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Monetary policy transmission mechanism in Poland

What do we know in 2023?

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Summary

This report presents the current body of knowledge on the monetary transmission mechanism in Poland. The presented findings confirm the impact of short-term interest rates on a range of macroeconomic variables, indicating in particular that following a monetary policy tightening there is – *ceteris paribus* – an appreciation of the domestic currency, and, with a lag, a decrease in the volume of credit, economic activity, and inflation.

The changes in the Polish economy in recent years have had a multi-directional impact on the monetary policy transmission. On the one hand, the decline in the zloty-denominated debt of households and non-financial corporations to banks (in relation to GDP) contributed to weakening of monetary transmission. On the other hand, the impact of monetary policy on the economy was enhanced by a fall in the share of foreign currency loans in private sector debt, as well as by growing trade openness of the Polish economy. In addition, the latest NBP business survey suggests that the frequency of price changes has increased markedly in recent years, which – *ceteris paribus* – implies a fall in price rigidities. This, in turn, may have weakened the impact of monetary policy on economic activity and strengthened its impact on prices. In order to assess how the above changes, along with the severe shocks affecting the Polish economy in recent years, influenced the monetary policy transmission mechanism, structural vector autoregression models allowing changes in economic mechanisms over time were estimated. However, the obtained results do not allow an unambiguous assessment of these changes. Point responses of GDP and inflation to a monetary policy shock have recently been smaller – in absolute values – than previously; yet this may have been due to greater precision of the estimation rather than reflecting an actual weakening of the transmission of monetary policy.

A more comprehensive assessment of the strength of the impact of as well as lags in the monetary policy transmission mechanism was conducted employing the structural MMPP and NECMOD models. According to the simulations from these models, following a monetary policy tightening – reflected in a 1 p.p. rise in the WIBOR 3M rate for one quarter – the nominal effective exchange rate appreciates rapidly (by 0.8%-1.2%). The more restrictive monetary conditions have a somewhat lagged downward impact on economic activity, slowing annual GDP growth by a maximum of 0.3 p.p. (2-4 quarters after the interest rate change). The appreciation of the exchange rate and the weaker demand dampen price growth, reducing the annual CPI inflation rate by a maximum of 0.3 p.p. (6 quarters after the interest rate change). Core inflation decreases to a similar extent (by 0.2-0.3 p.p., after 6-8 quarters). The fall in these two inflation measures is, however, generated via the respective transmission channels to a different extent: whereas the exchange rate channel accounts for almost half of the CPI inflation response, its significance for core inflation is markedly smaller (approx. 25%). In this latter case the key role is played by the changes in inflation expectations and the interest rate channel.

Analysis of the interest rate channel focused on the impact of changes in the money market rate (WIBOR 3M) on interest rates on new household and corporate deposits and loans. According to the model analyses, the interest rate on new household deposits adjusts to a large extent (89%) to changes in WIBOR 3M, while the adjustment of the interest rate on corporate deposits is somewhat weaker. At the same time, in 2020-2022 the adjustment of the interest rate on deposits was slightly slower than earlier, particularly in the case of household deposits. On the other hand, the interest rate on new loans to households and enterprises fully adjusts to changes in WIBOR 3M and in the last years this impact has not changed significantly. Besides the adjustment of new loans, changes in NBP policy rates also lead to changes in interest rates on previously granted loans with

a floating interest rate. Given a significant share of this type of liabilities in the amount of housing loans in Poland, the impact of increases in NBP interest rates in 2021-2022 on the costs of servicing mortgage loans (in relation to GDP), estimated on the basis of reported interest rates on these loans, was considerably stronger than in the case of the actions of other central banks of the Central and Eastern Europe region.

Due to the ongoing reforms of interest rate benchmarks, the transmission of monetary policy to WIRON rates was also examined for the first time in the report. The analysis showed that term WIRON rates adjust in full, although with a lag, to changes in the NBP reference rate, i.e., differently from the forward-looking WIBOR term rates.

Monetary policy tightening contributes to limiting bank loans, not only reducing the demand for loans (interest rate channel), but also limiting its supply (credit channel). The analysis of the importance of the bank lending channel in the monetary policy transmission mechanism in Poland shows that the impact of the adjustment of credit supply accounts for approx. 20% of the fall in the value of loans granted by commercial banks in response to a restrictive monetary policy shock. At the same time, both the path of adjustment of lending policy of commercial banks and its impact on the volume of loans vary between segments of the credit market. In the case of corporate loans, following an increase in interest rates, the standards and terms on loans are tightened, which gradually translates into a fall in credit growth for these entities. Both elements of lending policy are also adjusted in the case of consumer loans; however, growth of these liabilities responds only to a tightening of credit standards. In the case of housing loans, there is some evidence that banks tend to tighten standards (but some of the obtained reactions are on the borderline of statistical significance). Also, a reduced rate of growth of this type of lending is observed.

An important role in the monetary policy transmission in Poland is played by the exchange rate channel. The zloty exchange rate is shaped by both global factors and – to a lesser degree – domestic factors, including ones related to monetary policy. The results of single-equation models and models based on the transmission of exogeneous exchange rate shocks through the price chain show that an appreciation of the nominal effective exchange rate of the zloty by 1% causes a fall in the level of consumer prices (CPI) of approx. 0.09%. However, the scale of the impact may increase along with the rise in inflation, reaching even 0.15% when inflation is high. Aside from this asymmetry, the inclusion of a wider set of feedbacks – in particular, the impact of changes in the exchange rate on economic activity – as well as the diversified nature of exchange rate shocks, suggests that the exchange rate pass-through effect may be stronger: an appreciation of the zloty by 1% can lead to a fall in the level of consumer prices (HICP at constant taxes) by even approx. 0.20%.

Inflation expectations of the private sector are also an important element of the monetary transmission mechanism. The recent period has seen an increase in the impact of current changes in prices (in particular, of core inflation) on short-term inflation expectations of consumers, enterprises, and financial sector analysts. In the case of enterprises, this was accompanied by a strengthening of the response of inflation expectations to changes in the interest rate. At the same time, the central bank communication continued to be a significant factor affecting inflation expectations of enterprises and financial sector analysts. Additional analyses show that after publication of the NBP projection, analysts revise their inflation forecasts towards the central bank's projection path, to the largest extent in the case of forecasts for the current and next year.

A comprehensive analysis of the development of inflation expectations of various groups of agents, formed in different time horizons, is performed by a newly developed tool: so-called inflation expectation heat maps. On their basis, it can be stated that despite inflation running at an elevated level, inflation expectations of external experts remained in line with the path of disinflation presented in the NBP projections. The responsiveness of long-term inflation expectations of experts

to so-called inflation surprises and to changes in short-term expectations did not increase; however, there was an increase in the responsiveness of medium-term inflation expectations to a surprise in the inflation data.

The results presented in the report should be treated with caution, with a focus on the described processes rather than on point-based assessments of the strength of individual dependencies contributing to the monetary policy transmission mechanism. The occurrence of strong shocks in the global and domestic economy, as well as a firm response to them on the part of economic policy, make it difficult to precisely isolate the impact of changes in interest rates on macroeconomic aggregates.

Introduction

Narodowy Bank Polski (NBP) implements monetary policy under the direct inflation targeting strategy, its main instrument being the short-term interest rate.[1] The purpose of this report, as of its previous editions[2], is to gauge the impact of this monetary policy instrument on macroeconomic aggregates of the Polish economy, notably on inflation.

The report was drafted amid unique circumstances, which had a significant impact on the timing and manner of conducting empirical studies and on the interpretation of their results. Firstly, after several years of low volatility of the key monetary policy instrument, recent years have seen severe shocks in the global economy, related first to the COVID-19 pandemic, and then to the Russian aggression against Ukraine. Isolating the effects of domestic monetary policy from the macroeconomic aggregates, which have recently been subject to very sharp fluctuations and heavily influenced by global factors (e.g., Szafranek *et al.*, 2023), is a challenging task and requires an adjustment of the modelling approaches. It becomes necessary to include additional variables in macroeconomic modelling, approximating or capturing the effects of shocks affecting global and domestic economy, to seek to reduce the impact of outlier observations on the identified relationships, and to be guided by expert knowledge and the results of models estimated on a sample ending before the period of severe shocks. Secondly, due to the outbreak of the COVID-19 pandemic, in line with other central banks, NBP significantly eased monetary policy in 2020 – not only by lowering interest rates, but also by launching, for the first time ever, purchase of Treasury securities as well as debt securities guaranteed by the Treasury in the secondary market under structural open market operations. As a result, in the currently estimated models of the conventional monetary policy transmission it is essential to control for the effects of asset purchase operations (see Hertel *et al.*, 2021; Hertel *et al.*, 2022) – either by employing short-term interest rate measures accounting for the effects of these operations (so-called shadow interest rates) or by identifying conventional and unconventional monetary policy shocks and response functions to them within a single model. Thirdly, under present circumstances asymmetric effects are more likely to occur, which do not materialise in linear models of the monetary policy transmission mechanism estimated over a long sample of observations. In particular, persistently elevated inflation levels may increase the degree of inertia of inflation processes and enhance the impact of exchange rate movements on consumer prices (the so-called exchange rate pass-through effect). Moreover, the transmission mechanism may evolve due to the persistently heightened uncertainty.

The findings of the research presented in this report show that NBP monetary policy affects a range of macroeconomic variables, including economic activity and inflation. However, the circumstances described above imply that the detailed results presented in this report must be viewed

[1] See: *Monetary policy guidelines* for the subsequent years: https://nbp.pl/en/monetary-policy/mpc-documents/monetary-policy-guidelines.
[2] Demchuk *et al.* (2012), Kapuściński *et al.* (2014), Kapuściński *et al.* (2016), Chmielewski *et al.* (2018) and Chmielewski *et al.* (2020).

with caution, and attention should be focused on processes rather than point estimates of the strength of the individual relationships constituting the monetary policy transmission mechanism.

Section 1 of the report contains the theoretical remarks and analysis of structural determinants of the monetary policy transmission mechanism in Poland. Section 2 presents updated estimates of the strength and lags of the monetary policy transmission mechanism, using various models that describe this mechanism in a comprehensive manner. Section 3 presents the findings on the basic relationships of the monetary policy transmission mechanism, i.e., interest rate transmission, the importance of bank credit and the exchange rate to the monetary policy transmission mechanism, as well as the formation of inflation expectations by different groups of agents. Section 4 is devoted to special topics of the report. These address the impact of inflation and GDP projections published by NBP on the forecasts of financial sector analysts, as well as a comprehensive analysis of the formation of inflation expectations and their evolution using so-called inflation expectations heat maps. The report closes with the Conclusion.

1. Structural factors affecting the monetary policy transmission mechanism

1.1. Theoretical introduction

Literature on the effects of monetary policy tends to distinguish three traditional channels of their transmission: the interest rate channel, the exchange rate channel, and the credit channel.[3]

The interest rate channel is the key channel of monetary policy transmission mechanism. It accounts for the impact of central bank interest rates on money market rates, and, through them, on the interest on deposits and loans in commercial banks, and further on consumption and investment. The main theoretical mechanism explaining the impact of interest rates on consumption is the intertemporal substitution effect – changes in interest rate alter the slope of the consumption profile in such a manner that higher interest rates result in lower current consumption and higher future consumption. In turn, the direct impact of interest rate changes on investment, is, within the traditional understanding of the interest rate channel, mainly related to changes in the cost of capital as well as changes in the net present value (NPV) of investment projects. The above mechanisms are not the only ones explaining the impact of monetary policy on consumption and investment decisions, and the contemporary understanding of the interest rate channel has been significantly expanded.

The broadly understood interest rate channel also comprises other channels, such as the cash-flow channel identified in the Polish transmission mechanism, or – somewhat less important in Poland – the asset price channel. The cash-flow channel relates mainly to households and accounts for the impact of monetary policy decisions on households' income and interest payments on variable-rate financial instruments. In Poland, this channel refers mainly to households which have incurred variable-rate housing loans. Assuming no change in their income, a tightening of monetary policy leaves the indebted households with less disposable funds available for consumption or savings. The asset price channel refers to the effects associated with the wealth channel and the so-called Tobin's q channel. Within the wealth channel, monetary tightening causes the price of financial assets held by households to fall, reducing their wealth. Consequently, households, feeling less wealthy, cut back on consumption. The Tobin's q channel refers to the relationship between investment spending and the ratio of market value of enterprises to the cost of replacement capital (the so-called Tobin's q). When the q ratio is high, corporate investment expenditure rises, because companies have the capacity to buy more capital goods by financing the purchase with share issues. An increase in interest rates translates into a fall in share prices and a lower Tobin's q. Hence, in order to purchase a given amount of capital goods, companies would have to issue more shares, which would potentially lead to the dilution of existing share ownership in the firm's equity. In

[3] It should be noted that there exist various classifications of the relationships within the monetary policy transmission mechanism. For in-depth discussion, see previous reports on the monetary policy transmission mechanism in Poland (Demchuk *et al.* 2012; Kapuściński *et al.*, 2014; Kapuściński *et al.*, 2016; Chmielewski *et al.*, 2018 and Chmielewski *et al.*, 2020).

effect, the current owners' inclination to approve new share issues is weaker, and the limited inflow of new funds to the firm causes investment to decline.

Another significant channel of monetary policy transmission, i.e., the exchange rate channel, accounts for the response of the exchange rate to a change in the interest rate, explained on the grounds of the uncovered interest rate parity theory. A change in the exchange rate further affects the price competitiveness of exports and the prices of imports. The impact of exchange rate movements on inflation is thus both direct (and prompt) – through a change in import prices – and indirect, being a result of changes in demand pressure due to changes in net exports.

As the operation of the credit market is characterised by imperfections, such as information asymmetry and segmentation, monetary policy affects the supply of bank credit through the credit channel.[4] The main components of this channel are the balance sheet channel and the bank lending channel. In line with the concept of the balance sheet channel, a rise in interest rates causes a fall in economic agents' net assets and a deterioration in their expected future financial position, reducing the value of their loan collateral and thus diminishing their creditworthiness while raising the so-called external financing premium (due to increased credit risk). Within the bank lending channel, a tightening of monetary policy translates into a deterioration in banks' balance sheets (a decline in their equity through the negative impact of higher interest rates on the quality and pricing of assets), and an increase in the external financing premium and in the lending rates to the non-financial sector. These effects may override banks' propensity to expand lending amid higher interest rates on loans and rising net interest rate margins.

Private sector expectations play an important role across the above channels. Some studies, however, distinguish a separate expectations channel, emphasising the impact of monetary policy on inflation expectations, and through those, on inflation.

1.2. Major structural features affecting the monetary policy transmission mechanism in Poland

1.2.1. Major structural features influencing the strength and lags in the monetary policy transmission mechanism in Poland

Empirical evidence from various economies shows that the strength and lags of the impact of monetary policy actions on economy depend on a range of structural factors, including, in particular, the degree of development of the financial system, the level of competition in the banking sector, labour market rigidities and the openness of the economy (see Mateju, 2014; Georgiadis, 2014; Havranek and Rusnak, 2013). In this context, the literature also emphasises the importance of monetary policy strategy, central bank independence and transparency of monetary policy (Brandao-Marques *et al.*, 2020).

[4] The impact of interest rates on demand for bank credit is accounted for in the interest rate channel.

A comparison of selected structural characteristics of Polish and the euro area economies shows that some factors may strengthen the monetary policy transmission mechanism in Poland – in comparison to the euro area – while others may weaken it (Figure 1). The degree of development of the financial system in Poland as measured by the financial sector assets and debt of households and non-financial corporations in relation to GDP was on an upward trend until the mid-2010s, gradually boosting the strength of the monetary policy transmission mechanism. In recent years, however, this trend has been halted: since approximately 2014, the financial sector assets relative to GDP have remained fairly stable, and since 2017 non-financial sector debt in relation to GDP has been falling. Compared to euro area economies, both these indicators are low (below the 25th percentile). The relatively low level of development of the financial system on the one hand potentially weakens the monetary policy transmission mechanism; on the other hand, it may reduce its lags[5] (see Havranek and Rusnak, 2013). Another factor potentially shortening the lags in the Polish transmission mechanism and additionally boosting the response of inflation to monetary policy impulses is the greater, and growing, trade openness of the economy compared to that of the euro area.[6] This reinforces the importance of the exchange rate channel in the monetary policy transmission mechanism, in particular its direct effects, manifesting themselves with a slight lag (exchange rate influence on consumer prices via import prices). At the same time, it should be noted that a significant part of Polish trade transactions take place within the so-called global supply chains, which may in turn reduce the sensitivity of output and prices to exchange rate movements (Ahmed *et al.*, 2015).

The degree of concentration in the banking sector in Poland as measured with the share of the largest five banks in banking sector assets or the Herfindahl-Hirschman index is low relative to euro area economies, which suggests a higher competition in the Polish banking sector.[7] This reinforces the operation of the interest rate channel. In addition, the strength of monetary policy transmission is supported by a high proportion of variable-rate loans,[8] which enhances the cash-flow channel[9] (see Box 3 in section 3.1.3).

The relatively small price and wage rigidities in Poland reduce the impact of monetary policy on real quantities (output and employment) while strengthening its impact on prices and wages. The Polish labour market characteristics – such as the employment protection index or trade union membership in relation to total workforce – point to smaller wage rigidities than in the euro area. Furthermore, significantly fewer employees than in the euro area are covered by collective wage

[5] It is assumed that a developed financial market offers a range of instruments hedging against the risk of interest rate changes, which may delay the response of the agents holding these instruments to interest rate changes. Therefore, in economies with less developed financial market, the absence of such instruments may accelerate the response of the private sector to changes in monetary policy.

[6] Trade openness is measured as the share of imports in GDP. In the case of the euro area countries, only imports from outside the euro area were taken into account.

[7] In 2021 the concentration of the banking sector increased due to realisation of the government programmes counteracting the effects of COVID-19 by Bank Gospodarstwa Krajowego (see NBP, 2022).

[8] Up until the beginning of 2020, almost all new housing loans were characterised by variable interest rates (or rates fixed over a period of up to one year). In the second half of 2022, the share of such loans dropped to approx. 50%. Looking at the entire non-financial sector, the share of new variable-rate loans in 2022 averaged 85% (ECB data).

[9] The cash-flow channel was discussed in section 3.1.5 of the previous edition of the report (Chmielewski *et al.*, 2020).

bargaining.[10] Also, price rigidities in Poland seem smaller than in the euro area (Macias and Makarski, 2013). As survey data from the enterprise sector show, the frequency of price changes has increased markedly in recent years, which points to diminishing price rigidity (Box 1).

Apart from structural features, the impact of the monetary policy actions on economy may depend on the level of uncertainty: during periods of heightened uncertainty the effects of interest rate change on economic activity might be weaker, while on inflation stronger, due to lower price rigidity (Vavra, 2014). Among the reasons for the weaker response of economic activity in periods of elevated uncertainty[11] the literature mentions also the withholding of investment and hiring by companies (due to the fact that investment projects are characterised by fixed costs and are not fully reversible), and with regard to households – the withholding of consumption due to the increased importance of the precautionary motive (see Bloom, 2014). Interest in this topic is recent and, consequently, aggregate-data empirical studies on this issue are scarce and only partially support theoretical inferences. Empirical studies for the United States and the euro area show that the response of economic activity (GDP, investment, and consumption) to a conventional monetary policy shock is weaker and less persistent in times of elevated uncertainty than in the periods of low uncertainty (Aastveit *et al.*, 2017; Castelnuovo and Pellegrino, 2018; Pellegrino, 2017, 2018). With regard to the response of prices, the results are ambiguous.[12]

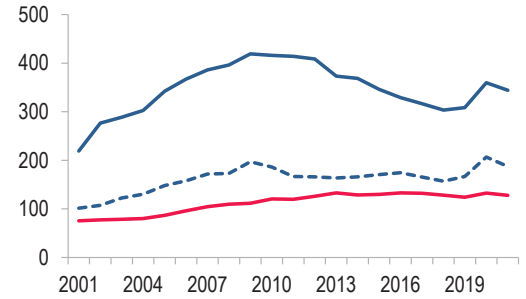
[10] According to OECD data in Poland this concerned 13.4% of employees (2019 data), while the median for twelve euro area countries for which data are available stood at 75.1% (the 25th percentile was 33.8% and the 75th percentile 97.5%; data for 2018).

[11] It is worth adding that uncertainty is countercyclical. Consequently, the conclusions of the studies specifically referred to the low effectiveness of monetary policy in stimulating the economy.

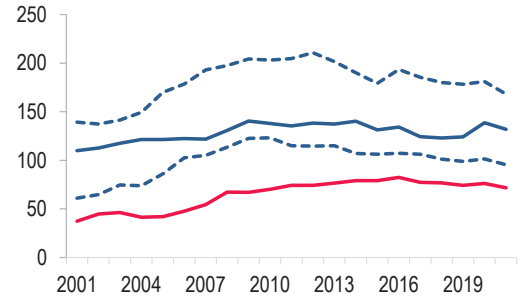
[12] Aastveit *et al.* (2017) and Pellegrino (2018) did not find a significant difference in the response of prices to a monetary policy shock in the US economy in times of high and low uncertainty. For the same economy, Castelnuovo and Pellegrino (2018) provided evidence on a faster response of inflation in times of high uncertainty, which, with the weaker response of economic activity, was explained by the authors with a steeper slope of the Phillips curve in uncertain times. For the euro area in turn, Hauzenberger *et al.* (2021) found a weaker immediate response of inflation to a conventional monetary policy shock in periods of high uncertainty, and no significant difference in the response after a year from the shock.

Figure 1. Structural determinants of the monetary transmission mechanism – comparison of Poland and the euro area

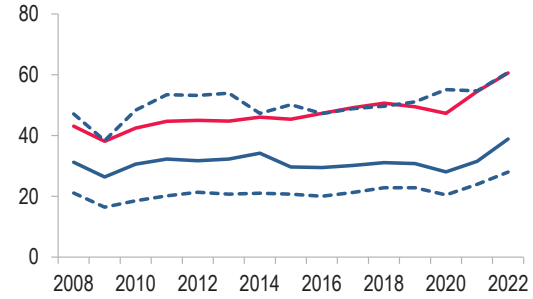
A. Financial sector assets (% GDP)[1]



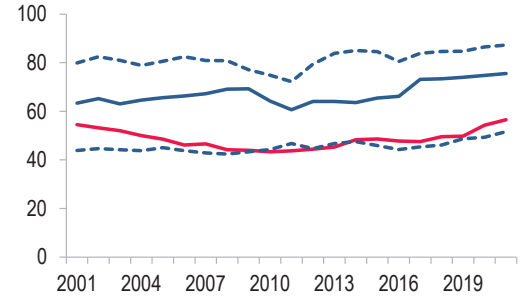
B. Debt of the non-financial sector (% GDP)[1]



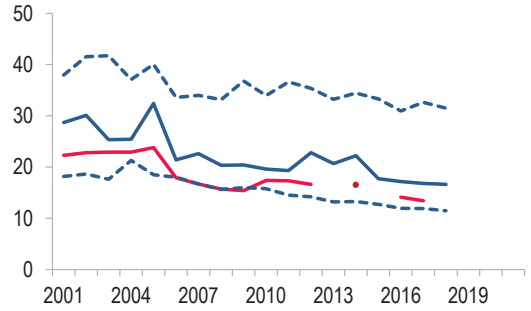
C. Imports (% GDP)[1]



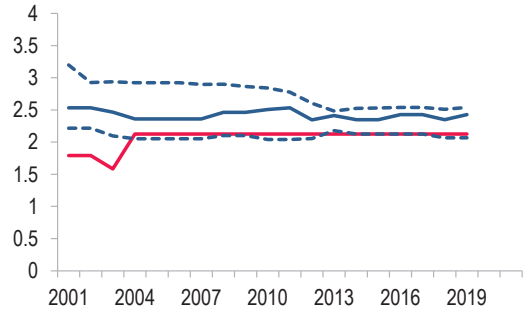
D. Share of 5 largest banks in banking sector assets (%)[2]



E. Share of trade union members in the workforce (%)[3]



F. Employment protection index (fixed-term and regular contracts)[3]



Notes: The red line denotes the index in Poland. The blue line presents the median for the euro countries, and the dashed lines – the 25th and 75th percentile of the index in the euro area countries. Chart A – in order to improve the clarity of the chart the 75th percentile of the index, which takes very high values (exceeding 1000% since 2007 on) is not shown. Chart C – for the euro area countries only imports from outside the euro area are taken into account. The euro area group of countries does not include Spain due to a lack of data. The period preceding 2008 has been omitted due to data being available for only a small number of countries. Charts E and F – the euro area country group does not include Cyprus and Malta as no data are available.

Source: 1 – Eurostat data, 2 – ECB data, 3 – OECD data. Own calculations.

Box 1. Price setting according to NBP survey data from the enterprise sector

According to the declarations of the companies surveyed by NBP at the end of 2022[13], for 45% of them, the price of the products offered in 2022 was calculated based on marginal cost plus a mark-up (fixed or variable). These are the companies capable to influence prices of the offered products and services. It suggests that they operate in line with the monopolistic competition model, in which pass-through of changes in the marginal operating costs to prices of offered goods and services may be incomplete and extended over time, which means the presence of price rigidities. In the case of the remaining companies (55%), the price is determined by external factors, such as competitors' prices or the requirements of key customers. Hence those firms operate in an environment closer to the perfect competition model, in which price setting is determined by changes in marginal costs and price rigidities do not exist.

The bargaining power of companies varies depending on the size of the examined entities. Prices are markedly more often cost-based (augmented by a mark-up) in the case of large companies (55% of firms) and the small and medium-sized enterprise sector (51%) than for micro-firms, employing up to nine people (40%). At the same time, survey data point to a marked strengthening in the market power of enterprises across the analysed groups compared to 2017, when the last similar survey was conducted.[14]

In 2022, approximately half of the surveyed companies with a workforce of at least 10 (i.e., small, medium-sized and large companies) and ¼ of micro-businesses had long-term contracts with their clients. Businesses maintaining long-term contracts clearly revised the prices of the offered goods and services less often – the share of companies rarely changing their prices (annually or less often) in the group of companies maintaining long-term contracts was almost twice as high (39% of the companies) as in the group of entities not using such contracts with clients (21% of the firms). The propensity to enter into long-term contracts depends in turn on the size of the company. Long-term contracts were most often opted for by large enterprises (60%) and entities from the small and medium-sized sector (52%) and markedly less frequently by micro-firms. In the case of large enterprises, as well as medium-sized and small enterprises these percentages are close to those recorded in 2017. In contrast, there was a significant decline in the share of micro-firms maintaining long-term contracts (to 28%, from 37% in 2017).

Indexation. One of the ways to price the offered products or services by the surveyed entities was to relate them to the publicly available price indices, i.e., their indexation. In the case of spikes in prices of goods like those observed in 2022, the algorithms used for indexation may cause the prices of the offered products to drift significantly away from the marginal costs of producing the goods and services, and price adjustments will occur with a significant time lag. Survey data suggest that the indexation mechanism should not impact substantially price rigidities.

[13] The analysis is based on the NBP Annual Macroeconomic Survey (1,696 companies) and the Micro study (996 companies) conducted in November and December 2022.

[14] In 2017, 32% of micro-businesses and 42% of small, medium-sized and large companies declared that they set prices of the offered goods and services on the basis of costs plus a mark-up (fixed or variable). The significant rise in the role of costs in the price-forming process might have partially been related to a robust growth in supply prices.

The surveyed enterprises use the indexation mechanism to set prices of the offered products to a moderate degree. Only 4% of the entities use it as their default price-setting mechanism; a further 20% use it frequently. At the same time, 76% of the entities do not use indexation at all, or only marginally. The use of indexation in setting output prices is closely related to its use in input pricing. This means that the mechanism acts primarily as a safeguard against changes in production factor prices, making the pace of growth in input and production prices mutually dependent, with no marked change in the mark-up. At the same time, the share of entities using indexation among companies experiencing a major impact of input prices on output prices is approx. 8 p.p. higher than among other enterprises.

The market power of companies extensively using the indexation mechanism is on average stronger than of those not using indexation. The declarations of 57% of companies frequently using indexation indicate that they can price their products independently based on costs (plus a mark-up). The corresponding figure for firms which rarely use indexation was 52% and for those which do not use it at all, 43%.

Output prices in companies which mainly use the indexation mechanism for pricing are updated relatively infrequently.[15] In contrast, companies using the indexation mechanism to a large extent, although not as the main price-setting mechanism, have changed prices significantly more often than those that did not use indexation (or did so rarely). Thus, it is difficult to determine conclusively how the indexation mechanism affected price rigidities.

Frequency of price adjustments. The findings of the NBP surveys suggest that price rigidities decreased in 2022 as there had been a marked increase (compared to 2017) in the frequency with which companies change the prices of the offered products (Table B1.1). Companies' responses show that around 20% of them change their price at least once a month, 35% once every quarter or six months, and a further 27% every year or less frequently. Based on this distribution, the monthly frequency of changes in product prices was quantified at approx. 35% (assuming one company – one price), both among micro-firms and larger companies (small, medium-sized and large companies).[16] This represents a marked increase in the frequency of price adjustments relative to 2017, when the corresponding figure was 25% for small, medium and large entities and 22% for micro-businesses. As a consequence, there has been a decline in the average price duration from about four to about three months. This suggests a significantly faster adjustment process among the surveyed entities to the rapidly changing costs following sharp increases in factor prices, particularly for the supply of materials and raw commodities. Weaker price rigidities may support the effectiveness of the monetary policy transmission mechanism.

[15] In the survey, 43% of these entities declared that they change their prices annually or less frequently, compared to 29% for the other entities.

[16] When calculating the frequency of monthly price changes, responses indicating a different (irregular) price setting period, which were markedly more numerous in the case of micro-businesses, were omitted.

Table B1.1. Frequency of price changes by companies, distribution of responses (%)

Year	Size of enterprise	Daily	Weekly	Monthly	Quar-terly/Semi-annually	Annually or less frequently	Other
2017	Micro-enterprises	4.0	2.1	2.9	14.2	48.4	28.5
	Small, medium-sized and large enterprises	4.1	3.2	6.7	18.9	59.6	7.4
2022	Micro-enterprises	4.3	4.2	9.3	30.4	27.1	24.8
	Small, medium-sized and large enterprises	4.3	3.7	14.1	40.9	27.9	9.1

Source: NBP data. Own calculations.

There is a considerable heterogeneity in producer price rigidity across various sections of the economy (Table B1.2). According to the 2022 survey, the monthly frequency of price changes ranges from 20% for services related to real estate (which translates into a 5-month period between price changes) to 58% in accommodation and catering (translating into a less than 2-month period between price changes). In most of the analysed sections, the frequency of price adjustment has risen (to the greatest extent in construction, transportation and information and communication). Slightly less frequent price changes were observed in 2017 in administration and related support activities. At the same time, there is a close correlation (88%) between the frequency of changes in the respective sections in 2022 and 2017.

Table B1.2. Monthly frequency of price changes

	2022	2017
Real estate activities	20%	10%
Professional, scientific, technical activities	23%	12%
Information, communication	24%	9%
Administrative and support activities	24%	28%
Industry	33%	22%
Transportation	39%	23%
Construction	39%	22%
Trade	48%	35%
Accommodation and catering	58%	55%

Source: NBP data. Own calculations.

The smallest businesses (micro-firms) use the strategy of regular price changes less frequently than larger companies; instead, they tend to respond to changes in the economic environment to a greater degree. A considerable percentage of micro-firms (24.8% in 2022 and 28.5% in 2017) were unable to clearly state the frequency of their price changes, which may suggest that in the case of these businesses price adjustments are highly irregular. This means that in their price-setting processes micro-businesses (which have a weaker market power) tend to adjust to the operating environment more often than larger enterprises, and this pattern has not changed since 2017.

1.2.2. Main structural factors affecting individual channels of the monetary policy transmission mechanism in Poland

According to the literature, the characteristics mentioned in section 1.2.1 should determine the strength and lags of the monetary policy transmission mechanism to the greatest degree. However, for individual channels of the transmission mechanism in Poland other factors are also relevant.

An additional factor strengthening the interest rate channel in 2004-2019 was an increase in zloty-denominated loans to households in relation to GDP, amid a declining volume of foreign currency loans to households in relation to GDP since 2012 (Figure 2.A). Yet, in the period 2021-2022, the volume of zloty loans to households (in relation to GDP) declined, probably due to the effects of the COVID-19 pandemic, including a rise in uncertainty, as well as the monetary tightening and the tighter conditions of creditworthiness assessment recommended by the Financial Supervision Authority.[17] The volume of the zloty-denominated loans to non-financial corporations (as a share of GDP) remained relatively stable between 2009 and 2018, yet in recent years its share has been diminishing, hitting the level close to that in 2005 in 2022.

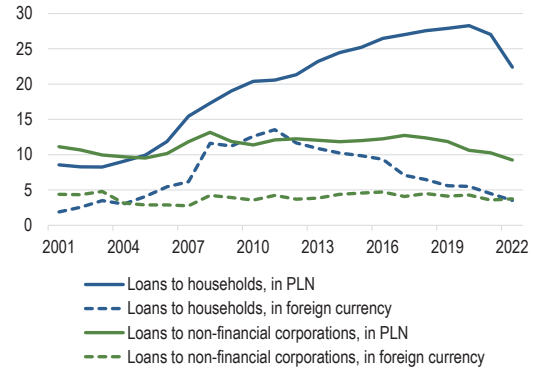
Monetary policy transmission via the interest rate channel and the credit channel is supported by the important role of loans in external financing sources of non-financial corporations (Figure 2.B). The functioning of these channels, however, continues to be weakened by a limited role of zloty-denominated loans in funding investment (Figure 2.C). More than ¾ of private sector investment is financed with investors' own funds; the share of domestic bank loans in turn hovers around 11%. Another factor contributing to the weaker impact of monetary policy is companies' use of trade credit in their daily operations (despite a decline from 2004, its share in the liabilities of the non-financial corporate sector was 12.8% in 2021, compared with 25.8% for other loans; Figure 2.B), as well as companies' recourse to foreign funds (in 2021, 38.8% of the non-financial corporation sector's debt resulting from loans and debt securities was due to foreign entities). Large companies, in contrast to small and medium-sized ones, experience fewer problems in sourcing funding, including loans (i.e., they are less credit-constrained), and they respond to a smaller degree to changes in monetary policy (see Dedola and Lippi, 2005). Empirical studies show that after monetary policy tightening, it is primarily the small firms that are affected by banks constraining the supply of credit (see Oliner and Rudebusch, 1995). However, this factor should not weaken monetary policy transmission in Poland. The share of large enterprises in the sector's value added is indeed – against the background of other economies[18] – relatively small (in 2020 it was 44.9%); moreover, the importance of other forms of external financing than bank credit available to large enterprises (i.e., issue of company bonds or shares) remains limited (Figure 2.B).

[17] In March 2022 the Financial Supervision Authority recommended adopting a minimum change of interest rate of 5 p.p. in the process of creditworthiness assessment by banks with regard to mortgage-secured loans (previously by 2.5 p.p.; see https://www.knf.gov.pl/knf/pl/komponenty/img/Stanowisko_UKNF_do_bankow_ws_ryzyka_kredytowego.pdf).

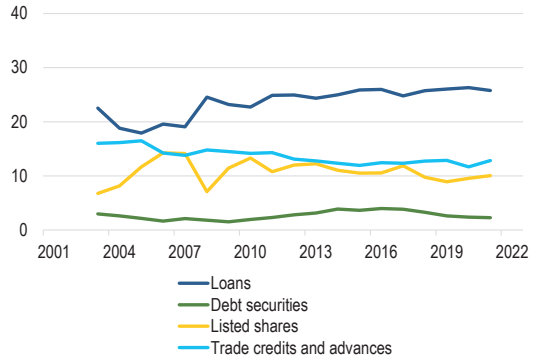
[18] See: Poschke (2018).

Figure 2. Factors affecting operation of the interest rate channel and the credit channel

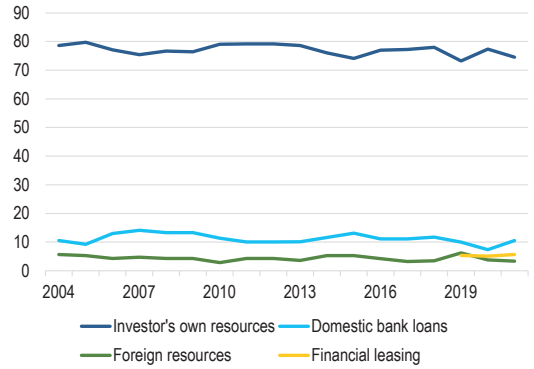
A. Non-financial sector loans at domestic banks (% of GDP)



B. Sources of external financing of non-financial corporations (% of liabilities)



C. Main sources of private sector investment financing (% of capital expenditure)



Notes: Chart C – data relate to businesses with a workforce of over 49.

