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Contents

Abstract

In this research note I provide the first estimates of the transmission of monetary policy in Poland to risk-free rates, WIRON rates. I take into account the effects of changes in the policy rate, in the width of the standing facilities corridor and in the reserve position of the banking sector. I also make comparisons to the transmission to POLONIA and WIBOR rates. I find both the overnight and term WIRON rates to be affected by interest rate policy and other components of the operational framework of Narodowy Bank Polski. This makes the transmission similar as to the POLONIA rate, but to some extent different than to WIBOR rates. For the term rates, by construction, there are differences in transmission lags. This might have implications for the transmission mechanism of monetary policy in Poland in the future. The extent will depend on the character of changes in the policy rate (unexpected versus expected), and the term of the rate chosen for financial contracts and instruments. Given the limited number of observations, the conclusions should be treated with caution.

JEL codes: E43, E52.

Keywords: transmission mechanism of monetary policy, interest-rate pass through, risk-free rates, interest rate benchmark reform.

1 Introduction

Since December 2022, WIRON (Warsaw Interest Rate Overnight) rates, a group of risk-free rates for Poland, can be used in financial contracts and instruments. Furthermore, they are expected to replace WIBOR (Warsaw Interbank Offered Rate) rates in existing contracts in 2025, with a compensating spread. Therefore, WIRON rates should be expected to play an important – and eventually major – role in the transmission mechanism of monetary policy in Poland.

Taking the above-mentioned factors into account, this study provides the first estimates of the interest rate pass-through to risk-free rates in Poland, which is its main contribution to the literature. It also appears to be one of few to econometrically approach the issue of monetary policy transmission to risk-free rates in general, within the global trend to replace LIBOR (London Interbank Offered Rate)-type rates with risk-free ones.

WIRON is a transaction-based overnight rate, based on deposits accepted by a panel of banks from other banks, other financial institutions and, perhaps crucially, also from non-financial corporations. The term curve is constructed by compounding the overnight rate in a backward-looking manner.

This contrasts with WIBOR rates, on which retail lending contracts (and variable-income financial instruments) tend to be based. They are forward-looking and do not cover the non-financial corporation deposit market. After a reform in 2019, they do cover deposits from other financial institutions (on top of deposits from banks), corrected with a spread versus interbank quotes. Currently WIBOR rates combine plain, interpolated and extrapolated transaction rates, and quotes under the so-called waterfall method. Another available rate, the POLONIA (Polish Overnight Index Average) rate, on which the operational target of monetary policy is formulated, covers only deposits from a panel of banks. It is a transaction-based rate. For more details regarding the construction of WIRON rates, see resources on the web page of their administrator, GPW Benchmark.[1]

Given the form of the paper (i.e. a research note), it is not meant to provide an exhaustive literature review of the matter. On the global interest rate benchmark reform, the Reader is referred to Shrimpf and Sushko (2019). On the transmission of the policy rate to interbank rates in Poland and its changes after the Global Financial Crisis, see the series of reports on the transmission mechanism of monetary policy in Poland (the last one being Chmielewski et al., 2020) and, for example, Maciaszczyk (2018), Kapuściński and Pietryka (2019), Fiszeder and Pietryka (2018), Sznajderska (2016), Kliber et al. (2016), Płuciennik et al. (2013), Lu (2012), and Kliber and Płu-

[1] GPW Benchmark, Transaction-based Indices, Indices details, https://gpwbenchmark.pl/indices-details. On WIBOR rates, see https://gpwbenchmark.pl/en-dokumentacja. On the POLONIA rate, see https://nbp.pl/statystyka-i-sprawozdawczosc/stawka-referencyjna-polonia/ (only in Polish).

ciennik (2011). The operational framework of Narodowy Bank Polski is described, for example, in Annual Reports on Banking Sector Liquidity and Monetary Policy Instruments of Narodowy Bank Polski (for example, NBP, 2022) and Kapuściński and Pietryka (2019).

The study focuses on three areas. The first one is the transmission of the policy rate, but also of other components of the operational framework of Narodowy Bank Polski (NBP), to the WIRON rate. The latter (i.e. the considered components of the NBP operational framework other than the policy rate) are the width of the standing facilities corridor and the reserve position of the banking sector (through the so-called liquidity effect; see Disyatat, 2008, for a discussion); the reserve position of the banking sector is not a component of the operational framework as such, but it is affected by open market operations and the required reserve ratio. The study researches into the pass-through to the WIRON rate in a comparative fashion, using the POLONIA rate as the reference point. The second area of focus of the study is the transmission to the WIRON term curve, controlling for the width of the standing facilities corridor and the reserve position of the banking sector as well. The last area covered is transmission lags and the difference between them, as compared to WIBOR rates. The latter required constructing a relatively novel empirical approach for the modelling of WIBOR rates.

I find both the overnight and term WIRON rates to be affected by interest rate policy of Narodowy Bank Polski, the width of the standing facilities corridor and the reserve position of the banking sector. This makes the transmission similar as to the POLONIA rate, but to some extent different than to WIBOR rates. For the term rates, by construction, there are differences in transmission lags. This might have implications for the transmission mechanism of monetary policy in Poland in the future. The extent of changes in the transmission mechanism will depend on the character of changes in the policy rate (unexpected versus expected) and the term of the rate chosen for financial contracts and instruments. Given the limited number of observations, the conclusions should be treated with caution.

The rest of the article is structured as follows. The second section outlines the econometric models used in the study. The third section describes the data used. The fourth section presents the results. The last section concludes and provides policy implications.

2 Models

In order to provide empirical estimates for the three areas of focus of the study highlighted in the introduction, I estimated the parameters of three sets of econometric models.

In empirical studies on the interest rate pass-through, interest rates tend to be treated as non-stationary, either on the basis of unit root test results or referring to earlier literature (see, for example, Andries and Billon, 2016, for a review). This also concerns earlier studies using Polish data, which tend to use the error correction framework (see, for example, Chmielewski et al., 2020). Here, using ADF and KPSS tests, in some cases I found inconclusive evidence on the presence of the unit root. The same concerns cointegration test results. Furthermore, as far as models for term WIRON rates are concerned, the number of (monthly) observations was small – likely too small to infer about the presence of the unit root (both in rates themselves and in residuals, or error correction terms). Therefore, while in most cases I employed the error correction framework, a cautious interpretation of the results is suggested.

