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ALTERNATIVE INVESTMENTS - MEASURING RISK AND INVESTMENT EFFICIENCY

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Purpose: The aim of the work is to compare various forms of investing in a changing economic environment. When the level of inflation is significant, it is very difficult to find an investment with a high expected rate of return and a low level of risk. Investing efficiency analysis is an important element of business activity, it contributes to the multiplication of the assets of institutions and private persons.
Design/methodology/approach: In the work, the profit rate was determined and the NPV was calculated taking into account inflation. Changes in the precious raw materials market and the real estate market were analyzed.
Findings: Rate of return on selected investments were calculated and the optimal possibilities of allocating funds were indicated.
Research limitations/implications: The article examines only selected investment opportunities: in gold and on the real estate market. In finance, there are also other options for investing, for example on the capital market, in investment funds, in treasury bonds.
Practical implications: The conclusions recorded in the work may be used by investors in the future, when the economic situation is not stable, but the decision-maker will have to solve the problem of allocating the accumulated capital.
Social implications: The results contained in the work may be helpful in making individual and collective investment decisions, they may be used to multiply capital, protect funds against the effects of inflation.
Originality/value: The article compares the effectiveness of various investments during the crisis and selects the most profitable forms of investment. The article is addressed to decision makers in the investment process.

Keywords: investment process, efficiency, NPV, investment risk.

Category of the paper: research paper.

1. Introduction

Effective capital placement and investment are issues often discussed in the literature on economics and finance. There are many different forms of capital placement. However, they differ in the expected rate of return on investment as well as the level of risk and uncertainty. According to W. Rogowski, the investment is a long-term one risk allocating funds to achieve future benefits (Rogowski, 2004). Safe and profitable investment of capital is one of the important economic issues (Begg, Dornbusch, Fischer, 2007; Taylor, Mankiw, 2009).

The aim of the study is to compare various forms of investing in the years 2000-2021. The chosen time period, the first twenty years of the 21st century, was marked by significant instability due to many economic characteristics. The financial crisis of 2007-2009 and the coronavirus pandemic in 2020-2021 are certainly important periods. In the aforementioned periods, economic conditions changed significantly and the amplitude of fluctuations of many economic indicators increased. Investors have often looked for ways to safely invest their capital so that it does not lose its value (Dorosz, 2014; Kołodko, 2010).

The analysis of the method, effectiveness and risk of investing is an important element of business activity, as it contributes to the multiplication of the assets of companies, institutions and private persons. The choice of the form of investment is not easy, it significantly affects the investment result and the achieved rate of return on investment. The decision maker can choose from many options, including: setting up a bank deposit, buying bonds, investing on the stock exchange, purchasing precious metals or placing his savings on the real estate market. This paper focuses on three selected forms of investing capital, namely the profitability of setting up a bank deposit, buying gold and investing in real estate. Various investment variants were compared to determine the investment efficiency. It has been shown that in the first twenty years of the 21st century it is possible to invest with a positive profit, but the investing process is burdened with risk, uncertainty of the future state of the economy and a high level of inflation which significantly reduces the profit.

The conclusions recorded in the work may be used by institutional and individual investors in the future, when the economic situation will not be stable, and the decision-maker will have to solve the problem of locating the accumulated capital.

2. Research methodology

2.1. Investment effectiveness assessment - rate of return

The profitability assessment of an investment project can be carried out with the use of various calculation methods (Nowak, 1997; Marcinek, 2001; Rogowski, 2004; Dobija, 1997).

The most intuitive method is to calculate a simple rate of return. This rate determines the ratio of the annual profit to the value of the initial capital:

$$R = (Z / K)\ 100\% \quad (1)$$

where:

R - annual rate of return,

Z - annual (net) profit,

K - starting capital.

The above formula uses annual figures. However, in the case of investment activity, individual years may differ significantly from one another. Then it is advisable to determine the average rate of return according to the formula:

$$Rp = (Zn / Kn)\ 100\% \quad (2)$$

where:

R_p - average rate of return,

Z_n - average annual net profit,

K_n - average annual capital employed.