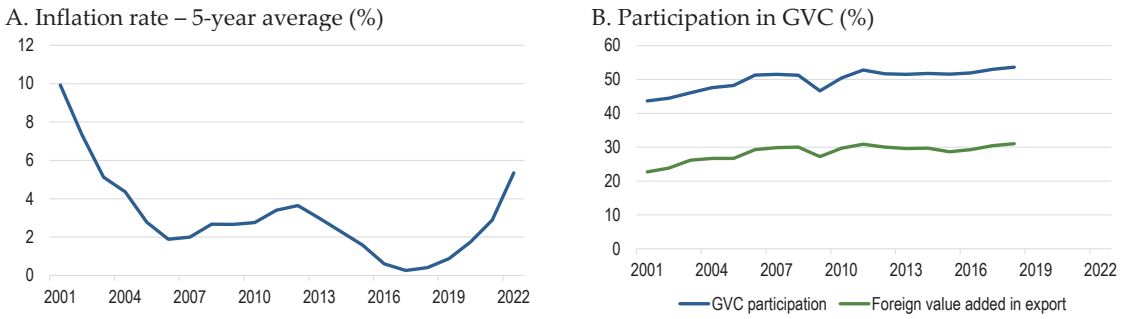
Source: NBP and Statistics Poland data. Own calculations.

Factors strengthening the operation of the exchange rate channel (the growing trade openness, high share of imports in consumption[19]) and factors limiting it (participation of Polish companies in the global value chains, in particular a relatively high share of foreign value added in Polish exports[20] – Figure 3.B) were already discussed in section 1.2.1. It is worth adding at this point that in periods of elevated inflation – such as during preparing this report (Figure 3.A) – the strength of this channel may be increasing due to a stronger impact of the exchange rate on prices (see, e.g. Gagnon and Ihrig, 2004; An and Wang, 2012; Ben Cheikh and Louhichi, 2016; Jašová *et al.*, 2016).

[19] In line with the estimates presented in Ortega and Osbat (2020), the share of direct imports in private consumption in Poland (approx. 17%, 2014 data) is higher than in most euro area countries (only in Ireland and Slovakia is this share higher; in the case of euro area countries, the authors took into account only imports from outside the euro area).

[20] In 2018, the share of foreign value added in Polish exports was approx. 31%, whereas in the euro area it amounted to approx. 18%, and in EU countries – approx. 13.7%.

Figure 3. Factors affecting the operation of the exchange rate channel

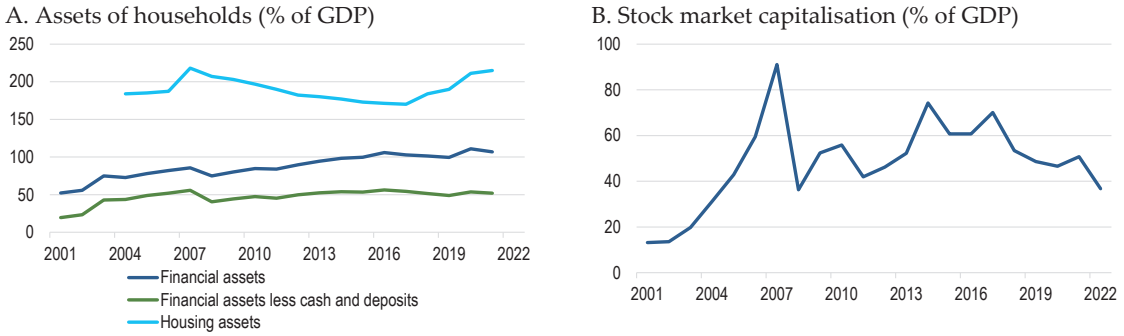


Notes: Graph B – participation in GVC is measured as the sum of foreign value added in exports and domestic value added in foreign exports. Data ends in 2018.

Source: Statistics Poland and OECD data. Own calculations.

The role of the asset price channel in the monetary policy transmission mechanism remains limited in Poland. In the past twenty years, the financial assets of households (measured in relation to GDP) have increased; this, however, was mainly due to a rise in cash and deposits (Figure 4.A). After excluding these two items, the value of household assets relative to GDP in 2021 was somewhat smaller than before the onset of the global financial crisis. Also, the stock market capitalisation (in relation to GDP) is currently much smaller than in 2007 (Figure 4.B). The rise in the housing assets of households in relation to GDP has potentially acted to strengthen the asset price channel; however, this indicator is still slightly lower than in 2007 (Figure 4.A).

Figure 4. Factors affecting the operation of the asset price channel



Source: NBP, Warsaw Stock Exchange and Statistics Poland data. Own calculations.

2. Main characteristics of monetary policy transmission mechanism in Poland

2.1. Stylized facts and changes in the monetary policy transmission mechanism over time

The stylised facts regarding the monetary policy transmission mechanism described in this section were determined on the basis of impulse response functions to monetary policy shocks obtained from structural vector autoregression (SVAR) models. However, this analysis is complicated by the shocks which hit both the global and domestic economy in 2020-2022. The devastating impact of COVID-19 on the estimated impulse response functions (not only to monetary policy shocks) has been noted and described in recent literature. In general, there exist two theoretically sound ways to address this problem. Since the impact of the pandemic on many aspects of the economy was unprecedented, temporarily disrupting "normal" economic mechanisms, the first approach suggests that pandemic observations should be treated as atypical, so the models should be estimated without taking these observations into account (see Schorfheide and Song, 2022). The second approach is to attempt to include additional exogenous shocks, processes, and modifications in standard empirical models in order to separate the "normal" economic mechanisms from the pandemic disruptions (see Ng, 2021; Lenza and Primiceri, 2022). Interestingly, both approaches ultimately lead to the same result: impulse response functions from models with time-invariant coefficients should look similar, both using the pre-pandemic sample and the sample including the pandemic (provided that the effects of the pandemic are properly controlled for). On the other hand, Carriero *et al.* (2022) show that the use of models allowing for time-varying covariance components of economic shocks, to some extent makes the model parameter estimates robust to the impact of atypical observations from the pandemic period. Therefore, impulse response functions to a monetary policy shock obtained from the SVAR with time-varying parameters (TVP-SVAR) estimated with the inclusion of pandemic observations may be treated as reliable.

Based on the above considerations, the SVAR models with time-invariant coefficients applied in this report are estimated using observations up to 2020 Q1.[21] With regard to models with time-varying coefficients (TVP-SVAR), a longer sample was used, ending in 2022 Q3. Both models comprise 5 variables, i.e., the consumer price index[22], GDP, the volume of zloty-denominated loans to

[21] The traditional way to estimate SVAR models requires the introduction of a sufficient number of restrictions in order to achieve the so-called point identification. As a result, the impulse response function to a monetary policy shock is uniquely determined, and the associated error bands have a standard interpretation (uncertainty assuming the model is true). Point identification has, however, certain disadvantages. By changing the identification schemes, we obtain different impulse response functions to a monetary policy shock. For this reason, the SVAR model used in this section was estimated with reference to the notion of so-called set identification. In this case, the interpretation of the response to a monetary policy shock is different. The path of the impulse and its error band is compliant with an infinite number of model structures, provided that the latter comply with a certain minimum number of assumed restrictions. Thus, error bands around the mean response to a monetary policy shock also reflect the uncertainty related to the model itself.

[22] In the SVAR model it is the CPI index, while in the TVP-SVAR model the HICP index at constant taxes.

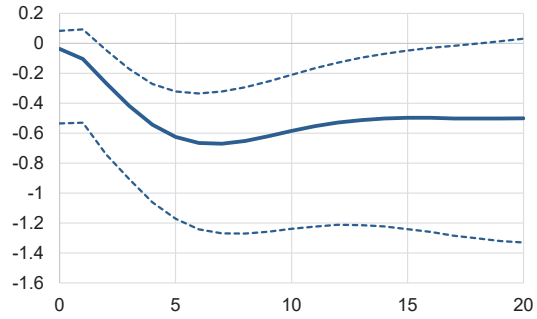
non-financial corporations and households, the real effective exchange rate (REER, an increase denotes appreciation of domestic currency) and the short-term interest rate (WIBOR 3M)[23].

The results of the SVAR model estimated on the sample until 2020 Q1 show that after a monetary policy shock, the exchange rate appreciates rapidly (Figure 5), although the estimate itself is subject to considerable uncertainty (wide error band). The remaining variables respond with a delay. The maximum response of loans occurs after 7-8 quarters. On the other hand, the response of economic activity reaches its maximum point somewhat earlier, after 6-7 quarters. In turn, the maximum impact of monetary policy on the consumer price index takes place with a lag of 8-9 quarters.

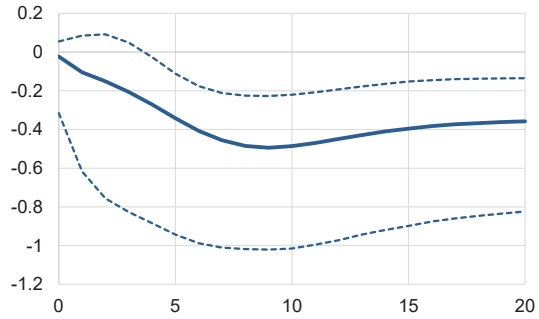
[23] In the TVP-SVAR model, to take into account the period of non-standard monetary policy (i.e., purchase of Treasury securities as well as debt securities guaranteed by the Treasury in the secondary market under structural open market operations), the shadow interest rate was used instead of WIBOR 3M. This measure was obtained on the basis of affine term structure models (Wu and Xia, 2016; Bauer, 2018).

Figure 5. Impulse response functions from the time-invariant SVAR model

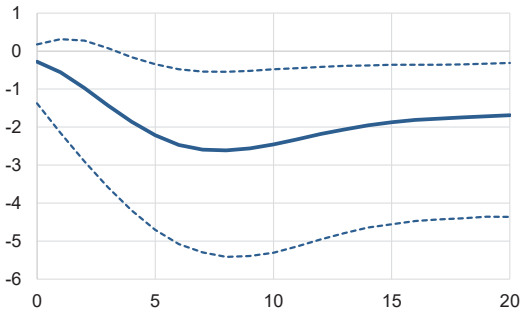
A. Response of GDP (%) to a monetary policy shock



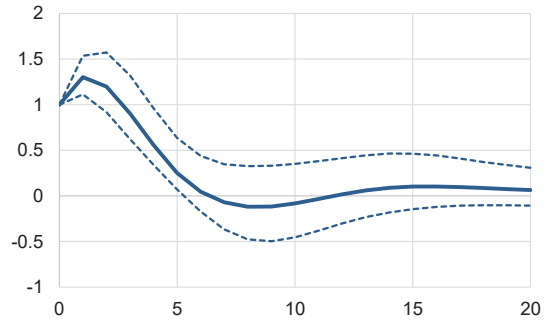
B. Response of CPI (%) to a monetary policy shock



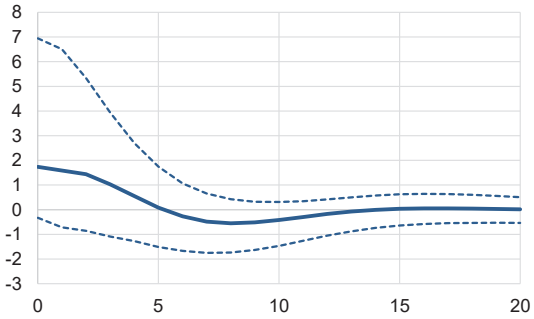
C. Response of loans (%) to a monetary policy shock



D. Response of WIBOR 3M (p.p.) to a monetary policy shock



E. Response of REER (%, increase – appreciation) to a monetary policy shock



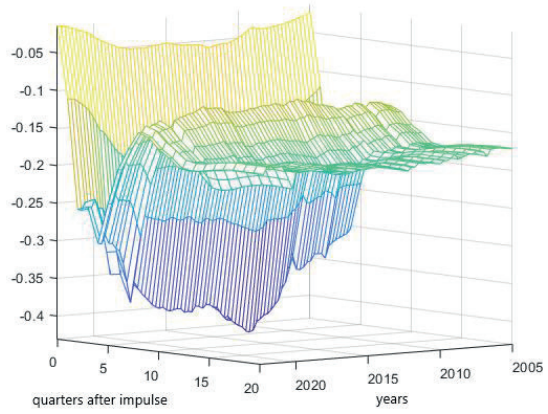
Notes: Monetary policy shock equal to a 1 p.p. rise in the interest rate. Horizontal axes – quarters after the shock. The dashed lines denote a 68% error band.

Source: NBP, Statistics Poland and BIS data. Own calculations.

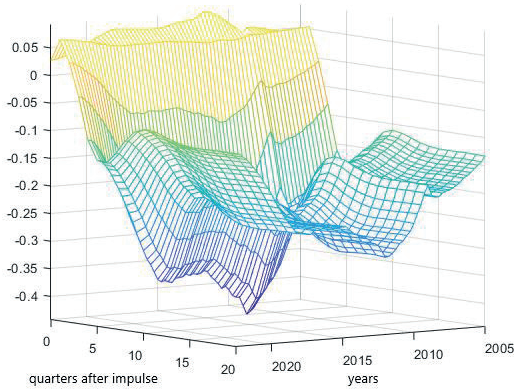
The results obtained from the SVAR model allowing for time-varying parameters[24] show that towards the end of the analysed sample point estimates of the impact of a monetary policy shock on economic activity and inflation were – in absolute terms – slightly lower than before (Figure 6, Figure 7, Figure 8). This, however, probably results more from a more precise estimation of the response functions to the monetary policy shock rather than from an actual weakening in the monetary policy transmission mechanism. The reason is that in past two years we observed a larger variability of short-term interest rates compared to the period before the COVID-19 pandemic.

Figure 6. Changes in the response functions to the monetary policy shock from the TVP-SVAR model

A. Response of GDP (%) to a monetary policy shock



B. Response of HICP at constant taxes to a monetary policy shock (%)



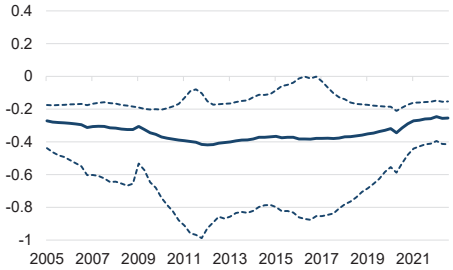
Notes: Monetary policy shock equal to an 0.25 p.p. increase in the interest rate.

Source: NBP, Statistics Poland and BIS data. Own calculations.

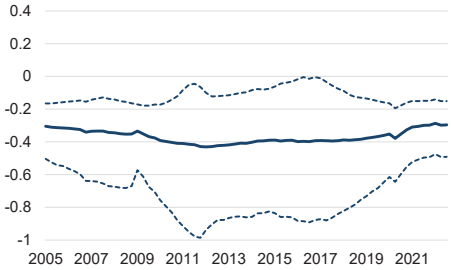
[24] The TVP-SVAR model used in this report is described in Kocięcki (2020). In particular, in contrast to the prevailing alternative approach (Primiceri, 2005), the model does not require the assumption of a recursive identification scheme for a matrix of simultaneous relations. In fact, it allows for estimation of all time-varying parameters in this matrix.

Figure 7. Changes in GDP response to a monetary policy shock over time, selected horizons

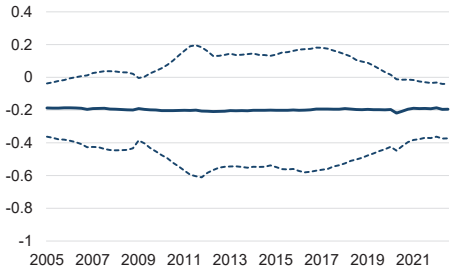
A. After two quarters following the shock



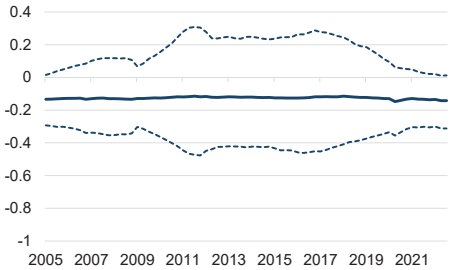
B. After four quarters following the shock



C. After six quarters following the shock



D. After eight quarters following the shock

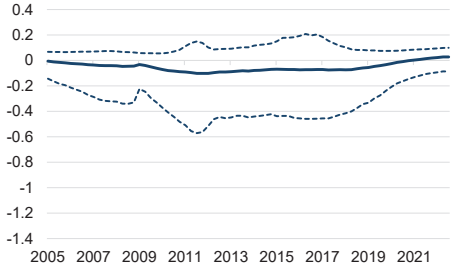


Notes: Monetary policy shock equal to an 0.25 p.p. increase in the interest rate. The dashed lines denote a 68% error band.

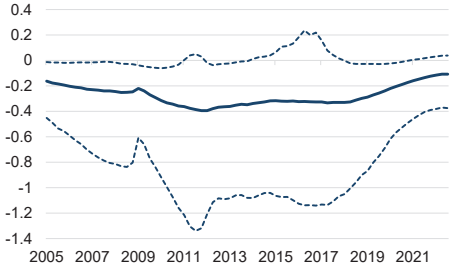
Source: NBP, GUS, BIS and Eurostat data. Own calculations.

Figure 8. Changes in the consumer price (HICP at constant taxes) response to a monetary policy shock over time, selected horizons

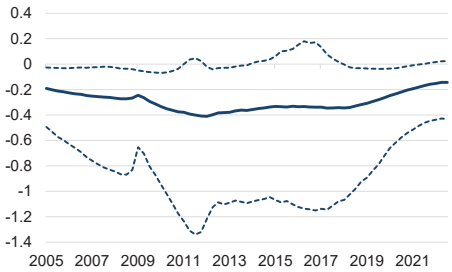
A. After two quarters following the shock



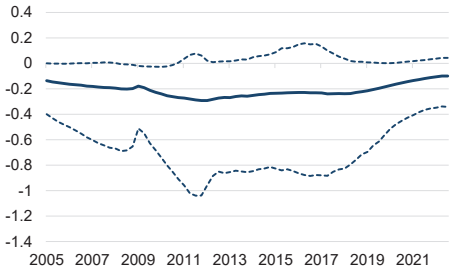
B. After four quarters following the shock



C. After six quarters following the shock



D. After eight quarters following the shock



Notes: Monetary policy shock equal to an 0.25 p.p. increase in the interest rate. The dashed lines denote a 68% error band.

Source: NBP, Statistics Poland, BIS and Eurostat data. Own calculations.

2.2. Strength and lags in the transmission mechanism and the relative importance of individual transmission channels

This part of the report presents the simulated effects of a short-term interest rate change based on the structural models more deeply grounded in economic theory than the SVAR models.

2.2.1. Structural models used to analyse the monetary policy transmission mechanism

In the simulations, we use two models reflecting the monetary policy transmission mechanism, i.e., the Small Monetary Policy Model (MMPP) and the basic NBP forecasting model, i.e., NECMOD.

The MMPP model is based on the paradigm of New Keynesian economics and is constructed around four fundamental macroeconomic relationships considered in such models, i.e., the aggregate demand curve, the Phillips curve, the exchange rate equation referring to the concept of the uncovered interest rate parity and the monetary policy rule. The model has been re-estimated to include the data up to the end of 2022.[25] A detailed description of the MMPP model can be found in Annex 1.

The NECMOD macroeconomic model is a macro-econometric, multi-equation model of the Polish economy used to prepare inflation and GDP projections, published three times a year in NBP Inflation Reports. Detailed information on the NECMOD model can be found on the NBP website[26], in particular in studies by Budnik *et al.* (2009) and Greszta *et al.* (2012).

2.2.2. Main characteristics of monetary policy transmission mechanism

To assess the strength and lags of the transmission of monetary policy impulses, we have conducted a simulation in which the short-term interest rate (WIBOR 3M) was increased by 1 p.p. for a period of one quarter and then allowed to develop according to the monetary policy rule in the subsequent periods. We assume that in the period under analysis no other shocks occur, which means that the obtained responses of selected macroeconomic variables (Figure 9, Table 1) show the effects related only to the change in the interest rate.

The simulation results obtained from both models display considerable similarity both in qualitative and quantitative terms. A tightening of monetary policy causes an immediate appreciation of the exchange rate, which reaches the maximum in the third quarter after the interest rate impulse. The nominal effective exchange rate then appreciates, depending on the model, by approx. 0.8%-1.2% compared to the baseline path (i.e., the path of the exchange rate when no change of interest rate takes place). The maximum response of annual GDP growth is observed somewhat sooner in the MMPP model (the second quarter after the interest rate change) than in the NECMOD model

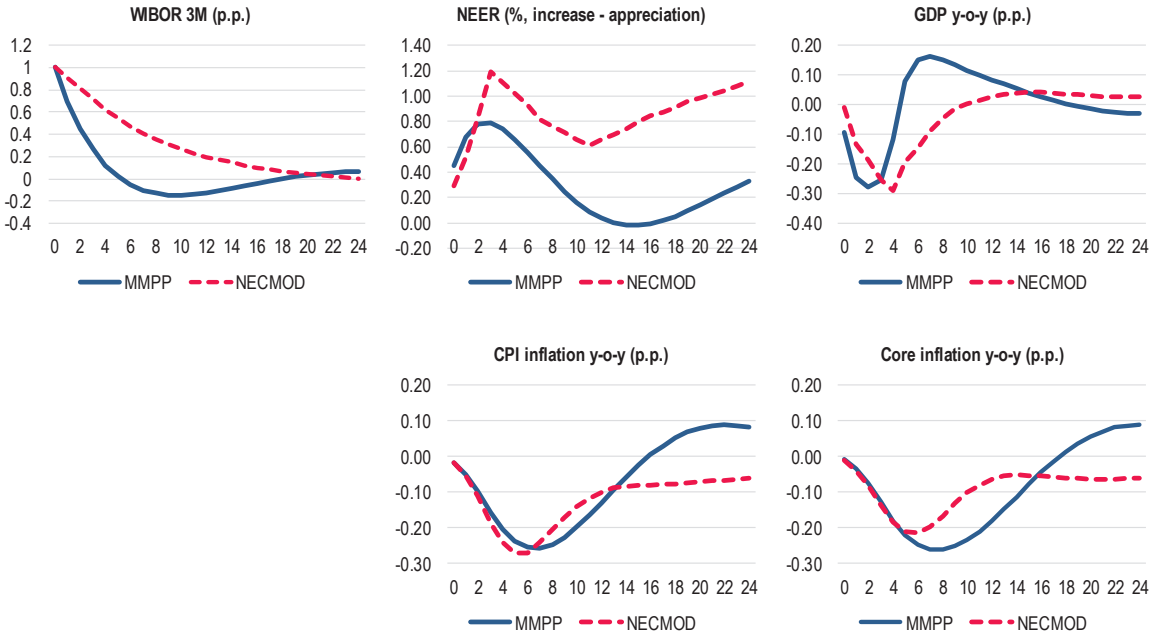
[25] Due to the specific qualities of this period and the intensity of the shocks affecting the global and domestic economy and the response of economic policy, a range of additional variables were considered. Specifically, these include the so-called shadow interest rate, the Global Supply Chain Pressure Index (GSCPI, Benigno et al., 2022), the COVID-19 Stringency Index, see https://ourworldindata.org/covid-stringency-index), or dummy time variables. Hence the results of this re-estimation should be treated with caution.

[26] The link: https://nbp.pl/en/monetary-policy/inflation-and-gdp-projection/necmod.

(the fourth quarter after the interest rate change), while the strength of this response is similar (a decline in annual GDP of approx. 0.3 p.p.). The maximum fall in year-on-year core inflation (inflation net of food and energy prices) amounts to approx. 0.2-0.3 p.p. and occurs with a lag of 6-8 quarters. In turn, regardless of the model, the maximum decline in overall CPI inflation amounts to 0.3 p.p. and occurs approximately 6 quarters following the interest rate change.

As described above, after one quarter the interest rate rule is activated in both models, whose arguments are the deviation of inflation from the NBP target and the output gap. Therefore, the falls in inflation and economic activity cause a due easing of monetary policy. It is markedly faster in the MMPP model than in the NECMOD model.

Figure 9. Monetary policy transmission mechanism—results from structural models



Notes: Horizontal axes – quarters after the shock.

Source: Own calculations.

Table 1. Monetary transmission mechanism – summary of results from structural models

	MMPP	NECMOD
Nominal effective exchange rate (increase – appreciation)		
strength of maximum response (in %)	0.78	1.19
lag of maximum response (quarter)	3	3
GDP growth y-o-y		
strength of maximum response (in %)	-0.28	-0.29
lag of maximum response (quarter)	2	4
Core inflation y-o-y		
strength of maximum response (in %)	-0.26	-0.22
lag of maximum response (quarter)	7-8	6
CPI inflation y-o-y		
strength of maximum response (in %)	-0.26	-0.27
lag of maximum response (quarter)	6-7	5-6

Notes: The lag of maximum response is defined as the quarter or quarters in which the response of the given variable is equal to the maximum, accurate to two decimal places.

Source: Own calculations.

2.2.3. Assessment of the relative strength of the main channels of the transmission mechanism

The response of inflation to the monetary policy shock presented in the previous section contains the effects of various transmission channels. As in the previous reports, we evaluate the relative strength of the main channels of monetary policy impact on inflation. For this purpose, we use the MMPP structural model, in which the interest rate channel and the exchange rate channel are represented. In addition, the relevance of inflation expectations for the monetary policy transmission mechanism was considered.[27]

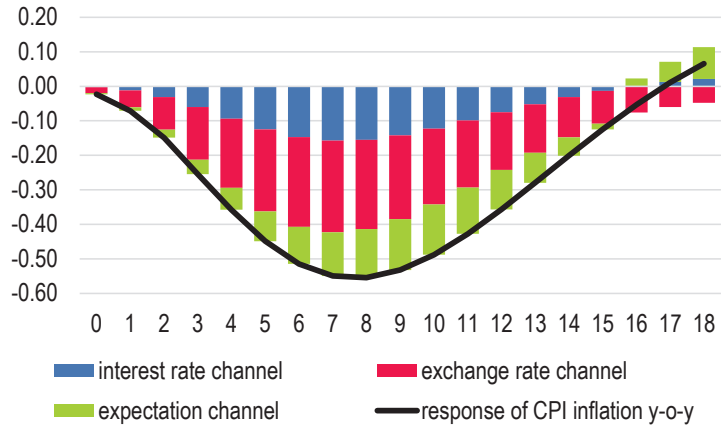
The simulation exercise was run in three steps. In the first step, the response of core and CPI inflation y-o-y to an increase of 1 p.p. in the short-term interest rate for a period of four quarters was estimated. This period is longer than in the simulations of the transmission mechanism described in section 2.2.2, which makes the effects of individual transmission channels more visible. In the second step, by conducting an analogous simulation of a rise in the short-term interest rate, with inflation expectations of enterprises, consumers and financial market analysts fixed, we obtained an approximation of the impact of interest rates on inflation through other paths than the adjustment of inflation expectations. In the final step, the nominal effective exchange rate was additionally fixed, and the resulting reduction in the response of inflation was considered to approximate the exchange rate effects. The unexplained part of the response of core inflation to an interest rate impulse was put down to the effects of the interest rate channel. This kind of differentiation of the

[27] The MMPP model does not explicitly include the bank lending channel, but its strength compared to the traditional interest rate channel is small (see section 3.2.1 of this report).

strength of the monetary policy transmission channels is not precise and provides only an approximate sense of their relative importance.[28]

In line with the simulation results including all the feedback loops of the MMPP model, the maximum response of CPI inflation y-o-y to a rise in the short-term interest rate occurs in the seventh and eight quarter following the monetary policy tightening and amounts to -0.6 p.p. (Figure 10). Approximately 47% of it can be attributed to the exchange rate channel effects, 28% to the interest rate channel and 24% to the effects of changes in inflation expectations. On the other hand, in the case of y-o-y inflation net of food and energy prices, the maximum effect materialises in the eighth and ninth quarter after the change of the interest rate and stands at approx. -0.6 p.p. (Figure 11). The exchange rate channel has a clearly smaller importance than in the case of CPI inflation: it accounts for around 25% of the maximum decline in core inflation, while the interest rate channel accounts for 32% and the change in inflation expectations effects for 43%.

Figure 10. Strength of individual channels of the monetary transmission – impact on CPI inflation y-o-y

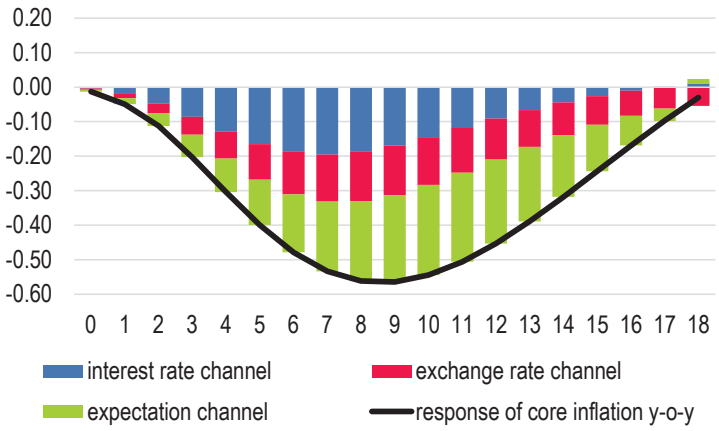


Notes: Horizontal axis – quarters after the shock. Estimates based on the MMPP model.

Source: Own calculations.

[28] For instance, inflation expectations, in the part determining the level of real interest rates, should be considered as part of the interest rate channel.

Figure 11. Strength of individual channels of the monetary transmission – impact on core inflation y-o-y



Notes: Horizontal axis – quarters after the shock. Estimates based on the MMPP model.

Source: Own calculations.

3. Selected relationships of the monetary policy transmission mechanism in Poland

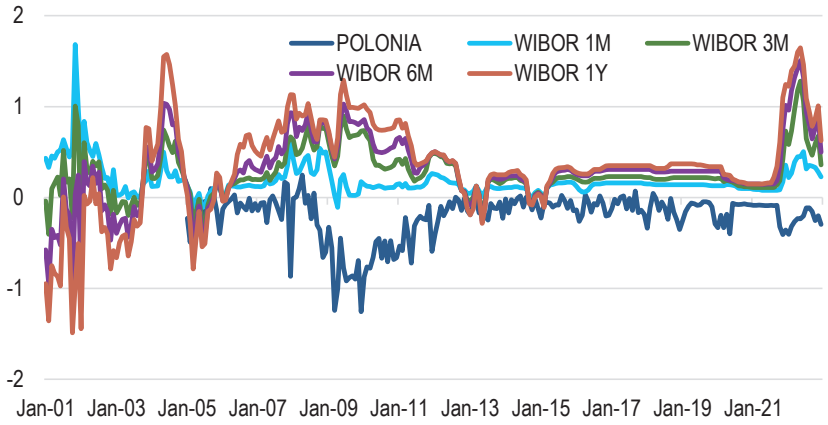
3.1. Interest rate transmission

This section of the report presents the results of empirical research concerning the impact of the NBP reference rate on the money market rate and, indirectly, on interest rates on household and corporate loans and deposits. In the analysis of the interest rate transmission, we used spreads over the NBP reference rate and single-equation econometric models describing the equilibrium between the interest rates under consideration and the path of adjustment to the equilibrium.

3.1.1. Transmission to money market rates

From 2013, spreads between money market rates and the NBP reference rate were low and stable for a long period (Figure 12). After the start of the monetary policy tightening cycle in October 2021, spreads rose sharply, particularly in the case of interbank market rates with longer maturities. The stronger increase in money market rates than in the NBP reference rate in this period can be explained by expectations of further monetary policy tightening. From mid-2022, along with the reduction of the gap between the current and expected NBP interest rates, the spreads began to decline.

Figure 12. Spreads between the POLONIA rate and the WIBOR rates and the NBP reference rate (in p.p.)



Source: NBP data. Own calculations.

Analysis of cumulative changes of money market rates against cumulative changes of the NBP reference rate in monetary policy tightening and easing cycles shows that changes in central bank interest rates are reflected in similar changes in the interbank market rates (Table 2).[29] In the period

[29] An exception was the period of disruptions due to the global financial crisis (particularly in the case of the overnight rate, which was related to the need to supply the banking sector with liquidity).

following the change in the NBP reference rate, interest rates with longer maturities (WIBOR 6M and WIBOR 1Y) adjusted on average to smaller extent than rates with shorter maturities, since they are to a larger extent dependent on expected changes in interest rates in the future, so a part of the adjustment occurs even before the expected change in the NBP reference rate.

Table 2. Cumulative changes in the NBP reference rate and money market rates during monetary policy tightening and easing cycles (in p.p.)

Start of cycle	End of cycle	NBP ref. rate	POLONIA	WIBOR 1M	WIBOR 3M	WIBOR 6M	WIBOR 1Y
Mar.01	Jun.03	-13.75	.	-14.5	-14.0	-13.3	-12.9
Jul.04	Aug.04	1.25	.	1.5	1.2	1.2	1.0
Mar.05	Mar.06	-2.50	-2.5	-2.5	-2.2	-2.0	-1.8
Apr.07	Jun.08	2.00	2.0	2.0	2.0	2.3	2.3
Nov.08	Jun.09	-2.50	-2.7	-2.9	-2.8	-2.5	-2.3
Jan.11	May12	1.25	1.5	1.4	1.1	1.0	0.8
Nov.12	Jul.13	-2.25	-2.3	-2.3	-2.2	-2.1	-2.1
Oct.14	Mar.15	-1.00	-0.9	-0.9	-0.8	-0.8	-0.8
Mar.20	May.20	-1.40	-0.9	-1.1	-1.2	-1.2	-1.2
Oct.21	Dec.22*	6.65	64	6.7	6.8	6.9	7.0
Average change in relation to change in NBP reference rate (in %)			**98.3**	**96.4**	**93.2**	**88.4**	**81.7**

Notes: The analysis covers the period from January 2001 to December 2022. Changes in money market rates are calculated on monthly averages. Until January 2011 the interest rate decisions of the MPC were usually taken at the end of the month, but since then they have been taken at the beginning of the month. For this reason, when calculating cumulative changes of money market rates, if the first change in the NBP reference rate in the cycle took place in the first (second) half of the month, the change is calculated in relation to the previous (given) month. Similarly, if the last change in the interest rate took place in the first (second) half of the month, the change is calculated in relation to the given (next) month. * Due to the data availability, the analysis of changes in interest rates in the cycle starting in October 2021 ended in December 2022.

Source: NBP data. Own calculations.

3.1.2. Transmission of the NBP reference rate and the reserve position of the banking sector to WIRON rates. Comparison with transmission to POLONIA and WIBOR rates

Since December 2022 it has been possible to use the WIRON (Warsaw Interest Rate Overnight) rates in agreements and financial instruments. In addition, in line with the "Road Map"[30] the conversion of existing agreements using WIBOR is assumed in 2025 so that they will be based on WIRON rates. This may mean that WIRON rates will have a significant – and in the coming years growing – importance in the monetary policy transmission mechanism. Given the above conditions, this part of the report presents the results of the first study[31] of the transmission of the NBP reference rate to WIRON rates (i.e., the overnight rate and 1-, 3- and 6-month rates; in the later part of the section "the WIRON index" in the singular, without indicating the length, means the

[30] Summary of the expected Roadmap for the replacement of WIBOR and WIBID benchmarks with WIRON index, Financial Supervision Authority: https://www.knf.gov.pl/knf/en/komponenty/img/mapa_drogowa_ang.pdf.

[31] A more detailed description of the summarised results in this section can be found in the study of Kapuściński (2023a).

overnight rate). An attempt was also made to determine the importance of other factors in explaining the volatility of these rates.

It is worth beginning by indicating two differences between the WIRON rates and the POLONIA and WIBOR rates. Firstly, the WIRON rates are determined on the basis of interest rates on deposits accepted not only from financial institutions, as in the case of the WIBOR rates, but also from non-financial corporations. In comparison, the POLONIA rate, which the operational target of NBP refers to, covers only deposits accepted from banks (a narrower category than "financial institutions"). Secondly, term WIRON rates are calculated as a compound of the past overnight rate, by which, in contrast to term WIBOR rates, they have a backward- and not forward-looking character. The construction of the WIRON rates is described in resources available on the website of the administrator, GPW Benchmark.[32]

Data for the WIRON index, which this analysis is based on, begin in January 2019 and end in December 2022.[33] For term indices the time series are shorter, accordingly (as indicated above, this is because they are based on the past overnight rate). Due to the relatively short period that the analysis was able to cover, both the result based on econometric models and the preliminary conclusions about the basic characteristics of the WIRON rates drawn on the basis of charts, should be treated with caution. The conclusions are limited to the period covered by the analysis, and the dependencies between the WIRON rates and other variables may evolve (see Box 2).

