables below (Tables 5–10).

Table 5

Covariance matrix for companies from portfolio I

	Covariance matrix									
	ARH	DOM	INP	JWC	1AT	GTC	JSW	MT.US	ENG	ENA
ARH	0.0011	0.0003	0.0001	0.0001	0.0003	0.0001	0.0005	–0.0001	0.0001	0.0004
DOM	0.0003	0.0006	0.0001	0.0001	0.0002	0.0002	0.0004	0.0000	0.0001	0.0002
INP	0.0001	0.0001	0.0010	0.0000	0.0001	0.0000	0.0002	0.0001	0.0000	0.0002
JWC	0.0001	0.0001	0.0000	0.0003	0.0000	0.0000	0.0002	0.0000	0.0000	0.0001
1AT	0.0003	0.0002	0.0001	0.0000	0.0007	0.0001	0.0004	0.0000	0.0001	0.0002
GTC	0.0001	0.0002	0.0000	0.0000	0.0001	0.0009	0.0005	0.0002	0.0001	0.0002
JSW	0.0005	0.0004	0.0002	0.0002	0.0004	0.0005	0.0028	0.0000	0.0001	0.0008
MT.US	–0.0001	0.0000	0.0001	0.0000	0.0000	0.0002	0.0000	0.0022	–0.0001	0.0000
ENG	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001	–0.0001	0.0004	0.0002
ENA	0.0004	0.0002	0.0002	0.0001	0.0002	0.0002	0.0008	0.0000	0.0002	0.0012

Source: own calculations based on quotations available on https://stooq.pl (access date: 1.08.2021)

Table 6

Covariance matrix for currencies from portfolio II

	Covariance matrix	
	AUD	EUR
AUD	0.00004	0.00001
EUR	0.00001	0.00002

Source: own calculations based on quotations available on https://www.nbp.pl/home.aspx?f=/kursy/arch_a.html (access date: 20.08.2021)

The covariance illustrates the relationship between the rates of return and indicates the direction of changes. However, it does not measure the strength of the relationship between the rates of return (Pera et al., 2014).

Table 7

Correlation matrix for companies from portfolio I

	Correlation matrix									
	ARH	DOM	INP	JWC	1AT	GTC	JSW	MT.US	ENG	ENA
ARH	1.0000	0.3181	0.0802	0.1110	0.3173	0.1088	0.2706	–0.0558	0.1463	0.3742
DOM	0.3181	1.0000	0.1160	0.1573	0.2709	0.2908	0.2854	–0.0273	0.1732	0.2797
INP	0.0802	0.1160	1.0000	–0.0337	0.1190	0.0201	0.0960	0.0469	–0.0661	0.2002
JWC	0.1110	0.1573	–0.0337	1.0000	0.0666	–0.0162	0.2054	–0.0274	0.1266	0.1086
1AT	0.3173	0.3822	0.0896	0.0666	1.0000	0.1621	0.2755	–0.0087	0.0913	0.2179
GTC	0.1088	0.2908	0.0201	–0.0162	0.1621	1.0000	0.2896	0.1117	0.0918	0.2147
JSW	0.2706	0.2854	0.0960	0.2054	0.2755	0.2896	1.0000	–0.0167	0.0716	0.4442
MT.US	–0.0558	–0.0273	0.0469	–0.0274	–0.0087	0.1117	–0.0167	1.0000	–0.0723	–0.0306
ENG	0.1463	0.1732	–0.0661	0.1266	0.0913	0.0918	0.0716	–0.0723	1.0000	0.2616
ENA	0.3742	0.2797	0.2002	0.1086	0.2179	0.2147	0.4442	–0.0306	0.2616	1.0000

Source: own calculations based on quotations available on https://stooq.pl (access date: 1.08.2021)

Table 8

Correlation matrix for currencies from portfolio II

	Correlation matrix	
	AUD	EUR
AUD	1.4831	–0.0169
EUR	–0.0169	0.6743

Source: own calculations based on quotations available on https://www.nbp.pl/home.aspx?f=/kursy/arch_a.html (access date: 20.08.2021)

The positive correlations observed in the vast majority of cases indicate that an increase in one feature is accompanied by an increase in the average values of the other feature.