2.2. Taking into account the volatility of interest rates and the level of inflation in the assessment of investment effectiveness

The investment period is often long enough that interest rates will change during it. This should be taken into account when determining the effectiveness of the investment. If we mark the profit with the symbol Z, and the invested capital with the symbol K, then the following formulas can be used:

Effective interest rate $r_{ef}(n)=Z_n/K_{n-1}$

- For a simple interest rate (r - nominal interest rate): $r_{ef}(n)=r/(1+(n-1)r)$.
- For compound interest $r_{ef} = r$.
- For compound interest with capitalization in subperiods: $r_{ef}=(1+(r^{(m)}/m))^m-1$, ($r^{(m)}$ - nominal interest rate of capitalization in sub-periods, m - number of sub-periods in the base period).
- For compound interest with capitalization over periods: $r_{ef}=(1+mr_{(m)})^{1/m}-1$, ($r_{(m)}$ - nominal interest rate of capitalization over periods),

Average interest rate

- For a simple interest rate $\bar{r} = \frac{1}{n}\sum_{j=1}^{m} n_j r_j$ (r_j - interes rate for period n_j)
- For compound interest in arrears $\bar{r} = \sqrt[n]{\prod_{j=1}^{m}\left(1+r_j\right)^{n_j}} - 1$
- in sub-periods $\bar{r} = \sqrt[n]{\prod_{j=1}^{m}\left(1+\frac{r_j}{m_j}\right)^{n_j m_j}} - 1$
- in excess $\bar{r} = \sqrt[n]{\prod_{j=1}^{m}\left(1+m_j r_j\right)^{n_j/m_j}} - 1$

In the economic reality, an important element is the decrease in the value of capital resulting from inflation. When inflation is not taken into account in determining the profitability of an investment, the obtained result is not a correct and accurate measure of investment effectiveness. The following financial mathematics formulas can be used to add inflation to your analysis:

The actual interest rate on the capital

$r_i=(r-i) / (1+i)$ (3)

where:

i-inflation,

r – capital interest rate.

Inflation rate

$i=(r-r_i) / (1+r_i)$ (4)

- m-period inflation rate $i(m) = \prod_{k=1}^{m}(1+i_k) - 1$
- average inflation rate $\bar{i} = \sqrt[m]{\prod_{k=1}^{m}(1+i_k)} - 1$

2.3. Deterministic NPV method

In finance, the inflows and outflows of money (i.e., income or expenses, outlays) that occur at regular intervals are referred to as cash flows. Let CF0 denote the payment (income or expense) at the beginning, and denote CFi (i = 1, 2, ..., n) the payment falling at the end of the i-th period. To calculate the current value of the stream of money (CF0, CF1, ..., CFn), each element of this stream should be reduced to the present (i.e. discounted), and then the values obtained in this way should be added up. We will then get the following formula for the present value of the cash flow:

$$PV = CF_0 + \frac{CF_1}{1+r} + \frac{CF_2}{(1+r)^2} + \cdots + \frac{CF_n}{(1+r)^n} = \sum_{i=0}^{n} \frac{CF_i}{(1+r)^i} \tag{5}$$

In the formula above, r is the interest rate. The formula for the future value is:

$$FV = CF_0(1+r)^n + CF_1(1+r)^{n-1} + \cdots + CF_{n-1}(1+r) + CF_n = \sum_{i=0}^{n} CF_i(1+r)^{n-i} \tag{6}$$

When planning an investment, you should assess whether it is profitable. Let CF0 denote the expenditures that we have to incur to start the investment (initial outlays) and CF1, CF2, ..., CFn denote the expected investment income or related expenses in subsequent time periods (e.g. months, quarters, years). The number n, i.e. the number of time periods considered, is called the economic lifetime of the investment. Let us assume that the interest rate is constant and equal to r in the considered period of time. The net present value of the investment called the quantity:

$$NPV = \sum_{i=0}^{n} \frac{CF_i}{(1+r)^i} \tag{7}$$

When assessing the profitability of an investment, we adopt the following rule:

- if NPV > 0, the investment is profitable and it is worth implementing it, because the anticipated revenues, discounted at the moment of starting the investment, exceed the initial expenditures;
- if NPV < 0 - the investment is not profitable;
- when NPV = 0, the expected profit is at zero level.