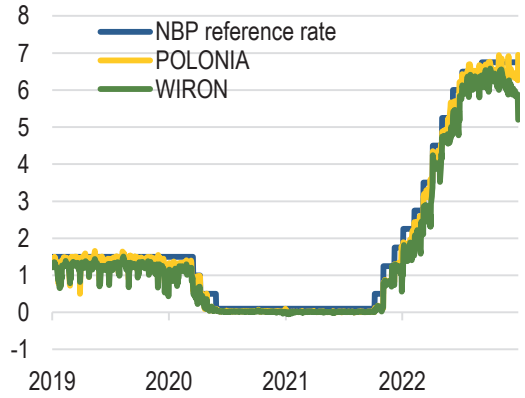
Similarly to the POLONIA rate, the WIRON index changes its trend along with changes in the NBP reference rate. It is also characterised by a similar short-term volatility as the POLONIA rate. Both rates seem to adjust to changes in the NBP reference rate immediately. However, there may also be factors other than interest rate policy affecting the WIRON index and POLONIA rate (Figure 13).

On the other hand, a comparison of WIRON 3M and WIBOR 3M rates against changes in the NBP reference rate reveals the delayed character – resulting from its construction – of the former and the forward-looking character of the latter. The WIBOR 3M rate adjusts to changes in the NBP reference rate, at least in part, already at the moment that expectations of its change over the next three months arise. On the other hand, the WIRON 3M rate takes into account the changes in monetary policy actually made over the previous three months – to the extent that they were reflected in the WIRON index (Figure 14Figure 14).

[32] *Transaction-based indices*, Indices details, GPW Benchmark, https://gpwbenchmark.pl/indices-details.

[33] At the time of preparing the main part of the analysis this was the whole range of data available. In the later period, the analysis was extended with data from 2023 Q1, and its results are presented in Box 2.

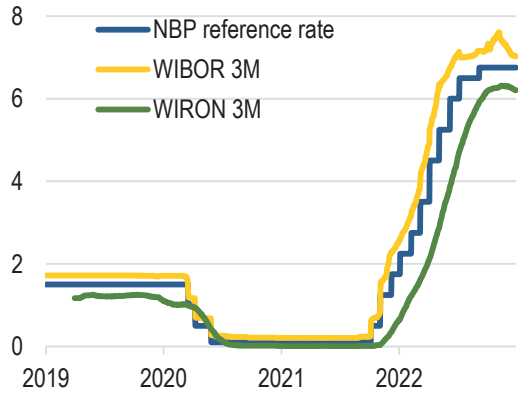
Figure 13. WIRON index against the NBP reference rate and POLONIA rate



Notes: daily data.

Source: NBP and GPW Benchmark data.

Figure 14. WIRON 3M rate against the NBP reference rate and WIBOR 3M rate



Notes: daily data.

Source: NBP and GPW Benchmark data.

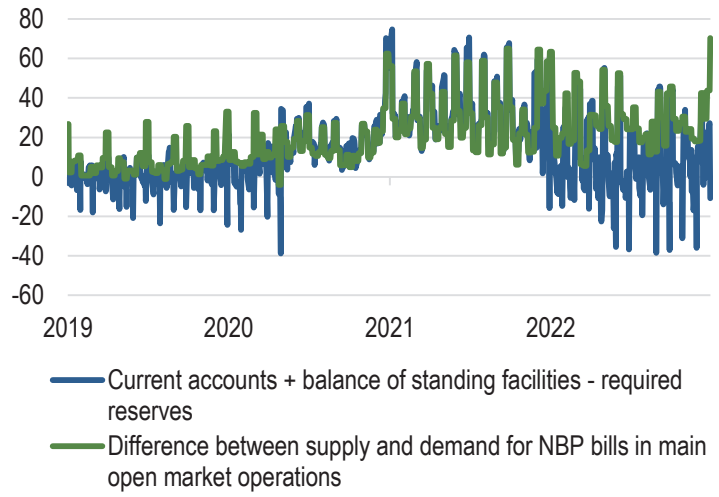
The qualitative conclusions formulated above are consistent with the results of the econometric models. First, the parameters of the model for the WIRON index were estimated. The following were used as explanatory variables: the NBP reference rate, the width of the interest rate corridor (between the NBP lombard rate and the NBP reference rate, as well as between the NBP reference rate and the NBP deposit rate)[34] and the reserve position of the banking sector, measured as the difference between the value of banks' current accounts, increased by the balance of standing facility operations (deposit and credit operations) and the level of required reserve.[35] Due to the endogeneity of the latter indicator[36], the difference between supply and demand for NBP bills on the basis of open market operations was used as an instrumental variable for it (Figure 15). For comparative purposes, parameters of an analogous model were estimated for the POLONIA rate.

[34] It should be noted that the width of the interest rate corridor is not a factor affecting the WIRON index and the POLONIA rate independently (despite the fact that, for the purposes of simplification, it was included in the econometric model in this way). It impacts in interaction with the reserve position of the banking sector. A narrower corridor mitigates the consequences of any reserve surpluses (although not without potential side effects; see Bindseil and Jabłecki, 2011). The interest rate on deposits of financial institutions other than banks and non-financial institutions may affect this to a lesser extent since they do not have access to NBP's overnight deposit facility.

[35] This was a model in levels of variables whose parameters were estimated on daily data (as mentioned, in the sample from the beginning of 2019 to the end of 2022). Explanatory variables used other than those listed are dummy variables for the week of the reserve maintenance period, the variable specifying the number of the week in the reserve maintenance period and the dummy variable for the last day of the month.

[36] A lower overnight rate may lead to the performance of a fine-tuning open market operation, which would be associated with a fall in the reserve position; this endogeneity is confirmed by statistical tests.

Figure 15. Reserve position of the banking sector and difference in supply and demand of NBP bills in main open market operations (PLN billion)



Notes: daily data.

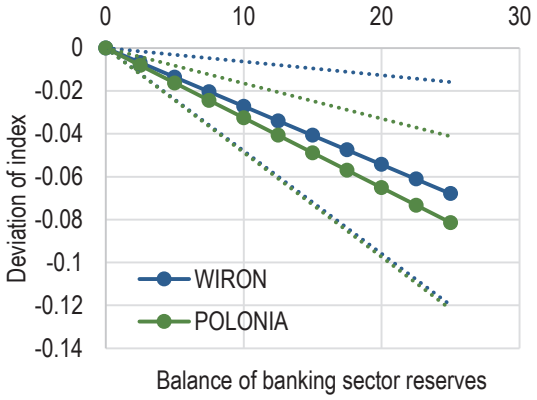
Source: NBP data.

Both in the model explaining the WIRON index and the model for the POLONIA rate, the estimate of the parameter responsible for the long-term relationship between a given rate and the NBP reference rate was close to unity, implying full transmission; by full transmission we mean one-to-one impact. In the case of both rates, on average, the wider the corridor between the lombard rate and the reference rate, the higher the rates, and the greater the difference between the reference rate and the deposit rate, the lower the rates. In both cases, the reserve position of the banking sector is also important.

It is also worth drawing attention to two differences. Firstly, in terms of point estimates, the WIRON index is slightly less sensitive to the reserve position of the banking sector (Figure 16). However, the confidence intervals of the estimates overlap to a significant extent. Secondly, in the case of the WIRON index, a significant effect of the last day of the month has been identified, when the rate is on average 0.23 p.p. lower. No such effect has been found for the POLONIA rate. The "last day of the month" effect is most likely a consequence of the bank tax, which lowers the willingness of the taxpayers to accept deposits with a term covering that day. It may be reflected in the interest rate and/or the value of the transaction. The absence of the "last day of the month" effect for the POLONIA rate may be because the adjustment takes place to a greater extent through a lower value of transactions (see Kapuściński, 2022).

Both WIRON and POLONIA seem to be subject to a cycle corresponding to the required reserve maintenance periods. This is partly deterministic, being reflected in the statistical significance of certain dummy variables taking 1 for each week of the of the required reserve maintenance period.

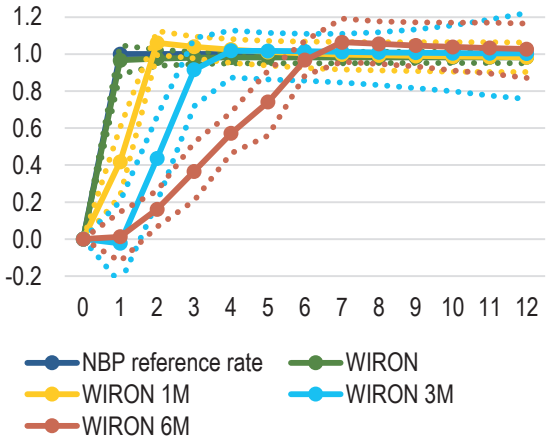
Figure 16. Relationship between the reserve position of the banking sector (PLN billion) and the WIRON and POLONIA rates (in p.p.)



Notes: The reserve position is measured as the sum of current accounts and the balance of standing facility operations minus the level of the required reserve.

Source: NBP and GPW Benchmark data. Own calculations.

Figure 17. Impact of increasing the NBP reference rate by 1 p.p. on the WIRON index



Notes: The solid line represents the response of the variable following an increase in the NBP reference rate by 1 p.p., and the dotted line represents the endpoint of the 95% confidence interval of the response, computed by the Monte Carlo method. The months are marked on the horizontal axis (the increase in the NBP reference rate takes place in period 1).

Source: NBP and GPW Benchmark data. Own calculations.

The parameters of the models were also estimated based on monthly data for WIRON term rates as well as for the overnight rate.[37] Their results indicate that a 1 p.p. increase in the NBP reference rate entails an immediate and proportional increase in the WIRON index (Figure 17). WIRON term indexes adjust fully, but with a lag, which length depends on the predefined term of the index. A long-run relationship was also identified between WIRON term rates and factors affecting the overnight rate, such as the width of the interest rate corridor or the reserve position of the banking sector, albeit with varying degrees of statistical significance. The significance of the latter variable seems to differentiate WIRON term rates from their corresponding WIBOR rates, which – in line with earlier studies – do not seem to be systematically related to the reserve position of the banking sector (see Sznajderska, 2016 as well as Kapuściński and Pietryka, 2019).

Figure 18 compares the adjustment of the WIRON 3M rate to the NBP reference rate (shown in the previous figure) with the adjustment of the WIBOR 3M rate (both based on estimates of parameters of econometric models). The results for the WIBOR 3M rate come from the model[38], whose parameters are estimated on a longer sample (since 2001). The model allows for different immediate

[37] These were error correction models whose parameters were estimated using instrumental variables methods (due to the above-mentioned endogeneity of the reserve position of the banking sector) on the sample from 2019 to the end of 2022 (in accordance with the availability of data during the preparation of the material).

[38] These were monthly error correction models where the parameters of the long-run relationships were estimated using FMOLS methods (fully-modified ordinary least squares), and the parameters of the short-run relationships were calculated using least squares method or instrumental variables methods (depending on the variant). As an additional explanatory variable (i.e., other than the one mentioned in the main text) we used the median of the probability of insolvency of commercial banks which were participants of the WIBOR panel (except for Bank Gospodarstwa Krajowego).

adjustment to expected and unexpected changes in the NBP reference rate. The adjustment of the WIBOR 3M to unexpected changes in the NBP reference rate proved to be stronger since the expected changes in the NBP reference rate are at least partly taken into account in the WIBOR term rates in advance.[39] In the case of the response of WIRON term rates, the distinction between the pass-through of expected and unexpected changes is less significant; there does not seem to be a difference here. Figure 18 shows that the full pass-through of an unexpected change in the reference rate to the WIRON 3M rate takes place three months later than in the case of the WIBOR 3M rate.

In the subsequent specifications of the model explaining the development of the WIBOR 3M rate, which take into account the advance transmission of the expected change in the reference rate, it was shown that the expectations about the change in the reference rate in the period of two and three months implied from the FRA (forward rate agreement[40]) rate have a statistically significant impact on the WIBOR 3M rate. The quality of point estimates of parameters explaining the scale of the preceding pass-through is, however, relatively low, due to *(i)* estimation of model parameters using the method of instrumental variables, combined with low quality of instrumental variables[41] and *(ii)* the occurrence of a correlation between the explanatory variables.

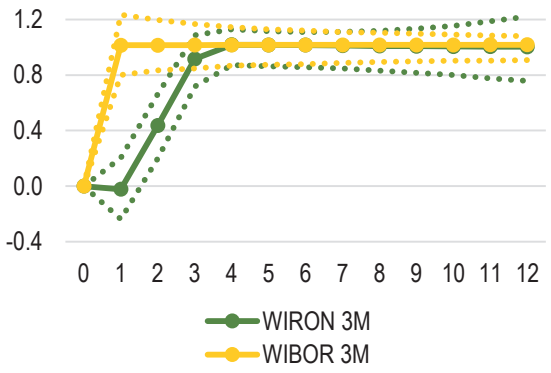
In view of the above-mentioned difficulties, theoretical transmission (i.e., based not on an econometric model, but on the expectations theory) was determined of the expected – at least for three months – change in the reference rate to the WIBOR 3M rate. In line with the theory of expectations, the 3-month rate should be the average of the expected overnight rate in the subsequent three months. For comparison, Figure 19 also presents the transmission of unexpected changes and transmission to WIRON 3M (regardless of whether the change is expected or not). The transmission of the expected change in the reference rate to WIBOR 3M begins in advance; however, it proceeds gradually. The difference in the period of full transmission (i.e., three months) thus remains unchanged. However, the difference between the moment in which the change in the reference rate begins to be taken into account in the WIBOR 3M rate and the beginning of it being taken into account in the WIRON 3M rate increases.

[39] Direct consideration of these expectations in the model is non-trivial, hence they were omitted from the base specification. In the later part of the material, the results of other variants of the model are also described.

[40] Forward rate agreement (FRA) is a contract in which a difference between the rate of contract and, in this case, WIBOR rate is settled on agreed-upon date. Thus, FRA rate reflects expectations about WIBOR.

[41] The necessity to use the method of instrumental variables resulted from the occurrence of endogeneity, consisting in two-way arbitrage between the WIBOR and FRA rates. Macroeconomic surprises, i.e., GDP, inflation, and industrial output, were used as instruments for measuring expectations regarding changes in the reference rate.

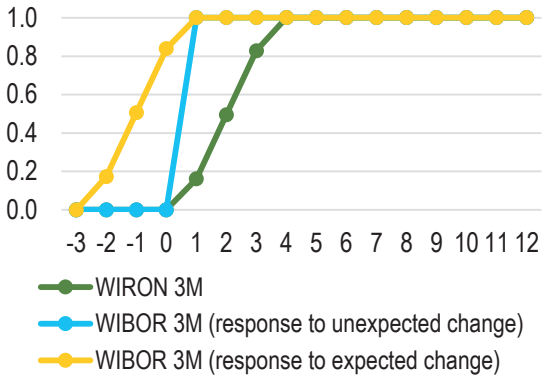
Figure 18. Impact of an unexpected increase in the NBP reference rate by 1 p.p. on the WIRON 3M and WIBOR 3M rates



Notes: The solid line represents the response of the variable following a 1 p.p. increase in the NBP reference rate, and the dotted line represents the endpoint of the 95% confidence interval of the reaction, computed by the Monte Carlo method. The months are marked on the horizontal axis (the increase in the NBP reference rate takes place in period 1).

Source: NBP and GPW Benchmark data. Own calculations.

Figure 19. Theoretical impact of an increase in the reference rate by 1 p.p. on the WIRON 3M and an unexpected or expected increase in the reference rate by 1 p.p. on the WIBOR 3M rate



Notes: The line represents the response of the variable following a 1 p.p. increase in the NBP reference rate in period 1. The months are marked on the horizontal axis.

Source: NBP and GPW Benchmark data. Own calculations.

The example above shows that any changes in the monetary policy transmission mechanism after the transition from WIBOR term rates to WIRON rates will vary depending on whether individual changes in the reference rate are expected or not. In the case of expected changes in the reference rate, we can expect a greater lag in the transmission mechanism, assuming limited anticipation of economic agents other than financial market participants. Any lags in the transmission mechanism could be offset by increasing the forward-looking nature of monetary policy. However, if agents are characterised by relatively high forward-lookingness, they make decisions on the basis of the reference rate expected in the future, regardless of current interest payments, changes in the monetary policy transmission mechanism should be limited. The term of the WIRON rates used in financial agreements will also be of importance. The shorter the term, the smaller any lag in the transmission mechanism will be. It is also worth paying attention to the previously mentioned occurrence of additional factors impacting on the key market interest rates, such as the reserve position of the banking sector.

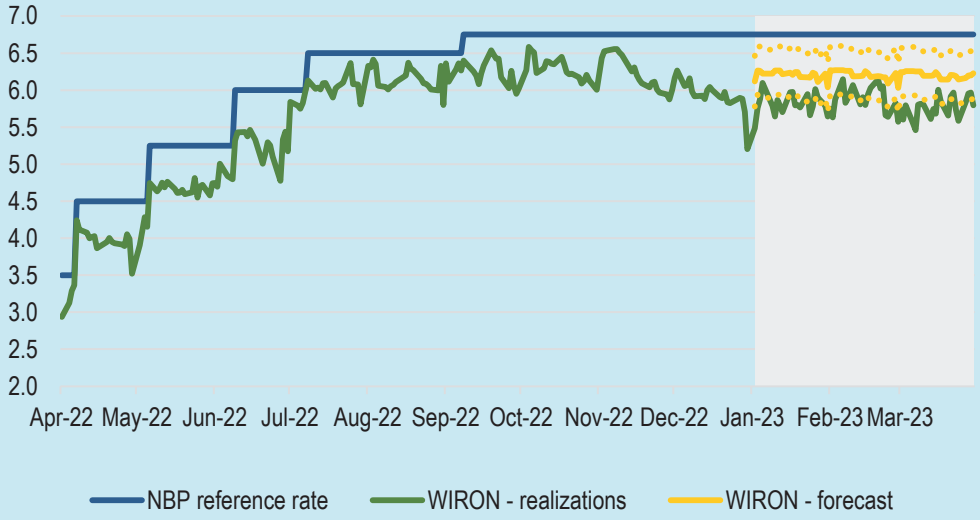
Box 2. Stability of transmission of the NBP reference rate to the WIRON index

The box presents the results of the assessment of the stability of the relationship between the WIRON index and the NBP reference rate and other variables (described in section 3.1.2.). The assessment uses observations from 2023 Q1, which became available only after the main part of this paper had been completed (and which therefore had not been taken into account).

The assessment of the stability of transmission of the NBP reference rate to the WIRON index was carried out in two ways.[42] Firstly, the path of the WIRON index in 2023 Q1 was compared with the forecasts for this index based on the econometric model, whose parameters were estimated on the sample for the years 2019-2022. Secondly, the parameters of the econometric model describing the relationship between the WIRON index and the NBP reference rate and other variables were estimated on a progressively longer sample from one ending in December 2022 to one also covering March 2023.

The results of the analysis show that in terms of point forecasts, the values of the WIRON index observed in 2023 Q1 deviated downwards from the long-term relationship identified by the econometric model, reflected in the forecast (Figure B2.1). In terms of interval forecasts, the data were at the lower bound of the 95% confidence interval.

Figure B2.1. WIRON index – data and forecast against the NBP reference rate



Notes: The dotted line represents the limits of the 95% confidence (analytically computed).
Source: NBP and GPW Benchmark data. Own calculations.

The parameter capturing the long-term relationship between the WIRON index and the NBP reference rate declined in point terms, while the results of the statistical test now suggest to reject the hypothesis that it is equal to unity (Figure B2.2). Therefore, after taking into account the next quarter of data, the transmission of the NBP reference rate to the WIRON index was no

[42] The standard way of achieving this aim (i.e., the assessment of stability) would be to test for the occurrence of structural change in the parameters of the econometric model. Due to the long-term stability of two explanatory variables – relating to the width of the interest rate corridor – the application of this approach in the case of the current analysis was not possible.

longer full. In addition, the parameter defining the sensitivity of the WIRON index to the reserve position of the banking sector declined in relation to the absolute value (Figure B2.3). It was also on the verge of statistical significance.

Figure B2.2. Evolution of the estimation of the parameter defining the impact of a 1 p.p. increase in the reference rate on the WIRON index

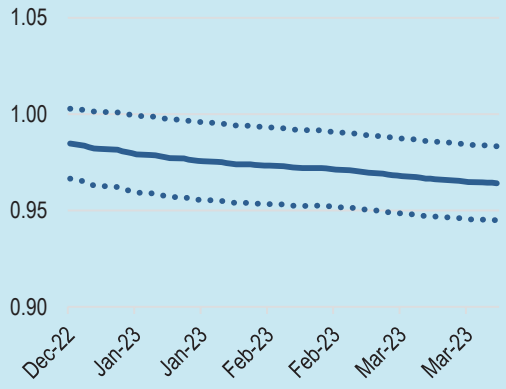
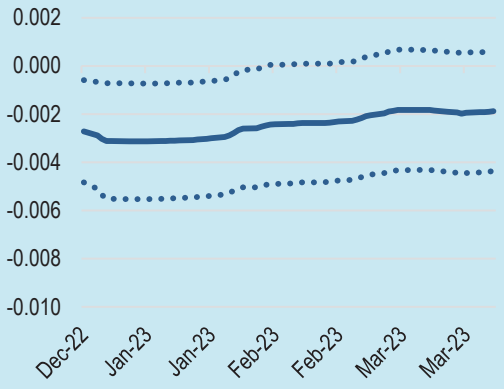


Figure B2.3. Evolution of the estimation of the parameter defining the impact of an increase in the short-term liquidity position of the banking sector by PLN 1 billion on the WIRON index



Notes: The solid line represents the estimation of the parameter on a gradually expanded sample, while the dotted line represents the limits of the 95% confidence interval (analytically computed).

Source: NBP and GPW Benchmark data. Own calculations.

Currently it is not possible to establish whether the observed deviation of the WIRON index from the long-term equilibrium with the NBP reference rate is temporary or whether the described changes will be permanent. Similarly, only after a greater number of observations have been received will it be possible to assess whether consequences of a systematic impact of a factor not included in the model are observed, or whether the deviations are random. The former would mean their partial predictability, while the latter would mean its absence. One of the possible explanations of the observed phenomenon is the so-called Goodhart law, according to which the statistical relationships that a given variable is subject to may break down when it becomes the subject of control (Goodhart, 1976).

Regardless of the causes, the above results indicate that after the transition from the WIBOR rates to the WIRON rates, the monetary policy transmission mechanism in Poland may become more complex.

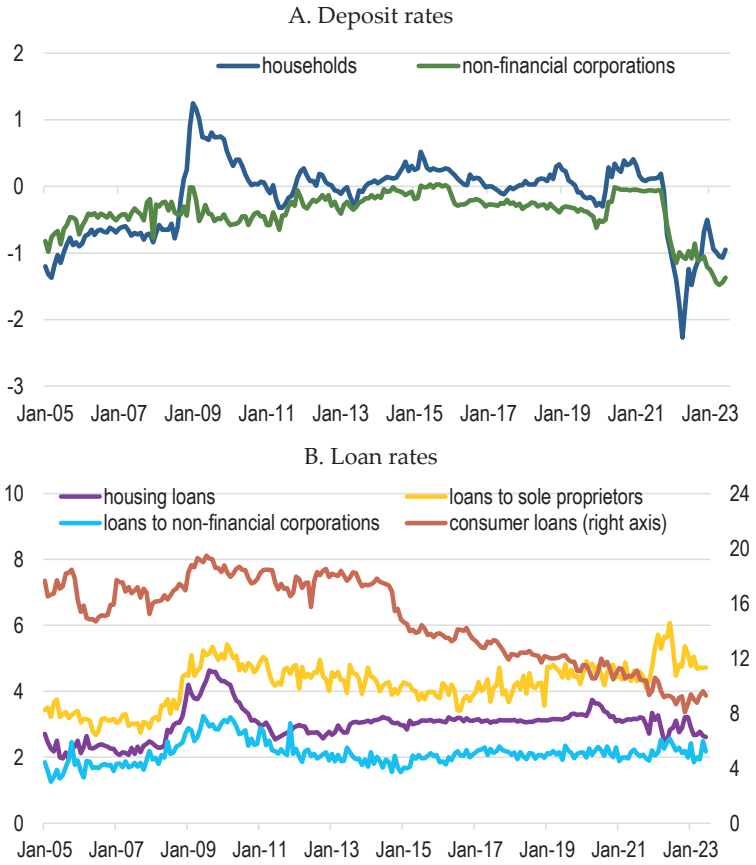
3.1.3. Transmission to retail deposit and lending rates

Changes in the NBP reference rate indirectly – via the money market rates – affect the interest rate on zloty loans to and deposits of the non-financial sector at commercial banks. The analysis presented in this section concerns the interest rates on new and renegotiated deposits and loans of the non-financial sector. In turn, Box 3 is devoted to the interest rate response of existing variable-rate loan agreements (which are an important part of the cash flow channel) to monetary policy decisions.

In 2021 Q4, spreads between the interest rate on non-financial sector deposits and the NBP reference rate became strongly negative (Figure 20). The historically large difference between the rates was partly due to the fact that retail deposit rates adjust to market rates gradually and less than proportionally (Table 3), which, amid a strong and rapid tightening of monetary policy, was reflected in a temporary widening of spreads. At the end of 2022, spreads between the NBP reference rate and the interest rates on household deposits narrowed significantly. In the case of the interest rate on loans for the non-financial sector, spreads were more stable. The largest changes were observed in the case of spreads of the interest rate on loans to sole proprietors[43], which since mid-2021 have increased (probably under the impact of fears of increased risk of these loans due to the expected economic downturn), and spreads for consumer loans, which declined.

[43] Sole proprietors are persons conducting business activity on their own account, employing up to nine people in total. In monetary statistics, this category is included in the household sector. The share of the volume of new loans for sole proprietors in new loans for the non-financial sector is relatively small. In the years 2015-2022 the average share of the volume of newly granted loans denominated in zloty for non-financial enterprises was equal to 47% of the volume of new loans for the non-financial sector, the share of consumer loans (excluding loans on current account) amounted to 25%, the share of housing loans was 19%, and the share of other loans for households (including loans to sole proprietors) was 9%.

Figure 20. Spreads between the interest rate on deposits and loans for the non-financial sector and the NBP reference rate (in p.p.)



Notes: The interest rate on housing loans and consumer loans is measured as the effective rate, capturing the total cost of credit to the consumer expressed as an annual percentage of the total amount of credit.

Source: NBP data. Own calculations.

Drawing conclusions about the effectiveness of the interest rate transmission to the retail rates only on the basis of spreads could be misleading. An analysis of spreads would correctly illustrate the effectiveness of interest rate transmission only under the assumption of immediate and complete pass-through, whereas the retail rates adjust to changes in the NBP reference rate with a lag and not always one-to-one. In addition, the scale and speed of monetary policy tightening in the cycle which started in October 2021 were several times larger than in the previous period, for which data on interest rates on loans and deposits from the non-financial sector are available. For these reasons quantitative analysis gives more reliable assessment of the effectiveness of interest rate transmission. In modelling of the interest rate transmission, the central bank interest rate usually is approximated with the interbank overnight rate, which is under the control of the central bank, or the money market rate of longer maturity, potentially better reflecting banks' cost of financing (see Andries and Billon, 2016). The WIBOR 3M rate, which fully adjusts to the NBP reference rate, was used for the analysis presented in this section.

Table 3 and Table 4 describe the process of the transmission of changes in the WIBOR 3M rate to changes in the interest rate of new and renegotiated household and corporate deposits and loans. Estimations were performed using observations from January 2005 to December 2022, under the assumption of a symmetrical response to increases and decreases in the WIBOR 3M rate.[44]

According to the results, changes in the WIBOR 3M rate are transmitted to household deposit rates in the long term in 89% (Table 3). Formal tests show that this adjustment is less than full (i.e., the long-term pass-through coefficient is statistically significantly different from unity). Looking at individual categories of household deposits, the interest rate on short-term deposits (up to 1 month) responds the least to changes in the money market rate, while the interest rate on deposits with an agreed maturity from over 1 month up to 3 months and from over 3 months up to 6 months respond the most (fully).

The adjustment of the interest rate on corporate deposits to changes in the WIBOR 3M rate is not complete and is somewhat weaker than in the case of household deposits (Table 3). For total corporate deposits and deposits with agreed maturity up to 1 month, the long-term pass-through coefficient is 0.83 and 0.80, respectively (transmission of changes in the market rate is not full). On the other hand, the long-term pass-through coefficient for interest rates on corporate deposits with an initial agreed maturity of over 1 month up to 3 months is not statistically significantly different from unity. The interest rate on corporate deposits in the initial months after the money market rate change adjusts faster than in the case of household deposits.

Table 3. Estimation of the speed and strength of transmission from the WIBOR 3M rate to the interest rate on deposits of the non-financial sector with various original maturities

Response of interest rate	Household deposits					Corporate deposits		
	total	Up to1 month	1-3 months	3-6 months	6-12 months	total	Up to 1 months	1-3 months
in 1st month	0.20	0.16	0.19	0.22	0.31	0.54	0.48	0.66
in 3rd month	0.58	0.48	0.54	0.63	0.64	0.83	0.80	0.80
in 6th month	0.79	0.68	0.82	0.90	0.83	0.83	0.80	0.90
in long term	**0.89** [0.83-0.95]	**0.84** [0.77-0.90]	**0.99** [0.90-1.08]	**0.99** [0.92-1.07]	**0.91** [0.84-0.99]	**0.83** [0.75-0.91]	**0.80** [0.71-0.88]	**0.99** [0.93-1.04]
Is pass-through full?	**no**	**no**	**yes**	**yes**	**no**	**no**	**no**	**yes**

Notes: The 95% confidence interval of the long-term response estimate is given in square brackets.

Source: NBP data. Own calculations.

[44] The relationship between the retail interest rate and WIBOR 3M was modelled using ARDL models (Pesaran and Shin, 1999; Pesaran *et. al.*, 2001), estimated on monthly data. This approach enables testing for a long-term relationship between variables, estimation of the long-term pass-through coefficient and the course of the short-term adjustment. In some cases, the models included as regressors additional variables (apart from WIBOR 3M rate). In models explaining deposit rates, these were dummy variables related to the global financial crisis and the bank tax, while in models explaining lending rates –the spread between the OIS rate and WIBOR 3M, the share of impaired loans, as well as the dummy variable related to the bank tax and the introduction of new regulations in the field of consumer loans.

In the long term, changes in market rates are fully transmitted to the interest rate on household and corporate loans (Table 4). An analysis of various types of household loans shows that the interest rate on loans to sole proprietors fully adjusts, while the interest rate on new housing loans adjusts in 84%. In the case of new consumer loans, the hypothesis of full adjustment cannot be rejected; however, the precision of this estimate is quite low (confidence interval is wide). Among household loans, the adjustment of interest rates on loans for sole proprietors is the fastest, and the adjustment of consumer loans – the slowest. At the same time, the response to the interest rate on total household loans is slower than in the case of corporate loans. However, for corporate loans, the pass-through to interest rates on small (up to PLN 1 million), medium (from PLN 1 to 4 million) and large (above PLN 4 million) corporate loans differs: in the long term, small loans adjust fully to the changes in the WIBOR 3M, while larger loans adjust to a lesser degree.

Table 4. Estimation of the speed and strength of the pass-through of the WIBOR 3M rate to the interest rate on loans of the non-financial sector

Response of interest rate	Household loans				Corporate loans			
	total	consumer	housing	for sole proprietors	total	small*	me-dium*	large*
in 1st month	0.34	0.12	0.37	0.66	0.92	0.82	0.56	0.86
in 3rd month	0.66	0.33	0.92	1.22	0.90	0.93	0.89	0.85
in 6th month	0.92	0.58	0.89	1.06	0.95	0.98	0.95	0.91
in long term	**1.12** [0.94-1.12]	**1.46** [0.82-2.11]	**0.84** [0.79-0.90]	**0.99** [0.91-1.07]	**0.98** [0.94-1.01]	**1.00** [0.97-1.02]	**0.96** [0.92-1.0]	**0.94** [0.89-0.99]
Is pass-through full?	**yes**	**yes**	**no**	**yes**	**yes**	**yes**	**no**	**no**

Notes: The 95% confidence interval of the long-term pass-through is given in square brackets. * Small corporate loans are loans of a value up to PLN 1 million, medium loans from over PLN 1 million to 4 million, large loans above PLN 4 million. Data on the interest rate on small and medium corporate loans are available from June 2010.

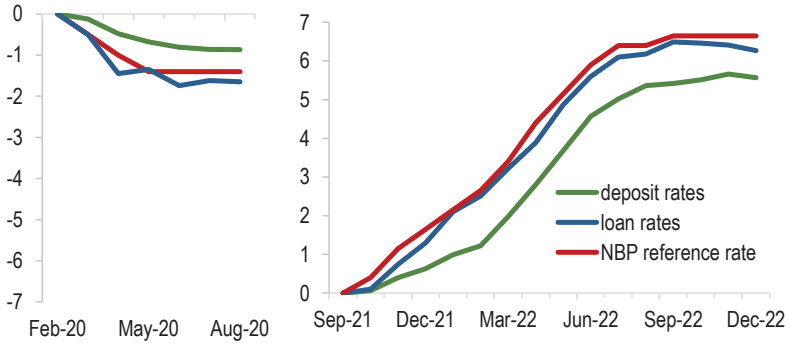
Source: NBP data. Own calculations.

In the current and previous monetary policy cycle (i.e., since 2020) the interest rate on deposits followed the changes in the NBP reference rate with a certain lag – which was also indicated by the widening of the spreads – unlike the interest rate on loans for the non-financial sector (Figure 21). The comparison of model estimates of the speed and strength of transmission of interest rates on a sample ending in December 2019 and in December 2022 confirms the slowdown in transmission of the money market rate to the interest rate on deposits, particularly household deposits (Figure 22). However, the pass-through of changes in the money market rate to the interest rate on loans was not subject to substantial changes, neither in the case of household loans, nor corporate loans.[45] The possibility for banks to adjust the interest rate on deposits in 2020 was limited by the very low, close to zero, level of the NBP reference rate in this period, which restricted the ability of banks to reduce the interest rate on deposits. On the other hand, during the period of the NBP reference rate hikes, the weaker response of the interest rate on deposits may be due to the high liquidity in the

[45] See https://www.obserwatorfinansowy.pl/bez-kategorii/rotator/dostosowania-stop-kredytowych-i-depozytowych-wbiezacym--cyklu-polityki-pienieznej.

banking sector, resulting from, among others, the reduction of the required reserve ratio[46], charging banks with the costs of supporting borrowers, or the heightened uncertainty about the level of the NBP reference rate in the future.

Figure 21. Cumulative changes in retail deposit and loan rates in the monetary policy cycles since 2020 (in p.p.)

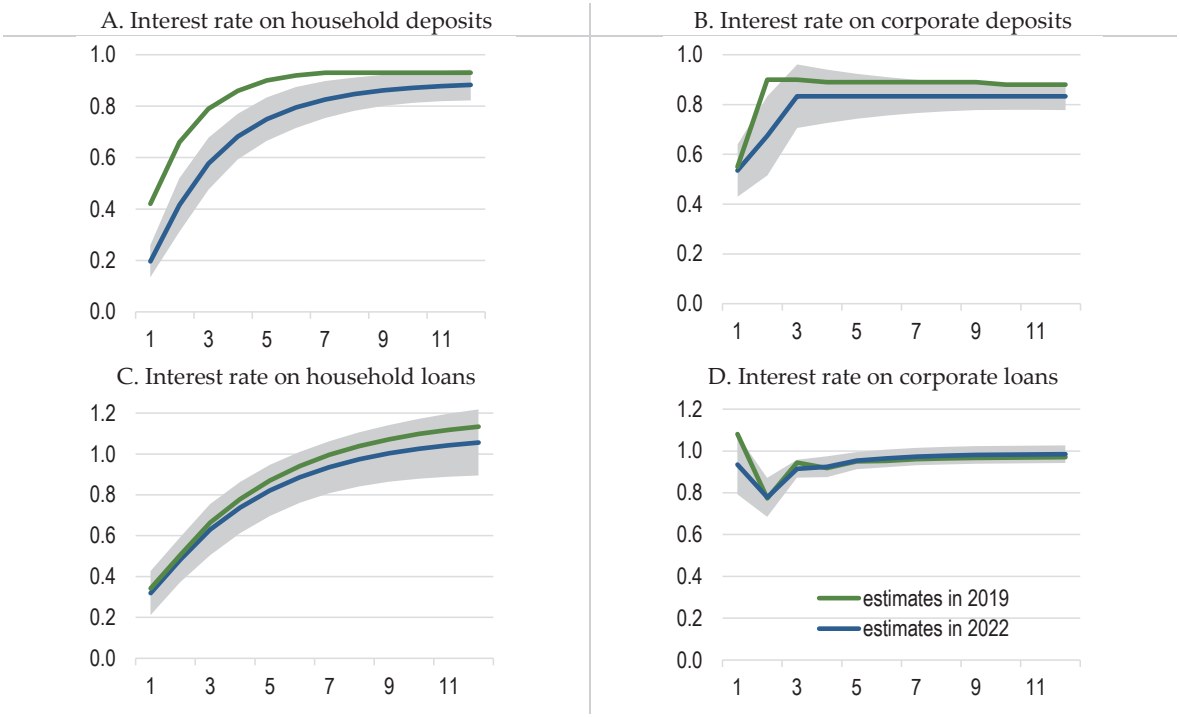


Notes: The chart presents the cumulative changes in the interest rate on loans and deposits of non-financial sector against cumulative changes in the NBP reference rate in the period February-August 2020 and September 2021-December 2022.

