Transactions-based Interest Rate Benchmarks

Consultation Paper

Waraw, May 2022
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Summary

This paper addresses the questions concerning the rules planned by GPW Benchmark S.A. ("GPWB", "Administrator") for constructing overnight (O/N) risk-free rate (RFR) indices and presents basic information on parameterisation of their method.

The paper presents differences in performance of the various indices that are planned to be delivered and how the subjects’ scope (types of entities whose transaction data is included in the calculations) and the type of transactions (unsecured deposit or conditional transaction: repo and buy/sell-back) impact the performance of the benchmark. GPWB presents three indices for public discussion and analysis:

✓ Warsaw Index for Deposit Market – WIRD,
✓ Warsaw Index for Financial Market – WIRF, and
✓ Warsaw Repo Rate – WRR.

The first two indices are based on unsecured deposit transactions in the group of credit institutions, financial institutions and, in the case of WIRD, large companies. WRR is an index which measures the interest rate on conditional transactions.

Over the past few years, the Administrator has carried out a range of analyses and taken a number of decisions to effectively describe the nature of the domestic money market taking into account:

(1) the experience and standards of foreign financial markets where IBOR-type indices have been or will be converted to new purely transactions-based RFR-type benchmarks,

(2) the results of domestic market analyses taking into account the information pool in the various segments of the money market,

(3) the availability of high-quality data, which in the case of the Polish market is a result of bottom-up engagement of entities involved in the data contribution process related to provision of the WIBID and WIBOR Reference Rates, and

(4) the characteristics of the domestic money market, including: (a) the volatility of interest rates in the O/N segment, (b) lasting differences in the behaviour of interest rates in transactions across market segments, and (c) the implications of introducing the concept of risk-free interest rate benchmarks for widespread use in the financial market.

The key conclusion emerging from the research is that high volatility of an O/N index is a characteristic feature of the domestic money market in contrast to foreign indices of this type, as confirmed also by a comparison of the transactions-based indices proposed by the GPWB with the POLONIA rate provided by the NBP and present on the Polish money market for a long time. Importantly, the application of outlier cut-off procedures does not ensure a significant reduction of index volatility.

Another important finding is that an increased information pool has a positive effect on the volatility of an index: this means that the larger the data set for the calculation of an index, the lower the index volatility.

A third finding emerging from the data analysis and comparison of performance of the GPWB transactions-based indices is that the indices based on unsecured deposit data, i.e., WIRD and WIRF, are characterised by significantly lower historical average values compared to the POLONIA Reference
Rate while the WRR index is characterised by average values close to the Reference Rate provided by the central bank.

Fourth, the information pool as measured by the average volumes on the reference market for a given index is largest for WIRD, smaller for WIRF, and smallest for WRR. The higher the transaction volume, the lower the probability that the index cannot be determined and the greater the safety of transactions, especially in view of the rather high index volatility. Important factor in selection of a benchmark is its resilience to structural changes that may affect the individual segments that determine the composition of the index’s reference market.

This consultation does not concern the term structure for interest rates, i.e., how to determine the 1M, 3M, or 6M benchmark. However, the Paper presents some key elements related to the construction of such indices based on a methodology different from the concept of IBOR-type benchmarks.

The methodology underlying the term structure for interest rate based on an O/N benchmark deploys the concept of compound interest. This means that the term structure for interest rate is the result of daily “adding up” the actual values of the O/N benchmark over the period for which the index is to be defined. This concept allows: (1) to build a purely transactions-based longer term index, which means that the method does not take into account any elements or instruments other than a series of past values of the O/N index, and (2) to base the calculation on a clear standard mathematical formula without taking into account any other factors or variables.

Given that the pool of transactions with long maturities is limited, construction of longer term indices based on term transactions would require substitute or fallback procedures, such as the use of observations from previous days or averaging of information from previous days; from a certain perspective, this undermines the ability to present specific information about the reference market which the Administrator aims to measure. In the case of term indices resulting from calculations based on the concept of compounding, their adjustment to the current conditions is delayed due to the gradual addition to the term index value of each successive observation of the underlying O/N index.

