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# MATCHING NBP INTEREST RATES TO DIFFERENT VERSIONS OF THE TAYLOR RULE

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A b s t r a c t

The interest rate is the basic instrument of monetary policy, directly or indirectly affecting basic macroeconomic variables, such as inflation, unemployment and economic growth. The aim of the article is to compare the NBP reference rate with hypothetical rates calculated on the basis of different variants of the Taylor rule and to indicate which of those variants is best suited to the situation in Poland. The study period of 2000-2017 was adopted for the analysis. On its basis, it was found that in most cases the real interest rate of the central bank in Poland strongly coincided with rates that would have been set if one of the varieties of the Taylor rule had been in force. The best match coincided with the modified version of this rule, which was created after the economic crisis. That means that the NBP took into account both the deviations of inflation from the target and the GDP gap when making decisions regarding interest rates.

## DOPASOWANIA STÓP PROCENTOWYCH NBP DO RÓŻNYCH WERSJI REGUŁY TAYLORA

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S ł o w a k l u c z o w e: stopa procentowa, cel inflacyjny, wzrost gospodarczy, reguła Taylora.

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Abstrakt

Stopa procentowa jest podstawowym instrumentem polityki monetarnej, mającym bezpośredni lub pośredni wpływ na podstawowe wielkości makroekonomiczne, jak inflacja, bezrobocie i wzrost gospodarczy. Celem artykułu jest porównanie stopy referencyjnej NBP z hipotetycznymi stopami obliczonymi na podstawie różnych wariantów reguły Taylora oraz wskazanie, który z tych wariantów był najlepiej dopasowany do sytuacji w Polsce. Do analizy przyjęto okres badawczy 2000-2017. Na jej podstawie stwierdzono, że w większości przypadków rzeczywista stopa procentowa banku centralnego w Polsce w dużej mierze pokrywała się ze stopami, które byłyby ustalone, gdyby obowiązywała jedna z odmian reguły Taylora. Najlepsze dopasowanie dotyczyło zmodyfikowanej, powstałej po kryzysie gospodarczym, wersji tej reguły. Oznacza to, że NBP podczas podejmowania decyzji dotyczących stóp procentowych brał pod uwagę zarówno odchylenia inflacji od celu, jak i lukę PKB.

## Introduction

The interest rate is the basic instrument of monetary policy, exerting a fundamental impact on the volume of loans and deposits in the economy, as well as on the demand for and supply of money. The latter, in turn, has a significant influence on basic macroeconomic values, such as inflation, unemployment and economic growth.

The specialist literature emphasizes that the interest rate policy may be discretionary or rule-based. In the first case, decision-makers carry out a free judgment of the current and forecasted future economic situation and on this basis change the central bank interest rates, which then affect interest rates on the interbank market and those offered by banks to their clients. In the case of discretion, the decisions made are solely the result of independent opinions and decisions made by monetary authorities according to their own knowledge and conscience.

An alternative to discretionary policy is rule-based policy. In that case, the optimal interest rate could be calculated by inserting appropriate values of specific variables into a given formula. The specialist literature underlines that in such a case monetary policy would automatically react to changes in the most important economic categories that are assumed to be the central bank's objectives.

In Poland, as in most European countries, the main task of the central bank is to combat inflation. That results from the most important legal instrument, which is the Constitution of the Republic of Poland. It contains a provision according to which "the National Bank of Poland shall be responsible for the value of Polish currency" (the Constitution of the Republic of Poland, art. 227). Therefore, the aim of monetary policy is clearly defined, and the only constitutionally determined task of the NBP is to prevent the depreciation of the Polish zloty.

Nevertheless, it stems from a lower-level legal document, namely the Act on the National Bank of Poland that sometimes the central bank may also take

into account an alternative goal. That Act contains a provision stating that the implementation of the main objective should take place "while supporting the economic policy of the Government, insofar as this does not constrain the pursuit of the basic objective of the NBP" (The Act on the National Bank of Poland, art. 3).

Considering the provisions contained in the two most important legal acts for monetary policy, their implementation should be examined on the basis of the Taylor rule. According to this rule, the central bank should change interest rates under the influence of inflation deviations from the target and GDP deviations from the potential level.

