

## DO BONDS INDEXED TO INFLATION PROTECT AGAINST ITS NEGATIVE EFFECTS? ANALYSIS OF RATES OF RETURN IN REAL TERMS FOR TREASURY BONDS ISSUED BY POLAND

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**Purpose:** The aim of the article is to examine whether inflation-indexed treasury bonds issued by the Polish Minister of Finance protect investors' capital against the negative consequences of an increase in the price level.

**Design/methodology/approach:** The condition which has to be met in order to achieve a positive net rate of return in real terms has been established. The historical and current rates of return on investment in the inflation-indexed treasury bonds issued by the Polish Minister of Finance were analysed to check whether they meet this condition.

**Findings:** Own research has shown that in general, operation principle of bonds indexed to inflation should allow the investor to gain protection from negative effects of price changes. Yet, the example of Polish treasury bonds shows that systematic reduction of interest premiums for the subsequent series of issued instruments, changes in the operation principles, negative effect of taxation and materialisation of the defined in article time-shift mismatch risk – in the high-inflation environment results in significantly negative values of the current net rates of return in real terms of the latest series of COI and EDO bonds. This means that these bonds have not protected investors from the negative effects of price increases and loss of purchase power of invested capital.

**Research limitations/implications:** The levels of real rates of return calculated in the way presented in the article, i.e. based on official data of the Statistics Poland, are representative for the entire economy, yet do not have to translate into the same value for the individuals – real rates of return calculated appropriately for the individual investor may vary in both ways and therefore be more or less favourable than presented in the article.

**Originality/value:** The demand for these investment products is increasing, which is surprising in the light of the article's findings. That may, result from investors' expectations regarding a decrease in inflation in the coming periods, as well as the fact that, despite the negative profitability in real terms, these instruments can more effectively minimize the real-term losses stemming from inflation than other types of investments of a similar risk level (deposits, savings accounts) what can be furtherly reviewed in the next research.

**Keywords:** inflation, inflation-indexed bonds, real rates of return, treasury bonds.

**Category of the paper:** Research paper.

## 1. Introduction

Relatively high levels of inflation bring attention of the economists, politicians and the whole societies. Inflation has a negative impact on the economy by reducing the real value of the capital. It also generates uncertainty in the markets and discourage from saving. Investors who eager to protect their capital against the loss of purchasing power, look for opportunities to allocate capital in assets that allow to counteract negative effects of inflation. One of the type of assets that should meet this objective are inflation-indexed bonds, which interest rates refer to the levels of price changes in the economy.

The aim of the article is to examine whether inflation-indexed treasury bonds issued by the Polish Minister of Finance protect invested funds against the negative consequences of a decrease in the purchasing power of capital due to increase in the price level. It has been hypothesized that these instruments do not grant full protection against this risk for the investor.

As part of this objective, author has established the condition which has to be met in order to achieve a positive net rate of return in real terms. The operation principles of the most popular inflation-indexed treasury bonds (four-year COI series and ten-year EDO series) were also examined and the historical and current rates of return on investment in the above-mentioned bonds were analysed in order to check whether they met the established condition.

In terms of methodology, the study consists of the financial analysis of historical and current rates of return on investment in inflation-indexed treasury bonds. The data was based on the content of the letters of issue and interest tables of issued bonds published by the Polish Minister of Finance. The inflation data were taken from the Statistics Poland (Polish central statistical office) databases. The period of 2010-2022 was adopted for the analysis.

## 2. Literature review

Although in the history of the development of financial markets there were many examples of initiatives aimed at counteracting the loss of the purchasing power of capital, the first bonds formally linked to the inflation index were those issued in Massachusetts in the 18<sup>th</sup> century during the American Revolutionary War (Shiller, 2003). They were created in connection with the recorded high levels of inflation resulting from the ongoing military actions and, in consequence, the anger of American soldiers referred to the rapid decrease in purchasing power of their pay. For example, a certain bond from 1780 represented liability which settlement referred to a price index linked to a basket of goods composed of a fixed number of measurement units of corn, beef, sheep's wool and leather products, what guaranteed that the real value of the received gratification will be kept.

The key date for the development of the inflation-indexed treasury bond market is considered to be 1981, when the UK government has issued a financial instrument which operational principles have resembled bonds that are being issued nowadays. In Poland, the first series of such instruments was issued in August 2004 (Bembenik, 2007).

Recent research (Gomez-Gonzales, 2019) indicates that issuing inflation-linked treasury bonds is quite popular among governments in developing countries. In the group of countries analysed by the researcher, the 23% (on average) of total debt incurred in their local currencies was linked to the inflation rates. It also accounted for the 13% of total debt issued in all currencies. It was indicated that the nature of inflation-indexed bonds is considered as counter-cyclical, which means that these instruments should protect the investor against fluctuations in the GDP growth rate. It has been noted that in times of crises, developing countries decide to substitute the foreign currency debt by the inflation-indexed one as it is relatively cheaper to issue. In more than half of the developing countries analysed by the researcher, the cost of issuing inflation-linked bonds was 1.2 to 5.0 percentage points lower than in the case of standard debt in local currency.

The analysis of the current situation on the Polish treasury bond market (Kulpaka, 2023) showed that since 2016, the popularity of treasury bonds issued by Poland has significantly increased, which also applies to the inflation-indexed instruments. Nevertheless, the share of treasury bonds in the sum of all financial assets owned by a statistical Pole still remains at a low level, yet it grows dynamically. In 2010, they amounted to 0.64% of all financial assets, while in 2021 this value was equal to 2.03%, which means that the share of these instruments rose more than three times over the reviewed period.

The literature review has shown that the operational principle of inflation-indexed treasury bonds issued by Polish Minister of Finance, especially in terms of its ability to protect the investor against the inflation – has not been analysed.