Pass-through to WIRON rate, compared to pass-through to POLONIA rate

The first set consisted of models for the WIRON rate and, for comparison, for the POLONIA rate. Both are overnight indices. The data frequency used was daily. I focused on the relationship in levels of variables of the form:

$$\begin{aligned} y_t = {} & \beta_0 + \beta_1 reference\ rate_t + \beta_2 marginal\ lending\ facility\ corridor_t \\ & + \beta_3 deposit\ facility\ corridor_t + \beta_4 reserve\ position_t \\ & + \sum_{i=1}^{4} \beta_5^i week_t^i + \beta_6 weeks_t + \beta_7 month\ end_t + \varepsilon_t, \end{aligned}$$

where y is either the WIRON or the POLONIA rate, $reference\ rate$ is the NBP reference rate, $marginal\ lending\ facility\ corridor$ is the difference between the marginal lending facility rate and the NBP reference rate, $deposit\ facility\ corridor$ is the difference between the NBP reference rate and the deposit facility rate, $reserve\ position$ is the difference between reserves, increased by net standing facilities, and required reserves, $week^i$ is a dummy variable, taking 1 for the i-th week of a reserve maintenance period, counted from the day of a given main open market operation to the day before the next one (starting from 0 before the first operation in a period)[2], $weeks$ is the number of main open market operations in a reserve maintenance period, $month\ end$ is a dummy variable taking 1 in the last working day of a month, and β are coefficients; t denotes time.

[2] I would like to thank Jarosław Wiśniewski for the idea of controlling for the stage of the reserve maintenance period by using week dummies, together with the way of their computation.

The use of the NBP reference rate, the width of the standing facilities corridor (in two parts, allowing for its asymmetry) and the reserve position of the banking sector as regressors gives the specification mapping on the Poole-type model of reserve management within the reserve averaging, corridor framework, as under operation in Poland (see Poole, 1968; Bech and Monnet, 2016). The reserve averaging framework means that the actual reserves have to equal the required reserves on average within the reserve maintenance period. Under the corridor framework there are central bank standing facilities in place (the marginal lending facility and the deposit facility), on which rates pose a limit on overnight interbank rates. Reserve maintenance period week dummies are to capture that at the beginning of the period any deviations of reserves from the requirement could have a smaller effect on an interest rate than at the end (when there is less time to compensate for a deviation). Here, weeks follow the cycle of main open market operations, which are conducted each Friday (4 or 5 each maintenance period). The month-end dummy is to capture any effects of window dressing, in particular, the consequences of the bank levy.

At this point, two qualifications appear to be worth making. First, neither financial institutions other than banks nor non-financial corporations have access to central bank standing facilities. This raises the width of potential fluctuations of rates on deposits from them. On the other hand, accepting a wholesale deposit from these two types of institutions also ends up increasing bank reserves (as any other deposit). The scale of their substitution and the pass-through to rates on them is an empirical question. Second, the width of the standing facilities corridor and the week of the reserve maintenance period are likely to operate in interaction with the reserve position of the banking sector, rather than independently. Due to the limited number of observations, a linear approximation of the relationship was used instead.

In this case the dynamics leading to the relationship in levels of variables at a daily frequency did not seem to be of much interest. Neither lags nor anticipatory effects should be expected. On the other hand, daily data (and the number of observations they offer) appeared to be important for a credible identification of the effects of factors other than the NBP reference rate. In any case, a unit root could be rejected neither for WIRON and POLONIA rates, nor for the NBP reference rate; on the other hand, evidence on the presence of the unit root in residuals was inconclusive (Table 1).

One independent variable, the measure of the reserve position of the banking sector used, requires an additional comment. Here, endogeneity could be suspected, since a low POLONIA (and hence WIRON, as their coverage partially overlaps) could trigger the conduct of a fine-tuning open market operation, which would lower the reserve position. Indeed, the exogeneity of this variable was rejected by an endogeneity test (Table 2). Therefore, the IV (instrumental variables) estimator was used.

The following four instruments were considered: a shock to autonomous factors, and a difference between the supply of and demand for NBP bills on main open market operations, fine-tuning quasi-regular operations (i.e. fine-tuning operations conducted at the end of a maintenance period) and irregular fine-tuning operations. A shock to autonomous factors was computed as a residual from a regression of the structural liquidity position of the banking sector (or, cumulative autonomous factors) on a deterministic trend, day and month seasonal dummies, and an autoregressive term. These variables appeared to be valid instruments a priori. While they affect the reserve position of the banking sector, they are not (directly) under central bank control. Furthermore, NBP is unlikely to compensate for them with open market operations in the very short term (i.e. within one day).

Regressing the reserve position of the banking sector on the above-mentioned set of instruments I found the latter two to have a negative coefficient, which suggests that the effect of conducting a fine-tuning operation itself, rather than of the difference between supply and demand, was captured (Table 3). Therefore, they were omitted in the next step. The coefficient for the shock to autonomous factors had an expected, positive sign, but on its own it explained a very small share of the variability of the dependent variable (with a borderline significant F-statistic of the model). Therefore, the difference between supply and demand on main open market operations, explaining half of variability in the reserve position of the banking sector in the sample, was used as the sole instrument.

Pass-through to term WIRON rates

As for the second set of models the dynamics were of key interest, here the fully-fledged error-correction framework was used. It took the following form:

$$\begin{aligned}
\Delta WIRON_t^j &= \beta_0 + \sum_{k=0}^{j} \beta_1^j \Delta reference\ rate_{t-k} \\
&+ \sum_{k=0}^{j} \beta_2^j \Delta marginal\ lending\ facility\ corridor_{t-k} \\
&+ \sum_{k=0}^{j} \beta_3^j \Delta deposit\ facility\ corridor_{t-k} + \sum_{k=0}^{j} \beta_4^j \Delta reserve\ position_{t-k} \\
&+ \beta_5 (WIRON_{t-1}^j - \beta_6 - \beta_7 reference\ rate_{t-1} \\
&- \beta_8 marginal\ lending\ facility\ rate\ corridor_{t-1} \\
&- \beta_9 deposit\ facility\ rate\ corridor_{t-1} - \beta_{10} reserve\ position_{t-1}) + \varepsilon_t,
\end{aligned}$$

where j is the term of a rate in months, k denotes lag length and the meaning of the remaining symbols is as in the previous equation.

Compared to the previous set of models, this one omits independent variables relevant only at the daily frequency. The lag length in the relationship in differences of variables is term-specific. The parameters of the model were estimated using the IV estimator, as in the previous case.[3]

Transmission lags for term WIRON rates, compared to transmission lags for term WIBOR rates