The aim of this article is to compare the basic NBP interest rate with hypothetical rates calculated on the basis of different variants of the Taylor rule. Moreover, the additional goal was to indicate which of those variants was best suited to the situation in Poland. The study period of 2000-2017 was adopted for the analysis. Due to the fact that changes in all NBP interest rates usually occur simultaneously and have the same directions, a reference rate was assumed to be a representative variable for the research. On the other hand, owing to the proximity of CPI and HICP inflation rates, only the latter (provided in international statistics, e.g. in the Eurostat database) was analyzed, as that rate is used to assess the fulfillment of the Maastricht inflationary criterion.

The study consists of this introduction and two main parts and conclusions. The first of the main parts presents the analyses of time series regarding the basic NBP interest rate compared with the most important macroeconomic variables specified directly as objectives in the above-mentioned legal documents. In the other main part, that rate was compared with rates calculated on the basis of different versions of the Taylor rule. The article ends with a summary containing final conclusions.

## Changes in NBP interest rates in the context of changes in inflation and GDP

### Interest rate versus inflation

In order to examine how the NBP responded to changes in the inflation rate, the latter was compared with the reference rate in Figure 1. The inflation rate was calculated as the 12-month average for April and October of a given year. In turn, the reference rate was that of June and December of the same year, respectively. The delay is caused by the fact that central banks, when setting interest rates, usually know the inflation rate for the previous two months.

The figure shows that changes in the two analyzed categories had almost always the same directions. What is more, the NBP's operations were to a large

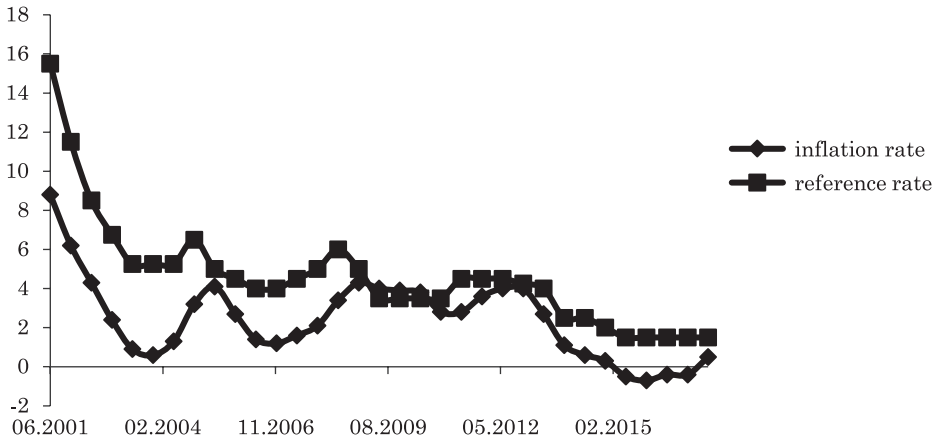


Fig. 1. HICP inflation rate and NBP reference rate in Poland in 2001-2017
Source: own study based on: *Podstawowe stopy procentowe NBP w latach 1998–2015* (2015), Eurostat, online (2017).

extent in line with the so-called Fisher hypothesis, according to which an inflation increase of 1 percentage point should cause the nominal interest rate (e.g. set by the central bank) to also increase by 1 percentage point – so that the real rate remains unchanged. This is also confirmed by the high correlation coefficient between the reference rate and the inflation rate, which for 33 (semi-annual) observations amounted to 0.807. The reaction of the interest rate to changes in the inflation rate was, therefore, strong; nevertheless, it did not take place as automatically as if based on the simple Fisher hypothesis. In this context, it is worth noting that striving to keep inflation as close to the target as possible each quarter would require frequent and considerable changes in interest rates, which would generate significant costs for the real economy (*Monetary Policy Guidelines for 2016*, 2015, p. 4).

## Interest rate versus economic growth

The correlation coefficient between the interest rate and the inflation rate, being high, but below 0.81, may suggest that the central bank in Poland was also guided by other variables, based on the provisions of the *Act* on the National Bank of Poland, according to which it may sometimes also support the government policy focused primarily on GDP growth.