### 3. Own research

High levels of inflation in Poland encourage investors to become more interested in instruments which, in its assumption, should protect them against the negative consequences of the increase in the price level. According to data published by the Polish Ministry of Finance, total sales of various series of treasury bonds issued in 2022 was equal to 57.1 billion PLN and was the highest in history. Among them, there are two series of publicly available inflation bonds<sup>1</sup>:

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<sup>1</sup> The analysis does not include so called ‘family bonds’: six-year ROS and twelve-year ROD series, which are also indexed to inflation and which combined accounted for 0.9% of the total sales value in 2022 (57.1 billion PLN). Such narrowing of analysis only to COI and EDO series bonds was made as ‘family bonds’ can be only purchased by the beneficiaries of the government social programme ‘Rodzina 500 plus’ and thus they are not available for every investor.

- four-year COI series (abbreviation stands for pol. *Czteroletnie Oszczędnościowe Indeksowane*, ten-year indexed [bonds designed for] savings), which accounted for 42.3% of total sales in 2022, and
- ten-year EDO series (abbreviation stands for pol. *Emerytalne Dziesięcioletnie Oszczędnościowe*, ten-year retirement [bonds designed for] savings), which accounted for 10.3% of total sales in 2022.

This means that, in total, publicly available inflation bonds accounted for the majority in terms of value (52.6%) of all issued treasury bonds in Poland in 2022.

### **3.1. Operation principles of inflation bonds offered by the Polish Minister of Finance and its level of sales**

The operation principles of different kinds of inflation-indexed treasury bonds (i.e. four-year COI and ten-year EDO) are similar, yet there are several differences that have to be furtherly analysed.

The name of individual series consists of three letters and four digits – the letters are indicating the type (series) of bonds, while the first two digits inform about the month in which the bond will be redeemed, and the last two indicate the year in which the redemption will take place – in line with the letter of issue. For example, the COI0127 bond is a four-year inflation-indexed instrument that will be redeemed in January 2027. The interest rate for each period is set in the letter of issue. It is defined as the sum of the recorded level of inflation and the interest premium. Two interest premiums are being set – one for the first year of saving and the second, constant, for the subsequent years of investment. In the vast majority of COI and EDO series in the analysed period the interest premiums for the first years of saving have been set at a different level than for the other years (both lower or higher). In case of deflation, the inflation factor is assumed to be equal to 0.00% for the purpose of interest rate calculation.

After the end of deflation period in Poland (2014-2016), the process of reducing the interest premium for the first year of saving has begun. As it has been constantly heading towards the 0.00% in subsequent series, the issuer has decided that starting from May 2017, COI and EDO series bonds will be issued with a fixed interest rate for the first interest period that is independent of inflation. This approach was maintained until the end of the analysed period (December 2022). It means that the series of COI and EDO bonds issued since May 2017 are *de facto* hybrids of a fixed-coupon bond (in the first period) and an inflation-indexed bond (from the second to the last interest period).

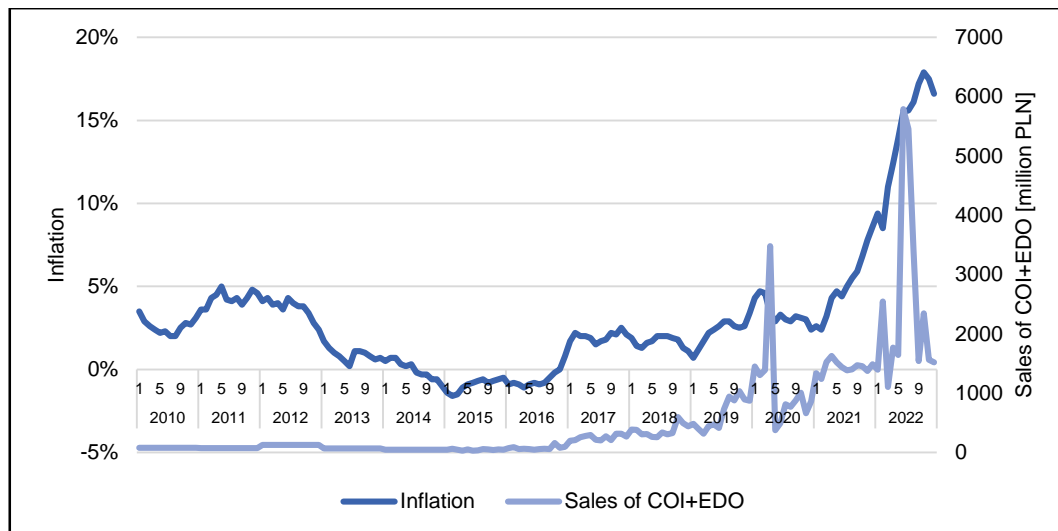
Among the differences between COI and EDO, interest capitalization should be pointed out, which for COI series bonds (*Obligacje 4-letnie...*) is annual and interest are also paid annually, with the deduction of capital gains tax, in accordance with art. 30b sec. 1 of the Polish act of 26<sup>th</sup> July 1991 on personal income tax 19,00% (*Ustawa z dnia 26 lipca 1991 r. o podatku dochodowym...*). On the other hand, the EDO series bonds (*Obligacje 10-letnie...*) differ in this respect from the COI series. The main difference is that annual capitalization of interest is not

being followed by its payment – the interest is cumulated and reinvested. The tax is charged only once, at the end of the whole investing period, when the bond is redeemed. What is more, the interest premiums on EDO series bonds, both in the first year of investment and in subsequent years, were historically higher than on COI series bonds, in order to reward the investor for a longer lack of access to the capital. The above means that investment in EDO bonds should be theoretically characterized by the higher rates of return than in COI series.

It should also be noted that there is a time shift between the inflation values, which are being taken into account to determine the interest rate, and the actual values for a given period. The interest rate in a given period depends on the past (last year's) inflation levels, not the current ones – thus, an investment in a COI or EDO bonds in each interest period protects against inflation that was reported for the previous period – not for the current one. This means that during the entire duration of the bonds, the capital is not hedged against price changes in the last period, yet it is enriched with appropriate interest for the period before its issuing.

In addition to that, the interest rate for the next interest period is determined in the month preceding the start of it. During this month, the latest available inflation data are those related to the month that precedes it (as an example, for the December series, the inflation reported for the October is used for interest rate settlement). The above means that there is a fourteen months long time-shift that can cause a significant decrease (or increase, respectively) in the full-period real-term profitability of the instrument. This phenomenon will be furtherly referred to as a time-shift mismatch risk. A satisfactory solution for investor to this problem could be a permanent bond rollover, i.e. replacing old bonds with the new ones, yet due to the change in operation principles and implementation of a hybrid structure of COI and EDO series bonds since May 2017, this action will no longer bring the intended benefits.