From the point of view of users that do not require or do not tend to accept exposure to interest rate risk, interest rate benchmarks based on the proposed concept seem interesting. The professional market can develop instruments enabling the construction of term structure taking into account expectations, which can also be observed in foreign markets. However, it is worth noting that the implementation of the new “backward-looking” concept, which is already put in place in some financial markets, is a demanding process and its implementation will impact economic processes.
1. Introduction

GPW Benchmark ("GPWB"), as Administrator, has worked with representatives of the banking sector and public institutions on the option of developing a family of interest rate benchmarks in Poland since 2018. The first analyses concerning the development of interest rate benchmark methodologies alternative in relation to the WIBID index and the WIBOR index methodologies, with the latter being a critical benchmark, were carried out when adjusting the Reference Rates to BMR\(^1\). The adjustment process was closed with the authorisation granted by the Polish Financial Supervision Authority (KNF) on 16 December 2020. The purpose of that work was, among others, to adequately identify the key elements of the Reference Rates method and to adequately define alternative ways of measuring the money market, including an assessment of the information pool of the segments of the money market. Thanks to the involvement of the entities participating in the adjustment of the Reference Rates, GPWB obtained high-quality transaction data, which were used to develop conclusions and recommendations for the construction of a family of interest rate benchmarks.

This Consultation Paper ("Paper") presents the conclusions and recommendations of the Administrator regarding the possibility of constructing new interest rate benchmarks in the domestic market, as well as the proposed parameterisation of selected types of indices and the rationale. We hope that the information presented will explain the details of the measures taken and allow for a clear presentation of the operating principles of the money market and its measurement methods.

The Consultation Paper provides information on the rationale underlying the development of alternative interest rate benchmarks. It defines the market to be measured in the case of each index, as well as the elements of the benchmark method, with particular reference to the process of preparing the input data. In the Paper, GPWB presents the results of some analyses and key conclusions necessary to understand the Administrator’s recommendations for the parameterisation of each benchmark.

In principle, the Paper concerns the optimal choice of an alternative benchmark for the domestic interest rate market and its appropriate parameterisation. The defined indices address the need to provide the Polish financial market with risk-free rate (RFR) indices. Moreover, in order to present the principles of using such a benchmark in financial instruments and contracts, the Paper provides preliminary information on the principles of creating a term structure of for interest rates on the basis of an RFR benchmark based on the concept of compounding.

Subsequent steps in the implementation of risk-free rate indices in credit instruments and contracts will require the development of tools for the application of new benchmarks based on the concept of compounding in financial contracts and instruments. The functioning of a term structure of interest rates built on the basis of compounding and the “backward-looking” concept is very different from a forward-looking curve concept of the existing IBOR-type benchmarks. While forward-looking curves anticipate changes in interest rates, backward-looking curves based on the compounding of actual historical values of O/N indices delay the impact of both increases and decreases in interest rates by the central bank.

Some information and conclusions are presented in the Annexes to this Paper.

1a. Interest rate benchmark

An important motivation for GPWB in its strategy of designing an alternative interest rate benchmark was to provide domestic supervised entities with a tool necessary to fulfil the obligation imposed under Article 28(2) BMR, i.e., the obligation to have contingency plans in place in case of a material change to or cessation of a benchmark they use.

In addition to the factors arising from the provisions of BMR which would make the contingency plans of supervised entities more transparent by introducing a clear reference to a specific benchmark, the Administrator considered it is worthwhile to take all possible steps to conduct research of the domestic market necessary to present a different way of measuring the real value of money in the money market. At the same time, it was considered necessary to carry out analyses corresponding to global trends and actions of administrators in developed markets in order to verify the rationale and applicability of global solutions in accordance with the standard set for existing benchmarks.