The last set of models was also within the error-correction framework.[4] However, the set of independent variables was adjusted to account for the forward-looking and potentially non risk-free nature of WIBOR rates. Furthermore, compared to the previous two sets, here the width of the standing facilities corridor and the reserve position of the banking sector were omitted. First, this is because the latter were found not to be significant in previous studies (Kapuściński and Pietryka, 2019; Sznajderska, 2016, see). Second, here data since the beginning of 2001 were used, and time series for these independent variables were not available for such a long period; in the case of the width of the standing facilities corridor, this was because the deposit facility was introduced only in December 2001. The core specification was the following:

$$\begin{aligned}\Delta WIBOR_t^j = {} & \beta_0 + \beta_1 \Delta reference\ rate_t^e + \beta_2 \Delta reference\ rate_t^u \\ & + \beta_3 \Delta default\ probability_t^j + \beta_4 \Delta reference\ rate_t^{e,t+1} \\ & + \beta_5 \Delta reference\ rate_t^{e,t+j} + \beta_6 (WIBOR_{t-1}^j - \beta_7 \\ & - \beta_8 reference\ rate_{t-1} - \beta_9 default\ probability_{t-1}^j) + \varepsilon_t,\end{aligned}$$

where $reference\ rate^e$ and $reference\ rate^u$ are the expected and the unexpected component of a change in the NBP reference rate, $default\ probability$ is a commercial bank default probability, $reference\ rate^{e,t+1}$ is a change in the NBP reference rate expected in a month (proxied by the FRA 1x2-WIBOR 1M spread) and $reference\ rate^{e,t+j}$ denotes a change in the NBP reference rate expected at the end of a given term (proxied by the following FRA spreads: FRA 2x3-FRA 1x2 for the 3-month term, FRA 3x6-FRA 2x3 for the 6-month term and FRA 9x12-FRA 6x9 for the 1-year term). The meaning of the remaining symbols is as in previous equations. Default probabilities

[3] Regarding the models for term WIRON rates, it is worth noting that the hypothesis of a unit root in error correction terms could not be rejected for 1- and 3-month terms. However, this might be due to the insufficient number of observations.

The lag length in the relationship in differences of variables was fixed and not chosen using information criteria. This is because the theoretical foundation for term-based lag length appeared to be strong, even if it resulted in a large number of parameters to be estimated, relative to the number of observations.

[4] The hypothesis of a unit root was rejected for WIBOR rates and the NBP reference rate (monthly data; the ADF test), but also stationarity was rejected (the KPSS test). In any case, the error-correction framework was necessary to address different effects of expected and unexpected changes in the policy rate in time t, as well as advance effects of its expected changes. The low power of the ADF test when the 'true' autoregressive coefficient is close to 1 are also worth noting.

were not available, and hence were omitted, for terms shorter than 3 months. Anticipatory effects of an expected change in the NBP reference rate seemed unlikely, and hence were omitted, for the ON rate; furthermore, the 1-month term was too short to account for them in a meaningful way.

The specification builds on Chmielewski et al. (2018). In that study, the short-run effects of a change in the NBP reference rate were allowed to differ *in time t* depending on whether the change is expected or not. This is because the effects of an expected change should be visible already before t. Therefore, any effect in t should be smaller than for an unexpected change. However, the anticipatory effect (i.e. *before time t*) was not directly accounted for. Here, it is meant to be captured by FRA spreads. The challenge lies in the arbitrage relations between WIBOR and FRA rates – in some sense, some FRA rates are a part of a given WIBOR rate, which is a form of endogeneity (consistent with the results of endogeneity tests). Therefore, the IV estimation for the relationship in differences of variables was necessary. The parameters of the relationship in levels of variables were estimated using the FMOLS (fully-modified ordinary least squares) method.

As instruments for FRA spreads, surprises in macroeconomic data releases (inflation, GDP and industrial production) were used. They appeared to be valid instruments a priori, as they are inherently unexpected and could affect interest-rate expectations at the same time (through the central bank reaction function, in terms of inflation control). The shares of explained variability were not very high (around 0.2), but – taken together with an expected, positive sign of the relationship – turned out to be enough at least for some purposes (see the Results section).

3 Data

In the case of the WIRON rate, data were available since the beginning of 2019. Data for term WIRON rates were available for shorter periods – for the 1M rate starting in February 2019, for the 3M rate starting in April 2019, and for the 6M rate starting in July 2019. This is because the term rates are calculated by compounding the overnight rate backwards. Data were taken from GPW Benchmark.

For the POLONIA rate, NBP data starting in 2019 were used as well, for comparability of the results, in particular, regarding the effects of the reserve position of the banking sector. It could be time-varying, with a switch in the subdued required reserve ratio regime between March 2020 and September 2021.

For WIBOR rates, Refinitiv data since 2001 were used. This (i.e. the longer series used) is because for that set of rates expectations matter, and in that respect the sample starting in 2019 might not have been very representative. From the point of view of the end of the sample – that is, the end of 2022 – policy rate expectations were overshot in the tightening part of the sample, leading to above-one coefficient estimates for the NBP reference rate (results for the shorter sample are available on request).

Data on policy rates and the measures of the reserve position of the banking sector were taken from NBP, the latter in PLN bn. Default probabilities were computed as a median for WIBOR panelists, excluding one bank, for which such estimates were not available. The source of the data was Bloomberg, similarly as for reference rate surprises and macroeconomic data surprises. FRA rates were taken from Refinitiv.

4 Results

4.1 Pass-through to WIRON rate, compared to pass-through to POLONIA rate

Table 4 presents the results of the models for WIRON (overnight) and POLONIA rates. In the case of both rates the long-run effect of a 1 p.p. increase in the NBP reference rate is estimated to be around 1 p.p. (0.98-1.02 p.p.), implying a full transmission in terms of point estimates. The Wald test – a formal way of establishing whether the transmission is full in terms of statistical significance – rejects the coefficient to be equal to 1 in the case of the POLONIA rate (Table 10). For the WIRON rate such a hypothesis could not be rejected. The former result differs across studies, depending on the sample, the frequency of the data and the method of estimation of the cointegrating regression.

The width of the standing facilities corridor affects both WIRON and POLONIA rates. They are the higher, the wider the difference between the marginal lending facility rate and the NBP reference rate, and the lower, the higher the difference between the NBP reference rate and the deposit facility rate. The reserve position of the banking sector is another important factor for both rates. In terms of the point estimate, the POLONIA rate is slightly more sensitive to its changes. Figure 4 presents this graphically, in the form in an inverse demand curve for the market of reserves. However, the confidence intervals overlap to a large extent.

Regarding seasonality within reserve maintenance periods and the number of main open market operations within them, in the sample at hand there is some evidence for both of the rates. There is a difference in the month-end effect, though. For the WIRON rate it is statistically significant, at as much as -0.23 p.p. In the case of the POLONIA rate it is not statistically significant. The effect itself might be due to the bank levy (see Kapuściński, 2022, for transaction-level evidence), and for the POLONIA rate it might manifest itself more in volumes and in rate variance than in its average level.

4.2 Pass-through to term WIRON rates

Table 5 presents the results of the models for WIRON rates – term, and, for comparison, the overnight one. In terms of point estimates, long-run multipliers for the effects of the NBP reference rate on the respective WIRON rates are the higher, the shorter the term (between 0.98 and 0.77). Perhaps interestingly, formally the hypothesis of them being indifferent from unity could not be rejected in any case. At least to some extent, this is due to the high variance of the estimates, resulting from a relatively small number of observations. This is the more limiting the longer the term of the rate, as for longer rates there are fewer observations and more lags in models at the same time.

For the 6-month rate, the effect is likely to be underestimated, as the sample does not cover the full effects of the most recent increase in the NBP rate (which took place in September 2022) at the time of writing the paper. Also, the sum of estimates of the short-run effects over lags tends to be around unity (including the 6-month rate case). With the full transmission to the overnight rate in daily data, and with the term rates being based on it, this is an expected result.