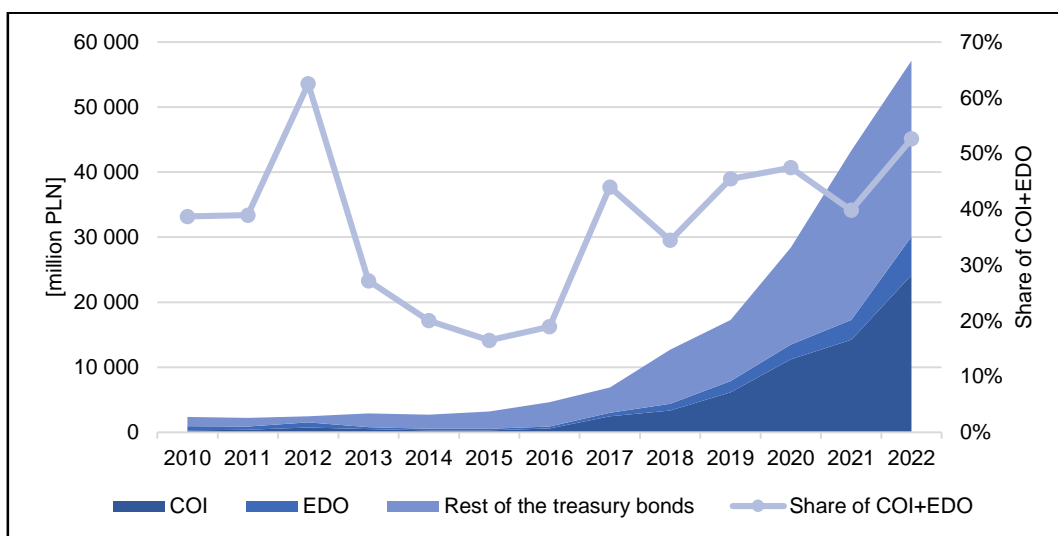
Figure 1 shows the levels of inflation to which COI and EDO bonds interest rates refer to, as well as the volume of their sales. Two peaks of interest should be pointed out – the first one in April 2020, which was related to the outbreak of the COVID-19 pandemic, the cycle of interest rate cuts performed by the Monetary Policy Council (body of National Bank of Poland) and the announcement of planned further lowering of the interest premium for the bonds issued from the subsequent month – May 2020. The second occurred in June-July 2022 and happened as a result of interest rate hikes, raising the interest premiums for the next series and introduction of the new types of bonds followed by an extensive marketing campaign conducted by the Minister of Finance. All of that has happened in the environment of still relatively low interest rates available on other forms of investment considered as alternatively safe – deposits and savings accounts.



**Figure 1.** Inflation levels and sales of inflation-indexed treasury bonds, 2010-2022.

Source: Own elaboration based on data: *Miesięczne wskaźniki cen towarów i usług konsumpcyjnych od 1982 roku*. Retrieved from: <https://stat.gov.pl/obszary-tematyczne/ceny-handel/wskazniki-cen/wskazniki-cen-towarow-i-uslug-konsumpcyjnych-pot-inflacja-/miesieczne-wskazniki-cen-towarow-i-uslug-konsumpcyjnych-od-1982-roku/#>, 30.06.2023; *Wyniki sprzedaży obligacji oszczędnościowych w grudniu*. Retrieved from: <https://www.gov.pl/web/finanse/wyniki-sprzedazy-obligacji-oszczednosciovych-w-grudniu3>, 30.06.2023.

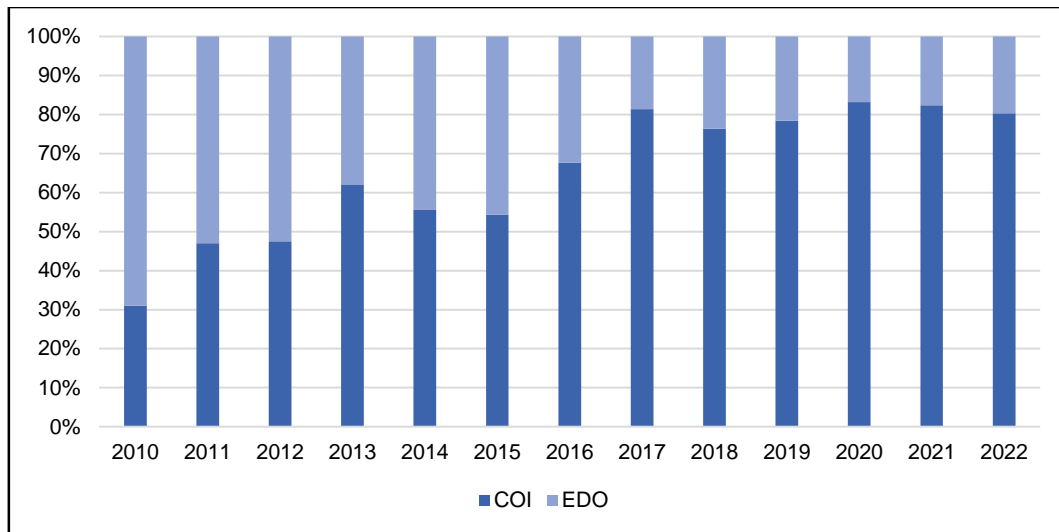
As indicated in the earlier part of the analysis, bonds in 2022 reached a record high level in terms of sales. Figure 2 presents a visible but gradual increase in the share of inflation-linked treasury bonds in total of treasury bonds issued, which shows that the increased interest of investors in government debt was not focused solely on inflation-linked type of bonds.



**Figure 2.** Sales volume of COI, EDO and other treasury bond series, 2010-2022.

Source: Own elaboration based on data: *Wyniki sprzedaży obligacji oszczędnościowych w grudniu*. Retrieved from: <https://www.gov.pl/web/finanse/wyniki-sprzedazy-obligacji-oszczednosciovych-w-grudniu3>, 30.06.2023.