Table 9

Beta coefficient for companies from portfolio I

	Betafactor [%]									
	ARH	DOM	INP	JWC	1AT	GTC	JSW	MT.US	ENG	ENA
ARH	–	44.89	8.53	20.51	40.11	12.17	17.14	–4.00	23.49	36.70
DOM	22.55	–	8.74	20.60	34.25	23.05	12.81	–1.39	19.70	19.45
INP	7.55	15.40	–	–5.86	10.66	2.11	5.72	3.17	–9.98	18.47
JWC	6.00	12.00	–1.94	–	4.56	–0.98	7.04	–1.06	10.99	5.76
1AT	25.09	42.66	7.54	9.75	–	14.34	13.81	–0.49	11.60	16.90
GTC	9.72	36.68	1.91	–2.68	18.32	–	16.40	7.17	13.17	18.82
JSW	42.70	63.55	16.11	59.94	54.97	51.12	–	–1.89	18.15	68.76
MT.US	–7.77	–5.37	6.95	–7.06	–1.53	17.42	–1.48	–	–16.17	–4.18
ENG	9.11	15.22	–4.38	14.58	7.19	6.39	2.83	–3.23	–	15.98
ENA	38.15	40.24	21.70	20.46	28.08	24.48	28.70	–2.24	42.81	–

Source: own calculations based on quotations available on https://stooq.pl (access date: 1.08.2021)

The above calculations show, for example, that for the pair of Archicom and Dom Development, an increase in the rate of return by one unit for the first company generates an increase in the rate of return for Dom Development by 0.22 percentage point.

Table 10

Beta coefficient for currencies from portfolio II

	Betafactor [%]	
	AUD	EUR
AUD	–	33.88
EUR	14.48	–

Source: own calculations based on quotations available on https://www.nbp.pl/home.aspx?f=/kursy/arch_a.html (access date: 20.08.2021)

For currency basket calculations, it can be deduced that an increase in the return of the Australian dollar by one unit generates an increase in the return of the euro by 0.14 percentage points.

5. Conclusions

Summing up the analyses carried out within the portfolio of shares and currencies, it can be stated that investing in companies listed on the stock exchange was a better solution. The average rate of return for the portfolio of companies, being the arithmetic mean of simple rates of return in the analyzed period, was 9.16%, and for the basket of currencies 6.20% (assuming an equal share of securities in portfolio I). Among the analyzed companies, the highest simple rate of return was recorded by Archicom S.A. – 52%, while in logarithmic terms – 42%. The loss was generated by the Global Trade Center, with a simple rate of return of −26% and a logarithmic rate of return of −30%. For the basket of currencies, the average rate of return was 6.20%, and the logarithmic rate was 6.01%. As already mentioned, a rational investor strives to minimize the risk with the assumed expected rate of return or with the simultaneous assumption of maximizing the expected rate of return. Therefore, drawing conclusions from historical data, it can be assumed that he would invest in a portfolio of companies.

This article is both about the importance of the topic of investing, and also emphasizes the importance of diversifying the investment basket. A wide spectrum of investment opportunities should be examined and analyzed, especially during periods of rising inflation, in order to secure the assets held. The presented method of analyzing investment activities can not only be used in academia, but also in economic life in the real world. The above work is a call for further research in the field of investing and presents the possibilities of their measurement. A good investor is not only characterized by a rational approach, but also by making responsible investment decisions, striving to achieve their financial goals in a sustainable and effective manner. The above article is also an incentive to undertake financial education in order to be aware of various financial instruments, as well as the possibilities of their use. It is worth mentioning that there are no perfect investors but one should strive to develop and build those features that can help to build an effective and balanced investment portfolio.

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Summary

In today's globalized world, investing is a key financial management strategy related to the hope of obtaining future economic benefits. Access to more and more information has created new opportunities for wealth creation, including investments in stocks, cryptocurrencies, gold, real estate and many other assets. The work emphasizes the importance of investing and diversifying the investment portfolio, especially in periods of inflation, using the example of a portfolio of listed companies compared to a currency portfolio. The study covers the period from December 2019 to December 2020, and the analysis aims to estimate the rate of return on investment based on the Markowitz and CAPM theories. The presented analysis method is applicable both in the academic environment and in real economic scenarios, encouraging further research on investments.

JEL codes: G17, G24, G32, G41

Keywords: *economics, finance, investment portfolio, Markowitz, CAMP*