The point estimates of long-run effects of the width of the standing facilities corridor and the reserve position of the banking sector are as for the overnight rate in daily data in terms of their sign (as before, at least partially by construction).[5] Their statistical significance varies, however, with relatively high standard errors for longer rates. The results can be summarised similarly for the short-run equations.

The error correction term is significant for the overnight and the 1-month rate, and is statistically insignificant for longer rates. In each case the point estimate is negative. This implies that the error correction mechanism – of rates returning to their relationship in levels after deviations from it – is operative at least in terms of points estimates.

4.3 Transmission lags for term WIRON rates, compared to transmission lags for term WIBOR rates

In Figure 5, the key results from Table 5 are presented graphically, in the form of responses to a 1 percentage point increase in the NBP reference rate. For the overnight rate, the full effect is expectedly immediate. For the 1-month rate it occurs a month later, for the 3-month rate after 3 months, and for the 6-month rate after 6 months (also quite expectedly and at least partially by construction). In such form, the results will be easier to compare with those for WIBOR rates, in terms of transmission lags.

Table 6 presents the results of models for WIBOR rates – term, and, for comparison, the overnight one. For the overnight and the 1-month term, there is one version of both the long-run and the short-run part of the equation. The point estimates of the long-run effects of a 1 p.p. increase in the NBP reference rate are somewhat above 1 (1.06 and 1.03, respectively). In the case of the overnight rate, this might be due to the omitted reserve position of the banking sector, as periods of excess reserves in the sample coincided with a lower policy rate. In any case, statistically, the one-to-one relation was rejected in these two cases. Moving to short-run dynamics, the effect of an expected increase in the NBP reference rate is higher than the effect of an unexpected increase for the overnight rate. This is because there is little reason for the overnight rate to respond in advance, an hence the rate does not adjust to unexpected no-changes in the policy rate. It is the opposite for the 1-month rate – a one-to-one (in terms of

[5] In principle, in the case of the reserve position of the banking sector exhibiting variability mainly within reserve maintenance periods, and little difference between reserve maintenance periods, it could have no effect on the term rates. This has not been the case, however.

the point estimate) effect of an unexpected change, and a smaller effect of an expected one (with the rest of the response realised in advance). Error correction terms are statistically significant and point negative for both rates.

For longer rates, four variants of the short-run part of the equation are presented (with a single variant of the long-run part). In the first one, no anticipatory effects of expected changes in the NBP reference rate are directly taken into account – only effects in time t, of both expected and unexpected changes. In the second variant, the effects of an expected increase in the 1-to-2-month horizon and at the end of the instrument are allowed in advance. In the remaining specifications these two horizons are included separately, in turn.

The results are similar for each of the three (i.e. 3-month, 6-month and 1-year) terms. Long-run multipliers for the effects of the NBP reference rate are around 1 in terms of point estimates (between 0.97 and 1.02) and statistically either not different from 1 or borderline different, depending on the significance level. Also, the first of the specifications for short-run dynamics implies that the full transmission of unexpected changes in the policy rate is immediate. The effect of expected changes, in time t, is estimated to be smaller (and the smaller, the longer the term of the rate). Risk, measured by default probabilities, appears to matter, at least in the long-run. Error correction term point estimates are negative, but not in all the cases they are statistically significant.

As for the advance effects of expected NBP reference rate changes, their inclusion in the models destabilizes the results somewhat, at least in terms of point estimates. This appears to be due to two reasons. The first one is a limited quality of instruments for them (i.e. for the advance effects of expected NBP reference rate changes). The second one is autocorrelation in policy rate changes, leading to some collinearity. When included separately, expected changes in the NBP reference rate are statistically significant. Included together, at least one of them is not. The point estimates appear to be difficult to interpret.

Summarising the results of this subsection, the time required for a change in the policy rate to be reflected fully in WIRON rates is equal to their term. This should be the case irrespectively of whether the change is expected or not. For WIBOR rates, the full transmission of unexpected changes in the NBP reference rate is immediate. The transmission of expected changes starts in advance, but how early cannot be easily derived from the results of econometric models.

Theoretically (according to the expectations theory of the term structure of interest rates), if a policy rate change is fully predicted from the very beginning, it should be partially reflected in a WIBOR rate (except for the overnight rate) in advance; for the 3-month term 3 months in advance, for the 6-month term 6 months in advance, and for the 1-year term a year in advance (see Figure 6).

These results imply that any difference in the transmission mechanism of monetary policy after the switch from WIBOR to WIRON rates will depend on two factors. The first one is whether a given NBP rate change will be expected or not. For the expected changes, the difference in transmission lags will be larger than for the unexpected ones. The second factor is which WIRON rate term will dominate as the base for lending (but also other) contracts – the shorter the term, the smaller the difference in lags. It also depends on what is assumed about the expectations of agents other than financial market participants – whether they are forward-looking or not; the higher the forward-lookingness, the smaller the difference in transmission lags. Furthermore, in contrast to term WIBOR rates (but similarly to the POLONIA rate), WIRON rates will be affected by an additional factor – the reserve position of the banking sector, giving it a role in macroeconomic fluctuations. For example, given the point estimate of the long-run multiplier (-0.01 after rounding), the reserve position of the banking sector at its 2019-2022 mean (14.3 PLN bn) implies a -0.12 percentage point contribution to the WIRON 1M rate, with a 95-percent confidence interval between -0.29 and plus 0.04 percentage point. However, as mentioned, a non-linearity with respect to the width of the standing facilities corridor is likely (with the above-mentioned estimate being valid for the sample mean width).

5 Conclusion

In this research note I provide the first estimates of the transmission of monetary policy in Poland to risk-free rates, the WIRON rates.

I find both the overnight and term WIRON rates to be affected by interest rate policy and other components of the operational framework of Narodowy Bank Polski. This makes the transmission similar as to the POLONIA rate, but to some extent different than to WIBOR rates. In contrast to term WIBOR rates (but similarly to the POLONIA rate), WIRON rates are affected by an additional factor – the reserve position of the banking sector, giving it a role in macroeconomic fluctuations.

For term rates, by construction, there are differences in transmission lags. This might have implications for the transmission mechanism of monetary policy in Poland in the future. The extent of changes in the transmission will depend on the character of changes in the policy rate (unexpected versus expected), and the term of the rate chosen for financial contracts and instruments.

While the conclusions apply to the 2019-2022 sample, the relationship between WIRON rates and their drivers might evolve. Given the limited number of observations, the conclusions should be treated with caution.