The structure of inflation-indexed treasury bonds held by investors, broken down by COI and EDO, is presented in Figure 3. It should be noted that there is a clear trend of increasing sales of four-year bonds compared to ten-year ones. The above should be explained by the fact that the difference in interest rates and bonuses offered by the Polish Minister of Finance between EDO and COI series is, in the opinion of investors, not sufficient to compensate for the 2.5 times longer period of lack of access to funds. In addition, the operation principle of EDO series bonds which is based on the non-payment of yearly interest, significantly hinders the use of this instrument to cover the current expenses of an investor by the regular inflows, which is significantly easier to achieve with COI series.



**Figure 3.** Share of COI and EDO series bonds in total purchased inflation-indexed treasury bonds, 2010-2022.

Source: Own elaboration based on data: *Wyniki sprzedaży obligacji oszczędnościowych w grudniu*. Retrieved from: <https://www.gov.pl/web/finanse/wyniki-sprzedazy-obligacji-oszczednosciowych-w-grudniu3>, 30.06.2023.

### 3.2. Analysis of the yield on inflation-indexed treasury bonds offered by the Polish Minister of Finance

Leaving aside the issue of time mismatch between actual inflation rate in the given period and the one used as a basis for the interest rate calculation, theoretically a bond, which interest rate is equal to inflation and furtherly enlarged by a premium of a positive value, should in each case be characterized by a positive rate of return in real terms. However, the existence of a capital gains tax (at 19.00%) reduces the profitability of such instrument. As a result of the above, with sufficiently high inflation levels, the situation may occur where the surplus of the interest rate over the inflation level (resulting from the interest premium), will not be able to cover the negative effect resulting from the taxation. Thus, the requirement of profitability was established and presented in formula (1).

$$(\text{Inflation rate} + \text{Interest premium}) \times (1 - \text{Tax rate}) > \text{Inflation rate} \quad (1)$$

After mathematical transformations, it occurs that the net rate of return on investment in real terms for an inflation bond will be positive when inflation is lower than the quotient of

- the product of the interest premium and one less the tax rate, and
- the tax rate,


as shown in formula (2).

$$\text{Inflation rate} < \frac{\text{Interest premium} \times (1 - \text{Tax rate})}{\text{Tax rate}} \quad (2)$$

It can be noted that an increase in inflation causes a decrease in the rate of return in real terms, due to the fact that the negative effect of the taxation increases together with the interest rate growth (which grows together with inflation) and cannot be offset by an interest premium that remains constant. Table 1 shows the one-period net rates of return in real terms of inflation-indexed bonds, with relation to the level of the interest premium. The range of data refer to historical values recorder for the second and subsequent interest periods for COI and EDO series bonds offered in 2010-2022. With the lowest margin of 0.75% (present in COI bonds series issued since May 2020), the break-even point (for the bond to not generate negative yield in real terms) with regard to inflation is equal to 3.20% (and thus remain within the National Bank of Poland's inflation target, which is equal to 2.50% with acceptable deviations of  $\pm 1\%$ ). Figure 2 shows the data from Table 1 in a graphical form.

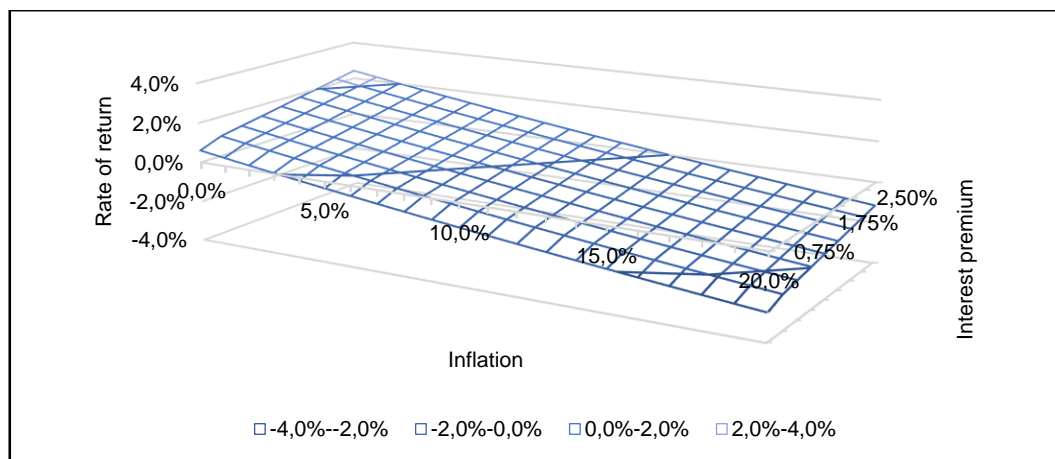
**Table 1.**

*One-period net rates of return in real terms, depending on interest premium levels and inflation*