Source: NBP data. Own calculations.

[46] In October 2021 the required reserve ratio was raised from 0.5% to 2% but was still lower than before the COVID-19 pandemic. The required reserve ratio returned to the pre-March 2020 level (i.e., 3.5%) in February 2022.

Figure 22. Response of the retail interest rates to changes in the WIBOR 3M rate – comparison of estimates



Notes: The chart presents the cumulative changes in the retail interest rates following an increase in the WIBOR 3M rate by 1 p.p. The blue line shows the adjustment path estimated on the basis of data up to December 2022, and the green line – to December 2019. The grey area marks the 95% confidence interval.

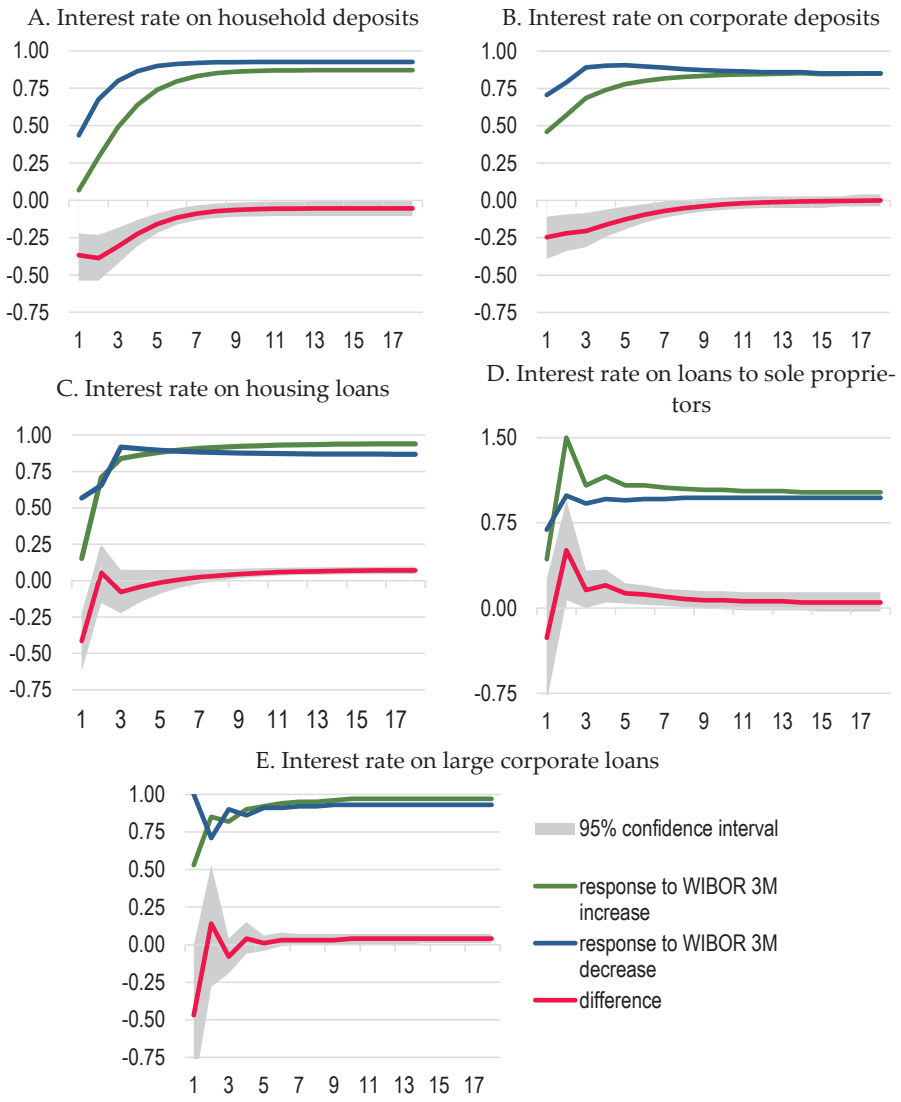
Source: NBP data. Own calculations.

The pass-through to interest rate on certain categories of deposits and loans proceeds differently in the case of decreases and increases of the money market rate (Figure 23).[47] The interest rate on total household and corporate deposits adjust faster to decreases in the money market interest rate than to its increases; however, in the long term the strength of the pass-through is the same, regardless of the direction of the change in the WIBOR 3M rate. On the other hand, the response of the interest rate on housing loans[48] is stronger in the long term in the case of increases in the money market rate than its decreases. The pass-through of increases in the money market rate to the interest rate on loans to sole proprietors is faster than in the case of decreases, but in the long term the difference in the adjustment is statistically insignificant. Among corporate loans, only the interest rate on large loans responds asymmetrically to the money market rate (again, in the long term, it is slightly stronger in the case of increases in the WIBOR 3M rate).

[47] The asymmetry of interest rate adjustments was assessed with ARDL models analogous to those described above, with the difference that they allowed for a different response of the interest rate to increases and decreases in the money market rate (see Shin, Yu and Greenwood-Nimmo, 2014).

[48] The estimate of the immediate response of the interest rate on housing loans to a change in the WIBOR rate varies in the case of increases and decreases of this index, but the formal asymmetry test, considering the full short-term dynamics in the model, indicates an absence of short-term asymmetry.

Figure 23. Adjustment of retail interest rates to increases and decreases in the WIBOR 3M rate



Notes: The chart shows the cumulative change in retail interest rates after an increase (green line) and a decrease (blue line) in the WIBOR 3M rate by 1 p.p. The red line represents the difference between response to an increase and the response to a decrease, and the grey area represents the 95% confidence interval of that difference.

Source: NBP data. Own calculations.

Box 3. The impact of an increase in the central bank policy rates in the years 2021-2022 on the average interest rate on outstanding housing loans in Poland against selected countries of Central and Eastern Europe

Following the earlier global monetary policy easing in 2020 in response to the outbreak of the COVID-19 pandemic, central banks in Central and Eastern Europe – amid rising inflation and a rebound in economic activity around the world, including in the domestic economies – were the first to start raising interest rates in 2021. In the following quarters they tightened their

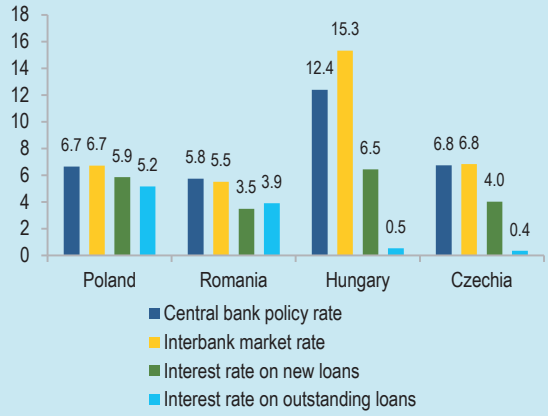
monetary policy significantly. During the analysed period, i.e., from May 2021 to February 2023,[49] the main central bank policy rate in Poland (the NBP reference rate) rose by a total of 6.65 p.p. (to 6.75%), in the Czech Republic (the 2W repo rate) by 6.75 p.p. (to 7.00%), in Hungary (the base rate) by 12.4 p.p. (to 13.00%), and in Romania (the policy rate) by 5.75 p.p. (to 7.00%). In Poland, the Czech Republic, and Romania the increases in the above-mentioned interest rates were accompanied by a rise in interbank market rates of a similar scale, while in Hungary the interbank market rate rose more strongly than the central bank's base rate due to the specificity of the monetary policy implementation system in Hungary. At the same time, in all the analysed economies interest rates on pure new loans to households for house purchase increased, most notably in Hungary and Poland.[50]

The pass-through of interbank market rates to the interest rate on outstanding amounts loans to households for house purchase in the domestic currency varied considerably across individual countries (Figure B3.1). An important structural factor influencing the heterogeneity was the market-specific share of loans with a floating interest rate compared to loans with a periodically fixed interest rate (Figure B3.2). In Poland, until 2020 almost all new housing loans were subject to variable interest rates; however, in 2022 the share of new loans with a periodically fixed interest rate increased. In Romania, the majority of loans were based on floating interest rates, although the share of new loans with a periodically fixed interest rate in previous years was, on average, significantly higher than in Poland. On the other hand, in Hungary the share of new loans with a periodically fixed interest rate has been very high since late 2018, while earlier on average over half of new housing loans were subject to floating interest rates. In the Czech Republic the majority of outstanding housing loans have periodically fixed interest rates.

[49] The beginning of the analysed period, i.e., May 2021, is the month directly preceding the first hikes of the central bank policy rates in Central and Eastern Europe in 2021 (which took place in June 2021), while the end of the period of analysis, i.e., February 2023, is due to the availability of data.

[50] In February 2023, the level of the interest rate on new housing loans in Poland (8.8%) was higher than in the Czech Republic (6.2%) and Romania (7.8%), but lower than in Hungary (10.5%).

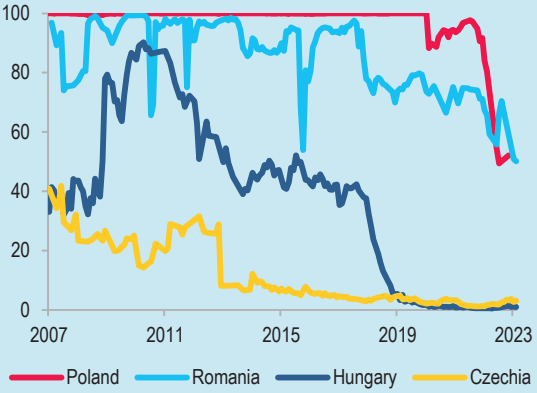
Figure B3.1. Changes in interest rate on housing loans in domestic currency, the central bank policy rate, and the interbank market rate since May 2021 to February 2023 (in p.p.)



Notes: Central bank policy rate for Poland – the NBP reference rate, for Romania – the Policy rate, for Hungary – the base rate, for the Czech Republic – the 2W repo rate. Interbank market rate for Poland – WIBOR 3M, for Romania – ROBOR 3M, for Hungary – BUBOR 3M, for the Czech Republic – PRIBOR 3M.

Source: Bloomberg, ECB and CNB data. Own calculations.

Figure B3.2. Share of new housing loans with a floating interest rate (or an interest rate fixed for a period of no longer than 1 year; in per cent)



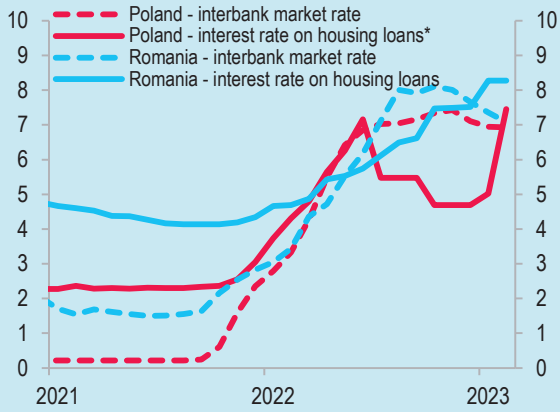
Notes: Data on new housing loans in domestic currency and euro.

Source: ECB data. Own calculations.

In Poland, due to the dominant share of housing loans subject to floating interest rates, increases in the interbank market rates were accompanied by stronger and faster increases in the interest rate on outstanding loans than in the other analysed countries (from 2.3% in May 2021 to 7.9% in July 2022), although – as a result of the introduction in Poland of the so-called loan repayment holidays[51] – the reported interest rates decreased in the second half of 2022 (they stood at 4.7% on average in 2022 Q4), while in February 2023 they stood at 7.5% (Figure B2.3).[52] In Romania, the increase in interest rates on housing loans was more spread over time than in Poland, yet the total scale of the increase between May 2021 and February 2023 was also much larger than in the Czech Republic and Hungary (despite a somewhat smaller scale of increases in the central bank policy rates than in the remaining analysed economies). This was due to a relatively high share of loans with floating interest rates in the absence of unconditional administrative measures that would lead to a significant and widespread reduction in the impact of interest rate increases on interest charged on housing loans.[53] However, due to the low share of loans subject to a floating interest rate in the Czech Republic and Hungary, the interest rate on outstanding loans rose only slightly, while in Hungary the administrative freezing of interest rates of the majority of housing loans (at the level of 27 October 2021; Figure B2.3) had a limiting impact.[54]

Figure B3.3. Interest rate on housing loans in domestic currency against the interbank market rate (per cent; monthly average)

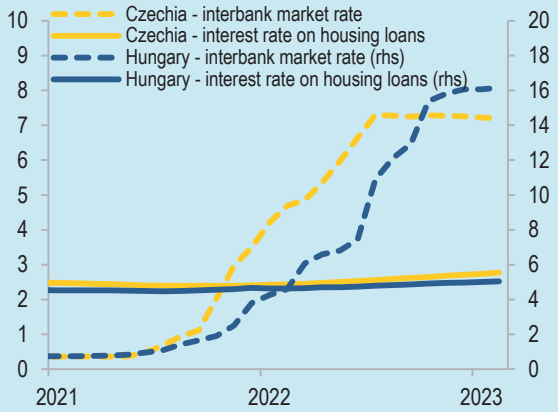
A. Poland and Romania



Notes: Interbank market rate for Poland – WIBOR 3M, for Romania – ROBOR 3M. * For Poland the interest rate on housing loans in domestic currency in the period July-December 2022 is presented as a quarterly average in 2022 Q3 and Q4 due to the specificity of the schedule of the loan repayment holidays.

Source: Bloomberg and ECB data. Own calculations.

B. Czech Republic and Hungary



Notes: Interbank market rate for Hungary – BUBOR 3M, for the Czech Republic – PRIBOR 3M.

Source: Bloomberg, ECB and CNB data. Own calculations.

The heterogenous scale and pace of changes in interest rates on loans – along with the diversified size of housing loans in relation to GDP (Figure R3.4) – was reflected in marked differences in the scale of growth of debt servicing costs in the analysed segment. The growth in debt servicing costs was estimated on the basis of a comparison of aggregated instalments of housing loans in the domestic currency in the period from May 2021 to February 2023, based on the average reported interest rate for these loans[55], with the amount of instalments in the scenario of no change in interest rate. The following were assumed: a constant stock of housing loans in

[51] In Poland, regulations came into force on 29 July 2022, under which holders of a housing loan in PLN, taken out before 1 July 2022 in order to meet their own housing needs, could suspend the repayment of instalments free of charge for a maximum of 8 months (August and September 2022, 2 selected months in the fourth quarter of 2022 and 1 selected month in each quarter of 2023). The loan repayment period was extended by the number of months with suspended instalment payments.

[52] In the interest rate statistics, the interest on balances is calculated as the quotient of the interest accrued in the reporting month and the average balances of the agreement for which interest was accrued, which allows for the *ex-post* measurement of total, actual interest income and interest charges (see *Manual for users of interest rate statistics*. NBP, 2021). The specificity of the construction of loan repayment holidays in Poland is reflected in the significant monthly volatility of the reduced interest rate (e.g., in 2022 Q4, instalment payments could be suspended for two selected months, and in 2023 Q1 for one selected month).

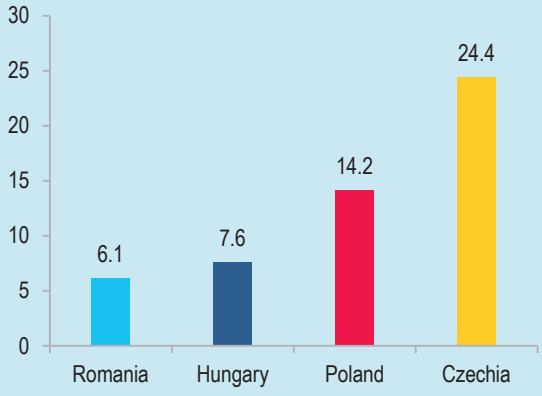
[53] From 1 July 2022, regulations were introduced in Romania under which households whose financial situation has significantly deteriorated could apply for suspension of loan instalments for a period of 9 months. During the period of suspension of payments, in the case of some housing loans, interest was to be charged for later repayment. In the opinion of the International Monetary Fund, the impact of these measures on the economy and the financial sector was limited by the relatively restrictive eligibility criteria and the short period for accepting applications (IMF, 2022).

[54] In addition, for a significant part of the analysis period, a credit moratorium was available to a wide group of borrowers in Hungary.

[55] The analysis used information on interest rates on loans from the ECB's MFI Interest Rate Statistics and CNB, as well as data on the outstanding amounts of housing loans published by national central banks.

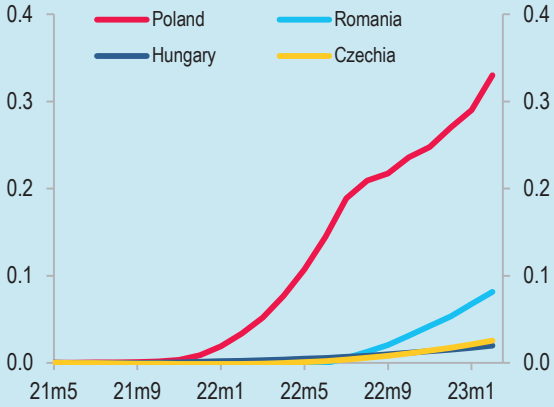
the domestic currency at the May 2021 level, an average remaining loan repayment period of 20 years[56] and repayment of loans according to so-called equal instalments.[57] The thus estimated cumulative increase in the amount of aggregated housing loan instalments in domestic currency estimated in the period from May 2021 to February 2023 can be approximated as 0.33% of GDP in Poland, 0.08% of GDP in Romania, 0.03% of GDP in the Czech Republic and 0.02% of GDP in Hungary (Figure B3.5).[58] The negligible growth in instalments in the Czech Republic and Hungary reflected only a slight increase in interest rates on loans in the analysed period. On the other hand, the increase in total instalments in relation to GDP in Poland compared to Romania was more than three times higher in the analysed period, which was associated with a much faster increase in interest rates on loans (particularly up to July 2022), more than twice as high ratio of housing loans in the domestic currency to GDP and a slightly greater scale of increases in central bank policy rates in Poland than in Romania. The stronger impact of interest rate increases on the total instalments of housing loans in Poland than in the remaining countries of the region in the analysed period should contribute to a more effective transmission of interest rate increases in terms of reducing demand and, consequently, lowering inflation.

Figure B3.4. Ratio of housing loans in domestic currency in May 2021 to GDP (percentage of GDP for 2021)



Source: Eurostat, ECB, NBP, BNR, MNB and CNB data. Own calculations.

Figure B3.5. Approximate cumulative increase in the amount of aggregated instalments of housing loans in the domestic currency, estimated on the basis of changes in the reported interest rate on these loans (percentage of GDP)



Source: Eurostat, ECB, NBP, BNR, MNB and CNB data. Own calculations.

[56] This is consistent with the assumptions adopted by BIS when calculating debt service ratios following the methodology of Drehmann *et al.* (2015).

[57] Due to the unavailability of comparative data, the analysis did not take into account the uptake of the measures allowing to temporarily suspend the payment of capital instalments in some periods that were implemented in some of the analysed countries; neither overpayments/early repayments of loans were taken into account.

[58] Estimates are given as a percentage of GDP for 2021.

3.2. The credit channel in the monetary policy transmission mechanism

This section considers the role of the credit channel in the monetary policy transmission mechanism. Section 3.2.1 focuses on the bank lending channel, which is part of the credit channel. It covers the multilateral relationship between monetary policy, the strength of banks' balance sheets and credit. The empirical analysis uses bank-level panel data. Section 3.2.2 deals with the broadly understood credit channel, analysed on the basis of survey data on banks' lending policy. Data on PLN loans are used here, decomposed in terms of institutional sector and purpose.

3.2.1. Estimates of the significance of the bank lending channel in the monetary policy transmission mechanism

The bank lending channel has two stages. At the first stage, monetary policy affects the strength of banks' balance sheets. At the second stage the strength of banks' balance sheets affects lending. As a result, the impact of monetary policy on credit through other channels of the monetary policy transmission mechanism is strengthened (Disyatat, 2011).

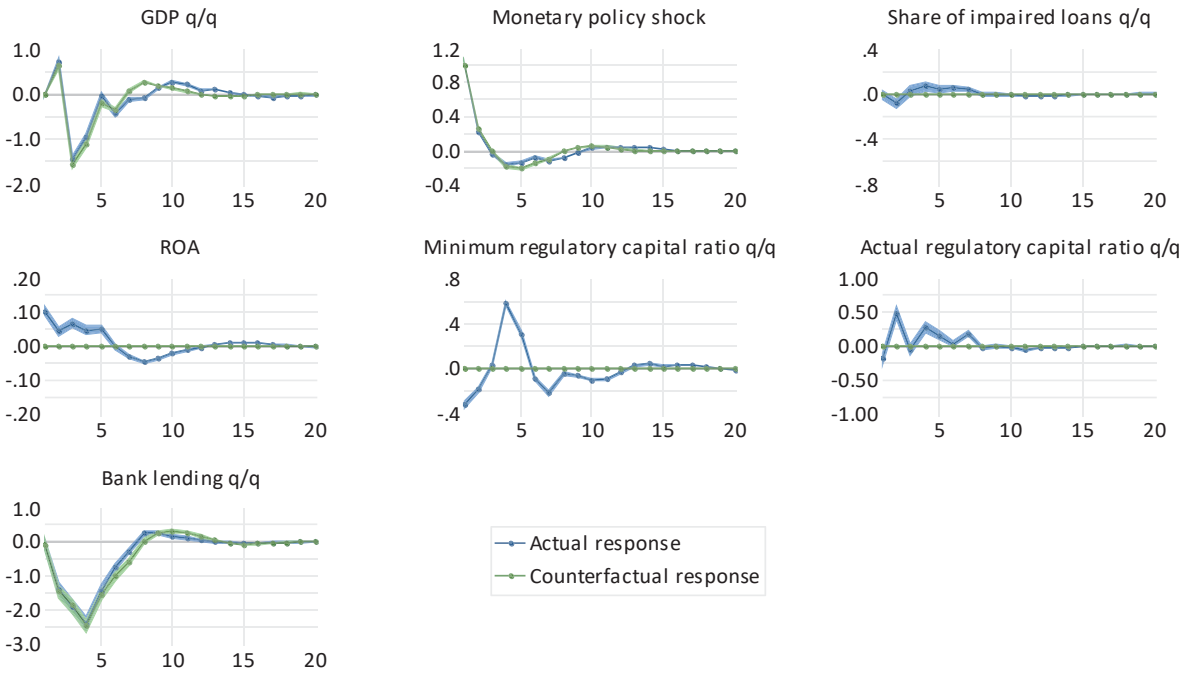
The importance of the analysed channel in the monetary policy transmission mechanism in Poland was assessed based on estimates of parameters of PVAR (Panel Vector Autoregression) econometric models.[59] These take into account GDP, monetary policy shock identified outside the models (in accordance with the method described by Swanson, 2021), the share of impaired loans, ROA (Return On Assets) of banks, the minimum required capital ratio, the actual capital ratio and the volume of loans. The assessment of the significance of the bank lending channel consisted in a comparison of the actual response of lending to a monetary policy shock and the counterfactual response, i.e., excluding the influence of monetary policy on the strength of banks' balance sheets.

The response of variables, including lending, to a monetary policy impulse[60] were obtained separately *(i)* from a model whose parameters were estimated on a sample of cooperative and commercial banks (Figure 24) *(ii)* based only on a sample of commercial banks (Figure 25). In this first case, the uncertainty of the estimates is probably underestimated – the confidence intervals are very narrow due to the very large number of observations.

[59] The described results are an update of earlier estimates of the significance of the bank lending channel in the monetary policy transmission mechanism (Kapuściński *et al.*, 2016; Kapuściński, 2017). The current study (Kapuściński, 2023b) included a longer sample (i.e., from the beginning of 2001 to the third quarter of 2022), a greater number of banks (i.e., 660 commercial and cooperative banks or 60 commercial banks) and a wider measure of lending (i.e., besides household loans and loans to the non-financial sector, also taking into account loans to local government units) and methodological solutions were adapted.

[60] The monetary policy shock was normalised so that it corresponded to a 1 p.p. increase in the WIBOR 1M rate. The response of the variables, which appears to be large in terms of absolute value, is a result of the normalisation.

Figure 24. Response to monetary policy impulse – results obtained for commercial and cooperative banks

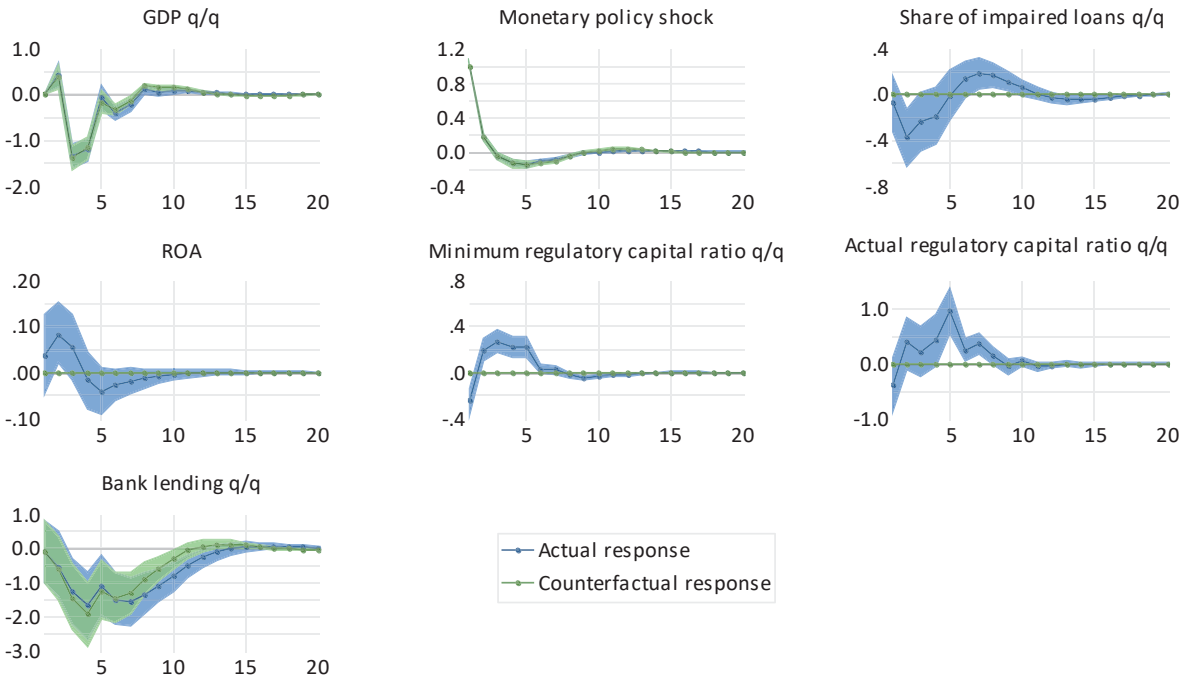


Notes: The line represents the median and the shaded area is the 95% confidence interval computed by the bootstrap method. The responses of GDP growth and lending growth are measured in p.p. The horizontal axis shows the quarter following the shock.

Source: NBP and Statistics Poland data. Own calculations.

Impulse responses based on both versions of the model show that monetary policy tightening is associated with a reduction in GDP growth. The share of impaired loans rises only after several quarters. The profitability of banks initially improves; however, it then falls, probably due to the deteriorating quality of loans. However, this is not reflected in a fall in actual capital ratios. On the contrary, they improve. The absence of a fall in capital ratios may be because in certain periods of monetary policy tightening there was a simultaneous tightening of capital regulations due to supranational regulations. This is reflected in the response of the minimum capital ratio to the monetary policy impulse. However, ultimately lending decreases compared with the scenario without monetary policy tightening, as estimated earlier.

Figure 25. Response to monetary policy impulse – results obtained for commercial banks

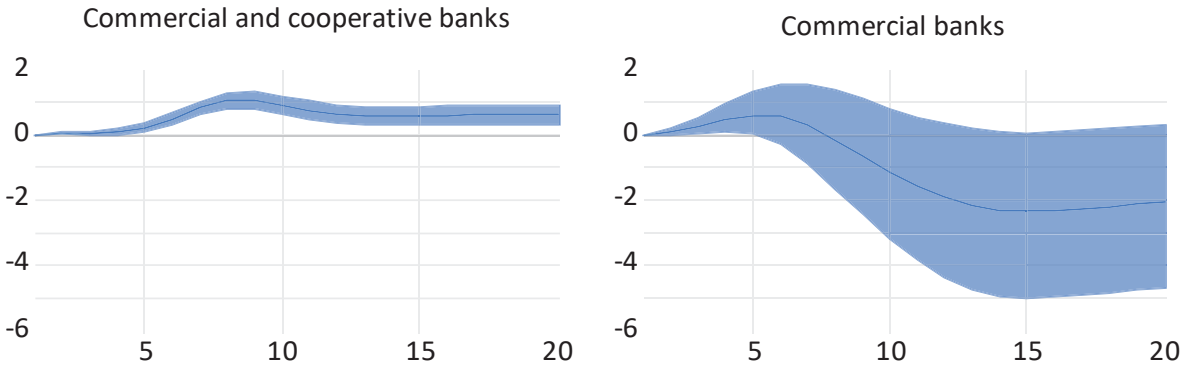


Notes: The line represents the median and the shaded area is the 95% confidence interval assigned by the bootstrap method. The responses of GDP growth and lending growth are measured in p.p. The horizontal axis shows the quarter following the shock.

Source: NBP and Statistics Poland data. Own calculations.

Concerning the differences between the results based on individual variants of the model, in the sample including not only commercial banks, but also cooperative banks, the counterfactual response of lending, i.e., the response after excluding the bank lending channel, is not weaker than the actual response; on the contrary, it is slightly stronger (Figure 26). This may be due to the fact that in the case of cooperative banks, the unfavourable impact of monetary policy on the quality of loans is more than offset by the positive impact on the interest margin, which is reflected in profitability. In the case of commercial banks, in the longer term, the negative impact on the quality of loans may prevail. According to current estimates, pointwise, in this case, the bank lending channel is responsible for 18% of the decrease in loans 20 quarters after monetary policy tightening. This is qualitatively consistent with earlier estimates. The difference in the response of the level of lending is borderline statistically significant.

Figure 26. Differences between the actual and counterfactual response of the credit level (in p.p.) to a monetary policy shock



Notes: The counterfactual response assumes no operation of the bank credit channel. The line represents the median and the shaded area is the 95% confidence interval computed by the bootstrap method. The horizontal axis shows the quarter following the shock.

Source: NBP and Statistics Poland data. Own calculations.

3.2.2. The impact of monetary policy shocks on standards, terms and conditions on corporate and household loans and lending

Lending standards are the minimum standards of creditworthiness, set by banks, that the borrower is required to meet to obtain a loan. Terms and conditions on loans are the features of the loan agreement between the bank and the borrower, including spread, non-interest loan costs, maximum loan size, collateral requirements, and maximum loan maturity. The statistically significant impact of monetary policy on standards, terms and conditions of granting loans, approximating the unobservable credit supply function, confirms the operation of the credit channel in the economy.

Data on banks' lending policy come from senior loan officer surveys conducted by NBP every quarter since the end of 2003. The banks participating in the survey have a dominant share (90%) of the corporate and household loans outstanding in the banking sector. In the NBP survey, the banks inform about changes in lending standards, terms and conditions as well as the reasons for these changes. The results are presented in the form of structures, i.e., the percentages of banks which chose a given option in response to particular questions (tightened considerably, tightened somewhat, no change, eased somewhat, eased considerably). The responses to all the questions are weighted with the share of the given bank in the market segment to which a given question relates.[61]

This section therefore shows how monetary policy shocks influence commercial banks' lending policy (credit supply) and how they are reflected in credit dynamics. Then, it provides evidence how lending to corporates and households responds to shocks to standards, terms and conditions, i.e., to exogenous changes in banks' risk appetite.

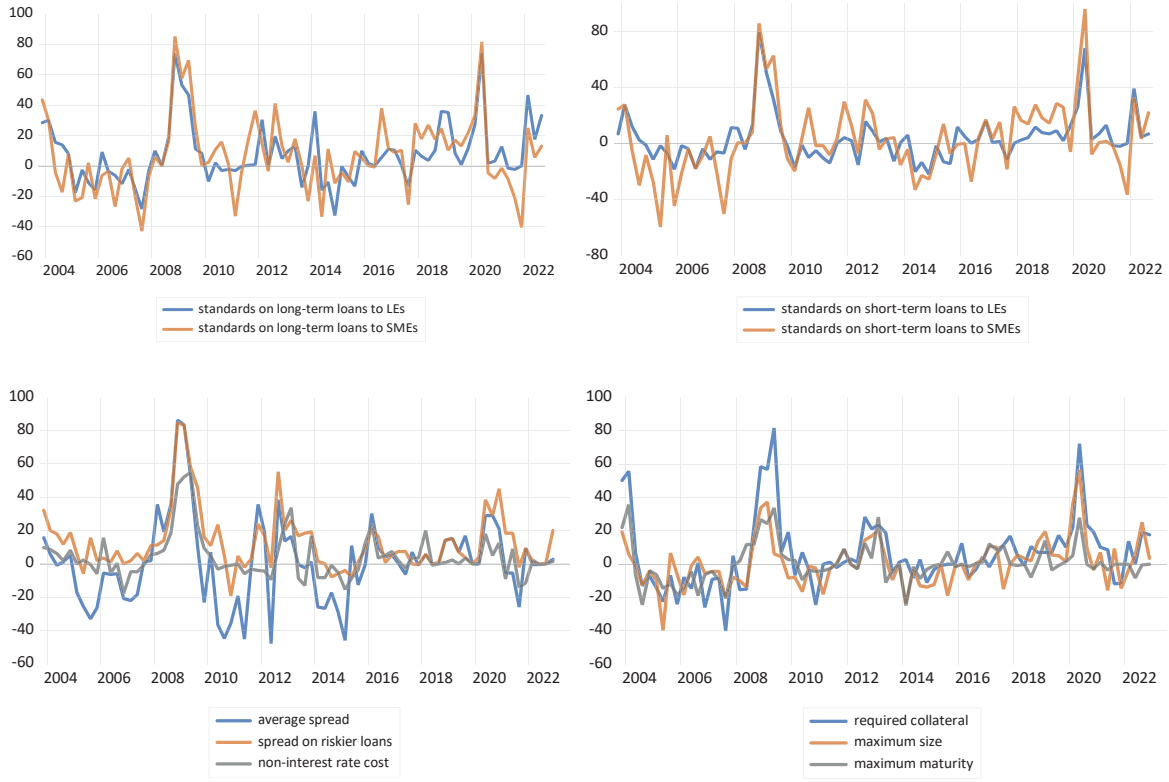
[61] See https://nbp.pl/en/financial-system/senior-loan-officer-opinion-survey.

The presented analyses are based on a set of structural vector autoregression (SVAR) models, constructed for various types of loans, lending standards and terms, and factors which banks indicate as a reason for changing lending policy. Apart from qualitative data from the survey, the models use quantitative variables, including GDP, gross fixed capital formation, inflation, loans, and interest rate (POLONIA). In the case of enterprises, the subject of modelling is long- and short-term zloty denominated loans, while in the case of households it is zloty denominated housing loans and consumption loans. The loans are in real terms.