When comparing several investment variants or comparing many different investments, we apply the NPV maximization principle, i.e. we implement a project for which the NPV has the highest positive value.

2.4. Probabilistic NPV method

Net Present Value (NPV) is an easy and effective method of assessing the effectiveness of an investment project, provided that all $\{CFi\}$ terms are precisely defined. However, economic practice shows that the adopted condition is rarely met. Predicting future revenues and expenses can prove to be difficult, sometimes even impossible. Then successive elements of the cash flow stream can be treated as random variables with a known probability distribution: $randomCF_0$, $randomCF_1$, ..., $randomCF_n$, with a finite expected value and a finite variance. However, each investment project is specific, its success largely depends on the method of managing its subsequent stages and on the tendency or aversion to taking risk. Thus, the distribution of the discussed random variable is subjective and can be determined by experts. The model in which the stream of cash flows is treated as the implementation of a random variable in the literature has been called the probabilistic model of net present value

from investments - PNPV (Przybycin, 2011). PNPV is then a random variable. The probabilistic NPV is defined as follows:

$$PNPV = \sum_{i=0}^{n} \frac{randomCF_i}{(1+r)^i} \tag{8}$$

In the case of a probabilistic NPV, it is possible to quantify the risk of an investment project. We determine the expected value of PNPV according to the formula:

$$E(PNPV) = \sum_{i=0}^{n} \frac{E(randomCF_i)}{(1+r)^i} \tag{9}$$

and its standard deviation as (10):

$$S(PNPV) = \sqrt{\sum_{i=0}^{n} \frac{S^2(randomCF_i)}{(1+r)^{2i}} + \sum_{i=0}^{n-1} \left(\sum_{j=i+1}^{n} r_{i.j} \frac{1}{(1+r)^i} \frac{1}{(1+r)^j} S(randomCF_i) S(randomCF_i) \right)} \tag{10}$$

where the variance of the random variable PNPV is under the root, and the symbol rij is the correlation coefficient of random variables $randomCF_i$ and $randomCF_j$.

When the random variables $randomCF_i$ form a system of independent random variables, then the standard deviation is reduced using the following form:

$$S(PNPV) = \sqrt{\sum_{i=0}^{n} \frac{S^2(randomCF_i)}{(1+r)^{2i}}} \tag{11}$$

As a measure of the risk of an investment project, we can then determine the coefficient of variation, defined as follows:

$$V_{PNPV} = S(PNPV) / E(PNPV) \tag{12}$$

The above-defined coefficient of variation determines the risk size of the investment project per unit of the average value of the PNPV random variable. The known value of the VPNPV coefficient of variation allows risk management investment project. Depending on the investor's willingness or aversion to risk, the decision-maker will select projects with a coefficient of variation assuming higher or lower values. The higher the value of the coefficient of variation, the greater the potential risk of the project.

2.5. The investment risk analysis

The risk level of an investment project has a significant impact on the financial result of this project, hence the growing interest in risk management methods in the investment process (Ostrowska, 2002). The investment literature clearly distinguishes between the concepts of risk and uncertainty. The risk can be measured. Risk is a situation in which the probability of achieving greater or less than expected results can be considered and the probability distribution of deviations of these results from their expected values is known. Uncertainty cannot be measured. Uncertainty is a situation in which the probability distribution of the discrepancy of

the results from their expected values is unknown and cannot be estimated. Thus, it can be written that risk is a measurable uncertainty.

Effective methods of managing investment risk include models for assessing the economic effectiveness of investment projects, for example the NPV or PNPV model.