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Appendix

Figure 1: NBP reference rate, and WIRON and POLONIA rates

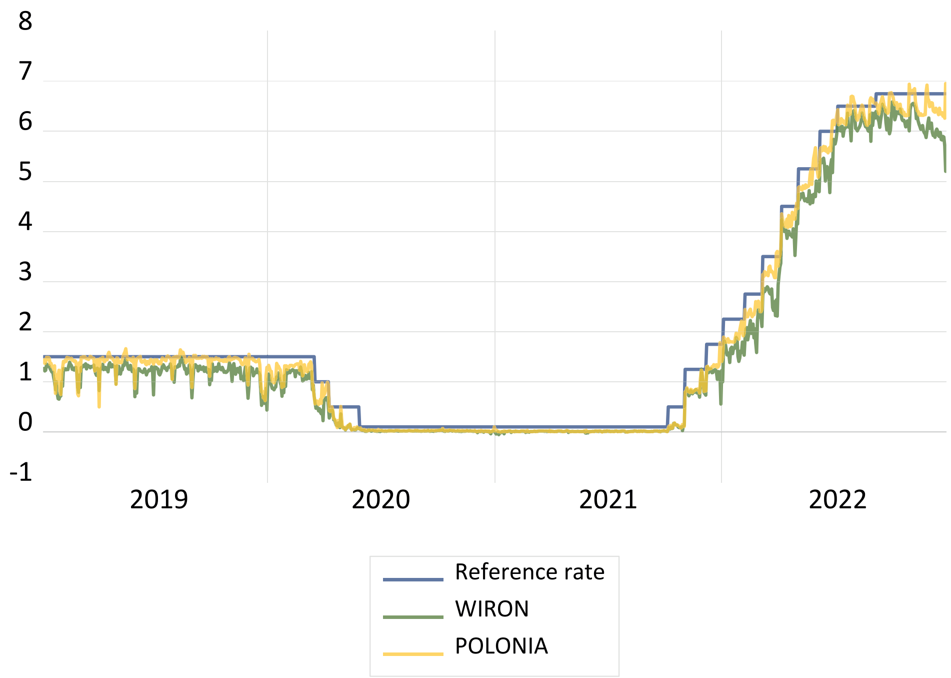


Figure 2: NBP reference rate and WIRON rates

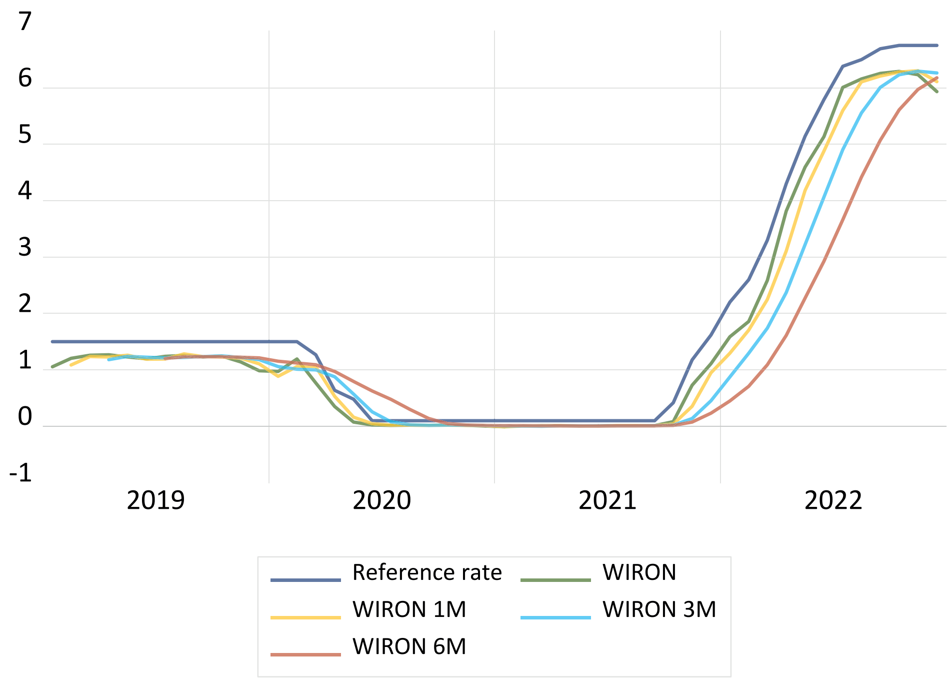


Figure 3: The NBP reference rate and WIBOR rates

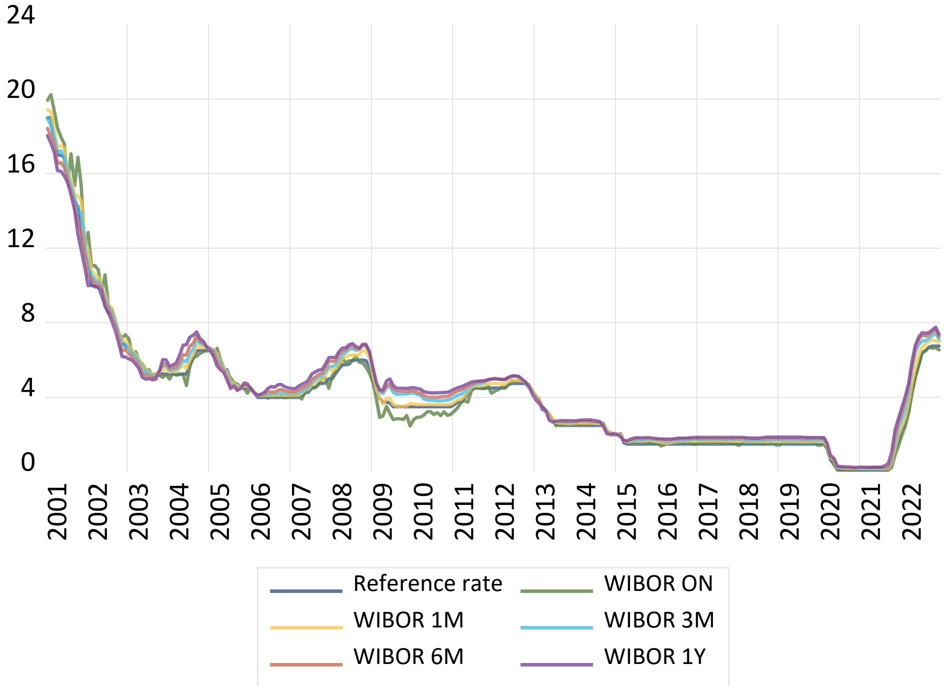


Table 1: Unit root and cointegration test results

	ADF test t-Statistic Lag specification		KPSS test LM-Statistic	Engle-Granger cointegration test tau-statistic Lag specification		z-statistic Lag specification	
	MAIC	SIC		MAIC	SIC	MAIC	SIC
WIRON daily	0.31	0.18	1.84***				
Residual				-2.69	-9.58***	-24.69	-196.62***
POLONIA	1.29	1.53	1.82***				
Residual				-4.36	-11.93***	-55.42	-289.5***
Reference rate daily	0.49	1.85	1.86***				
WIRON monthly	-1.14	-1.14	0.44*				
ECT				-4.03	-4.03	-27.41*	-27.41*
WIRON 1M	-1.76	-2.8*	0.43*				
ECT				-3.26	-3.26	-17.43	-17.43
WIRON 3M	-1.01	-2.32	0.4*				
ECT				-1.76	-1.76	-7.58	-7.58
WIRON 6M	-1.22	-2.57	0.37*				
ECT				-0.69	-2.55	-2.69	-46.72***
WIBOR ON	-3.1**	-3.1**	1.27***				
ECT				-2.44	-2.44	-14.49	-14.49
WIBOR 1M	-3.16**	-4.1***	1.3***				
ECT				-4.49***	-7.6***	-45.9***	-93.94***
WIBOR 3M	-3.82***	-4.58***	1.3***				
ECT				-3.28	-5.35***	-51.46***	-53.27***
WIBOR 6M	-3.9***	-4.46***	1.3***				
ECT				-2.48	-4.03**	-24.8*	-72.12***
WIBOR 1Y	-4.15***	-4.27***	1.31***				
ECT				-2.25	-3.65*	-17.2	-48.42***
Reference rate monthly	-3.4**	-4.09***	1.34***				

Note: ***, ** and * denote (a) ADF test and Engle-Granger cointegration test – rejection of the null hypothesis of a unit root at the 0.01, 0.5 and 0.1 level, respectively, (b) KPSS test – rejection of the null hypothesis of stationarity at the 0.01, 0.5 and 0.1 level, respectively.

Table 2: Endogeneity test results

	Difference in J-stats
WIRON	67.12***
POLONIA	31.8***
WIBOR 3M	13.1***
WIBOR 6M	6.92**
WIBOR 1Y	12.14***

Note: ***, ** and * denote rejection of the null hypothesis of exogeneity at the 0.01, 0.5 and 0.1 level, respectively.

Table 3: Suitability of instruments

Dep. Var:	Reserve position	Reserve position	Reserve position	Reserve position	FRA 1x2-WIBOR 1M	FRA 2x3-FRA 1x2	FRA 3x6-FRA 2x3	FRA 9x12-FRA 6x9
C	-3.27	-2.97	14.43	-2.98	-0.02	-0.04	0.05	-0.01
	(0.78)***	(0.92)***	(1.25)***	(0.93)***	-0.01	(0.01)***	(0.02)***	-0.01
Shock to structural liquidity position	0.41	0.44	0.44					
	(0.18)**	(0.19)**	(0.22)**					
Supply-demand, main open market operations	0.93	0.85		0.85				
	(0.04)***	(0.05)***		(0.05)***				
Supply-demand, quasi-regular open market operations	-5.44							
	(0.95)***							
Supply-demand, irregular open market operations	-1.22							
	(0.40)***							
GDP surprise					0.35	0.22	0.4	0.19
					(0.07)***	(0.05)***	(0.10)***	(0.06)***
Inflation surprise					0.32	0.22	0.66	0.14
					(0.06)***	(0.05)***	(0.09)***	(0.05)**
Industrial production surprise					0.02	0.01	0.03	0.02
					(0.01)**	(0.01)***	(0.01)***	(0.01)***
Observations:	1011	1011	1011	1012	263	263	263	263
R-squared:	0.6	0.5	0	0.5	0.2	0.17	0.25	0.1