In the period covered by the analysis (i.e., from 2003 Q4 to 2022 Q3) strong external disturbances in the functioning of the economy occurred: the global financial crisis, next the COVID-19 pandemic and then the war in Ukraine, which intensified the internal inflationary processes. The financial crisis and COVID-19 caused a particularly strong tightening of lending policy (Figure 27 and Figure 28). During the pandemic a series of fiscal and monetary policy actions were taken which affected the functioning of the financial sector and the real sector and may have distorted the previously observed reactions to shocks. An important factor from the point of view of an analysis of bank lending policy and lending was the introduction of the PFR Financial Shields, which reduced demand for bank loans on the part of enterprises. Therefore, net financing under the shields was introduced as an exogenous variable in the models describing corporate loans.[62]

[62] Statutory loan repayment holidays introduced in the second half of 2022 did not have a major impact on the presented results, as in practice they concerned only one quarterly observation.

Figure 27. Changes in standards, terms and conditions on corporate loans (q-o-q)



Notes: vertical axis: percentage (net) of banks changing lending policy. Positive values indicate a tightening and negative values an easing of lending policy. The abbreviation LE means large enterprises and SME – small and medium-sized enterprises.

Source: NBP data.

The standards on household housing loans in the analysed period remained strongly affected by regulatory factors. Following the global financial crisis, the regulator introduced several restrictions on granting housing loans, especially loans in foreign currencies. This caused a tightening of the standards and certain terms and conditions on loans irrespective of the situation of the households and banks (Figure 28). In turn, the sharp increase in the NBP reference rate from 2021 Q4 to 2022 Q3 and the accompanying adjustment of the money market (WIBOR 3M rose by 6.8 p.p.) caused an untypical response of banks' lending policy: standards on housing loans were tightened in order to limit access to new loans, while at the same time many terms and conditions were eased. The latter was probably aimed at reducing the risk of an increase in the share of non-performing loans in banks' loan portfolios.

Figure 28. Changes in standards, terms and conditions on household loans (q-o-q)

Notes: vertical axis: percentage (net) of banks changing lending policy. Positive values indicate a tightening and negative values an easing of lending policy. The vertical lines indicate the introduction by the regulator of Recommendation S (2006 Q3), Recommendation T (2010 Q4), new provisions of Recommendation S (2012 Q4), a new Recommendation S (2014 Q1), the entry into force of a maximum level of loan-to-value (LTV) defined in Recommendation S (2015 Q1), the entry into force of new provisions of Recommendation S on LTV and creditworthiness assessment (2016 Q1), an amendment of the requirements of Recommendation S, including shortening the period for which creditworthiness is checked (2021 Q2), and the implementation of amended recommendations of the KNF tightening procedures for determining the creditworthiness of persons applying for a loan (2022 Q2).

Source: NBP data.

3.2.2.1. Corporate lending

Models of corporate loans contain five variables and allow five structural shocks to be identified: aggregate demand shock, which is approximated by investment shock, credit demand shock (long- and short-term lending), shock to risk factor reported by banks in the survey, monetary policy shock, and the shock to lending standards or to terms and conditions.[63]

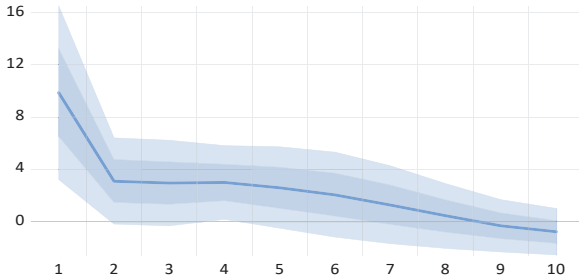
Response to monetary policy shock

The obtained results show that monetary policy shocks affect lending standards on long- and short-term loans for large as well as small and medium-sized enterprises, although in the case of short-term loans for small and medium-sized enterprises, the result is on the borderline of statistical significance. The impact of monetary policy is observed primarily in the first and second quarters after the shock. A monetary policy shock of approx. 0.2 p.p. (Figure 29.H) leads to an increase of approx. 10 p.p. in the share of banks (asset-weighted) tightening the lending standards on long-term loans, both for large as well as small and medium-sized enterprises. It also leads to an increase of approx. 5 and 7 p.p., respectively, in the share of banks tightening the lending standards for short-term loans (Figure 29.A-D). The response of lending standards on long-term loans is therefore greater, in terms of percentage points, than the response of lending standards on short-term loans. Monetary policy shocks also cause a response of lending terms and conditions. After unexpected monetary policy tightening, banks apply higher margins and require more collateral (Figure 29.E-G) and also shorten the loan maturity period, reduce loan amounts and increase non-interest loan costs.[64] The responses of lending terms and conditions fall within the range from 4 to 7 p.p.; the share of banks tightening the average margin increases the most.

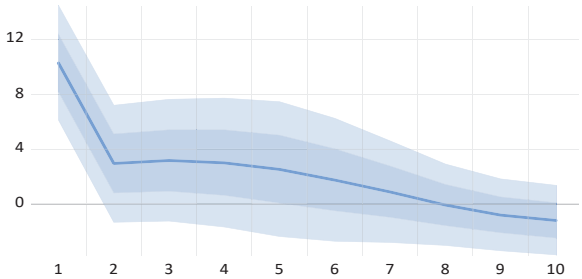
[63] The method of structural shocks identification is discussed in detail in Wróbel (2022).
[64] The adjustment of the remaining terms and conditions, not shown in the chart, have a similar shape.

Figure 29. Response of lending standards, terms and conditions on corporate loans (in p.p.) to a monetary policy shock

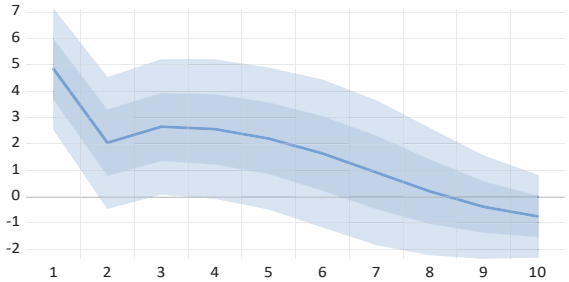
A. Standards on long-term loans for large enterprises



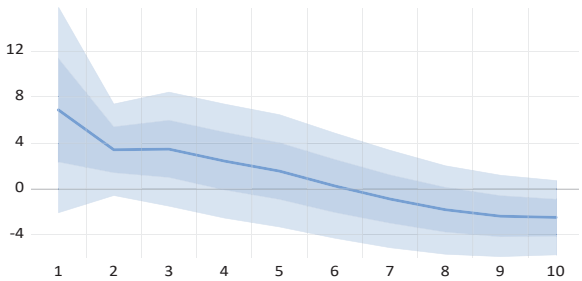
B. Standards on long-term loans for small and medium-sized enterprises



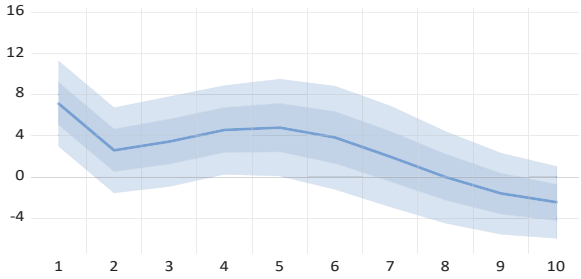
C. Standards on short-term loans for large enterprises



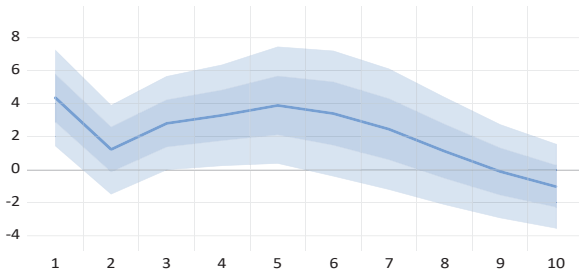
D. Standards on short-term loans for small and medium-sized enterprises



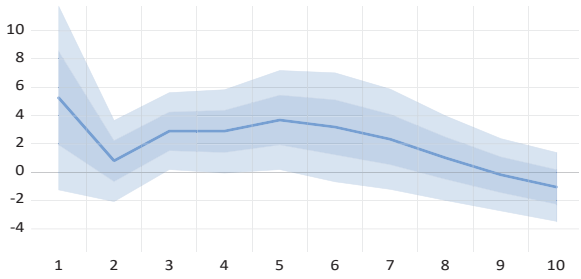
E. Average spread



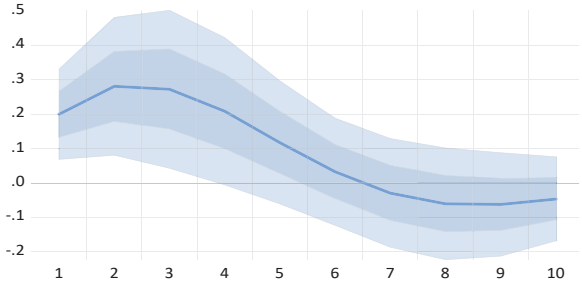
F. Spread on riskier loans



G. Required collateral



H. Monetary policy shock



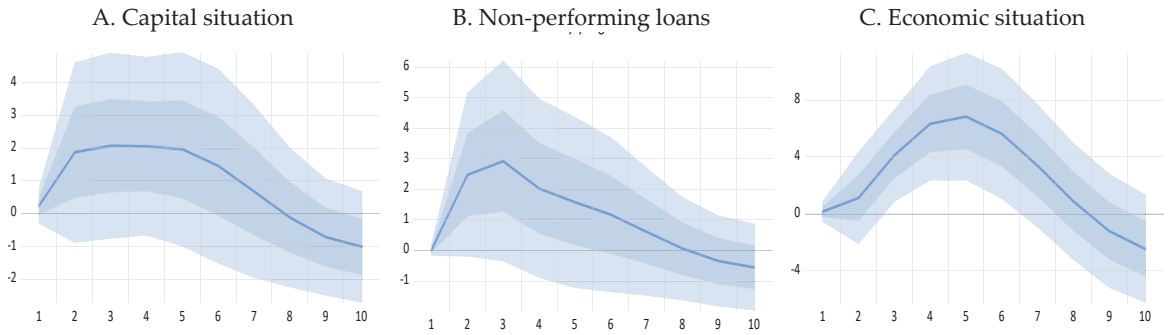
Notes: The solid line on figures A-G presents the response of lending standards or terms to a monetary policy shock (tightening). The dark blue (light blue) band illustrates the 68% (95%) confidence interval of the estimated response. Figure H shows the monetary policy shock. The quarters after the monetary policy shock are marked on the horizontal axis.

Source: NBP data. Own calculations.

Interest rate shocks also lead to greater perceived risk related to the condition of banks' balance sheets; however, this effect is not statistically significant (Figure 30). In turn, the risk – as perceived by the banks – of the expected economic situation, the industry-specific risk and the risk related to

the largest borrowers, increases in a statistically significant way. While the risk of the economic situation increases immediately after the shock, the industry-specific risk and risk related to the largest borrowers respond with a lag – the maximum response falls on the 4th-6th quarter following the shock.

Figure 30. Response of banks' perceived capital position, loan portfolio quality and perceived overall economic situation (in p.p.) to a monetary policy shock

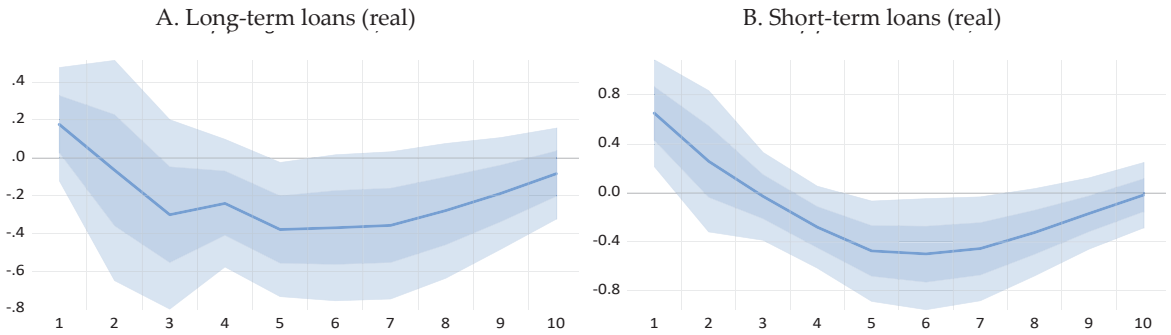


Notes: The solid line presents the response of the variable to a monetary policy shock (tightening). The dark blue (light blue) band illustrates the 68% (95%) confidence interval of the estimated response. The quarters after the monetary policy shock are marked on the horizontal axis.

Source: NBP data. Own calculations.

Monetary policy shocks affect the growth rate of loans to enterprises, although the responses are on the borderline of statistical significance (Figure 31). For both types of loans, the response functions are initially positive. In the case of long-term loans this is a short-term effect, statistically insignificant and difficult to interpret. The growth rate of long-term loans begins to decline after the first quarter following the monetary policy shock, and the maximum effect appears in the fifth quarter. In turn, the initial increase in the growth rate of short-term loans is statistically significant and lasts longer; the fall begins in the third quarter after the shock. The short-term credit "puzzle" is discussed in the literature (see Giannone *et al.*, 2019). It may have three sources: firstly, following a monetary policy tightening the banks may change the loan structure – increase the provision of less risky short-term corporate loans at the cost of lending to households (den Haan *et al.*, 2007); secondly – faced with increased external financing costs, enterprises may increase their demand for previously granted credit lines; thirdly, due to the economic downturn following the tightening of monetary policy, enterprises may face cash flow problems and therefore increase demand for short-term loans (Gertler and Gilchrist, 1995).

Figure 31. Response of growth of corporate loans (q-o-q, in p.p.) to a monetary policy shock



Notes: The solid line presents the response of the variable to a monetary policy shock (tightening). The dark blue (light blue) band illustrates the 68% (95%) confidence interval of the estimated response. The quarters after the monetary policy shock are marked on the horizontal axis.

Source: NBP data. Own calculations.

Response to credit supply shocks

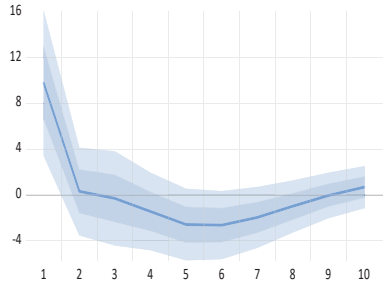
Shocks caused by banks' credit policy, i.e., the lending standards, terms and conditions, result from changes in banks' preferences for granting loans and attitudes to the risk incurred. Lower risk appetite causes banks to tighten their standards even though the Net Present Value (NPV) assessment of projects financed with a loan does not decrease.

Lending standard shocks for long-term loans to large and small and medium-sized enterprises, amounting to 10 and 16 p.p., respectively, lead to a rapid, temporary fall in the growth rate of long-term loans of approx. 0.5-0.6 p.p. (Figure 32), but the reaction of long-term loans is on the borderline of statistical significance. Analogous lending standard shocks for short-term loans to large and small and medium-sized enterprises, amounting to approx. 8 and 17 p.p., respectively, cause slower growth rate of short-term loans by approx. 0.8 p.p. (Figure 33). Like in the previous case, the response of loans is rapid. In the case of a shock to lending standards for small and medium-sized enterprises, the statistically significant response and return of lending growth to the initial level lasts longer than after a shock to standards for large enterprises.

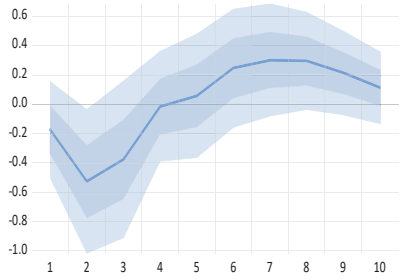
Shocks to most lending terms and conditions, such as the maximum loan amount shock, the maximum loan maturity shock, required collateral shock, and margin on riskier loans shock, also cause a statistically significant fall in the growth rate of long- and short-term loans. In turn, a non-interest costs shock leads to a fall in the growth rate of short-term loans.

Figure 32. Response of growth rate of long-term corporate loans (q-o-q, in p.p.) to lending standard shocks

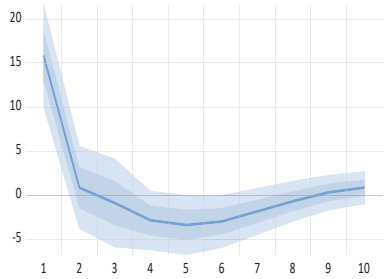
A. A shock to long-term lending standards for large enterprises



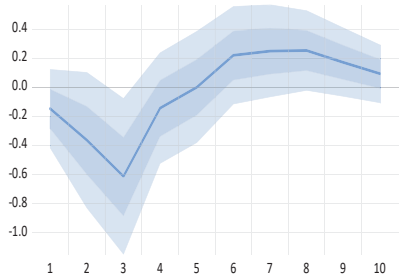
B. Response of total long-term loans (real) to a lending standard shock for large enterprises



C. A shock to long-term lending standards for small and medium-sized enterprises



D. Response of total long-term loans (real) to a lending standard shock for small and medium-sized enterprises

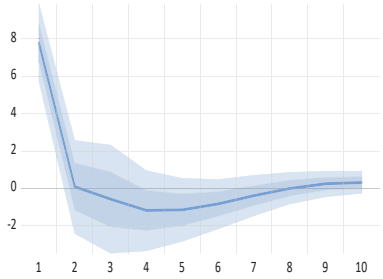


Notes: The solid line presents the response to the shock and the dark blue (light blue) band illustrates the 68% (95%) confidence interval of the estimated response. The quarters after the shock are marked on the horizontal axis.

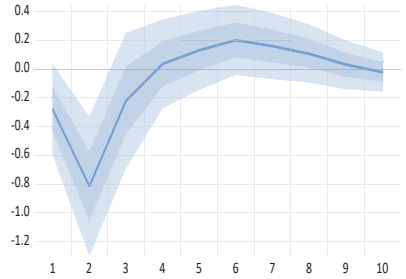
Source: NBP data. Own calculations.

Figure 33. Response of growth rate of short-term corporate loans (q-o-q, in p.p.) to lending standard shocks

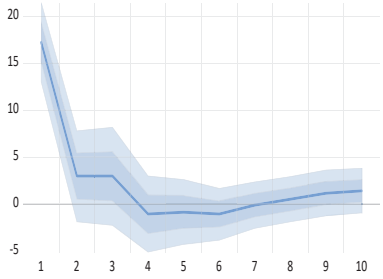
A. A shock to short-term lending standards for large enterprises



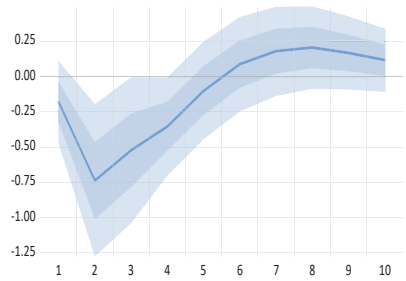
B. Response of total short-term loans (real) to a shock to short-term lending standards for large enterprises



C. A shock to short-term lending standards for small and medium-sized enterprises



D. Response of total short-term loans (real) to a shock to short-term lending standards for small and medium-sized enterprises



Notes: The solid line presents the response of the variable to the shock and the dark blue (light blue) band illustrates the 68% (95%) confidence interval of the estimated response. The quarters after the shock are marked on the horizontal axis.

Source: NBP data. Own calculations.

A comparison of the responses of loans to monetary policy shocks and lending standard shocks shows that the impact of the former occurs with a much greater lag than the latter. This is particularly the case with short-term loans. In addition, the return of the growth of corporate loans to the initial level lasts longer in the case of a monetary policy shock than a credit policy shock.

Forecast error variance decomposition[65] in the case of long-term loans shows that by the 4th quarter of the forecast horizon, POLONIA rate shocks account for approx. 1%, then in the following quarters their share reaches approx. 10%-12% and stabilizes at this level. The impact of lending standard shocks is observed mainly within the first three to four quarters, when they account for approx. 2%-7% (depending on the model) and remain at this level. In the case of a short-term loans, the role of interest rate shocks is greater than that observed for long-term loans initially amounting to 6%-8%. In the subsequent quarters, the share of interest rate shocks increases and stabilises at a level of 10%-13%. The role of lending standard shocks is similar to the role of interest rate shocks.

[65] Forecast error variance decomposition defines what part of the variability of the random error of the forecast with horizon k for the model variables is due to the occurrence of specific structural shocks. For high values of the forecast horizon, the variance decomposition is interpreted as the variance decomposition of the SVAR model variables. Here we discuss only the role of two shocks, the rest are shocks related to investment, which approximate aggregate demand, demand for credit and one of the risk factors indicated by banks (equity, NPL, competition, macroeconomic, industry, the situation of the largest borrowers).

3.2.2.2. Household lending

Response to monetary policy shocks

Monetary policy shocks[66] also affect lending standards on housing and consumer loans. A statistically significant response or a response on the borderline of statistical significance, depending on the model, has been observed only recently – it was not present in the sample that ended before the period of disturbances in the economy related to the COVID-19 epidemic. A monetary policy shock amounting to approx. 0.25 p.p. causes an increase in the share of banks tightening their lending standards on housing loans of approx. 15 p.p., and banks tightening their lending standards on consumer loans, depending on the model applied and risk factor present in it, of 8-12 p.p. (Figure 34).

However, monetary policy shocks have a weak impact on lending terms and conditions on housing loans – their response is statistically insignificant (Figure 35). On the other hand, the response of lending terms and conditions on consumer loans is statistically significant, at least in the first quarter following the shock. As shown in section 3.2.2.1, monetary policy shocks have an impact on at least some risk factors of credit policy in the case of corporate loans (including the perception of the overall economic situation, risk of the largest borrowers, industry-specific risk). In the case of analogous household credit policy risk factors, these responses are statistically insignificant. This may be a factor weakening the impact of the credit channel with respect to households.

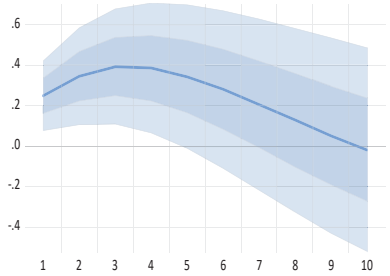
Following an unexpected tightening of monetary policy, the growth rate of housing loans declines[67] (Figure 36). The situation is different in the case of consumer loans. They do not respond in a statistically significant way, and in some models the point response is not intuitive (increase); only some of the models show a point decrease.

[66] In order to identify structural shocks, we adopt the following assumptions: aggregate demand affects all other variables without delay. Inflation, the impulse of which we identify with the aggregate supply shock, depends on the demand observed in the same period; the risk indicated in the Senior Loan Officer Opinion Survey depends on changes in aggregate demand and supply observed in the same period. The monetary policy of the central bank is influenced by changes in aggregate demand and inflation, as well as the banks' lending policy observed in the same period. On the other hand, the banks' supply policy depends on the changes in the real sector (GDP) observed in the same period, as well as on the development of risk factors and the interest rate.

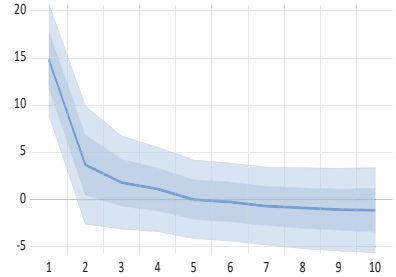
[67] To identify structural shocks in models containing loans (they enter the models instead of inflation) the same decomposition is used as in the case of enterprises (see Wróbel, 2022).

Figure 34. Monetary policy shock and the response of lending standards on household loans (in p.p.)

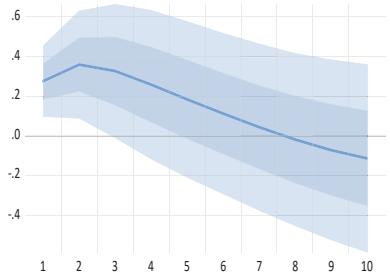
A. Monetary policy shock in the model for housing loans



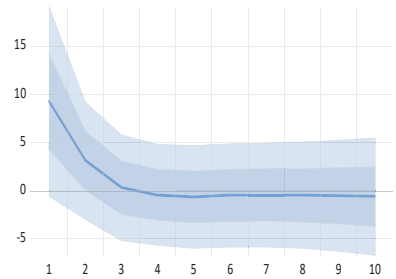
B. Response of lending standards on housing loans



C. Monetary policy shock in the model for consumer loans



D. Response of lending standards on consumer loans

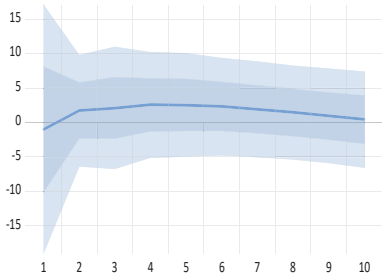


Notes: The solid line presents the response to the shock and the dark blue (light blue) band illustrates the 68% (95%) confidence interval of the estimated response. The quarters after the shock are marked on the horizontal axis.

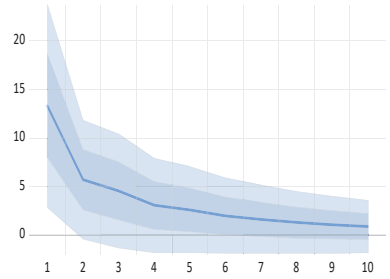
Source: NBP data. Own calculations.

Figure 35. Response of selected lending terms and conditions on household loans (in p.p.) to a monetary policy shock

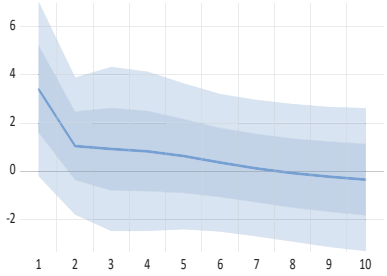
A. Average margin – housing loans



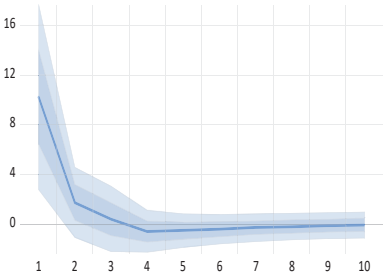
B. Average margin – consumer loans



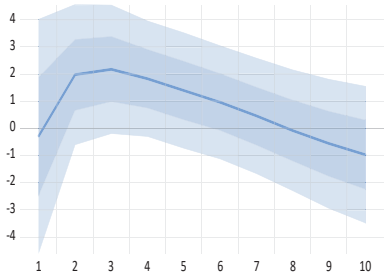
C. Margin for riskier loans – housing loans



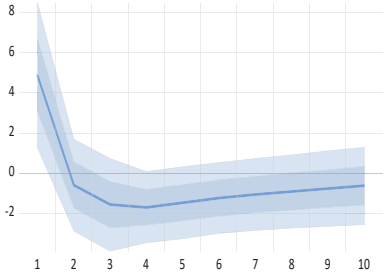
D. Margin for riskier loans – consumer loans



E. Required Loan-to-value (LTV) – housing loans



F. Required collateral – consumer loans

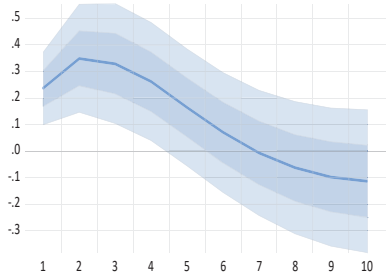


Notes: The solid line presents the response to the shock and the dark blue (light blue) band illustrates the 68% (95%) confidence interval of the estimated response. The quarters after the shock are marked on the horizontal axis.

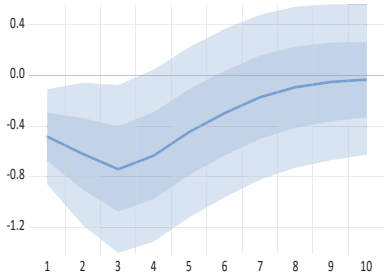
Source: NBP data. Own calculations.

Figure 36. Monetary policy shock and the response of growth rate of household loans (q-o-q, in p.p.)

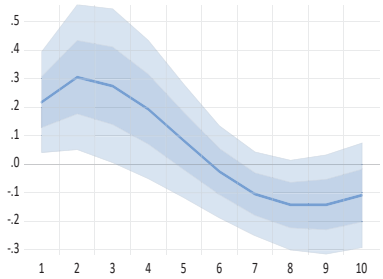
A. Monetary policy shock in the model for housing loans



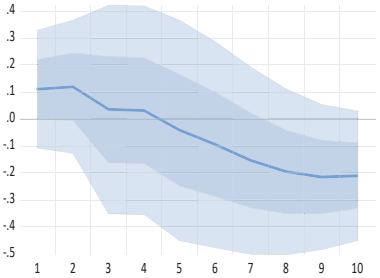
B. Zloty housing loans (real)



C. Monetary policy shock in the model for consumer loans



D. Consumer loans (real)



Notes: The solid line presents the response to the shock and the dark blue (light blue) band illustrates the 68% (95%) confidence interval of the estimated response. The quarters after the shock are marked on the horizontal axis.

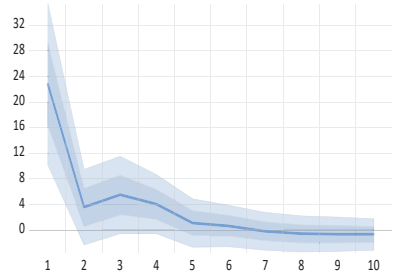
Source: NBP data. Own calculations.

Response to credit supply shocks

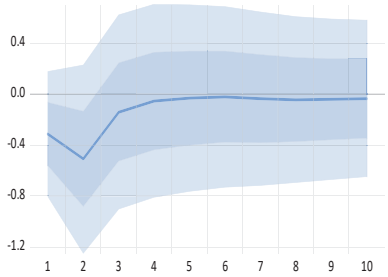
Following a typical lending standard shock for housing loans (an increase in the share of banks tightening credit policy by approx. 23 p.p.) the growth rate of loans falls by a maximum of 0.5 p.p. (Figure 37). However, this is not a statistically significant response. Housing loans respond similarly or even weaker to shocks to lending terms and conditions. On the other hand, consumer loans respond to lending standard shocks – a shock equal to 17 p.p. corresponds to a decrease in the growth rate of loans of approx. 0.4 p.p. Like housing loans, consumer loans react weakly to shocks to lending terms and conditions.

Figure 37. Lending standard shock and the response of the growth of household loans (in p.p.)

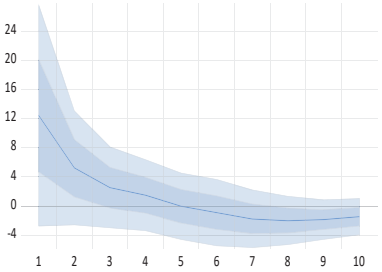
A. Lending standard shock for housing loans



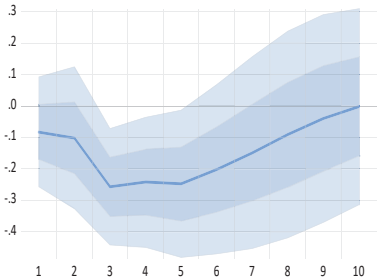
B. Zloty housing loans (real)



C. Lending standard shock for consumer loans



D. Consumer loans (real)



Notes: The solid line presents the response to the shock and the dark blue (light blue) band illustrates the 68% (95%) confidence interval of the estimated response. The quarters after the shock are marked on the horizontal axis.

Source: NBP data. Own calculations.

A comparison of the response of household loans to shocks related to NBP monetary policy and banks' credit policy shows that in the case of housing loans the maximum response to the first of these takes place only one quarter later than the maximum response to the second. On the other hand, consumer loans respond much faster to lending standard shocks than to monetary policy shocks.

The forecast error variance decomposition of housing loans shows that interest rate shocks in the initial quarters account for approx. 11%, and then their share decreases to approx. 9%. The role of lending standard shocks is negligibly small (approx. 2%). On the other hand, in the case of consumer loans, the role of interest rate shocks is negligibly small (approx. 1%), while lending standard shocks account for 4%-6% in the initial periods to approx. 14% in the10th quarter after the shock.

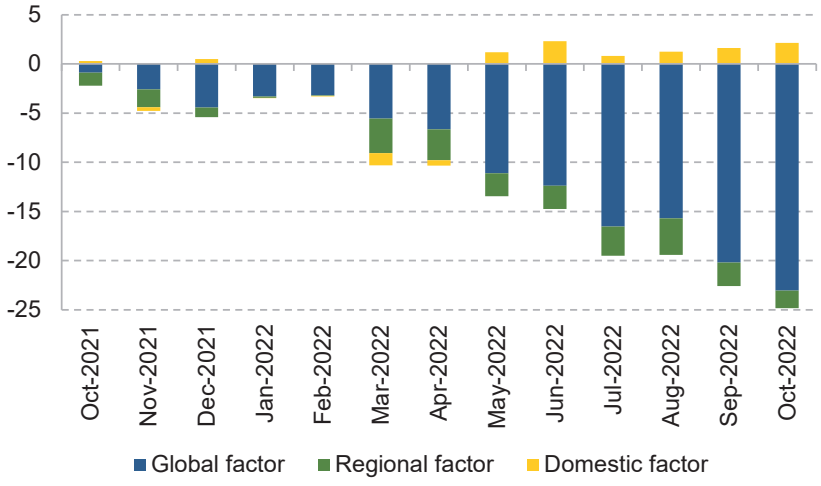
3.3. Exchange rate in the monetary policy transmission mechanism

3.3.1. Impact of global factors and domestic monetary policy on the exchange rate

Besides domestic monetary policy, global factors play an important role in shaping exchange rates[68] (Greenaway-McGrevy *et al.*, 2018; Lustig *et al.*, 2011). The impact of the global factor may result, among others, from the monetary policy conducted by the Federal Reserve of the United States or also from changes in sentiment in international financial markets. Some analyses distinguish the regional factor among external factors, characterizing changes in a given geographical area or in a group of economies with similar characteristics (Galati *et al.*, 2007; Adam and Szafrański, 2014).

The factor analysis that was conducted[69] indicated the dominant influence of external factors in shaping the zloty exchange rate against the US dollar. In the period from January 2000 to October 2022, the average contribution of the global factor in the variance decomposition of the monthly PLN/USD exchange rate was 67%, the regional factor 15%, and the domestic factor 18%. The impact of the global factor was particularly visible in the period of deteriorating sentiment in global financial markets due to, among others, the Russian invasion of Ukraine and the monetary policy tightening by the Federal Reserve of the United States (Figure 38Figure 38).

Figure 38. Historical decomposition of changes in the PLN/USD exchange rate, cumulative from October 2021 to October 2022



Notes: Exchange rate changes are measured as percentage logarithmic changes. An increase means appreciation of PLN.

Source: Bloomberg data. Own calculations.

[68] Verdelhan (2013) calls such factors "dollar" factors due to the dominant position of the US currency in international markets.

[69] Three statistical models were used. The first model is a static hierarchical factor model based on the approach used by Adam and Szafrański (2014). This method uses Principal Component Analysis (PCA). The remaining two models are based on Bayesian approaches to the estimation of a hierarchical factor: *(i)* Neely and Rapach (2011), Kose *et al.* (2003, 2008) and *(ii)* Moench, Ng and Potter (2013).

At the same time, domestic monetary policy has a statistically significant impact on the zloty exchange rate, with this impact depending on the instrument used.[70] Daily data analysis shows that a conventional monetary policy tightening shock tends to appreciate the PLN/USD exchange rate, with the strongest impact approximately 10 days after the shock (Figure 39). On the other hand, the restrictive forward guidance shock[71] and the quantitative tightening shock have a depreciating effect (Figure 41 and Figure 43). Arena *et al.* (2021) also indicates the lack of appreciation of the exchange rate after a quantitative tightening shock;[72] however, the above results regarding the reaction of the exchange rate to the quantitative tightening shock should be treated with caution because these estimates are based on a relatively short sample from the period of severe disturbances in the financial markets, related to, among others, the COVID-19 pandemic. On the other hand, in the case of a forward guidance shock, the estimated reaction may be a consequence of the impact of the shock on the country risk premium – its increase, related to the prospect of monetary policy tightening, may lead to a depreciation of the domestic currency. The coefficient of determination in a model considering only the above shocks is 2.4%, which is consistent with the low share of the domestic factor in the decomposition of exchange rate volatility.

Shapes of the response function of the monthly PLN/USD exchange rate to individual types of monetary policy shocks (Figure 40, Figure 42 and Figure 44) are consistent with the results obtained from daily data.[73] In particular, the response of the zloty exchange rate to a conventional monetary tightening shock is of an appreciating nature. It should be underlined that the strongest response appears one month after the shock and fades over time to become statistically insignificant. On the other hand, the monthly exchange rate responds depreciatingly to other types of shocks and after 2-3 months the size of the response becomes statistically indistinguishable from zero.