In view of the above, and considering the amendments to BMR which allow for an effective and lawful replacement of a critical benchmark (for instance, replacement of LIBOR CHF by SARON), the Administrator’s aim was to develop an index which could meet the objectives referred to in Article 23c and replace the WIBID and WIBOR Reference Rates in the case of the occurrence of conditions prompting the Administrator to cease their provision. However, the purpose of developing an alternative interest rate benchmark is not only to create a replacement (i.e., an index with a clearly defined construction and rules of use which would replace a benchmark currently used in existing financial contracts and instruments without fallback clauses). The benchmarks provided by the Administrator are intended as an attractive measurement tool for building new financial instruments and concluding new financial agreements on the basis of a new way of measuring economic reality. The current standard of construction of benchmarks as observed in case of foreign markets involves adaptation of the methodology depending on the situation in a given country as well as recognition of changes in economic reality, including among others the increasing financial position and importance of financial institutions and some companies, including their possibility to act on the derivatives market, the evolution of monetary policy objectives and strategies around the world, as well as structural changes in the economy influencing the representativeness of benchmarks.

Given the volatile nature of economic reality and financial markets, important elements in managing a process of change to a benchmark are an adequate assessment of its representativeness under the applicable method as well as an ability to distinguish transient events from permanent changes in the trends of index performance.

The WIBID and WIBOR Reference Rates play an extremely important role in the Polish economy. They have become a systemic element of the financial market, dominating the economic environment for over a quarter of a century as the most important reference point for credit agreements and financial instruments. The development of Polish benchmarks mirrored solutions established in other markets. IBOR-type benchmarks have historically emerged in response to the need for a single, more efficient way of fulfilling financial obligations arising from contracts and financial instruments, in contrast to alternative and rather heterogeneous solutions such as for example Treasury bill rates used as a reference for cash flow measurement.
The global proliferation of IBOR-type indices in the financial market unfolded in the 1990s and made it possible to abolish bilaterally determined indicators. The adoption of LIBOR as a single benchmark helped to fulfil the functions of a benchmark as a trustworthy and clearly defined proxy of the cost of money in the financial market.

The interbank money market has provided the basis for benchmark construction for good reason. This is because the interbank market plays a key role in monetary policy transmission and can be regarded as the starting point for the propagation of monetary policy impulses.

Since 2008, the credibility and integrity of global LIBOR benchmarks have been called into question as a result of manipulation and abuse by some employees of banks participating in the benchmark panels. This was facilitated by the completely declaratory nature of contributions and the discretionary role of existing procedures. The introduction of BMR into the European legal order was an emanation of global efforts aiming to make benchmarks in Europe resilient and representative. As a member state of the European Union, Poland has been obliged since 2018 to adapt the existing benchmarks to the new requirements in a process which produced a range of detailed additions and changes to the obligations of contributors and the Administrator.

To create optimal conditions for economic transactions, it is necessary to ensure efficiency of the financial market, which is subject to an objective and effective assessment of economic processes. Therefore, as in the case of an IBOR-type benchmark developed in response to market demand, it seems reasonable to monitor potential changes to and development of existing benchmarks in response to developments and changes in the financial market which is to be measured, and likewise to address changes and requirements of the market through the development of new benchmarks.

1b. Polish interest rate benchmarks

Following the experience of financial markets in a number of developed and developing countries, it seemed reasonable to create risk-free rate benchmarks for the Polish financial market. Definitions of risk-free rate benchmarks differ from country to country, but what all those definitions have in common is that such benchmarks mitigate the scale of incorporated risk as they are based solely on transaction data. BMR does not require that interest rate benchmarks can only be compliant with BMR provided they are based on transaction data, as laid down in Annex 1 to BMR. Nevertheless, the calculation of benchmarks based on transaction data provides the clearest and most understandable representation of the situation in the market which is being measured.