Figure 2 presents a comparison of the real GDP growth rate and the NBP interest rate in the years 2001-2017. The analysis was based on interest rates from June of the following year in relation to economic growth rates (due to delays

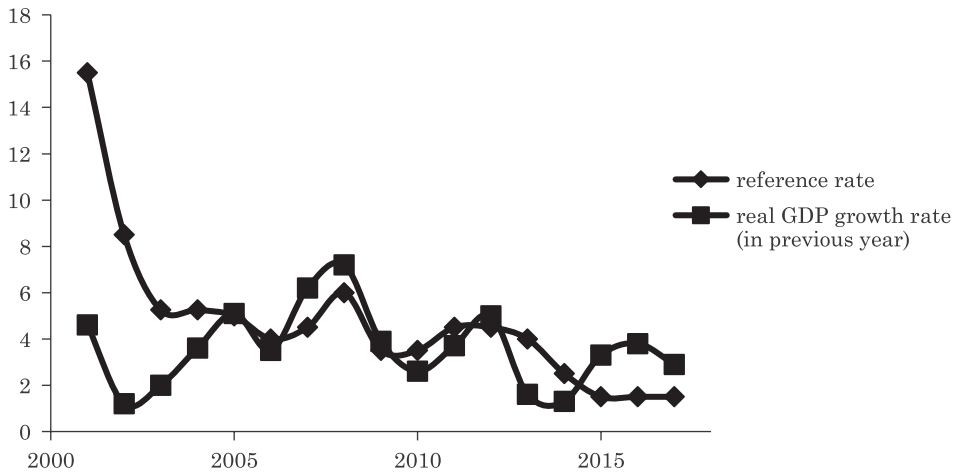


Fig. 2. Real GDP growth rate and NBP reference rate in Poland in 2001-2017
Source: own study based on: *Podstawowe stopy procentowe NBP w latach 1998–2015* (2015), Eurostat, online (2017).

in publishing GDP data). On the basis of the figure, it can be stated that changes in the basic interest rate seldom arose from the NBP reaction to fluctuations in the economic situation. However, that applies mainly to the initial and final years of the analyzed period, when changes in the rate of economic growth usually had the opposite direction to the systematically lowering reference rate. As a result, the correlation coefficient between the reference rate and the real GDP growth rate in the entire analyzed period was positive, but very low, amounting to 0.172 for 17 annual observations.

## NBP interest rate versus interest rate resulting from different versions of the Taylor rule

Considering that the central bank clearly defines the priority in terms of the purpose of its activity, a separate analysis of the relationships between the interest rate and economic growth requires greater cognitive values. Therefore, the analysis should be carried out in a more comprehensive way, including simultaneous effects of changes in inflation and GDP on NBP interest rates. To that end, we can use one of the Taylor rule versions. It should be emphasized that none of the versions of that rule is officially used by central banks. However, they may sometimes play a useful auxiliary role in monetary policy.

**Actual interest rate versus rate resulting from traditional adaptive Taylor rule**

The original formula of the Taylor (1993, p. 202) rule is presented as follows:

$$r = p + 0.5y + 0.5(p - 2\%) + 2\% \quad (1)$$

where:

$r$ – central bank interest rate[1],

$p$ – inflation rate over the last four quarters,

$y$ – GDP gap defined as the percentage deviation of real GDP from the potential GDP determined by the formula:

$$y = 100(Y - Yp)/Y \quad (2)$$

where:

$Y$ – real GDP,

$Yp$ – potential real GDP.

Formula (1) was used to calculate hypothetical optimal interest rates in the case where the traditional Taylor rule was applied. According to that formula, it was assumed that the coefficient of deviation of inflation from the target was 0.5. When calculating the output gap, instead of the percentage deviation of real GDP from the potential GDP, the deviation of the real GDP growth rate from the average for the ten-year previous periods was taken into account, e. g. for 2005 as an average of 1995-2004 (option I) and as an average of the entire 2000-2017 analyzed period (option II). Thus, in the latter case a non-moving but constant value of the potential rate (3.6%) was assumed. In addition, compared to formula (1), due to the other value of the inflation goal in Poland, the expressions: $p - 7\%$, $p - 5\%$, $p - 3\%$ and $p - 2.5\%$ were adopted for years 2001, 2002, 2003 and from 2004, respectively (instead of $p - 2\%$ existing in the original).