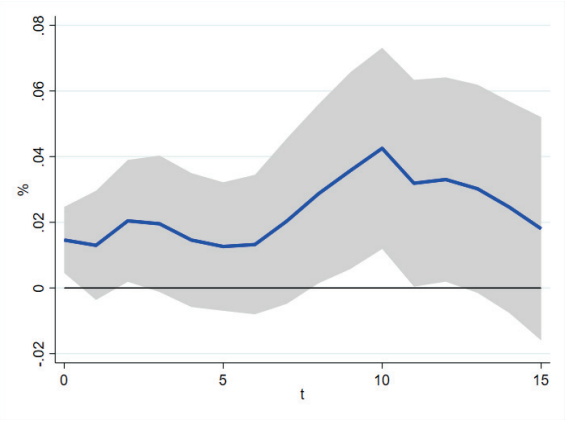
[70] To examine the impact of central bank's actions on the zloty exchange rate against the US dollar, impulse response functions were estimated using local projections (Jordà, 2005). Daily and monthly data for the PLN/USD exchange rate and variables representing individual monetary policy tightening shocks (conventional, forward guidance and quantitative easing) determined in accordance with the method proposed by Swanson (2021) were used for the estimation. The study used monetary policy shocks identified by Kapuściński (2023b).

[71] Positive forward guidance shock might be interpreted as unexpected announcement by NBP of more restrictive monetary policy in the future.

[72] According to Arena *et al.* (2021) the lack of a significant depreciation as a result of asset purchases by central banks in the economies of Central and Eastern Europe can be attributed to simultaneous currency interventions and sterilization of asset purchases.

[73] The results obtained on the daily data are robust to specification changes. The following variables have been added as control variables: lagged shock values, the VIX volatility index (in logarithm) and WIBOR 1M. Each time a similar shape of the impulse response function was obtained. For monthly data analogous modifications did not significantly affect the shape of the reaction function itself but limited their statistical significance.

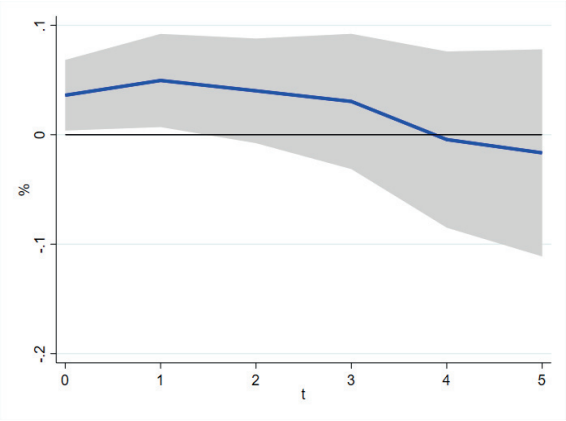
Figure 39. Response function of the daily PLN/USD exchange rate to conventional monetary policy shock



Notes: The horizontal axis shows the number of days after the shock, and the vertical axis shows the percentage deviations of the exchange rate from the level before the shock; an increase means appreciation; the grey background indicates the 90% confidence interval.

Source: Own calculations.

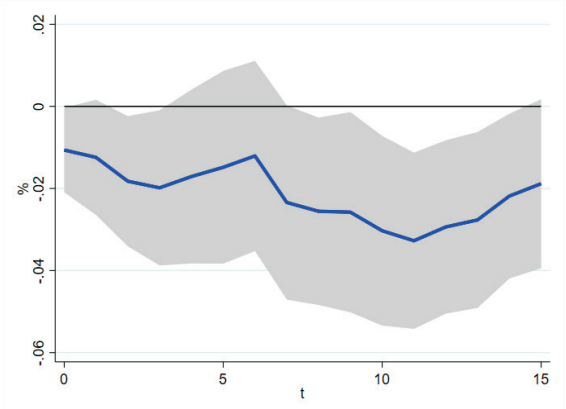
Figure 40. Response function of the monthly PLN/USD exchange rate to conventional monetary policy shock



Notes: The horizontal axis shows the number of months after the shock, and the vertical axis shows the percentage deviations of the exchange rate from the level before the shock; an increase means appreciation; the grey background indicates the 90% confidence interval.

Source: Own calculations.

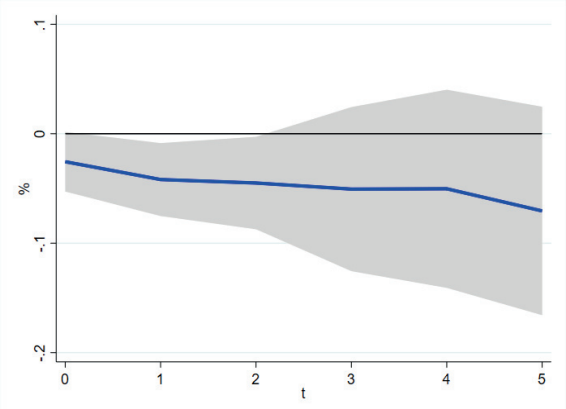
Figure 41. Response function of the daily PLN/USD exchange rate to forward guidance shock



Notes: The horizontal axis shows the number of days after the shock, and the vertical axis shows the percentage deviations of the exchange rate from the level before the shock; an increase means appreciation; the grey background indicates the 90% confidence interval.

Source: Own calculations.

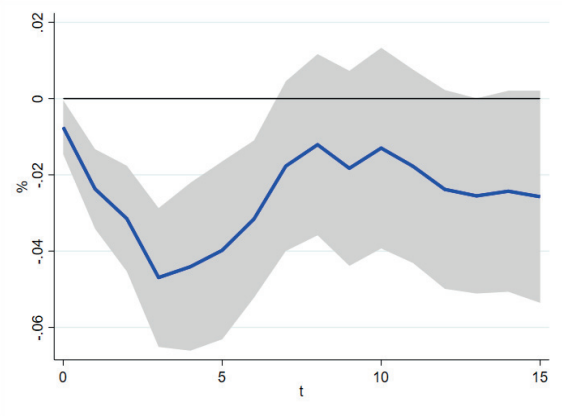
Figure 42. Response function of the monthly PLN/USD exchange rate to forward guidance shock



Notes: The horizontal axis shows the number of months after the shock, and the vertical axis shows the percentage deviations of the exchange rate from the level before the shock; an increase means appreciation; the grey background indicates the 90% confidence interval.

Source: Own calculations.

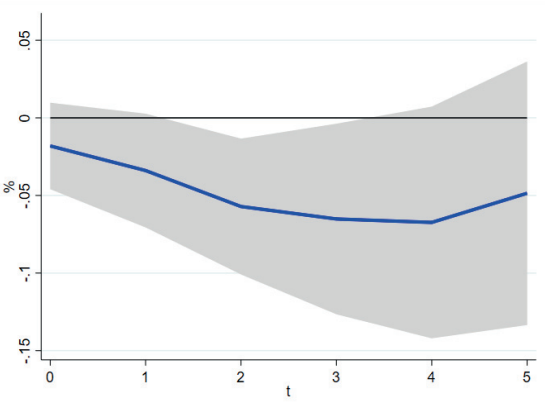
Figure 43. Response function of the daily PLN/USD exchange rate to quantitative tightening shock



Notes: The horizontal axis shows the number of days after the shock, and the vertical axis shows the percentage deviations of the exchange rate from the level before the shock; an increase means appreciation; the grey background indicates the 90% confidence interval.

Source: Own calculations.

Figure 44. Response function of the monthly PLN/USD exchange rate to quantitative tightening shock



Notes: The horizontal axis shows the number of months after the shock, and the vertical axis shows the percentage deviations of the exchange rate from the level before the shock; an increase means appreciation; the grey background indicates the 90% confidence interval.

Source: Own calculations.

Additional analysis also indicates that the PLN/USD exchange rate reacted to some of the actions of the Federal Reserve. Estimates of analogous local projection models were performed using US monetary policy shocks identified by Swanson (2021) as additional variables in addition to domestic monetary policy shocks. The impulse response functions determined on this basis show that, in accordance with economic intuition, the PLN/USD exchange rate depreciated in response to the conventional tightening shock and the forward guidance shock of US monetary policy. However, the impact of the shock related to quantitative easing conducted by the Federal Reserve proved to be insignificant.

3.3.2. Exchange rate pass-through to prices

To estimate the exchange rate pass-through (ERPT) effect, understood as the relation of the change in the price level to an exogenous change in the level of the exchange rate, two approaches were applied. Firstly, structural vector autoregression models were used to analyse the pass-through of exchange rate shocks to import prices, producer prices and consumer prices. The results of these analyses depend on the variables that have been included in the model as well as on the nature of the shock, which causes the initial change in the exchange rate. Secondly, single-equation models were used to estimate the ERPT effect for CPI inflation, core inflation (excluding food and energy prices), food prices and energy prices, as well as to assess the dependence of this effect on the level of inflation.

3.3.2.1. Pass-through effect in structural vector autoregression models

Current estimates of the impact of changes in the exchange rate on prices, made within the framework of the structural vector autoregression model (SVAR)[74], indicate that the long-term pass-through effect – understood as the ratio of the cumulative change in the price level to the cumulative change in the exchange rate – is 0.09 for consumer prices, 0.27 for producer prices, and 0.71 for import prices. This means that an appreciation of the zloty by 1% reduces the level of consumer prices by 0.09%, producer prices 0.27%, and import prices by 0.71%.[75] These estimates are close to those presented in the previous edition of the report. The price adjustment to exchange rate changes proceeds rapidly (Table 5) – in the second quarter following the shock to the exchange rate, import prices already reach their maximum adjustment, while producer prices reach approx. 81% of full adjustment, and consumer prices half of the full adjustment.

Table 5. Pass-through effect in the first four quarters following an exchange rate shock

	1st quarter	2nd quarter	3rd quarter	4th quarter
ERPT, import prices	0.56	0.71	0.71	0.71
ERPT, import prices (% maximum ERPT)	79%	100%	100%	100%
ERPT, PPI	0.19	0.22	0.25	0.26
ERPT, PPI (% maximum ERPT)	72%	81%	92%	98%
ERPT, CPI	0.01	0.04	0.07	0.09
ERPT, CPI (% maximum ERPT)	15%	48%	79%	100%

Source: Statistics Poland data. Own calculations.

In turn, the estimates of the pass-through effect in the structural Bayesian vector autoregression model (SBVAR)[76] depend on the nature of the exchange rate shock and the modelling setup of the Polish economy being considered. In this model, a risk aversion shock (analogous to exogenous exchange rate shock from the model of Forbes *et al.*, 2018) causes comparable changes in consumer price growth in terms of scale (the ERPT effect after 12 months is 0.13) as in the SVAR model for quarterly data. However, this is not the most important shock from the point of view of exchange rate volatility. Against the background of the remaining seven shocks identified in the SBVAR model[77], it is responsible for only 17% of the volatility of the effective exchange rate (contribution of the shock to the forecast error variance over a 12-month horizon). The cost-push exchange rate shock in this model is a much more important source of zloty exchange rate fluctuations, explaining 45% of its volatility. It has an immediate effect on the costs of domestic output and, with a lag, on consumer prices, both directly (through changes in the consumer goods import prices) and

[74] This model is estimated on the basis of quarterly data and takes into account the following variables: change in the price of a barrel of Brent crude oil, domestic output gap, change in the nominal effective exchange rate, change in import prices, change in PPI and change in CPI. See: McCarthy (1999, 2007).

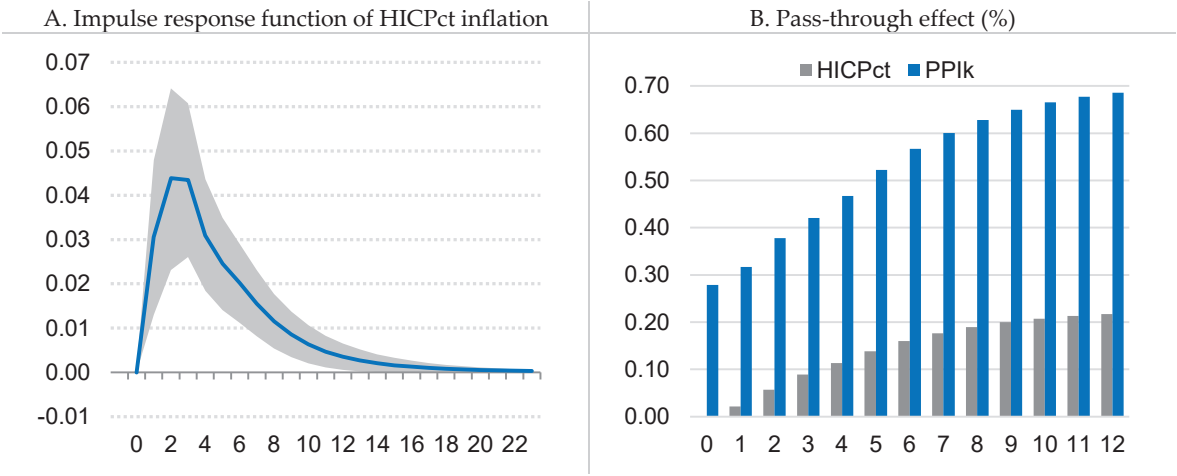
[75] An indicator often used in the literature is the pass-through effect four quarters after the change in the exchange rate, which in the SVAR model amounts to approx. 0.09 for consumer prices, approx. 0.26 for producer prices and approx. 0.69 for transaction prices in imports.

[76] Model estimated on the basis of monthly data (Szafranek *et al.*, 2023).

[77] Shocks in the model (domestic and external shocks of a supply or demand nature and exchange rate shocks and energy carrier price shocks) are identified by short-run sign restrictions in the impulse response function. More details on the construction of the model and its properties in Szafranek *et al.* (2023).

indirectly (through changes in producer prices and adjustments to the output gap). Figure 45 presents the pass-through of the exchange rate shock to HICP consumer prices at constant taxes and to PPI in the domestic market.

Figure 45. Impact of a 1-percent depreciation of the nominal effective exchange rate (exchange rate cost-push shock) and the pass-through effect in the BVAR model estimated on the basis of monthly data



Notes: Panel A presents the impulse response function of HICP inflation at constant taxes (HICPct) to an exchange rate cost-push shock along with a 68% confidence interval. Panel B presents ERPT estimates for the HICP index at constant taxes (HICPct) and for the index of producer prices in industry for the domestic market (PPIk). On the horizontal axis of both charts the months after the shock are marked.

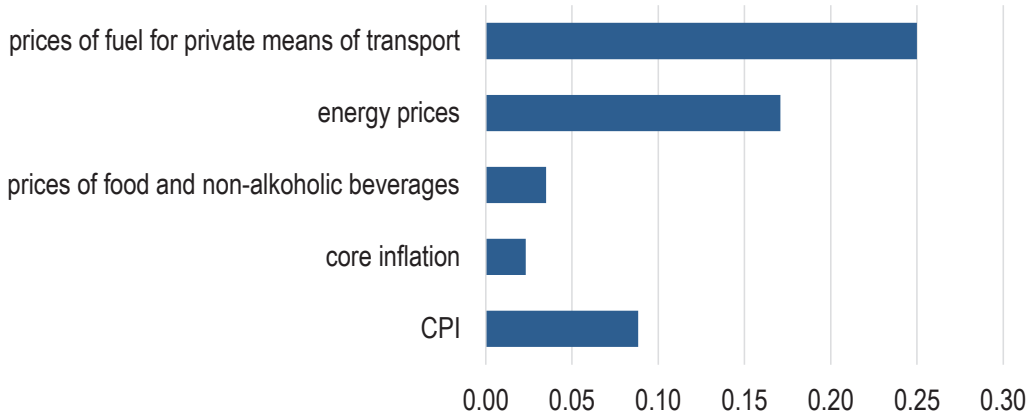
Source: Eurostat and Statistics Poland data. Own calculations.

Under the SBVAR model, an exchange rate cost-push shock causing a cumulative depreciation of the effective zloty exchange rate of 1% causes a cumulative change in producer prices of 0.68% and in consumer prices (HICP) of 0.21%. In this model, changes in the exchange rate are immediately (i.e., in the same month) passed to producer prices for the domestic market, but only partly (in approx. 28%) – mainly through prices of imported raw materials and inputs. The complete transmission (68% of the initial exchange rate impulse) occurs only after a year. On the other hand, the pass-through of exchange rate changes to consumer prices and the output gap occurs with a lag (the peak is 2-3 months after the initial impulse). Considering the links between nominal variables and the output gap, and assuming that the zloty exchange rate is influenced by global demand and supply factors, the degree of risk aversion or price changes in energy raw materials translates into a larger pass-through effect than in the SVAR model estimated on quarterly data. Therefore, a different estimate of ERPT compared to traditional models stems from the different system of identified structural shocks, as well as – although to a lesser extent – the monthly frequency of the economic events that was accounted for in the chain of domestic market price transmission.

3.3.2.2. Pass-through effect in single-equation models

Single-equation models[78] deliver similar assessments of the impact of the exchange rate on consumer prices as the quarterly SVAR model. The coefficient of long-term exchange rate pass-through in single-equation models is 0.09. However, the response of prices of individual components of the consumer basket to changes in the exchange rate varies (Figure 46). Energy prices, in particular the prices of fuel for private means of transport, respond to changes in the exchange rate to the greatest degree (long-term ERPT of, respectively, 0.17 and 0.25). The long-term effect of the exchange rate pass-through is the weakest in the case of prices of food and non-alcoholic beverages (0.03) and core inflation (0.02).

Figure 46. Long-term effect of the exchange rate pass-through on the CPI and components of the CPI basket

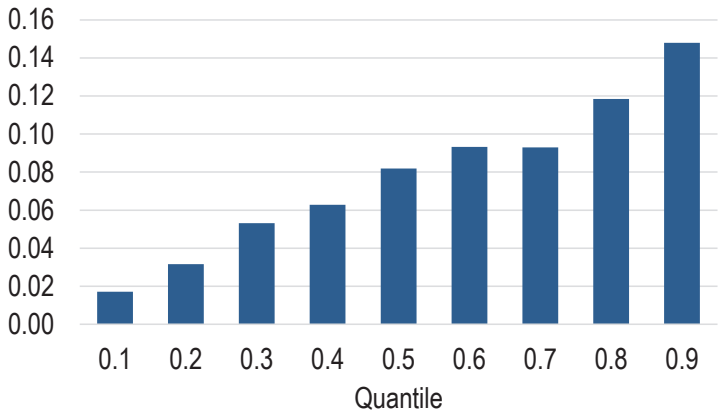


Source: Statistics Poland data. Own calculations.

At the same time, the impact of the exchange rate on consumer prices varies strongly depending on the level of inflation, as indicated by the conclusions from analogous single-equation models estimated with the use of quantile regression (Figure 47). For low levels of inflation, the pass-through effect is very small, not exceeding 0.02. On the other hand, for high levels of inflation this effect reaches as much as 0.15. Therefore, in the high inflation environment that we are currently dealing with, the price effects of exchange rate changes could be larger than would result from the linear models.

[78] See Takhtamanova (2010) and Anderl and Caporale (2022). In these models, estimated on monthly data, the dependent variable is CPI inflation m-o-m, and the explanatory variables – its lag, change in the nominal effective exchange rate, HICP inflation m-o-m in the euro area, the domestic output gap, and the change in the price of a barrel of oil. In some specifications, changes in the prices of energy and food commodities were used instead of prices per barrel of oil.

Figure 47. Long-term effect of the exchange rate pass-through depending on the level of inflation



Source: Statistics Poland data. Own calculations.

3.4. Formation of inflation expectations by private sector agents

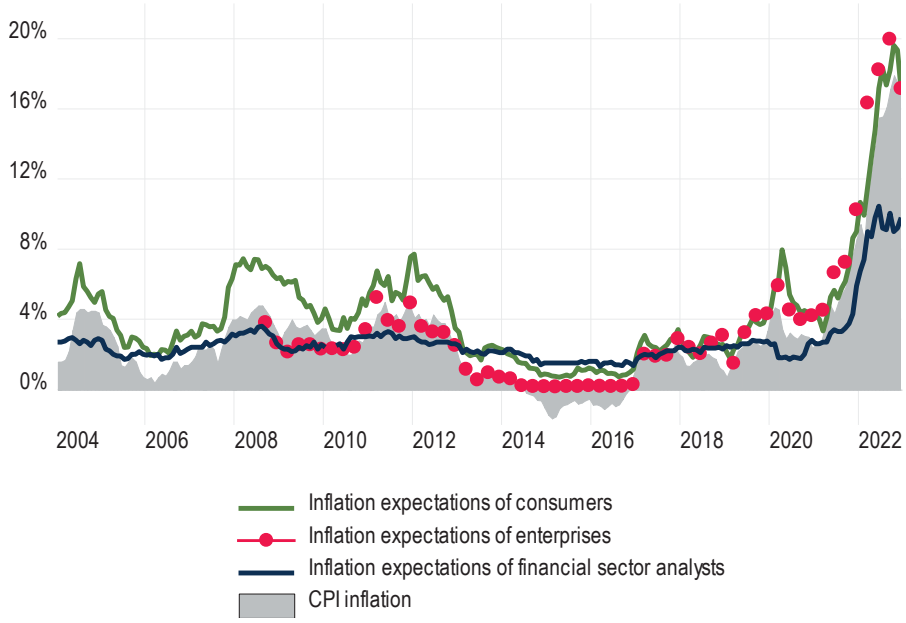
Inflation expectations of the private sector – both short-term, directly affecting the decisions of consumers and enterprises, and long-term, used e.g., in analysing the anchoring of expectations – are important for the monetary policy transmission mechanism.

3.4.1. Short-term inflation expectations

In the years of 2021-2022, i.e., amid rising and high inflation, short-term inflation expectations of consumers, enterprises and financial analysts rose sharply, while the scale of the increase in expectations of financial sector analysts was significantly lower than the scale of the increase of inflation expectations of the remaining groups of agents (Figure 48).[79]

[79] Measures of short-term inflation expectations of consumers, enterprises and financial sector analysts in this section are the same as used in the previous report.

Figure 48. Short-term (1-year-ahead) inflation expectations in Poland (%)



Notes: Inflation expectations of consumers and enterprises are quantified with the probability method using survey data from Statistics Poland and NBP (Quick Monitoring), respectively. Details on quantification and relevant references are included in section 3.2.1 of the 2016 edition of the report (Kapuściński *et al.*, 2016). Inflation expectations of financial analysts originate from surveys conducted by Refinitiv (formerly: Thomson-Reuters).

Source: NBP, Refinitiv and Statistics Poland data. Own calculations.

When analysing formation of short-term inflation expectations, single-equation models in the spirit of Cerisola and Gelos (2009) were used, having already been applied in previous editions of the report. Two types of models were estimated – in model (1) explanatory variables such as the real interest rate, the exchange rate, industrial output, the unemployment rate, wages, and the budget deficit were expressed in the form of annual changes, while in model (2) – they were expressed as deviations from the trend determined by the Hodrick-Prescott filter. These models were estimated on a sample covering the years 2003-2022 and using rolling regression in 72-month estimation windows (see Appendix 1).

The results of the estimation show that short-term inflation expectations of all groups of agents respond to the current price changes and economic activity, and the expectations of enterprises and financial sector analysts also respond to variables related to monetary policy (Table 6). Consumers adjust their expectations most strongly to current changes in food and energy prices, and their expectations are additionally influenced by a difference between subjectively perceived inflation and its official statistics. On the other hand, the impact of core inflation on inflation expectations seems to be strongest in the case of enterprises. Inflation expectations of financial sector analysts are less adaptive than expectations of consumers and enterprises. The NBP inflation target affects financial analysts' expectations to a larger extent than the expectations of other agents. On the other hand, the inflation expectations of enterprises respond more strongly to changes in interest rates and to NBP's inflation projections than do the expectations of financial sector analysts. All

groups of agents under consideration adjust their inflation expectations to changes in the economic activity (industrial output). One of the estimated models additionally shows the impact of the fiscal situation on the inflation expectations of enterprises.

Table 6. Factors influencing short-term inflation expectations

	Consumers		Enterprises		Fin. sector analysts	
	Model (1)	Model (2)	Model (1)	Model (2)	Model (1)	Model (2)
Core inflation	0.541*** (0.088)	0.599*** (0.079)	0.778*** (0.088)	1.066*** (0.117)	0.234*** (0.080)	0.272*** (0.069)
Food price growth	0.316*** (0.032)	0.287*** (0.031)	0.167*** (0.029)	0.112*** (0.043)	0.115*** (0.020)	0.102*** (0.016)
Energy price growth	0.173*** (0.019)	0.173*** (0.015)	0.137*** (0.021)	0.103*** (0.032)	0.093*** (0.020)	0.092*** (0.018)
NBP inflation target	-	-	0.186** (0.075)	0.314*** (0.081)	0.492*** (0.039)	0.551*** (0.029)
NBP inflation projection	0.137** (0.062)	0.133** (0.060)	0.389*** (0.082)	0.645*** (0.062)	0.369*** (0.036)	0.327*** (0.033)
Interest rate	-	-	-0.440*** (0.075)	-0.747*** (0.145)	-0.105** (0.046)	-0.352*** (0.068)
Exchange rate	-	-	-	-	-	-
Industrial output	0.047*** (0.011)	0.086*** (0.019)	0.047*** (0.009)	0.039* (0.021)	0.024*** (0.009)	0.040*** (0.011)
Unemployment rate	-	-	-	-	-	-
Wages	-	-	-	-	-	-
Budget deficit	-	-	-	0.108*** (0.041)	-	-
Inflation perception gap	0.589*** (0.161)	0.694*** (0.051)	x	x	x	X
Sample	2003:02-2022:10	2003:02-2022:10	2003:02-2022:05	2003:02-2022:05	2003:02-2022:10	2003:02-2022:10
Adjusted R^2	0.96	0.96	0.94	0.92	0.92	0.93

Notes: In the case of consumers, the inflation perception gap, i.e., the difference between perception of price changes (Consumer Perceived Price Index – CPPI) and CPI inflation, was used as an additional explanatory variable. In the case of enterprises, in monthly models we use data interpolated from quarterly data. The table shows the estimate of coefficients statistically different from zero – statistically insignificant variables (indicated by the "-" symbol) were not used in the estimation of the final versions of the models. The figures in brackets indicate the standard deviations of estimates of the parameters. *** p<0.01; ** p<0.05; * p<0.1.

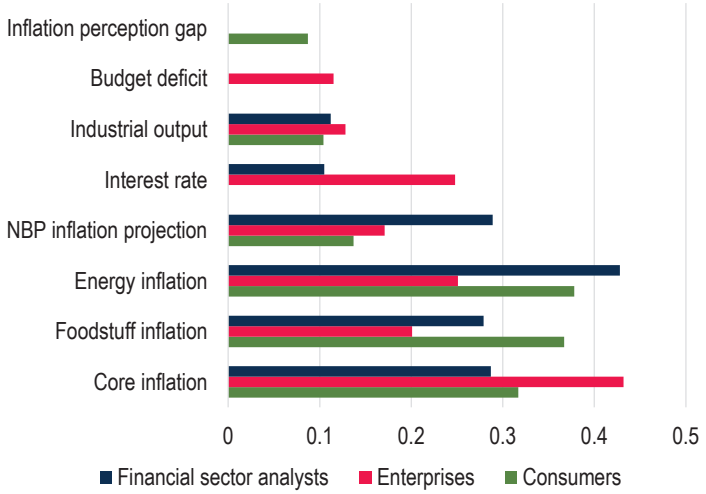
Source: Own calculations.

Changes in inflation expectations of all agents are largely influenced by changes in current prices (energy prices, food prices, and core inflation), as indicated by the standardised coefficients[80] of estimated models (Figure 49). According to the estimation results, changes in inflation expectations

[80] Standardised coefficients determine the impact of a typical shock of explanatory variables on inflation expectations, expressing it in units of typical volatility of inflation expectations (standard deviations).

of consumers are influenced to the greatest extent by current changes in food prices, energy prices and core inflation, while NBP inflation projections, industrial output and the inflation perception gap had a much smaller impact. Short-term inflation expectations of enterprises are mainly shaped by core inflation, changes in energy prices and interest rates, and to a lesser extent by changes in food prices, NBP inflation projections, economic activity and the budget deficit. On the other hand, inflation expectations of financial sector analysts mainly changed under the influence of current changes in energy prices, NBP inflation projections, core inflation and food price dynamics, and to a lesser extent in response to changes in industrial output and interest rates.

Figure 49. Standardised coefficients of the impact of individual variables on short-term inflation expectations



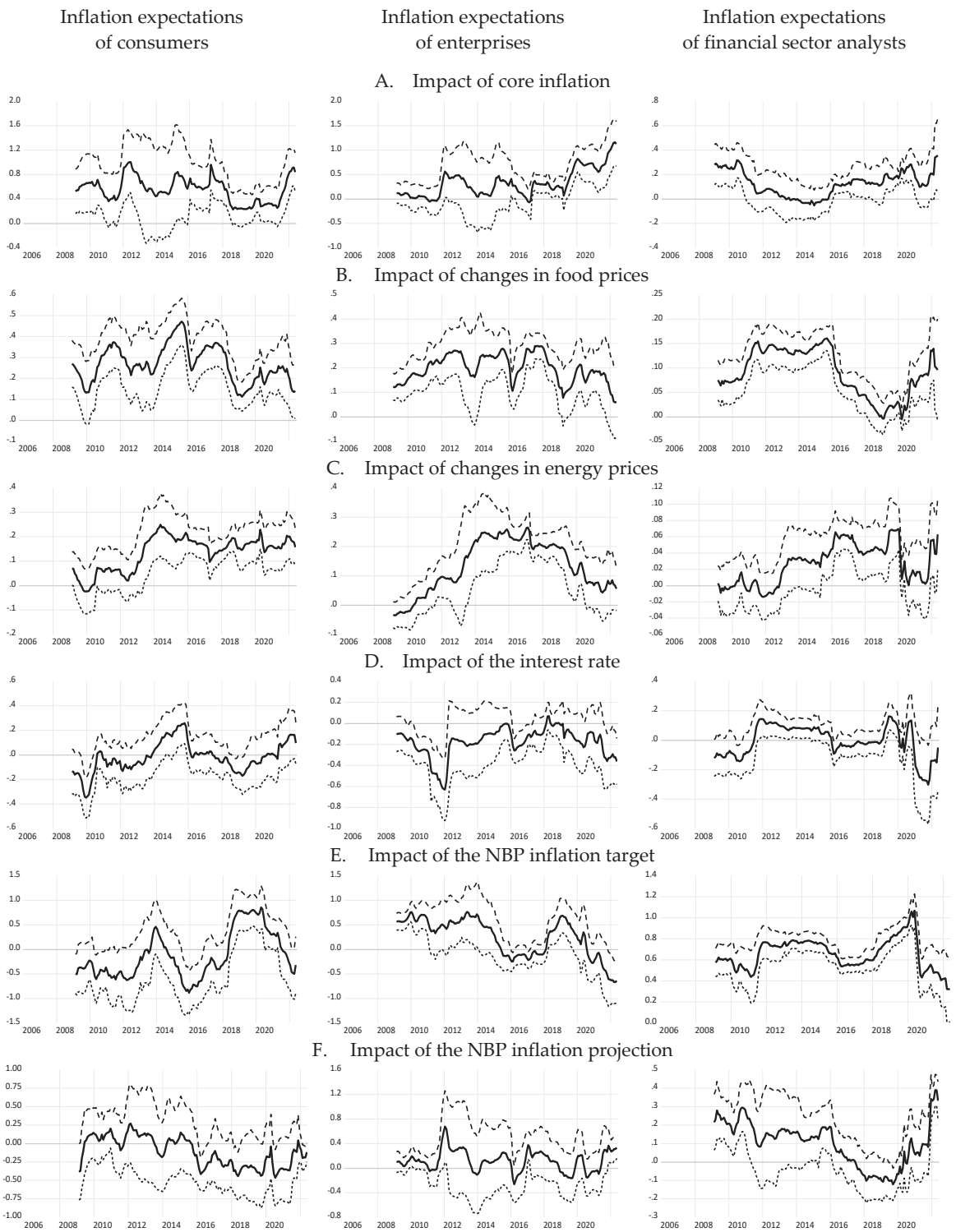
Notes: The chart presents estimates based on model (1). The NBP inflation target is omitted on the chart since its volatility in the sample was very low and concentrates only at the very beginning of the sample. The estimates obtained on the basis of model (2) are similar.

Source: NBP, Refinitiv and Statistics Poland data. Own calculations.

Formation of inflation expectations was subject to changes over time (Figure 50). In recent years the importance of core inflation has increased for short-term inflation expectations of all groups of economic agents, but particularly visibly in the case of enterprises.[81] This means an increase in the degree of backward-lookingness of inflation expectations. However, there is no sign of significant changes in the impact of energy and food price dynamics on the inflation expectations of the private sector – an exception here being the increase in the response of inflation expectations of financial sector analysts to changes in these prices in 2022. When it comes to the impact of monetary policy on short-term inflation expectations, in the recent period some strengthening of the impact of the interest rate on the inflation expectations of enterprises can be noticed, as well as an increase in the importance of the NBP inflation projection for inflation expectations of enterprises and financial sector analysts, alongside a decline in the importance of the NBP inflation target for these expectations.

[81] It is worth noting that the sensitivity of medium-term forecasts of private sector experts to inflation shocks has also increased recently (see section 4.2 of the report).

Figure 50. Change over time in the impact of current inflation indicators and factors related to monetary policy on short-term inflation expectations



Notes: The chart presents estimates based on model (1). The estimates obtained based on model (2) are similar. The dashed lines mark the 95% confidence interval.

Source: NBP, Refinitiv and Statistics Poland data. Own calculations.

3.4.2. Long-term inflation expectations

The analysis of the formation of long-term inflation expectations focuses on two characteristics related to the degree of their anchoring, i.e., their level relative to the NBP inflation target and the strength of the response to current events, data and information (Kumar *et al.*, 2015; Corsello *et al.*, 2021). An extended analysis of these issues is presented in section 4.2.

Information on long-term inflation expectations in Poland is limited. Survey measures of long-term inflation expectations are only available in the case of professional forecasters[82] and concern average inflation for the next five years. Based on inflation forecasts for the next five years and inflation forecasts for the current year and the next two it is possible to obtain the implied average inflation forecast for the fourth and fifth years of the forecasting horizon; however, the uncertainty of these estimates is substantial.[83] Therefore in the analysis below additionally medium-term expectations have been used.

In the middle of 2021, along with the increase in CPI inflation, the short-term and, to a lesser extent, the medium-term inflation expectations of professional forecasters increased sharply (Figure 51). The elevated level of medium-term inflation expectations suggests that forecasters expected that the increase in inflation would not be short-lived. However, the increase in medium-term expectations was much smaller than the increase in current inflation or short-term expectations, and their level indicated strong disinflation expected over the next eight quarters.

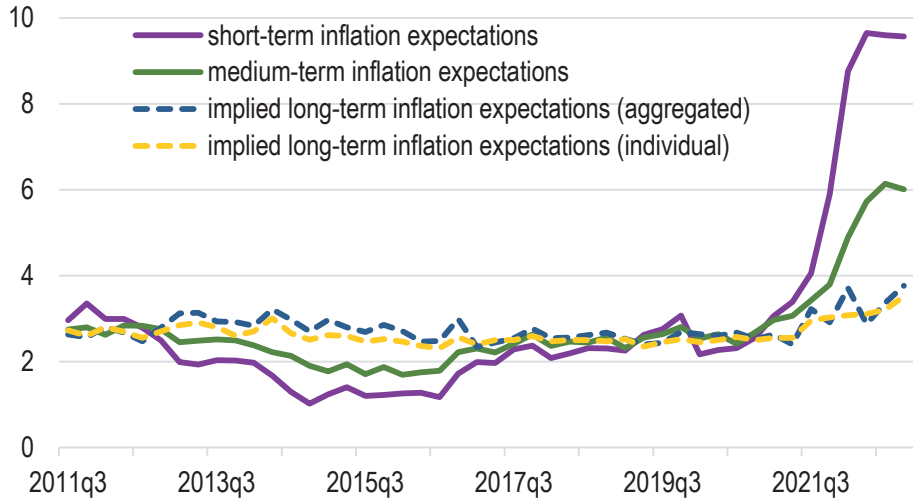
In the second half of 2021 the implied long-term inflation expectations also increased. At the end of 2022 they were close to the upper limit for deviations from the NBP inflation target. Due to the implied character of these expectations, their level should be treated with caution. Figure 51 presents their two different estimates. In both cases these are implied values of expected inflation in the fourth and fifth year of the forecast horizon, with the first of them calculated based on aggregated data, and the second of them on the basis of individual data. Given the unprecedented scale of inflation shock in 2021 and 2022, higher long-term inflation expectations may result from the expected gradual fading of this shock, consistently with the communication of the central bank.[84]

[82] Inflation expectations of professional forecasters come from the NBP Survey of Professional Forecasters (see https://amakro.nbp.pl).