In the process of investing, it is noticed that the higher the expected rate of return on investment, the greater the risk of loss. Thus, a risky investment can bring big losses, but on the other hand, it can give the investor above-average profits. The concept of a risk premium is then introduced. In the investment process, we determine the expected rate of return on investment and take a risk in such a size that the risk premium corresponds to the individual requirements of the investor.

3. Empirical analysis

The empirical analysis was based on the data for the years 2000-2022. In the article we will calculate the profitability of investing in two selected goods: gold and real estate. In the years 2000-2022, a growing trend in gold prices can be observed (Figure 1). The chart clearly shows the price increase after the financial crisis of 2007-2009 and the increase caused by the coronavirus pandemic and the armed conflict in the east.

Figure 1. Gold price chart in PLN per gram.

Data source: www.mennica.com, own study.

In the analyzed period, the price per square meter of flats commissioned for use also changed significantly (Table 1). In the analyzed period, the lowest price was recorded in the first quarter of 2003, and the highest in the third quarter of 2021. During this time, the price increased by more than 158%, representing an average annual increase of approximately 8.8%.

Table 1.
Price for 1 square meter of usable floor space of a residential building put into use

Year	1 Quarter	2 Quarter	3 Quarter	4 Quarter	Year	1 Quarter	2 Quarter	3 Quarter	4 Quarter
	in PLN					in PLN			
2022	5 252	x	x	x	**2010**	4 372	4 433	4 657	3 979
2021	4 944	5 112	5 347	5134	**2009**	3 895	3 924	3 783	3 964
2020	4 567	5 000	4987	5012	**2008**	2 970	3 186	3 478	3 631
2019	4 388	4 484	4 376	4 597	**2007**	2 683	2 650	3 041	2 890
2018	4 132	4 294	4 385	4 139	**2006**	2 560	2 445	2 557	2 619
2017	4 424	4 014	4 097	4 145	**2005**	2 505	2 336	2 528	2 388
2016	4 177	4 063	3 976	4 000	**2004**	2 412	2 562	2 386	2 195
2015	3 926	4 066	3 961	3 925	**2003**	2 071	2 332	2 117	2 432
2014	4 129	4 141	3 880	3 984	**2002**	2 400	2 400	2 484	2 330
2013	4 019	3 879	3 975	4 228	**2001**	2 350	2 490	2 700	2 500
2012	4 130	4 103	3 915	3 837	**2000**	2 245	2 280	2 300	2 300
2011	3 797	3 819	3 988	3 829	**x**	x	x	x	x

Data source: www.stat.gov.pl.

In this period, the level of inflation changed significantly (Figure 2). There is clear evidence of a strong rise in inflation since the beginning of 2021.

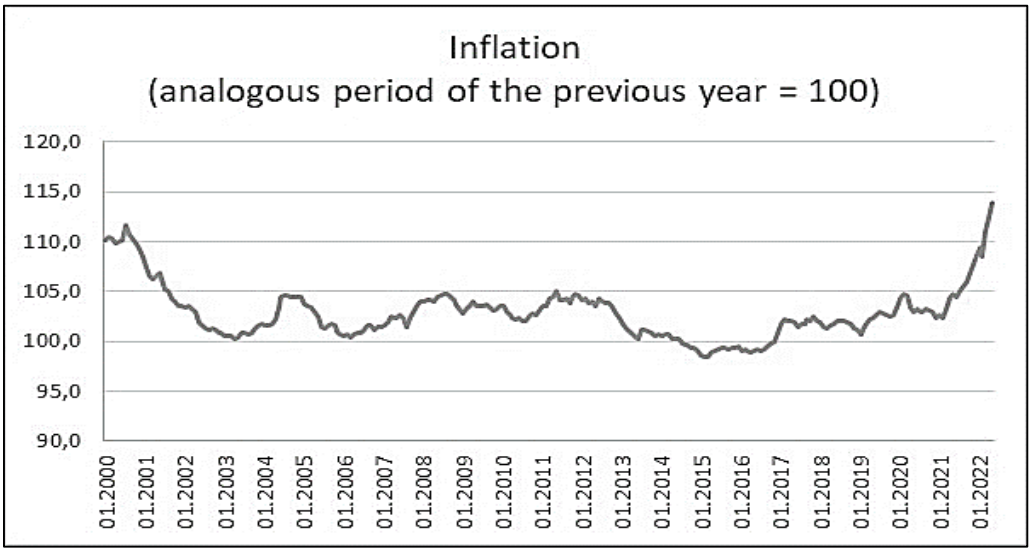

Figure 2. Inflation in Poland in the period 01.2020-05.2022, monthly data.