Figure 3 shows both the hypothetical rates calculated in the above-mentioned ways and the actual NBP interest rates. On the basis of the figure, it can be concluded that the latter were usually lower than what would arise from the presented rule. Therefore, that could suggest a slightly too expansionary monetary policy. However, that did not concern the initial and final years of the examined period, when we faced a reverse situation.

Nevertheless, it is worth noting that the direction of changes in the hypothetical and actual interest rates was usually the same. The correlation coefficient between those rates was also relatively high, which according to option I amounted to 0.736, and according to option II – 0.737 (in both cases with 17 observations). For both the options, that coefficient was, therefore, almost identical and slightly lower than in the analysis of simple relationships between

[1] In the original federal funds rate, as the proposal initially concerned the United States.

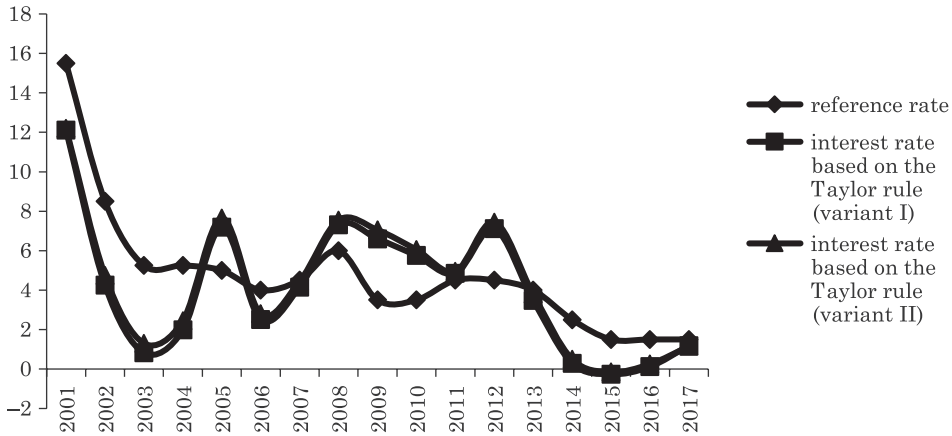


Fig. 3. Actual NBP reference rate and rate resulting from the traditional Taylor rule in Poland in 2001-2017

Source: own study based on: *Podstawowe stopy procentowe NBP w latach 1998–2015* (2015), Eurostat, online (2017).

the inflation rate and the interest rate, but much higher than between the economic growth rate and the interest rate.

Analyzing the sub-periods in which the actual interest rates were higher than those resulting from the Taylor rule, it is worth noting that they should be interpreted in a significantly different way. At the beginning of the 21st century, the monetary policy in Poland was probably too contractionary. According to many economists, interest rates were then reduced too slowly in relation to the needs of the economy characterized by low economic growth (see Fig. 2) and very high unemployment[2]. A faster reduction of interest rates would also be even more justifiable because inflation was then below the goal of 2.5% (see Fig. 1) (Grabia, 2015, p. 37).

In turn, considering the end of the examined period, the difference between actual and hypothetical rates (calculated on the basis of formula 1) was mainly due to the fact that the latter were very low and even negative in the final years. Therefore, if that rule was inflexibly applied, the central bank would have had to deviate from one of the fundamental principles, according to which we should desire positive interest after lending money to another entity. Otherwise, nobody would be interested in granting loans, because keeping money "in a drawer" would be more beneficial. In such a case, as proposed by Rzońca (2014, p. 46), an additional clause should be introduced to the Taylor rule, according to which the central bank interest rate should never be lower than 2%.

Apart from the problem of too low interest rates resulting from a rule, it is worth noting that inflexible adherence to it could cause the necessity of very

[2] The average annual unemployment rate in Poland in the years 2001-2004 was: 18.3%, 20.0%, 19.8%, 19.1%, respectively (Eurostat, online, access: 1.04.2016).

frequent changes in interest rates, which, as mentioned above, would limit market stability and macroeconomic credibility. Therefore, the NBP, in many cases, did not decide to make such a move, retaining some interest rate inertia (McCallum, 2000, p. 9).