Note: Robust standard errors in parentheses. ***, ** and * denote statistical significance at the 0.01, 0.5 and 0.1 level, respectively.

Table 4: Results of models for overnight rates (daily data)

Dep. Var:	WIRON	POLONIA
C	-0.77	-0.58
	(0.14)***	(0.12)***
Reference rate	0.98	1.02
	(0.01)***	(0.01)***
Marginal lending facility	1.71	1.41
corridor	(0.20)***	(0.14)***
Deposit facility	-1.46	-1.13
corridor	(0.14)***	(0.09)***
Reserve position	-0.0027	-0.0033
	(0.00)**	(0.00)***
Week 0	0.16	0.19
	(0.08)**	(0.08)**
Week 1	0.13	0.14
	(0.07)*	(0.07)*
Week 2	0.07	0.04
	-0.07	-0.07
Week 3	0.03	0.02
	-0.07	-0.07
Week 4	-0.01	0.01
	-0.07	-0.07
Weeks	0.04	0.02
	(0.02)*	-0.02
Month end	-0.23	0.03
	(0.04)***	-0.03
Observations:	1012	1012
R-squared:	0.99	1

Note: Robust standard errors in parentheses. ***, ** and * denote statistical significance at the 0.01, 0.5 and 0.1 level, respectively.

Table 5: Results of models for WIRON rates (monthly data) – part 1

Dep. Var:	WIRON	Δ WIRON	WIRON 1M	Δ WIRON 1M	WIRON 3M	Δ WIRON 3M	WIRON 6M	Δ WIRON 6M
C	-0.46	0.00	-0.67	0.00	-0.67	-0.01	-0.68	-0.01
	(0.18)**	(0.02)	(0.45)	(0.02)	(0.91)	(0.01)	(1.18)	(0.02)
Reference rate	0.98		0.98		0.91		0.77	
	(0.02)***		(0.04)***		(0.10)***		(0.14)***	
Marginal lending facility	1.78		2.65		3.61		4.53	
corridor	(0.42)***		(1.07)**		(2.17)		(2.74)	
Deposit facility	-1.61		-2.24		-3.08		-3.74	
corridor	(0.31)***		(0.72)***		(1.45)**		(1.83)**	
Reserve position	-0.01		-0.01		-0.02		-0.03	
	(0.00)*		(0.01)		(0.01)*		(0.01)*	
Δ reference rate		0.97		0.42		-0.02		0.01
		(0.04)***		(0.09)***		(0.12)		(0.07)
Δ reference rate(-1)				0.50		0.45		0.12
				(0.10)***		(0.10)***		(0.05)**
Δ reference rate(-2)						0.48		0.18
						(0.19)**		(0.09)*
Δ reference rate(-3)						0.10		0.19
						(0.13)		(0.12)
Δ reference rate(-4)								0.16
								(0.07)*
Δ reference rate(-5)								0.22
								(0.10)**
Δ reference rate(-6)								0.10
								(0.05)*
Δ marginal lending facility		1.32		0.74		0.17		0.10
corridor		(0.37)***		(0.46)		(0.33)		(0.19)
Δ marginal lending facility				0.33		-0.32		0.14
corridor(-1)				(0.48)		(0.54)		(0.37)
Δ marginal lending facility						0.70		-0.19
corridor(-2)						(0.37)*		(0.40)
Δ marginal lending facility						-0.30		-0.16
corridor(-3)						(0.41)		(0.97)
Δ marginal lending facility								0.22
corridor(-4)								(0.41)
Δ marginal lending facility								-0.23
corridor(-5)								(0.45)
Δ marginal lending facility								0.45
corridor(-6)								(0.75)
Δ deposit facility		-1.29		-0.62		0.06		0.02
corridor		(0.25)***		(0.24)**		(0.16)		(0.25)
Δ deposit facility				-0.47		0.09		-0.02
corridor(-1)				(0.29)		(0.40)		(0.27)
Δ deposit facility						-0.77		0.15
corridor(-2)						(0.34)**		(0.29)
Δ deposit facility						-0.18		-0.14
corridor(-3)						(0.13)		(0.63)
Δ deposit facility								-0.35
corridor(-4)								(0.33)
Δ deposit facility								-0.08
corridor(-5)								(0.13)
Δ deposit facility								-0.25
corridor(-6)								(0.33)

Note: continued on the next page.