| <b>RoR</b>  | <b>0,0%</b>  | <b>1,0%</b>  | <b>2,0%</b>  | <b>3,0%</b>  | <b>4,0%</b>  | <b>5,0%</b>  | <b>6,0%</b>  | <b>7,0%</b>  | <b>8,0%</b>  | <b>9,0%</b>  | <b>BEP</b>    |
|---|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|---------------|
| <b>0,75%</b>  | 0,6%         | 0,4%         | 0,2%         | 0,0%         | -0,1%        | -0,3%        | -0,5%        | -0,7%        | -0,8%        | -1,0%        | <u>3,20%</u>  |
| <b>1,00%</b>  | 0,8%         | 0,6%         | 0,4%         | 0,2%         | 0,0%         | -0,1%        | -0,3%        | -0,5%        | -0,7%        | -0,8%        | <u>4,26%</u>  |
| <b>1,25%</b>  | 1,0%         | 0,8%         | 0,6%         | 0,4%         | 0,2%         | 0,1%         | -0,1%        | -0,3%        | -0,5%        | -0,6%        | <u>5,33%</u>  |
| <b>1,50%</b>  | 1,2%         | 1,0%         | 0,8%         | 0,6%         | 0,4%         | 0,3%         | 0,1%         | -0,1%        | -0,3%        | -0,5%        | <u>6,39%</u>  |
| <b>1,75%</b>  | 1,4%         | 1,2%         | 1,0%         | 0,8%         | 0,6%         | 0,4%         | 0,3%         | 0,1%         | -0,1%        | -0,3%        | <u>7,46%</u>  |
| <b>2,00%</b>  | 1,6%         | 1,4%         | 1,2%         | 1,0%         | 0,8%         | 0,6%         | 0,5%         | 0,3%         | 0,1%         | -0,1%        | <u>8,53%</u>  |
| <b>2,25%</b>  | 1,8%         | 1,6%         | 1,4%         | 1,2%         | 1,0%         | 0,8%         | 0,6%         | 0,5%         | 0,3%         | 0,1%         | <u>9,59%</u>  |
| <b>2,50%</b>  | 2,0%         | 1,8%         | 1,6%         | 1,4%         | 1,2%         | 1,0%         | 0,8%         | 0,6%         | 0,5%         | 0,3%         | <u>10,66%</u> |
| <b>2,75%</b>  | 2,2%         | 2,0%         | 1,8%         | 1,6%         | 1,4%         | 1,2%         | 1,0%         | 0,8%         | 0,7%         | 0,5%         | <u>11,72%</u> |
| <b>3,00%</b>  | 2,4%         | 2,2%         | 2,0%         | 1,8%         | 1,6%         | 1,4%         | 1,2%         | 1,0%         | 0,8%         | 0,7%         | <u>12,79%</u> |
|  | <b>10,0%</b> | <b>11,0%</b> | <b>12,0%</b> | <b>13,0%</b> | <b>14,0%</b> | <b>15,0%</b> | <b>16,0%</b> | <b>17,0%</b> | <b>18,0%</b> | <b>19,0%</b> | <b>20,0%</b>  |
| <b>0,75%</b>  | -1,2%        | -1,3%        | -1,5%        | -1,6%        | -1,8%        | -2,0%        | -2,1%        | -2,2%        | -2,4%        | -2,5%        | -2,7%         |
| <b>1,00%</b>  | -1,0%        | -1,2%        | -1,3%        | -1,5%        | -1,6%        | -1,8%        | -1,9%        | -2,1%        | -2,2%        | -2,4%        | -2,5%         |
| <b>1,25%</b>  | -0,8%        | -1,0%        | -1,1%        | -1,3%        | -1,4%        | -1,6%        | -1,7%        | -1,9%        | -2,0%        | -2,2%        | -2,3%         |
| <b>1,50%</b>  | -0,6%        | -0,8%        | -1,0%        | -1,1%        | -1,3%        | -1,4%        | -1,6%        | -1,7%        | -1,9%        | -2,0%        | -2,2%         |
| <b>1,75%</b>  | -0,4%        | -0,6%        | -0,8%        | -0,9%        | -1,1%        | -1,2%        | -1,4%        | -1,5%        | -1,7%        | -1,8%        | -2,0%         |
| <b>2,00%</b>  | -0,3%        | -0,4%        | -0,6%        | -0,8%        | -0,9%        | -1,1%        | -1,2%        | -1,4%        | -1,5%        | -1,7%        | -1,8%         |
| <b>2,25%</b>  | -0,1%        | -0,2%        | -0,4%        | -0,6%        | -0,7%        | -0,9%        | -1,0%        | -1,2%        | -1,4%        | -1,5%        | -1,6%         |
| <b>2,50%</b>  | 0,1%         | -0,1%        | -0,2%        | -0,4%        | -0,6%        | -0,7%        | -0,9%        | -1,0%        | -1,2%        | -1,3%        | -1,5%         |
| <b>2,75%</b>  | 0,3%         | 0,1%         | 0,0%         | -0,2%        | -0,4%        | -0,5%        | -0,7%        | -0,9%        | -1,0%        | -1,2%        | -1,3%         |
| <b>3,00%</b>  | 0,5%         | 0,3%         | 0,1%         | 0,0%         | -0,2%        | -0,4%        | -0,5%        | -0,7%        | -0,8%        | -1,0%        | -1,1%         |

Source: Own elaboration.





**Figure 2.** One-period net rates of return in real terms, depending on interest premium levels and inflation.

Source: Own elaboration.

The conclusions from the analysis so far are as follows:

- the higher the inflation levels, the lower the rate of return in real terms, which results from the fixed nature of the interest premium and the growing negative effect of the taxation,
- the higher the interest premium levels, the higher the inflation levels may be, at which the investment will be still characterized by a positive rate of return in real terms,
- the lower the capital gains tax rate – the higher the inflation levels may be, at which the investment will be still characterized by a positive rate of return in real terms.

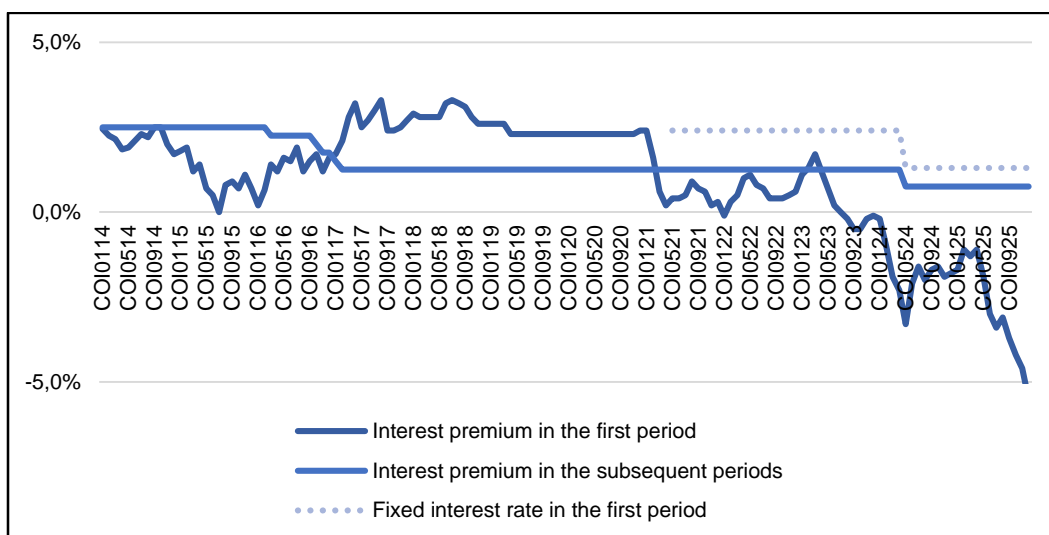
In the following parts of the article covering the analysis of the profitability of COI and EDO bonds, the scope of the research was limited to bonds issued from January 2010 to December 2021 – so that it is possible to calculate the current net rate of return in real terms for at least one interest period for each issued series, based on actual inflation data for 2022.