## Actual interest rate versus rate resulting from traditional anticipatory Taylor rule

In the conducted analysis, it was assumed that the central bank, when setting interest rates, takes into account officially published, but thus sometimes slightly outdated, data on inflation and GDP. Delays in the operation of monetary policy lead to opinions in the specialist literature that current changes in interest rates should take into account forecast basic macroeconomic categories. Therefore, an alternative to the above-mentioned adaptive rule may be the anticipatory Taylor rule. In such a case, it would be based not on actual, but on expected data on inflation and GDP. However, a problem would then be the inaccuracy of predictions formulated in other conditions than those that would occur in the future (Baranowski, 2014, p. 41-45, 67-71).

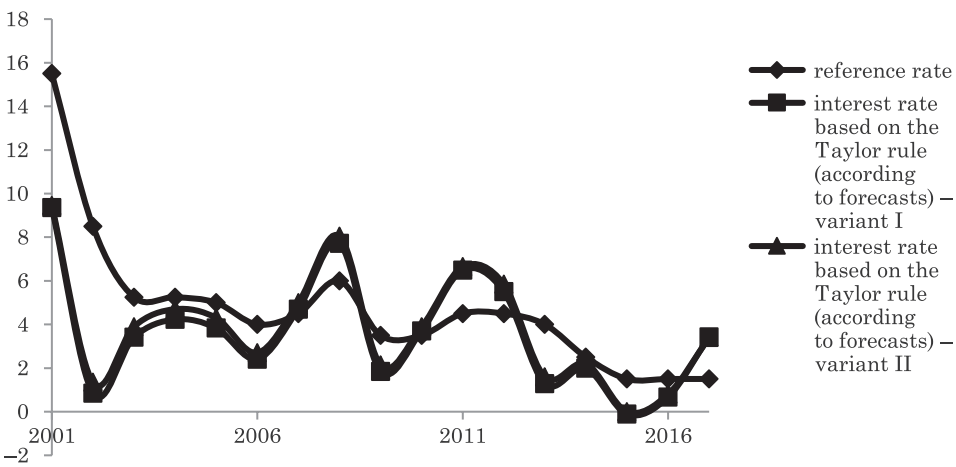


Fig. 4. Actual NBP reference rate and rate resulting from traditional Taylor rule on the basis of forecasts in 2001-2017

Source: *Podstawowe stopy procentowe NBP w latach 1998–2015* (2015), *Analiza wykonania budżetu państwa i założeń polityki pieniężnej w 2002 roku* (2002, p. 40, 46), *Analiza wykonania budżetu państwa i założeń polityki pieniężnej w 2003 roku* (2003, p. 32, 39), *European economic forecast* (Spring 2004, p. 113, 121, Spring 2005, p. 117, 124, Spring 2006, p. 131, 138, Spring 2007, p. 127, 134, Spring 2008, p. 138, 145, Spring 2009, p. 134, 141, Spring 2010, p. 182, 189, Spring 2011, p. 204, 211, Spring 2012, p. 152, 159, Spring 2013, p. 130,138, Spring 2014, p. 132, 140, Spring 2015, p. 154, 162).

Figure 4 presents a comparison of actual interest rates with rates consistent with the anticipatory (based on forecasts[3]) Taylor rule. The figure shows that, similarly to the previous version of the Taylor rule, actual interest rates were usually lower than the hypothetical rates calculated on the basis of the formula, but omitting the initial and final years of the analyzed period. However, the correlation coefficient between actual and potential interest rates in the case of the anticipatory rule was lower, amounting to 0.634 according to variant I and 0.646 according to variant II (for 17 observations). That may suggest that the NBP was more concerned with current data than economic forecasts.

## Actual interest rate versus rate resulting from modified Taylor rule

In recent years, there have been proposals to introduce additional variables to the interest rate rule, such as the natural rate of unemployment (Blanchard, 2011, p. 829, 830), the real exchange rate, the deviation of the rate of monetary aggregate growth from the target rate or the prices of financial assets. However, empirical studies do not unequivocally confirm that those variables have a significant impact on interest rates (Baranowski, 2014, p. 46-48, 56, 57).