Table 5: Results of models for WIRON rates (monthly data) – part 2

Dep. Var:	WIRON	Δ WIRON	WIRON 1M	Δ WIRON 1M	WIRON 3M	Δ WIRON 3M	WIRON 6M	Δ WIRON 6M
Δ reserve position		-0.01		-0.00		0.00		-0.00
		(0.00)		(0.00)		(0.00)		(0.00)
Δ reserve position(-1)				-0.00		0.00		0.00
				(0.00)		(0.00)		(0.00)
Δ reserve position(-2)						-0.00		-0.00
						(0.00)		(0.00)
Δ reserve position(-3)						-0.00		0.00
						(0.01)		(0.00)
Δ reserve position(-4)								-0.00
								(0.00)
Δ reserve position(-5)								0.00
								(0.00)
Δ reserve position(-6)								-0.00
								(0.00)
ECT(-1)		-0.50		-0.25		-0.00		-0.03
		(0.13)***		(0.10)**		(0.07)		(0.03)
Observations:	48	47	47	46	45	44	42	41
R-squared:	1.00	0.92	0.99	0.94	0.96	0.98	0.88	1.00

Note: Robust standard errors in parentheses. ***, ** and * denote statistical significance at the 0.01, 0.5 and 0.1 level, respectively.

Table 6: Results of models for WIBOR ON and WIBOR 1M rates (monthly data)

Dep. Var:	WIBOR ON	Δ WIBOR ON	WIBOR 1M	Δ WIBOR 1M
C	-0.21	-0.00	0.05	-0.01
	(0.06)***	(0.02)	(0.02)**	(0.01)
Reference rate	1.06		1.03	
	(0.01)***		(0.00)***	
Δ reference rate expected		1.07		0.93
		(0.12)***		(0.11)***
Δ reference rate unexpected		0.77		1.00
		(0.22)***		(0.08)***
ECT(-1)		-0.44		-0.34
		(0.10)***		(0.11)***
Observations:	263	262	263	262
R-squared:	0.99	0.62	1.00	0.86
Method:	FMOLS	OLS	FMOLS	OLS

Note: Robust standard errors in parentheses. ***, ** and * denote statistical significance at the 0.01, 0.5 and 0.1 level, respectively.

Table 7: Results of models for WIBOR 3M rate (monthly data)

Dep. Var:	WIBOR 3M	Δ WIBOR 3M	Δ WIBOR 3M	Δ WIBOR 3M	Δ WIBOR 3M
C	0.18	-0.01	-0.08	-0.02	0.01
	(0.04)***	(0.01)	(0.03)**	(0.01)	(0.02)
Reference rate	1.02				
	(0.01)***				
Default probability	762.83				
	(180.70)***				
Δ reference rate expected		0.84	1.27	0.41	0.06
		(0.12)***	(0.55)**	(0.16)**	(0.37)
Δ reference rate unexpected		1.02	1.26	0.64	0.39
		(0.11)***	(0.34)***	(0.17)***	(0.30)
ECT(-1)		-0.16	-0.18	-0.32	-0.35
		(0.08)**	(0.11)	(0.08)***	(0.13)***
Δ default probability		94.17	-47.87	213.48	323.70
		(159.54)	(306.43)	(192.54)	(173.86)*
FRA 1x2-			2.57	1.04	
WIBOR 1M			(0.92)***	(0.30)***	
FRA 2x3-			-3.65		1.92
FRA 1x2			(1.99)*		(0.76)**
Observations:	263	262	262	262	262
R-squared:	0.99	0.68	0.30	0.72	0.45
Method:	FMOLS	OLS	TSLS	TSLS	TSLS

Note: Robust standard errors in parentheses. ***, ** and * denote statistical significance at the 0.01, 0.5 and 0.1 level, respectively.

Table 8: Results of models for WIBOR 6M rate (monthly data)

Dep. Var:	WIBOR 6M	Δ WIBOR 6M	Δ WIBOR 6M	Δ WIBOR 6M	Δ WIBOR 6M
C	0.33	-0.01	-0.06	-0.02	-0.09
	(0.06)***	(0.01)	(0.02)**	(0.01)	(0.02)***
Reference rate	0.99				
	(0.01)***				
Default probability	260.93				
	(80.09)***				
Δ reference rate expected		0.70	0.27	0.36	0.25
		(0.17)***	(0.17)	(0.15)**	(0.21)
Δ reference rate unexpected		1.02	0.59	0.65	0.61
		(0.12)***	(0.11)***	(0.15)***	(0.12)***
ECT(-1)		-0.04	-0.37	-0.30	-0.39
		(0.05)	(0.09)***	(0.09)***	(0.09)***
Δ default probability		105.76	99.21	74.28	126.70
		(102.29)	(128.27)	(83.54)	(171.75)
FRA 1x2-			0.69	1.22	
WIBOR 1M			(0.51)	(0.28)***	
FRA 3x6-			0.47		0.88
FRA 2x3			(0.33)		(0.16)***
Observations:	263	262	262	262	262
R-squared:	0.99	0.61	0.76	0.72	0.67
Method:	FMOLS	OLS	TSLS	TSLS	TSLS

Note: Robust standard errors in parentheses. ***, ** and * denote statistical significance at the 0.01, 0.5 and 0.1 level, respectively.

Table 9: Results of models for WIBOR 1Y rate (monthly data)

Dep. Var:	WIBOR 1Y	Δ WIBOR 1Y	Δ WIBOR 1Y	Δ WIBOR 1Y	Δ WIBOR 1Y
C	0.45	-0.00	-0.02	-0.02	-0.02
	(0.08)***	(0.02)	(0.02)	(0.02)	(0.03)
Reference rate	0.97				
	(0.02)***				
Default probability	75.72				
	(36.34)**				
Δ reference rate expected		0.67	0.21	0.32	0.69
		(0.18)***	(0.25)	(0.13)**	(0.28)**
Δ reference rate unexpected		1.00	0.66	0.62	0.66
		(0.15)***	(0.19)***	(0.17)***	(0.19)***
ECT(-1)		-0.02	-0.27	-0.28	-0.22
		(0.05)	(0.09)***	(0.08)***	(0.10)**
Δ default probability		73.27	16.79	23.66	55.84
		(39.84)*	(33.56)	(29.75)	(55.62)
FRA 1x2-			1.81	1.41	
WIBOR 1M			(0.84)**	(0.34)***	
FRA 9x12-			-0.57		1.35
FRA 6x9			(0.91)		(0.50)***
Observations:	263	262	262	262	262
R-squared:	0.97	0.57	0.56	0.68	0.31
Method:	FMOLS	OLS	TSLS	TSLS	TSLS