### **Analysis of the yield on inflation-indexed treasury bonds of the COI series**

Figure 3 shows the historical interest premium for the offered series of COI bonds, with separate presentation of the premiums applicable to the first annual saving period and the ones assigned to subsequent periods (i.e. from the second to the fourth period). Starting from the period in which the COI series bonds became hybrid (May 2017), two lines were drawn – a dotted one, showing a specific fixed interest rate for the first period, and a dark blue one, representing self-calculated values that show the hypothetical level of interest premium for the first period, if the COI operation principle was not changed in May 2017. The values of this theoretically assumed interest premium were calculated as the difference between the actual interest rate set for the first period and the level of inflation that would have been taken into account for calculating the interest rate, with respect to the previously used methodology. Thus, the figure shows that the hypothetical interest premiums for the first year has been characterized by decreases in recent years, reaching significantly negative values for series

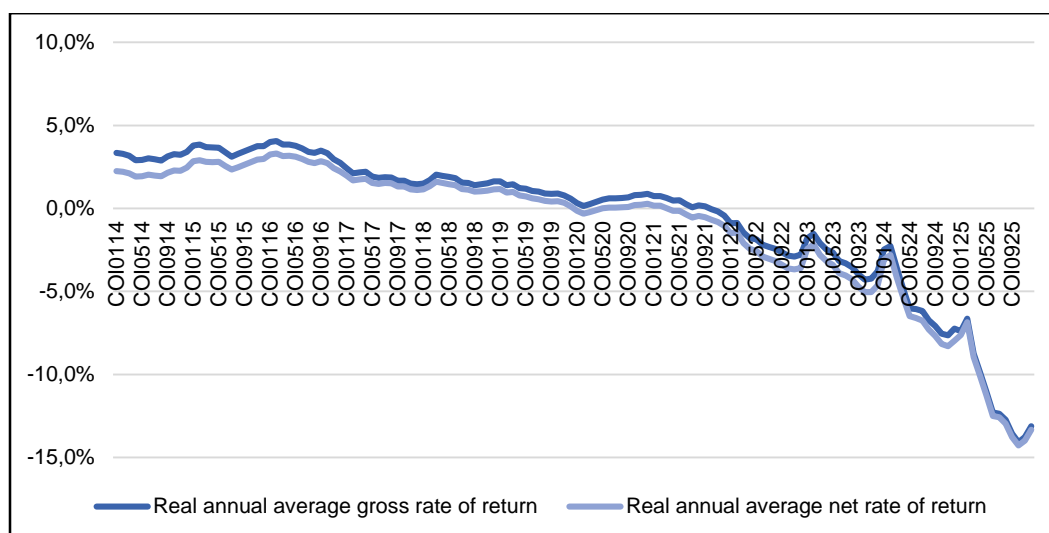
issued at the end of 2021. It should be noted that in terms of calculation of rate of return over the entire investment period, the interest premium set for subsequent periods is three times more important than the one for the first period, because it will be used to generate interest three times (in periods from the second to the fourth), while the interest rate for the first period will be used only once (in the first period). This means that the seemingly equivalent actions taken in 2012-2013 which consist of roughly equal increase of the interest premium in the first period at the expense of values set for the subsequent periods, were in fact unprofitable from the investors' point of view.

Figure 4 presents the rates of return in real terms for COI series bonds issued in 2010-2021. In the case of bonds that have been redeemed by the end of 2022 (series from COI0114 to COI1222) these values should be considered as final, while in the case of the rest (series from COI0123 to COI1225) the values represent the current levels of investment yield, based on ended and settled interest periods by the end of 2022. A comparative analysis of the data presented in Figures 3 and 4 shows that the reduction of the interest premiums for subsequent periods significantly reduced the rates of return compared to the values recorded for series issued in the previous years. In the case of the latest series, the previously described time-shift mismatch risk has also materialized. Among the already redeemed 108 series, 83 of them were characterized by a positive net rate of return in real terms, while 25 series did not protect the investor from an increase in the price level. Among the latest 36 series that were not redeemed by the end of 2022, none of them represent a positive net rate of return in real terms.



**Figure 3.** List of interest premiums for the first and subsequent periods set for COI bonds issued in 2010-2021.

Source: Own study based on Poland's Ministry of Finance and Statistics Poland data.



**Figure 4.** Final/current (in the case of not yet redeemed bonds) rates of return in real terms for COI series bonds issued in 2010-2021.

Source: Own study based on Poland's Ministry of Finance and Statistics Poland data.