Data source: www.stat.gov.pl, own study.

The values of the reference rate of the National Bank of Poland also changed, which significantly affect the amount of return on investment (Table 2).

Table 2.
Reference rate of the National Bank of Poland

valid from the date of:	reference rate		valid from the date of:	reference rate		valid from the date of:	reference rate
18.11.1999	16,5		26.08.2004	6,5		09.06.2011	4,5
24.02.2000	17,5		31.03.2005	6		10.05.2012	4,75
31.08.2000	19		28.04.2005	5,5		08.11.2012	4,5
01.03.2001	18		30.06.2005	5		06.12.2012	4,25
29.03.2001	17		28.07.2005	4,75		10.01.2013	4
28.06.2001	15,5		01.09.2005	4,5		07.02.2013	3,75
23.08.2001	14,5		01.02.2006	4,25		07.03.2013	3,25
26.10.2001	13		01.03.2006	4		09.05.2013	3
29.11.2001	11,5		26.04.2007	4,25		06.06.2013	2,75
01.12.2001	11,5		28.06.2007	4,5		04.07.2013	2,5
31.01.2002	10		30.08.2007	4,75		09.10.2014	2
26.04.2002	9,5		29.11.2007	5		05.03.2015	1,5
30.05.2002	9		31.01.2008	5,25		18.03.2020	1
27.06.2002	8,5		28.02.2008	5,5		09.04.2020	0,5
29.08.2002	8		27.03.2008	5,75		29.05.2020	0,1
26.09.2002	7,5		26.06.2008	6		07.10.2021	0,5
24.10.2002	7		27.11.2008	5,75		04.11.2021	1,25
28.11.2002	6,75		24.12.2008	5		09.12.2021	1,75
30.01.2003	6,5		28.01.2009	4,25		05.01.2022	2,25
27.02.2003	6,25		26.02.2009	4		09.02.2022	2,75
27.03.2003	6		26.03.2009	3,75		09.03.2022	3,5
25.04.2003	5,75		25.06.2009	3,5		07.04.2022	4,5
29.05.2003	5,5		01.01.2010	3,5		06.05.2022	5,25
26.06.2003	5,25		20.01.2011	3,75		09.06.2022	6
01.07.2004	5,75		06.04.2011	4		08.07.2022	6,5
29.07.2004	6		12.05.2011	4,25			

Data source: www. nbp.pl.

A popular form of investing is investing capital in precious metals, including gold. It is widely believed to be a safe capital investment. The average inflation in the years 2000-2022 was 2.8605%, in 2010-2022 it was 2.3320%, and in the period 2020-2022 it increased to the level of 5.4207% (Table 3). The average reference rate in 2000-2022 was 6.0662%, in 2010-2022 it was 3.1759%, and in the period 2020-2022 it decreased to 2.7577%. It is worth noting that in the period 2020-2022 the average inflation rate was higher than the average NBP reference rate. The effective interest rate in the analyzed periods was as follows: in the period 2000-2022 it was 0.0312%, in the period 2010-2022 it was 0.0082%, and in the period 2020-2022 it was negative at the level of - 0.02526%. On the basis of data from the Mint of Poland, gold was purchased at the earliest possible date in January - in 2000, 2010 and 2020, respectively. The results of investment efficiency with and without the average inflation rate are presented in Table 3. Investing in gold has proven to be profitable in each of the time periods considered. However, high inflation absorbs some of the profit. In each of the analyzed periods, the NPV value was positive, so the investor had no problem making a decision.