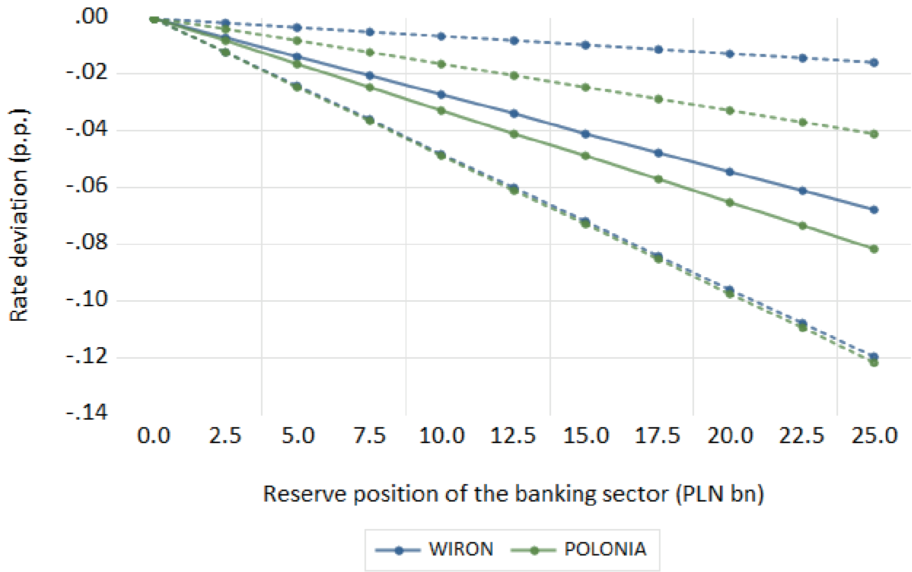
Note: Robust standard errors in parentheses. ***, ** and * denote statistical significance at the 0.01, 0.5 and 0.1 level, respectively.

Table 10: Wald test results

	t-statistic
WIRON daily	-1.69*
POLONIA	3.44***
WIRON monthly	-1.04
WIRON 1M	-0.59
WIRON 3M	-0.89
WIRON 6M	-1.56
WIBOR ON	5.34***
WIBOR 1M	7.05***
WIBOR 3M	2.46**
WIBOR 6M	-0.67
WIBOR 1Y	-1.7*

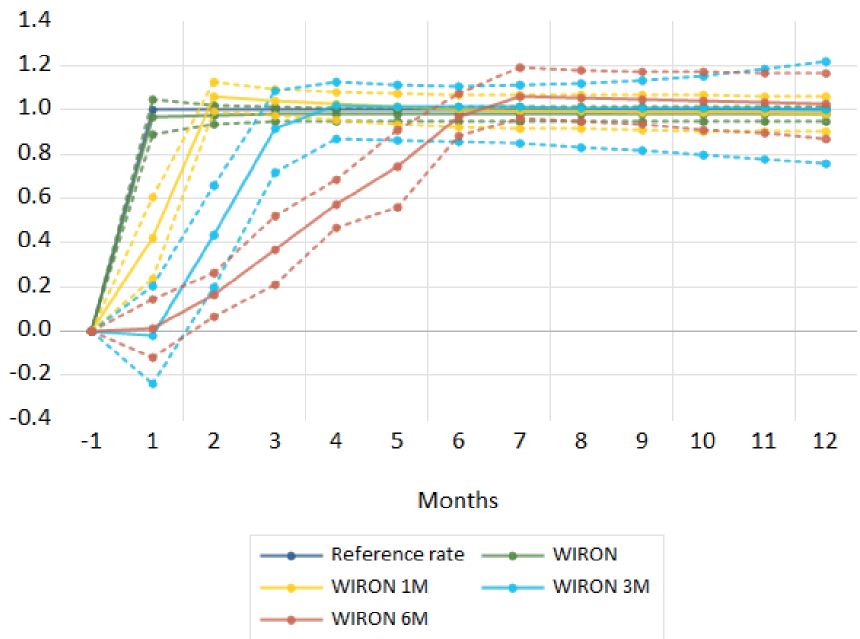
Note: ***, ** and * denote rejection of the null hypothesis of a long-run multiplier equal to 1 at the 0.01, 0.5 and 0.1 level, respectively.

Figure 4: Reserve position and rate deviations



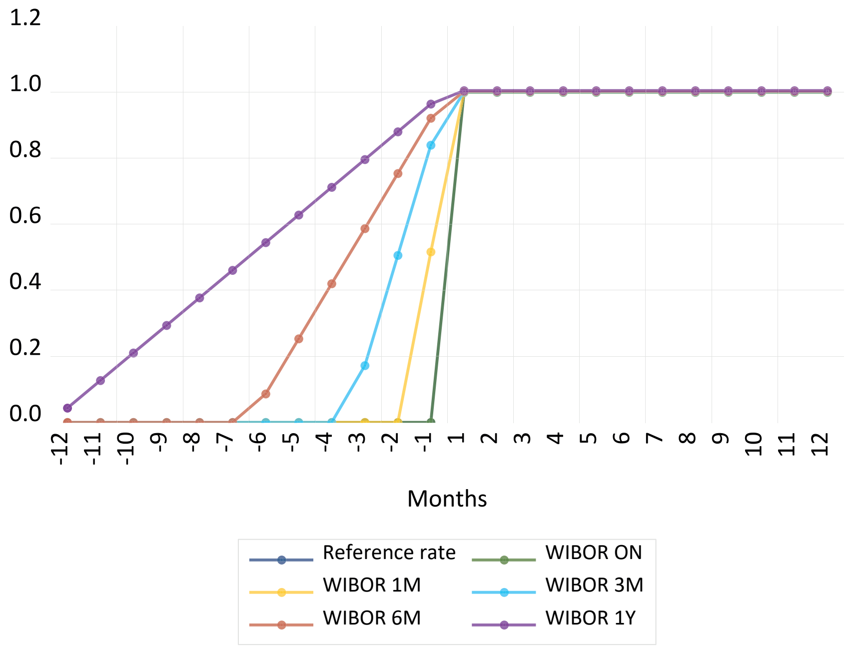
Note: 95-percent analytical confidence intervals.

Figure 5: Effects of change in NBP reference rate on term WIRON rates



Note: 95-percent Monte Carlo confidence intervals. On the horizontal axis, 1 marks the month of the change in the NBP reference rate, -1 the month before it etc.

Figure 6: Effects of expected change in NBP reference rate on WIBOR rates (theoretical)



Note: Reference rate overlaps with WIBOR ON. On the horizontal axis, 1 marks the month of the change in the NBP reference rate, -1 the month before it etc.

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