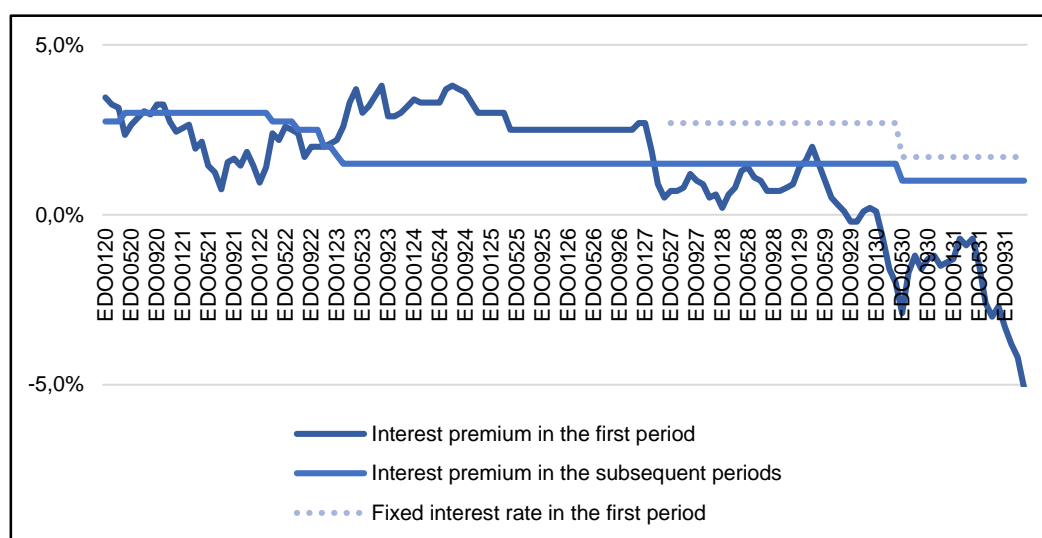
### Analysis of the yield on inflation-indexed treasury bonds of the EDO series

Conclusions drawn from the analysis of EDO series bonds are similar to those regarding COI series. The actions taken by the individual Polish Ministers of Finance in the scope of changes to the COI and EDO series bonds offers were made roughly in the same pattern.

As in the case of COI series, Figure 5 shows the historical data of interest premiums offered for the EDO bond series, with separate presentation of the premiums for the first periods and the subsequent ones (i.e. from the second to the tenth period). Also in this figure, the third line has been drawn, starting from the period in which the EDO series bonds became hybrid (May 2017), presenting a fixed interest rate for the first period and parallelly calculated values of the hypothetical interest premiums, assuming the EDO series operation principal used until April 2017 would not have been changed. Values of this hypothetical interest premium were calculated in the same way as for COI series, i.e. as the difference between the interest rate set for the first period and the value of inflation determined accordingly to the previously used methodology. The same conclusion as for COI series can also be drawn with regard to the negative impact of the operational principles changes on bonds' profitability, consisting of the increase of interest premium for the first period and in the same time decrease of the interest premium for the subsequent periods. Yet, in case of EDO series this negative effect is more significant due to the fact that the interest premium for the next periods is used for the interest rate calculation not three times, as in the case of COI series, but nine times.

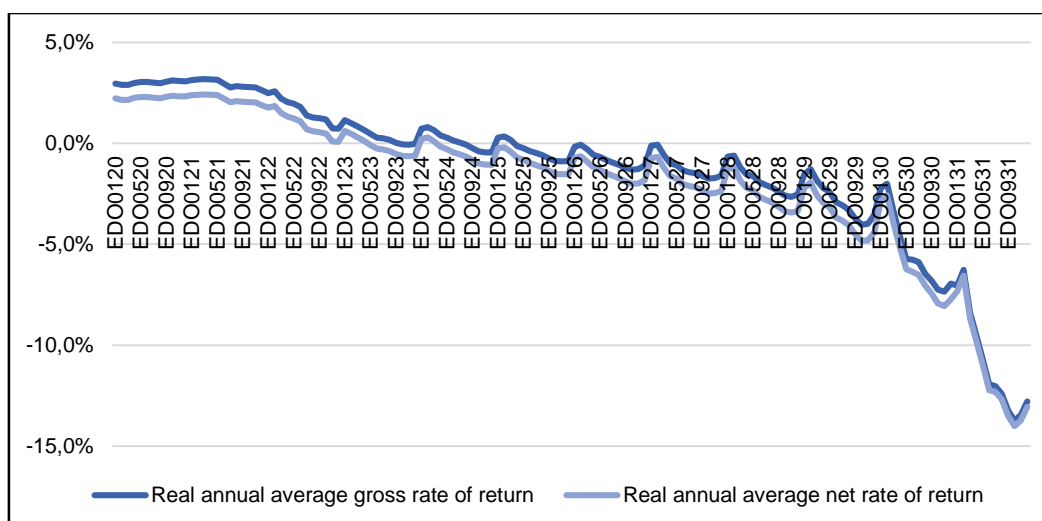
Similarly to analysis of COI series, Figure 6 shows the rates of return in real terms for EDO series bonds issued in 2010-2021. However, the proportion of bonds that have already been redeemed (series from EDO0120 to EDO1222) and are not yet redeemed (series from EDO0123 to EDO1231) has changed, which obviously results from differences in the length of the investment horizon between COI and EDO series. For the newer series, the time-shift mismatch

risk has also materialized, which had a negative impact on a larger number of series due to the longer time of investment. Among the 36 series already redeemed, all were characterized by positive profitability in real terms, while out of 108 not redeemed series of bonds by the end of 2022, only 7 represent of a current positive net rate of return in real terms – these are the earliest series, issued from January to April 2013 and from January to March 2014. The ‘jumping’ character of the values presented in Figure 6. results from the dynamically increasing inflation levels in the following months of 2021 and 2022 – which resulted in the fact that bonds issued in the first months of the year were based on much lower inflation levels than those issued at the end of the year. The same effect could be observed in the case of COI bonds, but to a smaller extent (only for the latest series).



**Figure 5.** List of interest premiums for the first and subsequent periods set for EDO bonds issued in 2010-2021.

Source: Own study based on Poland’s Ministry of Finance and Statistics Poland data.