Table 3.
Investment efficiency in gold

Investment period	**January 2000 – January 2022**	**January 2010 – January 2022**	**January 2020 – January 2022**
Form of investment	**Investment efficiency - annual rate of return in investment period (in %)**		
Investing in gold - selling gold in January 2022 at the price of the National Bank of Poland, excluding inflation	24,1328	10,6441	11,3072
Investment in gold - sale of gold in January 2022 at the price of the National Bank of Poland, including inflation	20,6808	8,1227	5,5838

Source: Own study.

During global crises, there is a greater interest in investing capital in the real estate market. In Poland, prices per square meter of commercial premises are gradually increasing. The purchase of real estate may protect the owner of the capital against the effects of inflation and a decrease in the value of the capital held. Table 1 shows the prices in PLN for 1 square meter of usable floor space of a residential building put into use in Poland in the years Q1 2000-Q1 2022. It can be seen that prices increased from quarter to quarter. It is also worth noting that when analyzing more accurate data on prices in individual regions, cities and agglomerations of Poland, it can be noted that prices were different in different cities. As a rule, prices per square meter in metropolitan areas are significantly higher than in small towns.

Table 4.
Investment efficiency on the real estate market

Investment period	**Investment efficiency - annual profit rate in the investment period (in %)**		
Form of investment	**Q1 2000–Q1 2022**	**Q1 2010–Q12022**	**Q1 2020–Q1 2022**
Investment in real estate - purchase of real estate in the first quarter of 2000, 2010 and 2020, respectively, and its sale in the fourth quarter of 2021 at the price of 5,134 per m2, excluding inflation	6,0883	1,6773	7,4995
Real estate investment - purchase of real estate in the first quarter of 2000, 2010 and 2020, respectively, and its sale in the fourth quarter of 2021 at the price of 5,134 per m2, including inflation	3,1380	-0,6397	1,9718

Source: Own study.

If one were to invest in flats commissioned for use in the Q1 of 2000, 2010, 2020, then taking into account interest rates and inflation, the value of these flats in the Q1 2022 would be equal to Table 4. However, the prices of flats in the analyzed period increased significantly. It is worth comparing the capitalized value of the initial capital from the Q1 of 2000, 2010 and 2020 and the average price per one square meter in the Q1 of 2022.

It should be emphasized, however, that the market prices of real estate both on the primary and secondary market differ significantly depending on the location of the real estate and its standard. The prices taken into account for 1 m2 of usable floor space of a residential building commissioned for use, provided by the Central Statistical Office, only showed certain trends on the real estate market. However, it should be remembered that investing in this market may not always result in a positive financial result. Taking into account the high level of inflation in 2022 and economists' forecasts regarding the expected level of inflation in subsequent periods, inflation should be taken into account in investment problems, as it has a significant impact on the result of investments.

4. Summary

In the analyzed examples, the data selected for the calculations were collected from the websites of the Central Statistical Office, NBP and the Mint of Poland. These are data for the historical period. However, it should be remembered that not all values are always known or determined in the investment process. In many cases, future cash flows are not known, but their probabilities can be predicted based on historical data. NPV allows you to assess which investment is profitable based on historical data. When investing, however, we do not know future values, e.g. gold prices or real estate prices. Then PNPV can be useful provided that the distribution of the rates of return of the analyzed quantities is known. Then it is worth using, in addition to the classic methods, also probabilistic methods, for example PNPV. There is always a risk involved in the investment process. There is no profit without risk. When taking a risk, the investor also takes into account the potential loss. Both in the investment market and in the precious metals market, it is possible to obtain a positive, but also a negative rate of return on investment. Nowadays, when the level of inflation is significant, it is very difficult to find an investment characterized by a high expected rate of return and a low level of risk. However, as it was shown in the paper, such investments are possible even in the period of large fluctuations in the economy.

The next stage of the research will be to analyze the distribution of rates of return on simulation examples and to adjust the investment method to the obtained distributions. It seems that using the PNPV method it is possible to obtain information on the choice of the investment method in relation to the obtained empirical distribution of rates of return.

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