Nevertheless, in the face of the recent crisis, there have been proposals to extend the monetary policy rule to the difference between interest rates on loans and deposits (Curdia & Woodford, 2009a, p. 36-38) or the difference between the interest rate at which borrowers are able to finance their operations and the central bank interest rate (Curdia & Woodford, 2009b, p. 28-39).

With regard to the latter proposal, it is worth noting that Taylor himself has recently called for some modification to his rule. Namely, the target value of the central bank interest rate should be equal to the rate resulting from the standard Taylor rule minus the spread between the three-month interest rates offered on the interbank market and one-day overnight transactions, which can be largely treated as a market forecast of the average central bank interest rate over the next three months. If the spreads between those rates are considerable (e. g. during the recent crisis), the actual cost of short-term funds is significantly higher than the cost that would result from the official rates of the central bank. In that case Taylor suggests, according to the rule that he has modified, the need to lower the latter (Woodford, 2010, p. 20-26).

Based on that proposal, Figure 5 presents a comparison of the actual NBP reference rate with the rate according to the Taylor rule adjusted for the difference between the three-month and one-day rates on the interbank market. In some sub-periods, that difference reduced to some extent the optimal rate for the economy computed with the help of the classic Taylor rule. However,

[3] The forecasts come from the documents of the European Commission *European Economic Forecast*. Data were taken from budget projects only for the period 2001-2003.

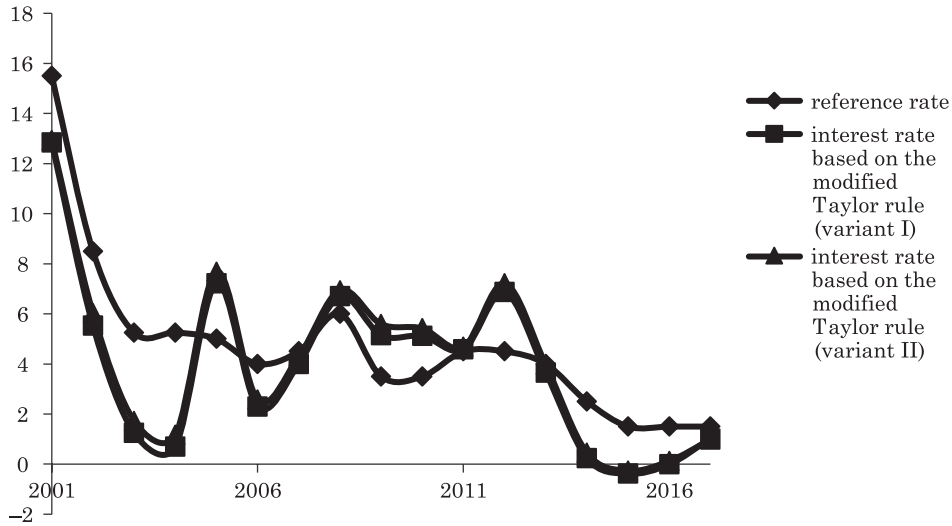


Fig. 5. Actual NBP reference rate and rate resulting from the modified Taylor rule in Poland in 2001-2017

Source: own study based on: *Podstawowe stopy procentowe NBP w latach 1998–2015* (2015), Eurostat, online (2017).

it concerned mainly recent years – during and after the economic crisis. In the remaining years, the difference was usually minimal.

On the basis of Figure 5, it can be observed that the interest rates resulting from the adjusted Taylor rule were usually also lower than the actual rates – again apart from the initial and final years of the examined period – as in the case of the classic Taylor rule. However, in the case of the adjusted rule, the correlation coefficient with the actual rate was higher than in the case of the traditional rule, amounting to 0.803 in variant I and 0.804 in variant II.