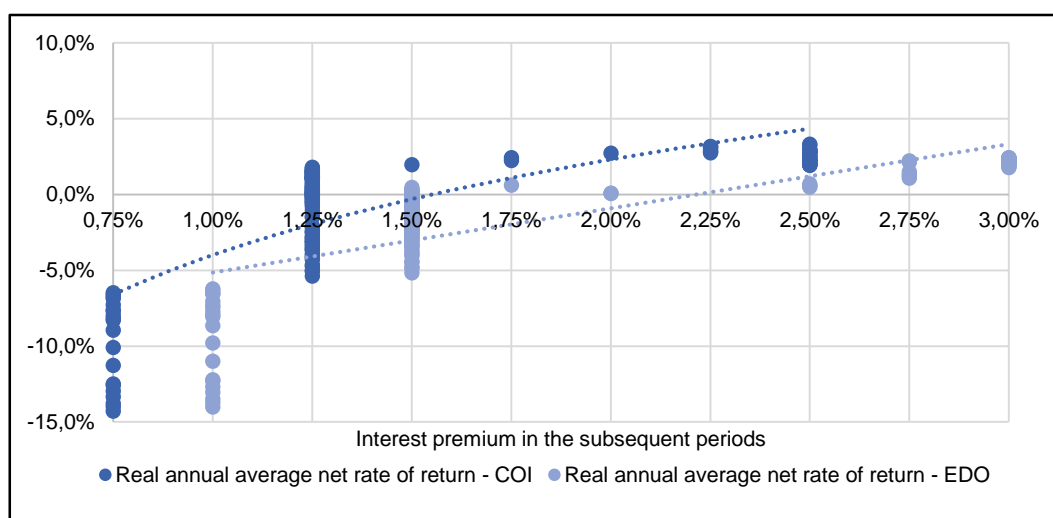


**Figure 6.** Final/current (in the case of not yet redeemed bonds) rates of return in real terms for EDO series bonds issued in 2010-2021.

Source: Own study based on Poland’s Ministry of Finance and Statistics Poland data.

### Comparative analysis of inflation-indexed treasury bonds of the COI and EDO series

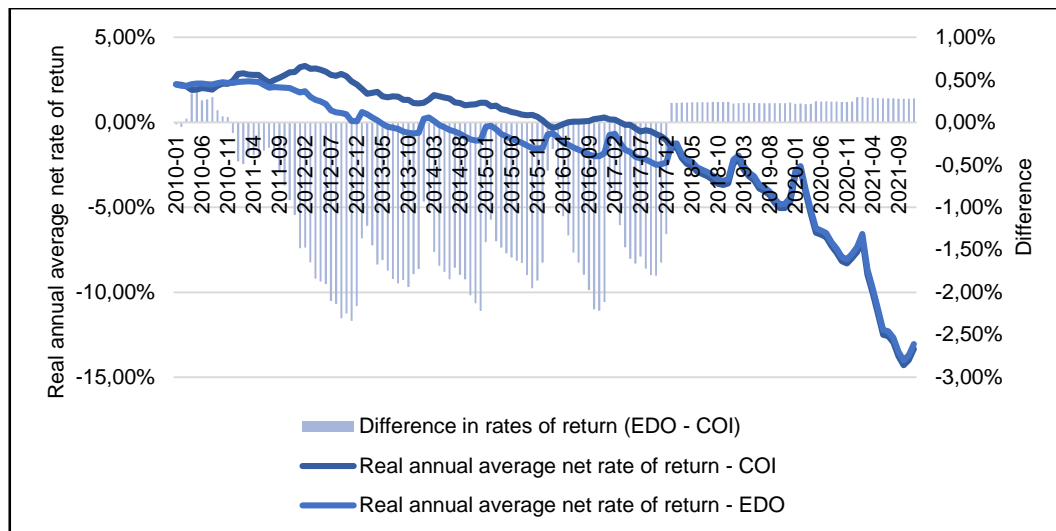
Figure 7 presents a summary of net rates of return in real terms for the analysed 288 series of inflation-indexed bonds (144 COI and 144 EDO) broken down by the interest premium values for subsequent periods. This summary shows, above all, an obvious positive correlation of profitability of individual series depending on the interest premium level set for the subsequent periods. In addition, it also shows that despite the lower interest premiums, the rates of return for COI series issued in the analysed period were on average higher than those for EDO series, which should be considered as an unexpected conclusion.



**Figure 7.** Comparison of average annual net rates of return in real terms for COI and EDO series bonds issued in 2010-2021.

Source: Own study based on Poland's Ministry of Finance and Statistics Poland data.

The explanation for this phenomenon can be found in Figure 8, which presents data of net rates of return in real terms for COI and EDO series bonds broken down by the periods of issuance. At the beginning of the analysed period, the initial expectation of a higher profitability of EDO series versus COI series finds its confirmation in the data. However, in the middle of the period, the profitability of investments in EDO series was much lower than the corresponding COI series. This was due to the fact that the longer investment horizon of EDO bonds has 'reached' the years 2021-2022, when inflation levels began to grow dramatically, negatively affecting profitability and materializing the time-shift mismatch risk. On the other hand, COI series issued in these periods were redeemed in the middle years of this decade, recording additional benefits resulting from the observed deflation. Differences in rates of return has minimized when the COI series' investment horizon also have 'reached' 2021-2022 data. As a consequence, rates of return on EDO series became once again slightly higher than COI series.



**Figure 8.** Comparison of average annual net rates of return in real terms for COI and EDO series bonds issued in 2010-2021.

Source: Own study based on Poland's Ministry of Finance and Statistics Poland data.

#### 4. Summary

Own research has shown that in general, operation principle of bonds indexed to inflation should allow the investor to gain protection from negative effects of price changes. Yet, the example of Polish treasury bonds shows that systematic reduction of interest premiums for issued instruments in the following series, the change in the operation principles and the negative effect of taxation and materialization of time-shift mismatch risk – in the high-inflation environment results in significantly negative values of the current net rates of return in real terms of the latest series of COI and EDO bonds. This means that these bonds have not protected investors from the negative effects of price increases and lose of purchase power, what confirms the hypothesis formulated in the introduction. In view of the above, it is surprising that the demand for these investment products is increasing, which may, however, result from investors' expectations regarding a decrease in inflation in the forthcoming periods, as well as the fact that, despite the negative profitability in real terms, these instruments can more effectively minimise the losses stemming from inflation than other types of investments of a similar level of risk (deposits, savings accounts) what can be furtherly reviewed in the next research.

With regard to the limitations of the practical application of the conclusions from the article, it should be pointed out that each investor has his own individual inflation basket. This means that the levels of real rates of return calculated in the way presented in the article, i.e. based on official data of the Statistics Poland, are representative for the entire economy, yet do not have to translate into the same value for the individuals – real rates of return calculated appropriately for the individual investor may vary in both ways and therefore be more or less favourable than presented in the article.

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