[83] The implied expected inflation in the 4th and 5th year of the forecast horizon is determined on the assumption that the forecasts of individual experts in different horizons are consistent and that the forecasters use the geometric mean formula and not the simplified arithmetic mean formula. However, it seems that it is difficult for some forecasters to maintain consistency between forecasts of average annual inflation for the next three years and for the next five years, especially in the period of exceptionally low or exceptionally high current inflation. This may lead to a measurement error of implied expectations based on aggregated forecasts. The median of individual implied forecasts should be more robust to inconsistencies in forecasts of individual experts.

[84] The NBP inflation projection published in November 2022 indicated that inflation would not return to deviation band of the NBP inflation target until 2025, i.e., 3 years since the publication of the projection (see section 4.2). Therefore, long-term expectations from this period did not differ significantly from the opinion of the central bank.

Figure 51. Inflation expectations of professional forecasters (%)



Notes: Short-term inflation expectations refer to the 4-quarter horizon, and medium-term – to the 8-quarter horizon, and are measured as the median of the aggregated distribution. Long-term inflation expectations are the implied expected inflation in the fourth and fifth year of the forecast horizon, determined on the basis of average annual inflation forecasts for the next five years and inflation forecasts for the current year and the next two years using the geometric mean formula. It is determined on the basis of aggregated forecasts or as the median of individual implied inflation expectations.

Source: NBP data. Own calculations.

The responsiveness of medium- and long-term inflation expectations to current information is assessed by verifying whether there is a relationship between revisions of these expectations and incoming macroeconomic news.[85] In particular, surprises in current inflation readings and the index of macroeconomic surprises, which includes readings of other macroeconomic variables, were applied.[86] In the case of long-term inflation expectations, their responsiveness to changes in short-term expectations is also examined, since short-term inflation expectations incorporate all information relevant to future inflation, and not only to current inflation (Buono and Formai, 2018). While anchored long-term inflation expectations should not react to new information at all, in the case of medium-term inflation expectations, some responsiveness is natural in the event of persistent shocks; however, attention should be paid to an increase in this responsiveness.

Regardless of whether they are measured with the use of aggregated or individual forecasts, implied long-term inflation expectations do not respond in a statistically significant way to inflation surprises related to CPI inflation or core inflation, or to the index of macroeconomic surprises (Table 7). Similarly, revisions of these expectations do not co-move with revisions of short-term

[85] Based on single-equation models estimated on quarterly data from 2011 Q4 to 2022 Q4. The dependent variable is a change (revision) in long- or medium-term inflation expectations. Each explanatory variable (macroeconomic surprises, change in short-term expectations) was considered separately. Several versions of these models were estimated: on a full sample with parameters constant in time, on a gradually expanded sample with parameters constant in time and on a full sample with time-varying parameters.

[86] Inflation surprise is the difference between the Statistics Poland inflation reading in the current period and its forecast according to a Bloomberg survey among analysts. The surprises included in the analysis also include Statistics Poland revisions of preliminary inflation estimates. The macroeconomic surprises index is the Citigroup Economic Surprise Index. Its positive value means that the readings of macroeconomic data indicated a stronger economic situation than analysts' forecasts.

expectations. These findings are confirmed by the estimates of the responsiveness of long-term inflation expectations to inflation surprises and to short-term expectations obtained from analogous models with time-varying parameters. In both cases, estimations of the reaction of long-term inflation expectations oscillate around zero and, apart from individual exceptions, are not statistically different from zero.

Models with time-varying parameters indicate that in 2022 the responsiveness of medium-term inflation expectations to inflation surprises and to short-term inflation expectations rose temporarily (Figure 52). This may indicate that experts perceived the increase in inflation in 2021-2022 as more persistent than in the past. At the end of 2022, this responsiveness approached its long-term average. On the other hand, estimates based on a gradually expanded sample, used in section 4.2, suggest an increased responsiveness of medium-term expectations to changes in short-term expectations throughout 2022.

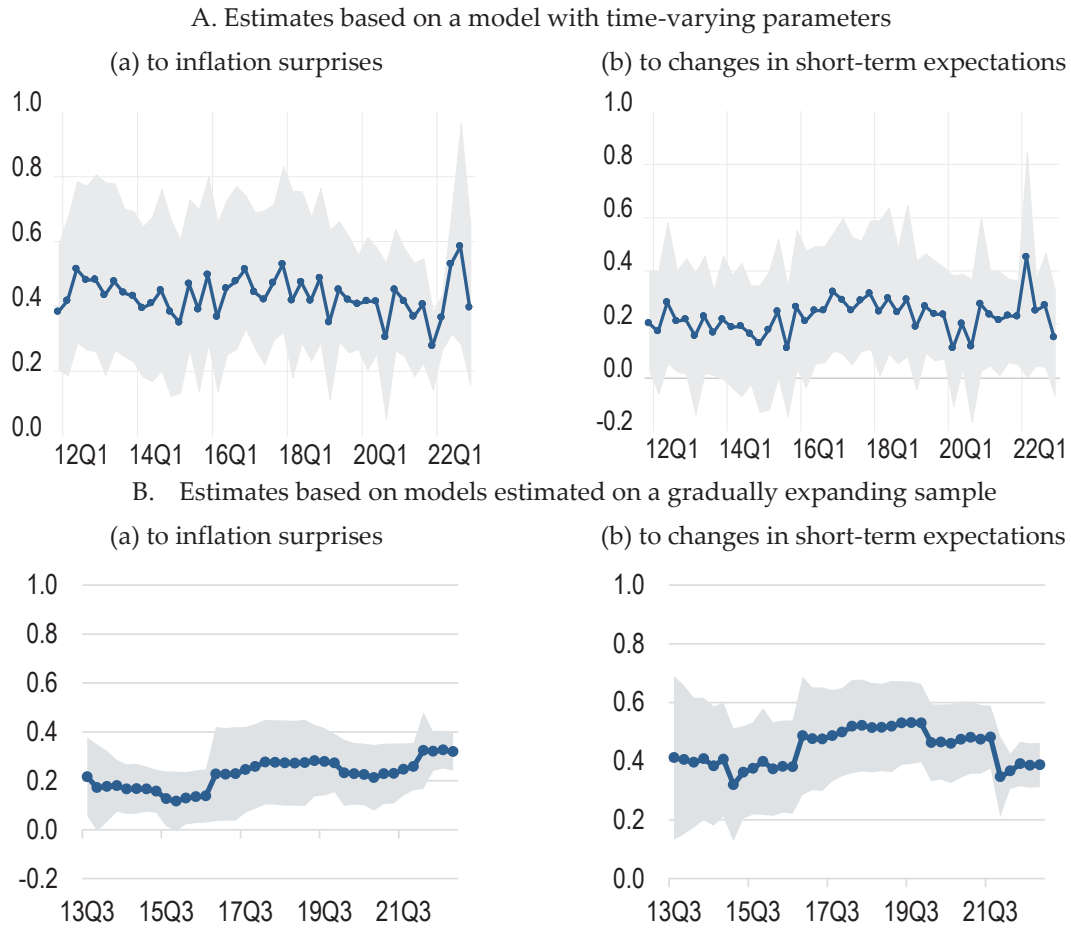
Table 7. Responsiveness of long-term inflation expectations of professional forecasters to current information

Measure of long-term expectations	Surprise in CPI inflation	Surprise in core inflation	Surprise index	Change in short-term inflation expectations
implied long-term expectations (based on aggregated data)	-0.05 (0.10)	0.24 (0.24)	-0.12* (0.07)	0.09 (0.06)
implied long-term expectations (based on individual data)	0.03 (0.04)	0.01 (0.09)	-0.004 (0.025)	0.04 (0.02)

Notes: The table presents the estimation of the parameter describing the reaction of the long-term inflation expectations of professional forecasters to macroeconomic surprises and to changes in short-term expectations (estimation error is given in brackets) obtained on the basis of single-equation linear regressions (each variable is considered separately). *** p<0.01; ** p<0.05; * p<0.1.

Source: NBP data. Own calculations.

Figure 52. Changes in responsiveness of medium-term inflation expectations of professional forecasters



Notes: The grey area marks the 95% confidence interval.

Source: NBP data. Own calculations.

4. Special topics

4.1. Central bank versus private sector experts' forecasts

An important element of the monetary policy transmission mechanism is the central bank's influence on the expectations of private agents through appropriate communication. A key instrument of central bank communication with the public is in turn the projection of inflation, GDP and other key macroeconomic variables. As Woodford (2005) indicates, by publishing its inflation projections, the central bank can directly influence inflation expectations and, consequently, achieve the desired goal of stabilising inflation, with lower volatility of output and shorter lags in the monetary policy transmission mechanism.

The literature points to two main reasons why professional private sector forecasters may incorporate central bank forecasts into their expectations. Firstly, the forecasters may believe that central bank forecasts are more accurate, for example due to larger resources allocated to the forecasting process at central banks than at private institutions. Secondly, private sector forecasters may believe that the central bank's forecasts contain signals concerning future monetary policy and its impact on the main macroeconomic aggregates. The reason is that when forecasting inflation or GDP at a certain level, the central bank has in hand instruments to bring both variables down to the levels provided in the projection (Hubert, 2011). Sometimes it is also pointed out that private agents may take into account the central bank's projections if they expect that the central bank has additional information which is not known to the private sector and which may affect the accuracy of the forecasts (de Mendonca and de Deus, 2019). The incorporation of information provided in central bank projections in setting forecasts by the private sector is possible in the sticky information models proposed by Mankiw and Reis (2002). In these models, the process of information propagation – for example from the central bank to private sector – occurs gradually under the assumption that the central bank has additional information available for use by private agents.

It is worth mentioning that the role of publication of macroeconomic forecasts by the central bank can also be considered in a broader sense, namely as providing free public information to the private sector. Theoretical models point to two major benefits resulting from disclosing public information on the economic situation to private agents. These include the ability to distinguish more accurately the signals coming from the economy from the information noise contained in the data (Woodford, 2001) and the reduced cost of collecting information, which in some cases may be quite significant (Mankiw, Reis, 2002). If the central bank holds more comprehensive information on economic developments than private agents, it may, in addition to influencing inflation expectations, also act as an institution providing additional free information to the agents.[87]

[87] However, in their theoretical discussion, Morris and Shin (2002) show that the coordinating effect caused by the public information may pose the risk of making the economy more exposed to common forecasts errors.

This part of the report presents the results of the study of the impact of the projections published by NBP on financial sector analysts' expectations regarding inflation and economic growth in Poland.[88] As part of its direct inflation targeting strategy, NBP publishes conditional forecasts of key macroeconomic variables, including CPI inflation and GDP. NBP published its first inflation projection in August 2004 and the first GDP projection in May 2005. Forecasts of both variables are published in the form of a fanchart, i.e., the probability distribution of the forecast, with the mode as the central path. In subsequent years, this set of forecasts was expanded to include further macroeconomic categories, for which, however, only central paths are published. The authors of the NBP projection are the bank's economists, and the projection itself is based on the NECMOD econometric model (Budnik *et al.*, 2009; Greszta *et al*., 2012). The projection is prepared under the assumption of constant NBP reference rate. The projection horizon usually covers the current calendar year and the following two years, although in certain situations it can be extended. Therefore, this horizon varies over time and typically ranges from 9 to 12 quarters depending on the month of publication.

The NBP projection is published in two stages. The 50% confidence intervals for inflation and GDP forecasts are communicated in a release following the Monetary Policy Council's (MPC) decision-making meeting, during which the Council discusses the projection. A few days later, the full projection is published as part of the *Inflation report*. The document contains a description of the forecast scenario and the central paths of the forecasts of the remaining macroeconomic categories, including the balance of risk. Given the scope of both parts of the projection publication, it can be assumed that for private sector economists compiling the forecasts, the information provided immediately after the MPC meeting may be sufficient for a potential modification of their forecasts. For this reason, this study uses the date of the MPC decision-making meeting during which the projection is presented and after which information on the confidence intervals for inflation and GDP forecasts is published as the date of publication of the projection.

In 2004, the inflation projection was published twice (in August and November), while in the following year it was published three times (in February, May, and August). As mentioned before, since May 2005, the inflation projection has been supplemented by a conditional GDP forecast. In 2006-2007, inflation and GDP projections were published four times a year, always in the last week of January, April, July, and October. Since 2008, NBP has been publishing a projection three times a year.[89]

The forecasts of private sector economists used in this study come from a monthly survey conducted by Refinitiv (formerly, Thomson-Reuters) among economists and market analysts employed by banks and other financial institutions who professionally deal with forecasting. They prepare forecasts of inflation, GDP, interest rates and other important macroeconomic categories related to the Polish economy. Survey participants are asked about future inflation and GDP

[88] This study is described in more detail in Kotłowski (2023).

[89] In the years 2008-2010, the projection was published in February, June and October, each time in the last week of the respective month. In 2011, the MPC's decision-making meeting was permanently moved forward by one week, accordingly, the publication of projections was also shifted from the last week of a given month to the first week of the following month.

growth for different forecast horizons – both fixed and varying. In order to keep in line with the NBP projection, whose horizon encompasses the current year and the following two years, the study takes into account analysts' forecasts set for a fixed point in time (the so-called *fixed date forecast*s), as in the case of the NBP projections. Financial sector analysts were not asked about the full forecast horizon, consistent with the NBP projection, in all rounds of the survey, which makes the length of the available sample different for each forecast horizon.

The aim of the study is to assess the extent to which the revisions of inflation and GDP forecasts made by financial sector analysts between the successive rounds of the Refinitiv survey in the months immediately after and before the publication of the NBP projections take into account the results of the NBP projections published in the meantime. The assessment of the impact of the NBP projections on market analysts' expectations was performed using a single-equation econometric model in which the revision of the median of analysts' forecasts (inflation or GDP) depends on the deviation of the median of analysts' forecasts from the survey before the publication of the projections and the central projection path for a specific horizon.[90] Moreover, the model takes into account other variables that may affect the revision of financial sector analysts' forecasts, in particular surprises in the releases of current inflation and current GDP growth, changes in commodity prices and changes in the exchange rate. Forecasts of CPI inflation and GDP growth for the current year *(h=0)*, for the next year *(h=1)* and two years ahead *(h=2)* were considered. A separate model was estimated for each of the variables and for each forecast horizon. As a consequence, the subject of estimation were the parameters of six versions of the single equation econometric model, estimated using the Newey-West estimator[91] taking into account the potential autocorrelation of the error term. The study covers the period from May 2005 to March 2023 and, as already mentioned, the number of observations for individual model variants was different and ranged from 30 to 52 observations.

The detailed form of the model on which the study was based can be expressed as follows:

$$\Delta X_t^h = \alpha_0 + \beta\left(Y_t^h - X_{t-1}^h\right) + \alpha_1 \Delta X_{t-1}^h + \gamma Z_t + \varepsilon_t$$

where ΔX_t^h denotes a change in the median of analysts' forecasts (regarding inflation or GDP) in the survey conducted immediately after the publication of the projection; $Y_t^h - X_{t-1}^h$ expresses a difference between the NBP projection and the median of analysts' forecasts (inflation or GDP) from a survey conducted immediately prior to the publication of the projection; and Z_t denotes the vector of other variables that may affect the revision of projections.[92] A positive and statistically

[90] Similar approach is used, among others, by Pedersen (2015) and de Mendonca and de Deus (2019).

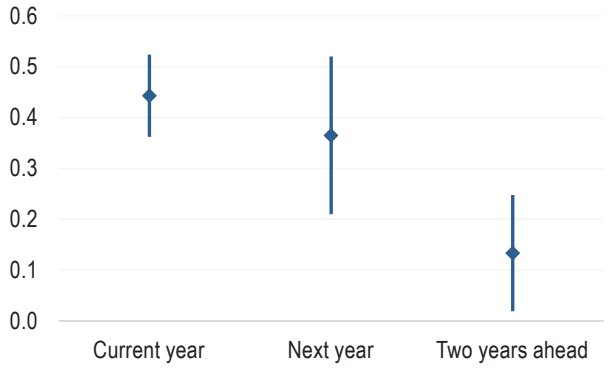
[91] As a part of the robustness analysis, the parameters of all versions of the model were also estimated using the *jackknife* method, which is more robust to the presence of outliers and jointly for the inflation and GDP forecasts using the *Seemingly Unrelated Regressions* (SUR) method to account for the potential interdependence of the error terms from the equations. The results obtained do not change the main conclusions stemming from the baseline approach.

[92] They include the difference between the latest CPI y-o-y inflation release and the median of analysts' forecasts formulated one month ahead – the so-called inflation surprise (only in the equation for inflation forecasts – source: Statistics Poland, Refinitiv); the difference between the latest GDP y-o-y release and the median of analysts' forecasts formulated one month ahead – the so-called surprise in GDP data (only in the equations for GDP forecasts – source: Statistics Poland, Refinitiv); changes in the value of the index of energy commodity prices (source: World Bank) and changes in the nominal effective exchange rate (source: BIS).

significant estimate of parameter β, means that the publication of the central bank projection is accompanied by a revision of financial sector analysts' forecasts towards the central NBP projection path.

The results obtained indicate that, in the period under consideration, the publication of the NBP projection had a statistically significant impact on the revision of the median forecast of CPI inflation of market analysts for each of the horizons considered, i.e., for the current year, for the next year and for two years ahead (Figure 53). Following the publication of the NBP projections, private sector economists revised their forecasts so that their median shifted towards the central projection path. The publication of the projection resulted in the largest revision of the CPI inflation forecasts for the current and next year. The 1 p.p. difference between the central projection path and the median forecasts of analysts in the pre-publication survey translated into a 0.44 p.p. change in the median forecasts for the current year and a 0.37 p.p. change in the forecasts for the next year. In contrast, the impact of the projection publication on the revision of inflation forecasts two years ahead seems noticeably weaker, although still statistically significant. In this case, a 1 p.p. deviation of the median in analysts' forecasts from the projections leads to a 0.13 p.p. revision of the forecasts. This result can reflect a larger role of the NBP inflation target for the formation of two-year-ahead forecasts than for shorter-term forecasts. Indeed, in its communication NBP clearly emphasises the medium-term nature of the inflation target (NBP, 2003) and analysts may identify the medium term with a longer projection horizon. The greater relevance of inflation target and the lower relevance of inflation projections for longer-horizon forecasts is also shown in studies for other economies, including the euro area (Łyziak and Paloviita, 2017).

Figure 53**.** The strength of the impact of the NBP projection publication on changes in the median of CPI inflation forecasts of private sector economists

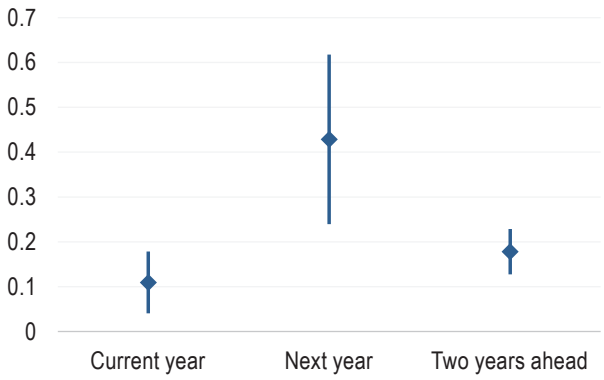


Notes: The chart shows the point estimate and the 90% confidence interval for the parameter measuring the relationship between the deviation of the projection central path from the median forecasts of CPI inflation of private sector economists in the survey immediately preceding the publication of the projection and the change in the economists' median forecasts in the survey conducted immediately after the publication of the projection (parameter β in the estimated equation).

Source: NBP, Refinitiv and Statistics Poland data. Own calculations.

The projections disclosed by the central bank affect the private sector GDP forecasts set also for all examined horizons, i.e., for the current year, for the next year and two years ahead (Figure 54). The impact of the projection on the next-year GDP forecasts is stronger than on two-year-ahead forecasts and on the forecasts for the current year. The initial discrepancy between the central path of the NBP projection and the median of individual GDP forecasts by 1 p.p. results in the adjustment of the median forecast by 0.43 p.p. for the next year, by 0.18 p.p. for two years ahead and by 0.11 p.p. for the current year.

Figure 54. The strength of the impact of the NBP projection publication on changes in the median of GDP growth forecasts of private sector economists



Notes: The chart shows the point estimate and the 90% confidence interval for the parameter measuring the relationship between the deviation of the projection central path from the median forecasts of GDP growth of private sector economists in the survey immediately preceding the publication of the projection and the change in the economists' median forecasts in the survey conducted immediately after the publication of the projection (parameter β in the estimated equation).

Source: NBP, Refinitiv and Statistics Poland data. Own calculations.

Among other factors considered, the revisions of financial sector analysts' forecasts were also affected by surprises in current inflation and GDP releases. They translated into adjustments of inflation forecasts for the current year and revisions of GDP forecasts for the current and next year, respectively. The revisions of inflation forecasts were also influenced by changes in energy commodity prices and, to a lesser extent, by the exchange rate movements.

4.2. Assessment of inflation expectations formation and their anchoring using heat maps

4.2.1. Introduction

Assessment of the degree of anchoring of inflation expectations is a complex task. Firstly, there are multiple measures of inflation expectations – formed by various groups of agents and related to different horizons. In narrow terms, the concept of inflation expectation anchoring refers to long-term expectations. However, medium- and short-term expectations can also signal risks of a de-anchoring of long-term expectations. Secondly, the concept of anchoring of inflation expectations

has several dimensions (e.g., Kumar *et al.*, 2015; Łyziak and Paloviita, 2017; Reis, 2022), referring to their level, the degree of uncertainty (divergence of opinions) of private sector agents, as well as the stability of these expectations (lack of responsiveness to short-term factors).

The aim of heat maps of inflation expectations is to present, in a synthetic and standardised way, a broad range of information concerning the evolution of inflation expectations of various groups of agents formed in different horizons. By showing the deviations of various expectation metrics from the levels considered as neutral, these maps facilitate the assessment of whether these metrics remain consistent with the concept of anchored expectations or whether they signal a risk of de-anchoring. Different colours illustrate the direction of deviation and its magnitude.

Two heat maps of inflation expectations are presented below. Map I is used to assess the degree of anchoring of long-term inflation expectations. Due to limited information on the long-term inflation expectations of economic agents (see section 3.4.2), it covers only experts' inflation forecasts. Map II, on the other hand, shows the metrics of short- and medium-term expectations of experts, enterprises, and consumers. The heat maps of inflation expectations in Poland presented in this report are inspired by the experience of the Bank of England (Anderson and Maule, 2014; Domit *et al.*, 2015), as well as the recent discussions at the *ESCB Expert Group on Inflation Expectations* (EGIE) forum and the resulting heat maps of inflation expectations in the euro area (Meyler *et al.*, eds., 2021).

4.2.2. The concept of anchored inflation expectations

Fully anchored long-term inflation expectations should be consistent with the central bank's inflation target and should be stable over time. This translates into a number of more specific empirically verifiable anchoring criteria (Kumar *et al.*, 2015). Firstly, on average, the level of inflation expectations should not deviate from the central bank's inflation target. Secondly, private sector agents should be confident that future inflation will be close to the inflation target, so that the individual uncertainty of agents setting expectations, as well as the divergence of those expectations between agents should be low. Thirdly, long-term expectations should not respond to current economic data, particularly to information on current inflation. In addition, long-term inflation expectations should not be sensitive to revisions of shorter-term inflation expectations, which incorporate all information relevant to the future inflation.

On the other hand, short- and medium-term inflation expectations may signal the risk of a decreasing degree of anchoring of inflation expectations. Obviously, persistently high short- and medium-term inflation expectations and the elevated uncertainty regarding future inflation may indicate the risk of de-anchoring of long-term inflation expectations. An important aspect to consider, however, is the consistency of these expectations with the central bank communication, i.e., the inflation projection. Short- and medium-term inflation expectations may in fact deviate from the central bank inflation target due to various shocks – particularly strong and persistent shocks – and lags in the monetary transmission mechanism, but they should be consistent with the central bank inflation projection. Instead, the risk of de-anchoring long-term expectations could appear if,

following an inflation shock, the expectations of private sector were to rise to a larger extent than suggested by the inflation projections published by monetary authorities and return more slowly to the inflation target (Domit *et al*., 2015). The strength of the response of short- and medium-term inflation expectations to inflation shocks is also important. The increased responsiveness of these expectations does not necessarily indicate declining confidence in the determination or effectiveness of monetary policy in terms of counteracting rising inflation. It may also be the result of the perceived larger inflation persistence. An additional factor reinforcing the risk of de-anchoring long-term inflation expectations is the uncertainty of private sector agents regarding the future inflation.

4.2.3. Construction of heat maps of inflation expectations

4.2.3.1. Inflation expectations and their metrics included in the heat maps

Heat maps are based on survey inflation expectations. Map I refers to long-term inflation expectations of professional forecasters. The horizon for these expectations is the next five years (annual average) or implied inflation in the fourth and fifth year of the forecast horizon (annual average). The heat map of short- and medium-term inflation expectations (Map II) takes into account short-term inflation expectations of consumers (in 12-month horizon), enterprises (in 3-month and 12-month horizon) and financial sector analysts (in 4-quarter horizon), as well as the short- and medium-term forecasts of professional forecasters (in 4-quarter and 8-quarter horizons). Each of the heat maps is divided into a section concerning the level of inflation expectations, responsiveness and uncertainty (or dispersion) of expectations. A detailed description of the metrics used in both maps is presented in Table 8 and Table 9.

Inflation expectation heat maps use colours of different shades to illustrate whether, in a given period *(t*), different metrics of inflation expectations, $m_{i,t}$, remain at their neutral level, $m_{i,t}^{*}$, consistent with the concept of anchored expectations, or deviate from it. Deviations of individual inflation expectation metrics from their neutral levels are expressed in units of variability of a particular metric, approximated by its standard deviation, $\sigma_{i,t-1}$. For the specific period and a particular inflation expectation metric, the colour (temperature) assigned to it depends on the index $h_{i,t}$, indicating by how many standard deviations the metric deviates from its neutral level:

$$h_{i,t} = \frac{m_{i,t} - m_{i,t}^{*}}{\sigma_{i,t-1}}$$

If the index $h_{i,t}$ is close to zero, it means that the *i*-th metric of inflation expectations in period t remains close to its neutral level, which corresponds to the white colour on the heat map. The more $h_{i,t}$ deviates from zero, the darker the shade of the colour signalling the deviation of the inflation expectation metrics from their neutral levels.

Table 8. Inflation expectation metrics included in Map I

Heat map row	Name	Explanation	Data source
I.1.	Average inflation over next 5 years (aggregated)	Average inflation expected by professional forecasters over the next 5 years (annual average). It is a median of the aggregate distribution, obtained by aggregating individual probabilistic forecasts.	NBP Survey of Professional Forecasters (NBP SPF), own calculations.
I.2.	Average inflation over next 5 years (individual)	Average inflation expected by professional forecasters over the next 5 years (annual average). This is the median of individual point forecasts.	NBP SPF, own calculations.
I.3.	Inflation in 4th and 5th year of the forecasting horizon (implied, aggregated)	Implied expected inflation by professional forecasters in the 4th and 5th year of the forecast horizon (annual average), derived from inflation forecasts in the current year and the following two years and average annual inflation over the next five years. Medians of aggregate forecast distributions were used in the calculations.	NBP SPF, own calculations.
I.4.	Inflation in 4th and 5th year of the forecasting horizon (implied, individual)	Implied expected inflation by professional forecasters in the 4th and 5th year of the forecast horizon (annual average), derived from inflation forecasts in the current year and the following two years and average annual inflation over the next five years. Individual point forecasts were used in the calculations and subsequently their median was determined.	NBP SPF, own calculations.
I.5., I.6.	Inflation in 4th and 5th year of the forecasting horizon (implied), response to inflation shock	Estimate of the response of implied inflation expected by professional forecasters in 4th and 5th year of the forecasting horizon (aggregated or individual) to inflation surprises on a gradually expanding sample. An inflation surprise is a difference between a forecast of current inflation (consensus from a Bloomberg survey) and its reading published by Statistics Poland.	NBP SPF, Bloomberg, own calculations.
I.7., I.8.	Inflation in 4th and 5th year of the forecasting horizon (implied), response to short-term inflation expectations	Estimate of the response of implied inflation expected by professional forecasters in 4th and 5th year of the forecasting horizon (aggregated or individual) to the change in their 4-quarter-ahead inflation expectations, on a gradually expanding sample. 4-quarter-ahead inflation expectations are measured as the median of the aggregate distribution or the median of the individual point forecasts.	NBP SPF, own calculations.
I.9.	Uncertainty about average inflation over next 5 years	Uncertainty concerning inflation over the next five years, based on forecasts of professional forecasters. It is measured as the difference between the 75th and 25th percentile of the distribution of aggregate inflation forecasts over the consecutive five years.	NBP SPF, own calculations.
I.10.	Disagreement of inflation expectations in 4th and 5th year of the forecasting horizon	The disagreement of implied inflation expected by professional forecasters in 4th and 5th year of the forecasting horizon, measured as the interquartile range of individual implied inflation forecasts.	NBP SPF, own calculations.

Table 9. Inflation expectation metrics included in Map II

Heat map row	Name	Explanation	Data source
II.1.	Enterprises, own prices in 3 months	Forecast of changes in enterprises' own prices over a 3-month horizon, seasonally adjusted.	NBP Quick Monitoring Survey (NBP QMS), own calculations.
II.2., II.3.	Enterprises, +12 months	Enterprises' inflation expectations in a 12-month horizon. A measure quantified based on qualitative survey responses using the probabilistic method.	NBP QMS, own calculations.
II.4.	Consumers, +12 months (probabilistic)	Consumers' inflation expectations in a 12-month horizon. A measure quantified based on qualitative survey responses using the probabilistic method. Quarterly average.	Statistics Poland, own calculations.
II.5.	Consumers, +12 months (quantitative)	Consumers' inflation expectations in a 12-month horizon. Average of quantitative declarations (after winsoring 5% highest and 5% lowest observations). Quarterly average.	Statistics Poland, own calculations.
II.6.	Financial sector analysts, +4 quarters	Inflation expected by financial sector analysts in 4 quarters. Median of point forecasts in the last month of the quarter.	Refinitiv, own calculations.
II.7.	Professional forecasters, +4 quarters	Inflation expected by professional forecasters in 4 quarters. A median of the aggregate distribution, obtained by aggregating individual probabilistic forecasts.	NBP SPF, own calculations.
II.8.	Professional forecasters, +8 quarters	Inflation expected by professional forecasters in 8 quarters. A median of the aggregate distribution, obtained by aggregating individual probabilistic forecasts.	NBP SPF, own calculations.
II.9.	Professional forecasters, +4 quarters, probability of range (1.5; 3.5)	Probability of 4-quarter-ahead inflation being within the band of deviations from the NBP inflation target (1.5%-3.5%), based on the aggregate forecast distribution of professional forecasters.	NBP SPF, own calculations.
II.10.	Professional forecasters, +8 quarters, probability of range (1.5; 3.5)	Probability of 8-quarter-ahead inflation being within the band of deviations from the NBP inflation target (1.5%-3.5%), based on the aggregate forecast distribution of professional forecasters.	NBP SPF, own calculations.
II.11.	Professional forecasters, +8 quarters, response to inflation shock	Estimate of response of professional forecasters' inflation expectations in the 8-quarter horizon to inflation surprises on a gradually expanding sample. 8-quarter-ahead inflation expectations are measured as the median of the aggregated distribution. An inflation surprise is a difference between a forecast of current inflation (consensus from a Bloomberg survey) and its reading published by Statistics Poland.	NBP SPF, Bloomberg, own calculations.
II.12.	Professional forecasters, +8 quarters, response to short-term inflation expectations	Estimate of the response of professional forecasters' inflation expectations in the 8-quarter-ahead horizon to the change in their 4-quarter-ahead inflation expectations, on a gradually expanding sample. Expected inflation is measured as the median of the aggregated distribution.	NBP SPF, own calculations.
II.13.	Enterprises, +12 months (disagreement)	The disagreement in enterprises' inflation expectations in 12-month horizon, based on qualitative responses (Index of Ordinal Variation, see Maag, 2009).	NBP QMS, own calculations.
II.14.	Consumers, +12 months (qualitative, disagreement)	The disagreement in consumers' inflation expectations in 12-month horizon, based on qualitative responses (Index of Ordinal Variation, see Maag, 2009). Quarterly average.	Statistics Poland, own calculations.

Heat map row	Name	Explanation	Data source
II.15.	Consumers, +12 months (quantitative, disagreement)	The disagreement in consumers' inflation expectations in 12-month horizon, based on quantitative declarations. Measured as the coefficient of variation across consumers. Quarterly average.	Statistics Poland, own calculations.
II.16.	Professional forecasters, +4 quarters (uncertainty)	Uncertainty of 4-quarter-ahead inflation, based on the aggregate forecast distribution and measured as the difference between the 75th and 25th percentile.	NBP SPF, own calculations.
II.17.	Professional forecasters, +8 quarters (uncertainty)	Uncertainty of 8-quarter-ahead inflation, based on the aggregate forecast distribution and measured as the difference between the 75th and 25th percentile.	NBP SPF, own calculations.

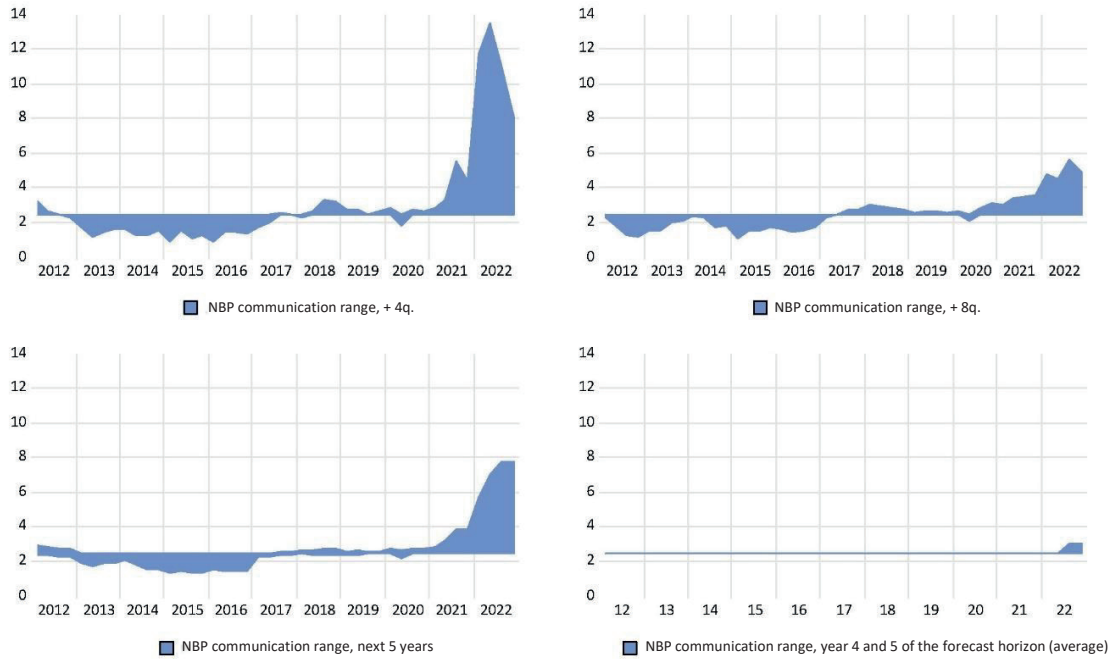
4.2.3.2. Neutral levels of inflation expectation metrics

Neutral levels of inflation expectation metrics depend on the feature of expectations under consideration (level, responsiveness, uncertainty) and their horizon (long or short- to medium-term) and, in certain cases, on the type of agents setting expectations.

When assessing the levels of expectations, the neutral values of the inflation expectations of financial sector analysts and professional forecasters are approximated by the so-called NBP communication range (Figure 55). For each of the observations of inflation expectations, this range is limited, on the one hand, by the NBP inflation projection published as close as possible to the time of declaring inflation expectations[93] and, on the other hand, by the NBP inflation target (2.5%). We assume that while short- and medium-term inflation expectations may deviate from the NBP inflation target, their deviation from the central bank's communication range, implying inconsistency of private sector assessments with the central bank communication, would indicate, among other things, a risk of de-anchoring of long-term inflation expectations. The inclusion of central bank projections – rather than just the inflation target – in the assessment of the level of long-term expectations results from the specific nature of the available measures of long-term inflation expectations of professional forecasters. This is because the original measure of inflation expectations of professional forecasters with the longest horizon relates to the average inflation over the next five years. Since the forecast at this horizon is affected by inflation expected in the near future, comparing this measure with the NBP inflation target rather than with the NBP communication range in assessing the degree of anchoring would be misleading. In the case of the alternative measure of long-term expectations, i.e., the implied inflation in the fourth and fifth year of the forecast horizon, its horizon overlapped with the extended horizon of the November 2022 NBP projection, which also justifies the comparison to the NBP communication range.