## Actual interest rate versus rate resulting from Taylor rule with higher importance of inflation deviation from the target

In the case of the Taylor rule, it is not always known which values of deviations of inflation from the target and GDP from the potential level would be optimal for a given economy. Of course, values of coefficients for deviations may be set a little differently than in the original formula. For instance, in analyses concerning Europe, where, principally, the sole legally sanctioned objective of monetary policy is to combat inflation, a deviation of the latter is, as a rule, given more importance than the GDP gap (Giammarioli & Valla, 2003, p. 12; Fernandez & Gonzalez, 2004, p. 23-25). In such a case, the monetary policy rule could take the following form:

$$r = p + 0.5y + 1.5(p - 2) + 2 \quad (3)$$

Thus, the only difference would be the value of the coefficient assumed for the deviation of the actual inflation rate from the goal (1.5, instead of 0.5).

Figure 6 presents a comparison of actual interest rates with rates consistent with the Taylor rule with higher importance of deviation of inflation from

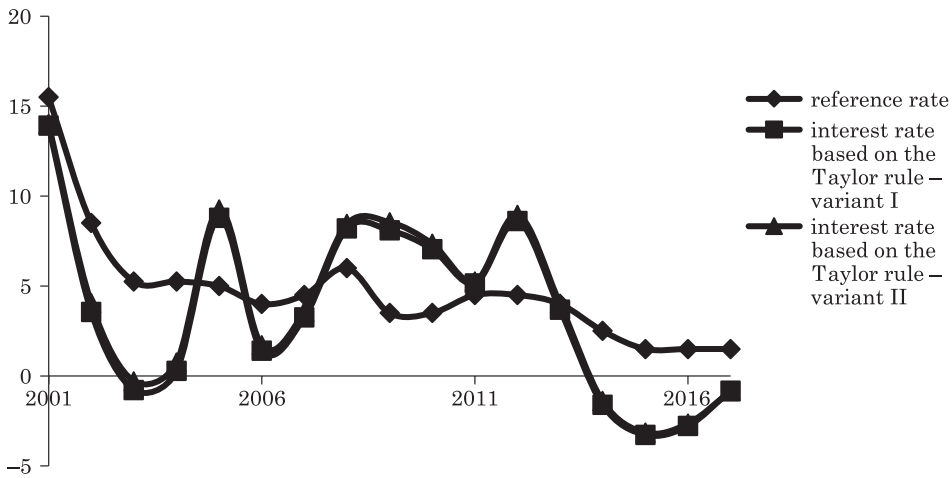


Fig. 6. Actual NBP reference rate and rate resulting from the Taylor rule with higher importance of inflation deviation from the target in Poland in 2001-2017
Source: own study based on: *Podstawowe stopy procentowe NBP w latach 1998–2015* (2015), Eurostat, online (2017).

the target. The figure shows that, similarly to the traditional version of the Taylor rule, actual interest rates were usually lower than hypothetical ones calculated on the basis of the formula, but again omitting the initial and final years of the analyzed period. However, the differences between actual and hypothetical rates were usually larger than in the traditional rule. It means the correlation coefficient between actual and potential interest rates in the analyzed case was lower, amounting to 0.672 according to both variants.

## Conclusion

On the basis of the analysis, several basic conclusions can be drawn.

1. The main task of the NBP in the light of the existing law is to care for the value of the national currency. However, that does not exclude taking into account the phase of the business cycle, and thus supporting the government policy, if the basic goal is not threatened.

2. The analysis of time series and correlation coefficients indicates that out of the two above-mentioned central bank goals it reacted much stronger to inflation than to economic growth changes. That was consistent with the hierarchy of objectives enshrined in the national legislation and with the DIT (direct inflation target) strategy adopted by the NBP.

3. However, a comparative analysis of the actual NBP interest rate and the rates computed on the basis of different versions of the Taylor rule indicates that the economic growth and the GDP gap were also taken into account. Nevertheless, the central bank did not observe those variables separately, but in the context of simultaneous changes in GDP and inflation.

4. The monetary policy rules should rather be an auxiliary function (e. g. such as an inflation projection) and not really be inflexibly applied. The analysis of different versions of the Taylor rule based on the correlation of rates calculated on their basis with the actual reference rate indicates that the modified rule, created after the economic crisis, was the best adapted to the empirical data. A slightly lower correlation occurred between the actual rates and rates calculated according to the traditional Taylor rule.

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