[93] Heat map data are presented at a quarterly frequency, while NBP inflation projections are published three times a year (in March, July, and November). Due to this discrepancy, Q3 and Q4 expectations are compared to the November NBP projections.

Figure 55. NBP communication range for short-, medium- and long-term forecasts (%)



Notes: For the long-term horizon covering the current year and the successive four years, the communication range limits are determined for each of these years separately and then averaged. For years not covered by the NBP inflation projections, the limits of the communication range are reduced to a single point, i.e., the NBP inflation target.

Source: NBP data. Own calculations.

In the case of short-term consumer inflation expectations, which are significantly biased[94], the neutral value of the level of expectations is approximated by the level of the long-term average of these expectations. On the other hand, for enterprises forming expectations in a way that combines the characteristics of inflation expectations of consumers and professional forecasters, the neutral value of the level of expectations is approximated either by their long-term average or by the NBP communication range. Inflation expectations running at near-neutral levels are marked in white on the heat map, while their upward (downward) deviations from neutral values are marked in shades of red (blue). Figure 56 illustrates the metrics of the level of inflation expectations against neutral values when the reference point is the long-term average, while Figure 57 – when the reference point is the communication range.

[94] This is a typical feature of survey measures of consumer inflation expectations found in many economies (see Arioli *et al.*, 2016).

Figure 56. Inflation expectations of enterprises (CPI in 12 months) vs. long-term average (Map II.2)

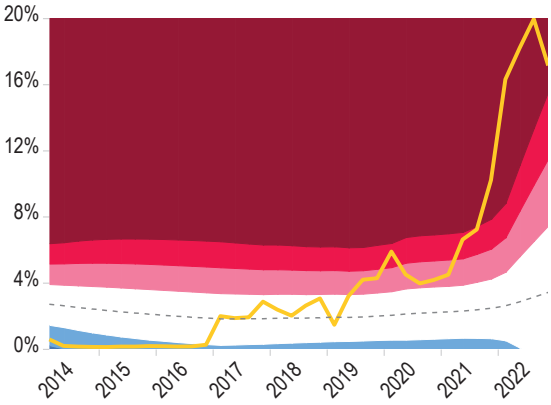
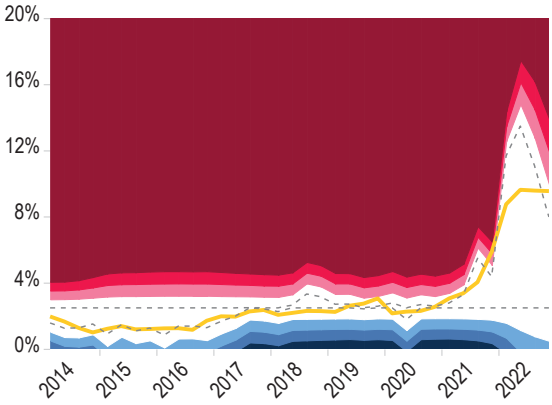
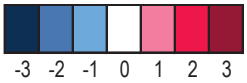


Figure 57. Inflation expectations of professional forecasters (+4q) vs. NBP communication range (Map II.7)



Notes: The yellow line represents an inflation expectation metric, while the dashed line represents neutral values (point or range). Legend: distance from the neutral value (in standard deviations of the variable):



Source: NBP and Statistics Poland data. Own calculations.

Additionally, Map II includes probabilities of inflation within the range of deviations from the NBP inflation target (1.5%-3.5%) in the short and medium term, derived from the aggregate forecast distributions of professional forecasters, relative to their long-run averages. A probability close to the average (or higher) corresponds to the white colour on the heat map, while the downward deviation of this probability from the long-term average is indicated by shades of grey (see the example graph of the metrics against neutral values: Figure 60).

Neutral values for the metrics of responsiveness of inflation expectations to short-term factors are determined depending on the horizon to which the expectations relate. While long-term inflation expectations should not react to short-term factors (in statistical terms, the response should not be significantly different from zero[95]), shorter-term expectations may show such a response. Therefore, in the case of these expectations, it is not the responsiveness itself that should attract attention, but rather its strengthening. Accordingly, the neutral value for the responsiveness of long-term expectations is zero (see the example: Figure 58), while for medium-term forecasts, the average response in the sample (see the example: Figure 59).

[95] Statistically insignificant (at the 10% level) and negative estimates of responsiveness of expectations are treated as zero.

Figure 58. Response of long-term expectations (in 4th and 5th year) to change in short-term expectations (+4q) (Map I.7)

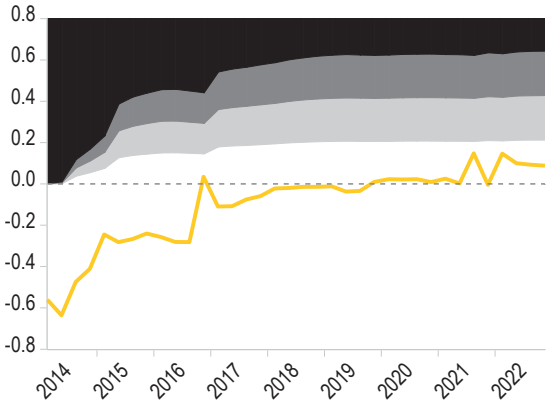
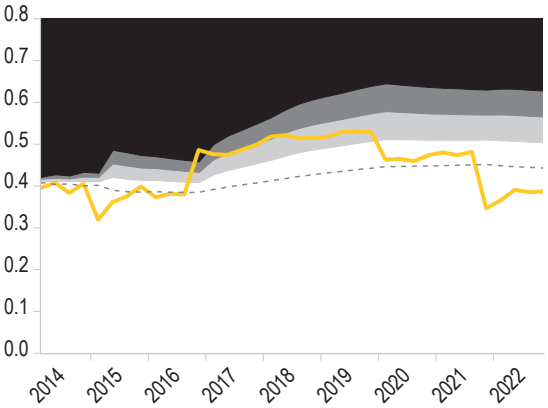
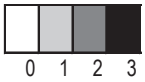


Figure 59. Response of medium-term expectations (+8q) to change in short-term expectations (+4q) (Map II.12)



Notes: The yellow line represents an inflation expectation metric, while the dashed line represents neutral values. Legend: distance from the neutral value (in standard deviations of the variable):



Source: NBP and Statistics Poland data. Own calculations.

The historical long-term cumulative average was used as a proxy for neutral levels of inflation expectation metrics related to inflation expectations divergence and uncertainty. An uncertainty close to the average or lower corresponds to the white colour on the heat map, while the upward deviations of the uncertainty from the long-term average are indicated by shades of grey (see the example graph of the metrics against neutral values: Figure 61).

Figure 60. Probability of 1.5%-3.5% range – inflation expectations of professional forecasters (+8q) vs. long-term average (Map II.10)

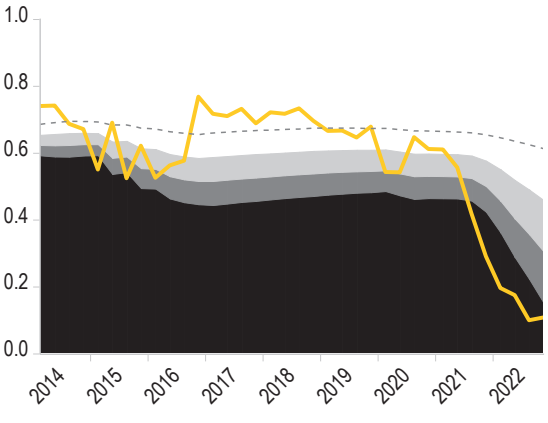
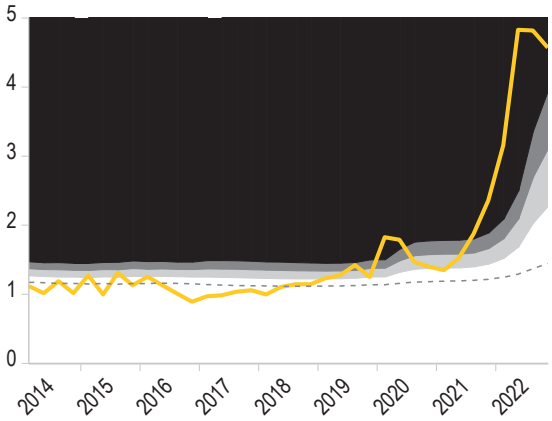
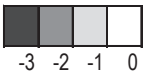
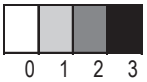


Figure 61. Uncertainty – inflation expectations of professional forecasters (+8q) vs. long-term average (Map II.17)



Notes: The yellow line represents particular metrics of inflation expectations, while the dashed line represents neutral values. Legend: distance from the neutral value (in standard deviations of the variable):





Source: NBP and Statistics Poland data. Own calculations.

4.2.4. Heat maps of inflation expectations

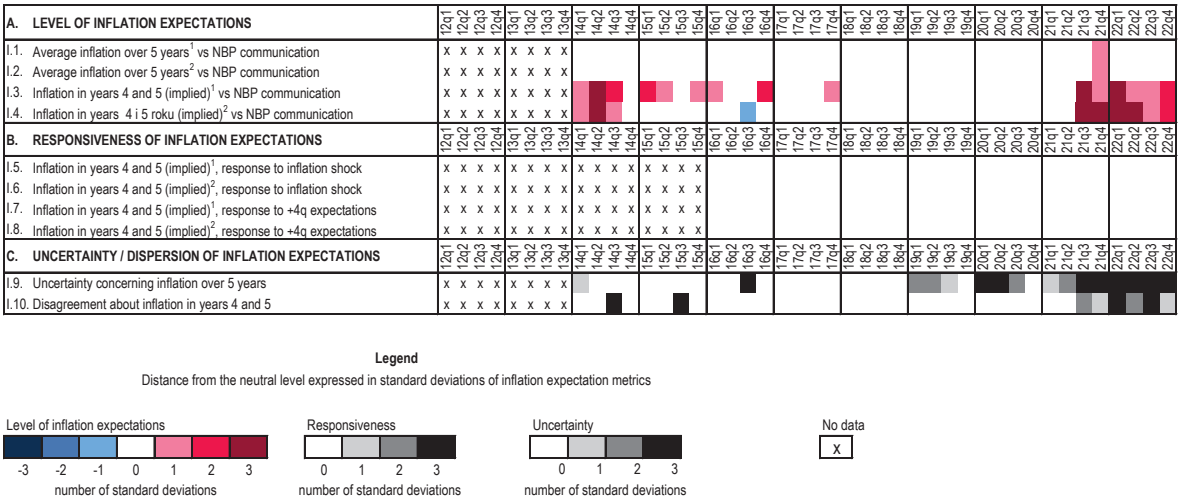
Heat maps of inflation expectations in Poland (Figure 62, Figure 63) indicate that, despite a strong rise in inflation in the recent period, the responsiveness of these expectations to inflation surprises and to changes in short-term expectations has not increased. On the other hand, experts' long-term forecasts and some features of their short- and medium-term expectations suggest that inflation can only gradually decline towards the inflation target.

The level of inflation expectations of professional forecasters for the next five years remains consistent with the NBP communication band. At the same time, since mid-2021, a period of sharp increases in energy commodity prices, experts have predicted that inflation would remain above the NBP inflation target for an extended period of time – the experts' implied forecasts for the fourth and fifth year of the forecast horizon have increased, placing them closer to the upper limit of deviations from the NBP inflation target (see section 3.4.2, in particular Figure 51). However, the increase in the implied long-term expectations relative to the rise in current inflation or short- to medium-term expectations is small. Due to the low volatility of implied inflation in the fourth and fifth year of the forecasting horizon, even slight deviations from the NBP inflation target result in a change of colour on the heat map. When analysing this measure, it should also be borne in mind that, due to its implied nature, it may be subject to higher measurement error than expected inflation over the next five years.

Medium-term inflation expectations of private sector experts remain, apart from isolated observations, consistent with the NBP communication band. However, their responsiveness to inflation shocks has increased recently, like the uncertainty of these forecasts. In addition, short-term consumer and enterprises inflation expectations remain at markedly elevated levels.

The analysis of the heat maps of inflation expectations thus provides important information from the point of view of the monetary policy transmission mechanism and its changes over the recent period. It indicates that the inflation expectations of private sector experts remain consistent with the scenario of inflation returning to the inflation target outlined in the central bank inflation projections. The increased responsiveness medium-term inflation expectations of private sector experts to inflation shocks resonates with the findings of the research presented in section 3.4.1 of the report, showing an increase in the responsiveness of short-term inflation expectations of consumers, enterprises and financial sector analysts to changes in current inflation.

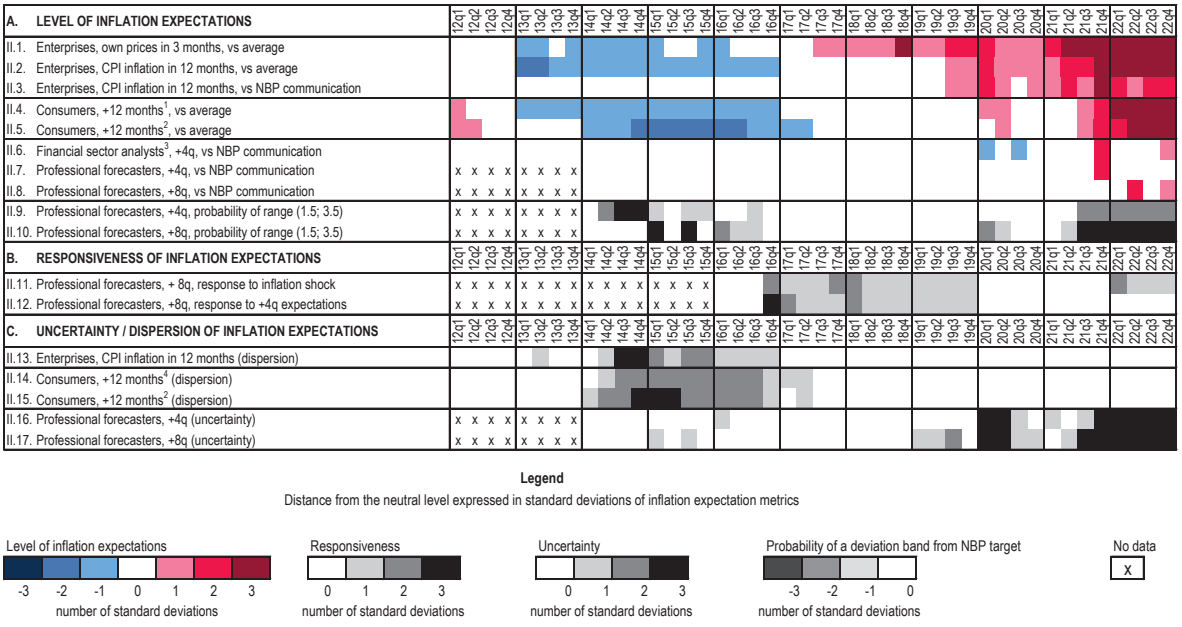
Figure 62. Heat map of long-term inflation expectations (Map I)



Notes: [1] – long-term expectations based on aggregate distribution; [2] – long-term expectations based on individual forecasts.

Source: NBP data. Own calculations.

Figure 63. Heat map of short- and medium-term inflation expectations (Map II)



Notes: [1] – quantified measure; [2] – quantitative measure; [3] – last forecast in the quarter; [4] – qualitative question. The inflation expectations of professional forecasters relate to the aggregated distribution.

Source: NBP and Statistics Poland data. Own calculations.

Conclusion

The findings of the research presented in this report confirm that despite the shocks that have affected the global and domestic economy in recent years, NBP monetary policy influences macroeconomic aggregates and its transmission occurs via various channels. The traditional interest rate channel is enhanced by the exchange rate channel and the credit channel as well as by the adjustment of private sector inflation expectations to changes in the central bank interest rates and communication. Although the point responses of economic activity and inflation to a monetary policy shock seem, in absolute terms, smaller recently than in previous periods, this is probably the result of a higher precision of current estimates (due to increased volatility of interest rates) rather than a manifestation of a real weakening in the monetary policy transmission.

Worth mentioning are new research areas and new research tools employed in this report. Firstly, in view of the ongoing reform of interest rate benchmarks, monetary policy transmission to WIRON rates was investigated for the first time. Secondly, the range of data analysed from the perspective of the operation of the credit channel was extended. Regarding the bank lending channel, both the commercial and cooperative banking sectors were included, and with regard to commercial banks' lending policy, both corporate and household loans were accounted for. Thirdly, the impact of global factors and the domestic monetary policy (including a purchase of Treasury securities and debt securities guaranteed by the Treasury in the secondary market under structural open market operations) on the path of the exchange rate was evaluated. Fourthly, a comprehensive analysis of the process of formation of inflation expectations was conducted, involving the use of the so-called heat maps, as well as the assessment of the impact of the projections published by NBP on private sector forecasts was updated. Fifthly, an analysis of changes in price stickiness was carried out based on the latest results from the business survey. Importantly, a range of additional variables were included in the analysis of the monetary policy transmission, thanks to which it was possible to control – at least to some extent – the effects of the last two years' shocks and of the monetary policy response to them.

The monetary policy transmission mechanism remains an area which requires extensive research. In particular, in the future it will be necessary to examine the impact of elevated inflation on the characteristics of inflation processes relevant to the monetary policy transmission mechanism. In the research presented in this report, this impact may not yet have materialized in full.

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Appendices

Appendix 1

Small Structural Model of Monetary Policy

The Small Structural Model of Monetary (MMPP) is built in a New-Keynesian framework around four basic macroeconomic relationships: the aggregate demand curve, the exchange rate equation, the Phillips curve, and the monetary policy rule (see Łyziak, 2016). The canonical form of the model was extended to include additional variables, in particular various measures of inflation (CPI inflation, inflation excluding food and energy prices, food price growth, energy price growth) and inflation expectations (survey measures of expectations of enterprises, consumers, and financial sector analysts). Below we present estimates of the model equations (Table A1.1) and the dynamic features of the model (Figure A1.1, Figure A1.2, Figure A1.3).

Table A1.1. Specification and estimation results of MMPP model

Aggregate demand curve		
$\hat{y}_t = \alpha_1 \hat{y}_{t-1} + \alpha_2 \hat{y}_t^{EA} + (1-\alpha_1-\alpha_2) E_t \hat{y}_{t+1} + \alpha_3 \hat{r}_t + \alpha_4 \hat{s}_t + \varepsilon_t^{\hat{y}}$		
Parameter	**Mean (st. dev.)**	**Notes**
α_1	0.422*** (0.004)	Symbols: $\hat{y}$ – domestic output gap, $\hat{y}^{EA}$ – output gap in the euro area, $\hat{r}$ – real interest rate gap (based on *shadow interest rate*), $\hat{s}$ – real effective exchange rate gap (increase – appreciation of domestic currency), E_t – expectation operator.
α_2	0.213*** (0.005)	
α_3	-0.098*** (0.003)	
α_4	-0.012*** (0.001)	
adjusted R^2	***0.79***	

Exchange rate equation		
$e_t = \beta_1 E_t e_{t+1} + (1-\beta_1) e_{t-1} + 0.25(i_t - i_t^{EA}) + \beta_2 (\hat{y}_t - \hat{y}_t^{EA}) + \varepsilon_t^e$		
Parameter	**Mean (st. dev.)**	**Notes**
β_1	0.314*** (0.006)	Symbols: e – nominal effective exchange rate (increase – appreciation of domestic currency), i – nominal short-term interest rate (WIBOR 3M), i^{EA} – nominal short-term interest rate in the euro area (EURIBOR 3M), $\hat{y}$ – domestic output gap, $\hat{y}^{EA}$ – output gap in the euro area, E_t – expectation operator.
β_2	0.183*** (0.041)	
adjusted R^2	***0.91***	

Hybrid New Keynesian Phillips curve		
$\pi_t^c = \gamma_1 \pi_{t+4\|t}^{e[e]} + (1-\gamma_1)\pi_{t-1}^c + \gamma_2 \hat{y}_t + \gamma_3 \hat{s}_t + \varepsilon_t^{\pi^c}$		
Parameter	**Mean (st. dev.)**	**Notes**
γ_1	0.181*** (0.004)	Symbols: π^c – annualised core inflation (net of food and energy prices), $\pi^{e[e]}$ – short-term inflation expectations of enterprises, $\hat{y}$ – domestic output gap, $\hat{s}$ – real effective exchange rate gap (increase – appreciation of domestic currency)
γ_2	0.177*** (0.006)	
γ_3	-0.019*** (0.002)	
adjusted R^2	***0.87***	

Food price inflation		
$\pi_t^f = \tau_1 \pi_{t-1}^f + \tau_2 \Delta e_t^{USD} + \tau_3 \Delta fpi_t^{PLN} + \tau_4 \pi_{t-1}^{c,q} + \tau_5 [p_{t-1}^f - \tau_6 fpi_{t-1}^{PLN} - (1-\tau_6)p_{t-1}] + \varepsilon_t^{\pi^f}$		
Parameter	**Mean (st. dev.)**	**Notes**
τ_1	0.509*** (0.028)	Symbols: π^f – food price inflation (quarter on quarter), e^{USD} – USD/PLN exchange rate (increase – appreciation of domestic currency), fpi^{PLN} – index of global food commodity prices expressed in terms of domestic currency, $\pi^{c,q}$ – core inflation (quarter on quarter, excluding food and energy prices), p^f – food price level, p – overall CPI price level, Δ – difference operator.
τ_2	-0.035*** (0.006)	
τ_3	0.034*** (0.005)	
τ_4	0.232*** (0.054)	
τ_5	-0.049*** (0.006)	
τ_6	0.902*** (0.095)	
adjusted R^2	***0.47***	

Energy price inflation		
$\pi_t^{en} = \vartheta_1 \pi_{t-1}^{en} + \vartheta_2 \Delta e_t^{USD} + \vartheta_3 \Delta epi_t^{PLN} + \vartheta_4 \pi_{t-1}^{c,q} + \vartheta_5 [p_{t-1}^{en} - \vartheta_6 epi_{t-1}^{PLN} - (1-\vartheta_6)p_{t-1}] + \varepsilon_t^{\pi^{en}}$		
Parameter	**Mean (st. dev.)**	**Notes**
ϑ_1	0.059** (0.028)	Symbols: π^{en} – energy price growth (quarter on quarter), epi^{PLN} – index of energy commodity prices expressed in terms of domestic currency $\pi^{c,q}$ – core inflation (quarter on quarter, excluding food and energy prices), p^{en} – energy price level, p – overall CPI price level, Δ – difference operator.
ϑ_2	-0.122*** (0.007)	
ϑ_3	0.111*** (0.004)	
ϑ_4	0.982*** (0.088)	
ϑ_5	-0.034*** (0.003)	
ϑ_6	0.874*** (0.085)	
adjusted R^2	***0.65***	

Inflation expectations of enterprises		
$\pi_{t+4\|t}^{e[e]} = \omega_1^{[e]} \pi_{t-1} + \omega_2^{[e]} \pi_{t+3\|t-1}^{e[f]} + \left(1 - \omega_1^{[e]} - \omega_2^{[e]}\right) \pi_{t+4} + \varepsilon_t^{\pi^{e[e]}}$		
Parameter	**Mean (st. dev.)**	**Notes**
$\omega_1^{[e]}$	0.366*** (0.007)	Symbols: $\pi^{e[e]}$ – short-term inflation expectations of enterprises, π – CPI inflation y-o-y, $\pi^{e[f]}$ – short-term inflation expectations of financial sector analysts
$\omega_2^{[e]}$	0.335*** (0.008)	
adjusted R^2	***0.79***	

Inflation expectations of financial sector analysts		
$\pi_{t+4\|t}^{e[f]} = \omega_1^{[f]}\pi_{t-1} + \omega_2^{[f]}\pi_t^{tar} + \left(1 - \omega_1^{[f]} - \omega_2^{[f]}\right)\pi_{t+4} + \varepsilon_t^{\pi^{e[e]}}$		
Parameter	**Mean (st. dev.)**	**Notes**
$\omega_1^{[f]}$	0.173*** (0.002)	Symbols: $\pi^{e[f]}$ – short-term inflation expectations of financial sector analysts, π – CPI inflation y-o-y, π^{tar} – NBP inflation target.
$\omega_2^{[f]}$	0.718*** (0.002)	
adjusted R^2	***0.84***	

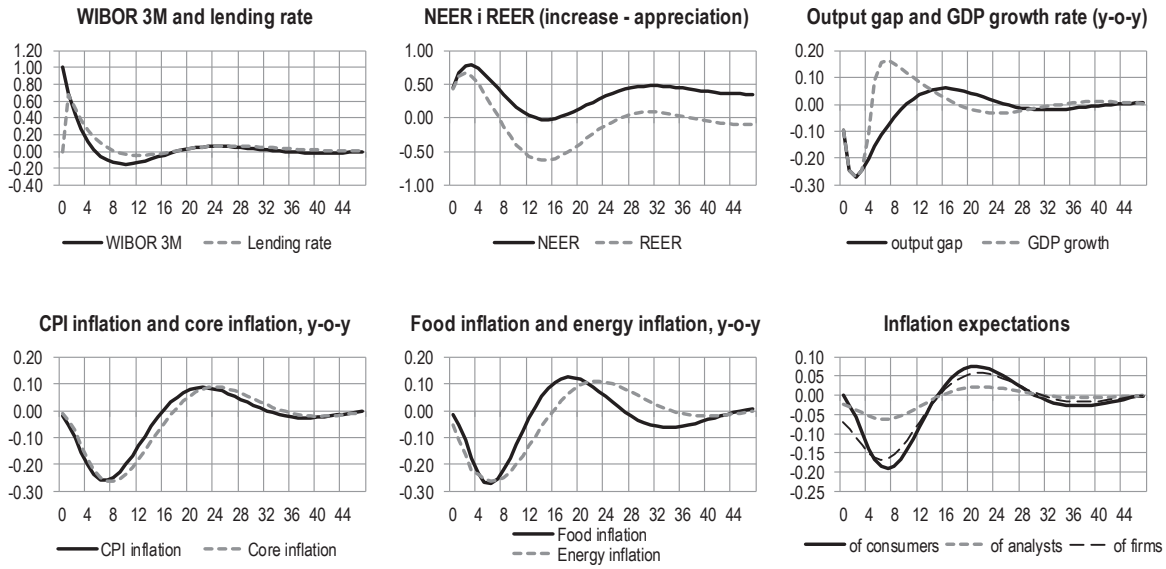
Inflation expectations of consumers		
$\pi_{t+4\|t}^{e[c]} = \omega_1^{[c]}\pi_{t-1}^{nc} + \left(1 - \omega_1^{[c]}\right)\pi_{t+3\|t-1}^{e[f]} + \varepsilon_t^{\pi^{e[e]}}$		
Parameter	**Mean (st. dev.)**	**Notes**
$\omega_1^{[c]}$	0.628*** (0.013)	Symbols: $\pi^{e[c]}$ – short-term inflation expectations of consumers, π^{nc} – food and energy price growth y-o-y, $\pi^{e[f]}$ – short-term inflation expectations of financial sector analysts.
adjusted R^2	***0.82***	

Monetary policy rule		
$i_t = \kappa_1 i_{t-1} + (1 - \kappa_1)\left[\kappa_2\left(\pi_t - \pi_t^{tar}\right) + \kappa_3\hat{y}_t\right] + \varepsilon_t^i$		
Parameetr	**Mean (st. dev.)**	**Notes**
κ_1	0.764*** (0.005)	Symbols: i – nominal short-term interest rate WIBOR 3M (*shadow rate*), π – CPI inflation yo-y, π^{tar} – NBP inflation target, $\hat{y}$ – domestic output gap.
κ_2	0.673*** (0.025)	
κ_2	1.078*** (0.026)	
adjusted R^2	***0.98***	

Notes: The MMPP model is estimated as a system of equations using the Generalised Method of Moments (GMM). The choice of the estimation technique is motivated by the fact that the model's forward-looking variables are represented either by survey data, prone to measurement error, or as their realised ex-post values. This means that the error in the equation with forward-looking variables is a combination of an exogenous shock and a measurement error or a random error characterising rational expectations (Cermeño and Villagómez, 2012). In line with the literature, our estimation employs past values of the explanatory variables as instruments (Beyer *et al.*, 2008). The basic set of instruments comprises four lags of the output gap, the exchange rate, CPI inflation and the interest rate, although the instruments vary slightly between the equations. The overidentifying restrictions test suggests the validity of the selected instruments. Standard errors of the estimations are given in parentheses (*** p<0.01; ** p<0.05; *p<0.1.). The sample period is 2001 Q1-2022 Q4.

Source: Own calculations.

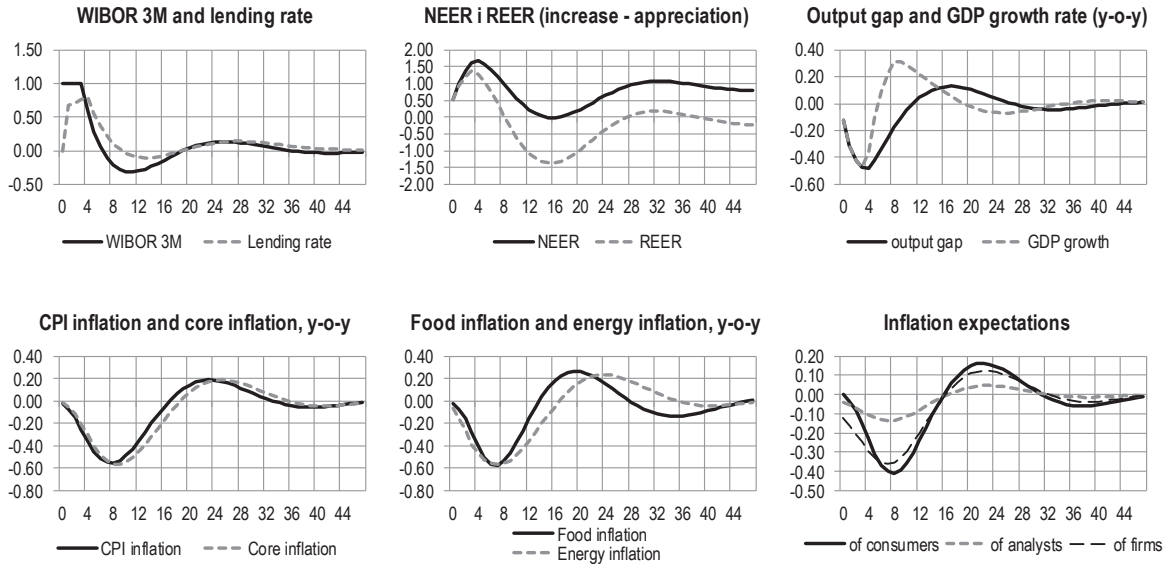
Figure A1.1. Response functions to interest rate impulse lasting 1 quarter



Notes: The above figures show the responses of selected variables to a 1 p.p. increase in the short-term interest rate lasting 1 quarter. The horizontal axis indicates the quarters after the shock.

Source: Own calculations.

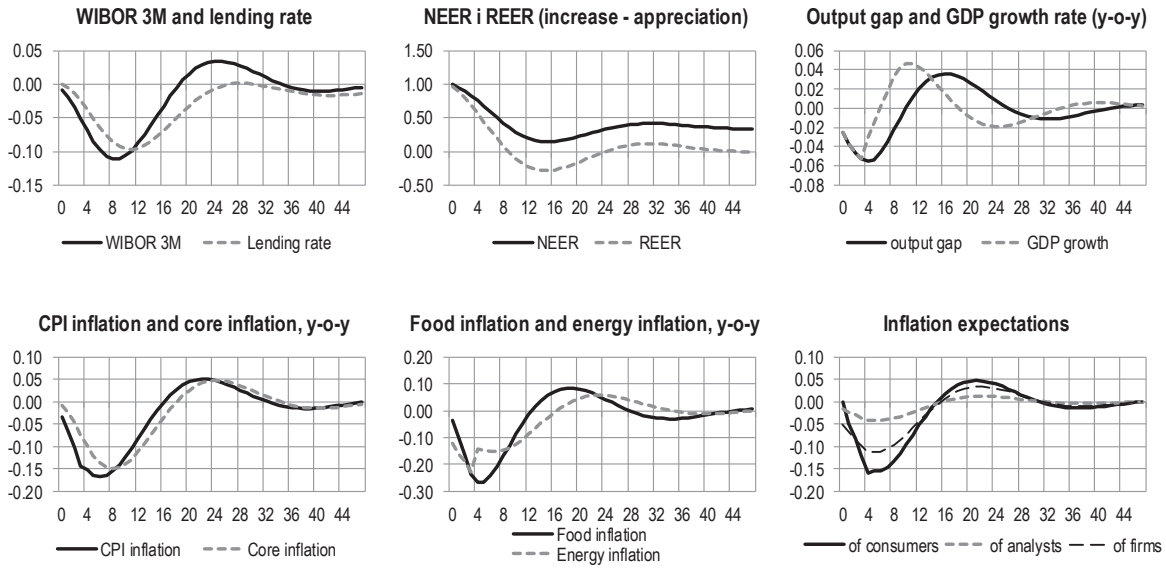
Figure A1.2. Response functions to interest rate impulse lasting 4 quarters



Notes: The above figures show the responses of selected variables to a 1 p.p. increase in the short-term interest rate lasting 4 quarters. The horizontal axis indicates the quarters after the shock.

Source: Own calculations.

Figure A1.3. Response functions to nominal effective exchange rate (NEER) impulse



Notes: The above figures show the response of selected variables to an appreciation of 1% in the zloty exchange rate lasting 1 quarter. The horizontal axis indicates the quarters after the shock.

Source: Own calculations.

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Appendix 2

Exploring the process of formation of short-term inflation expectations

Analysing the formation of short-term inflation expectations in Poland, the results of which are presented in section 3.4.1 of this report, we use the extended hybrid model of inflation expectations as proposed by Cerisola and Gelos (2009). The model was previously employed in the analysis of inflation expectations in Poland (Łyziak, 2016; Chmielewski *et al.*, 2020). In the model, inflation expectations are explained by past inflation, the central bank inflation target and a wide range of variables affecting future inflation. We express these variables in two ways: either as annual changes or, in line with the original approach, as deviations from a trend determined using the Hodrick-Prescott filter. The variables include: the real interest rate (r), the exchange rate (increase – depreciation) (e)[96], industrial output (y), unemployment rate (u), wages (w)[97] and budget deficit (d). In addition, in order to illustrate the impact of current price changes on inflation expectations, we use three measures of inflation that make up CPI inflation, i.e., core inflation excluding food and energy prices (π^c), food price growth (π^f) and energy price growth (π^{en}). In the study we consider inflation expectations of ($\pi^{e[\bullet]}$) consumers ($\bullet = c$), enterprises ($\bullet = e$) and financial sector analysts ($\bullet = f$), formed in the 12-month horizon. Due to the short-term nature of inflation expectations, we consider two elements of central bank communication, i.e., the NBP inflation target (π^{tar}) and NBP inflation projection (π^{proj}).[98]

The estimated equation takes the following form:

$$\pi^{e[\bullet]}_{t+12|t} = \alpha^{\pi^c}\pi^{c}_{t-1} + \alpha^{\pi^f}\pi^{f}_{t-1} + \alpha^{\pi^{en}}\pi^{en}_{t-1} + \alpha^{\pi^{tar}}\pi^{tar}_{t+12|t} + \alpha^{\pi^{proj}}\pi^{proj}_{t+12|t} + \alpha^{r}\Delta r_{t-1} + \alpha^{e}\Delta e_{t-1} + \alpha^{y}\Delta y_{t-1} + \\ + \alpha^{u}\Delta u_{t-1} + \alpha^{w}\Delta w_{t-1} + \alpha^{d}\Delta w_{d-1} + \varepsilon^{\pi^{e[\bullet]}}_{t}$$

We estimate the expectation models using monthly data[99] on a sample from 2003 to 2022 and using rolling estimation with 72-month windows. We use the OLS estimator with the Newey-West correction for heteroskedasticity and autocorrelation.

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[96] In the model on annual changes – a change in the nominal effective exchange rate; in the model on deviations – the real effective exchange rate gap.

[97] In the model on annual changes – a change in nominal gross wage; in the model on deviations – the real wage gap.

[98] Due to a high correlation of the latter with current core inflation, we include the NBP inflation projection as a residual from an equation in which it is explained by current inflation. Alternatively, it has been expressed as a deviation from current inflation – the results were very similar.

[99] Quarterly data are interpolated to monthly data.

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