The main alternative interest rate benchmarks operating globally are based on overnight (O/N) transactions. Analyses conducted on the basis of transaction data for the period 2016-2021 confirm that it is mainly O/N transactions that are concluded on the Polish money market as well, which justifies the Administrator’s search for an optimal benchmark at the O/N point of the yield curve.

Currently, there is POLONIA index available on the domestic market. It is provided by the National Bank of Poland on the basis of unsecured deposit transactions concluded by a defined group of banks. It is not widely used in financial instruments and contracts; importantly, it is not used in contracts and instruments covered by BMR. Taking into account the experience of foreign administrators, GPWB has conducted research on an extended range of financial market segments in order to define a representative population as a basis for the calculation of a benchmark.
As regards the directions of work aiming to broaden the scope of the analysis of the market to be measured, the Administrator could opt for a subjects’ extension, i.e., consider that the market to be measured is the deposit market including the interbank market, as well as the market of financial institutions, or even the market of large companies. Alternatively, the Administrator could opt for a horizontal shift across the market structure and seek optimal information on the price of cash flows in the market of secured (conditional) transactions.

GPWB carried out an exercise to develop indices in both secured and unsecured transactions markets, thus describing the complementary segments of the money market through which financial and non-financial entities manage their liquidity needs. Consequently, a proposal for three indices for the interest rate market was developed: (1) Warsaw Index for Financial Market – WIRF; (2) Warsaw Index for Deposit Market – WIRD; and (3) Warsaw Repo Rate – WRR.

WIRF reflects the volume-weighted mean interest rate on deposit transactions concluded by data contributors -the biggest Polish banks and branches of foreign credit institutions -with other data contributors as well as with other credit and financial institutions. The market which WIRD aims to measure has been expanded in order to include an additional deposit market segment: deposits of large companies.

WRR measures the market for transactions secured with wholesale treasury securities denominated in PLN. WRR describes the interest rate at which data contributors, i.e., major domestic credit institutions and branches of foreign credit institutions, conclude repo and buy/sell back transactions with other data contributors and with other credit and financial institutions. Importantly, as presented below (Table 4.1), WRR is an exceptional case among global indices: it is an index constructed on the basis of secured transactions where buy/sell back transactions dominate over repo transactions, which results from the characteristics of the Polish financial market and its operational and documentation standards.

The above indices constitute the Family of Transactions-based Interest Rate Benchmarks which GPWB plans to provide. The indices are calculated on the basis of contributions made by a defined group of banks under the Data Delivery Procedure (“DDP”, “Procedure”) i.e. Annex 7 to the WIBID and WIBOR Code of Conduct (“Code of Conduct”), delivered by means of verifiable and operationally automated processes. A code of conduct, rules, and a statement of the Family of Transactions-based Interest Rate Benchmarks will be provided to ensure that a preferred index can be used (in accordance with Article 3(1)(7) BMR).
2. Transaction data as input data for the calculation of transactions-based indices

The foundation of transactions-based interest rate benchmarks is to have high-quality input data. This assumption applies to all types of benchmarks, whereas actual transactions are the best type of input data and, according to Article 11(1)(a) BMR, shall be [...] sufficient to represent accurately and reliably the market or economic reality that the benchmark is intended to measure [...].

This means that the quality of data is directly related to the characteristics of the benchmark method as well as the quality of the analyses and simulations used in the development of the methodology. At the same time, the appropriate selection of transactions and the definition of the input data obtaining process are crucial for the adequate definition of procedures necessary to monitor the process and control the method, including the identification of errors or data which may relate to suspicious input data. The benchmark method is not about simplifying reality; it is about describing reality effectively according to the index definition.

2a. Description of markets

In the course of the adjustment of the WIBID and WIBOR Reference Rates method, principles for the use of transaction data in the method of the Reference Rates were defined, taking, first of all, into account the principle of data prioritisation. In order to properly define the benchmark methodology and subsequently verify the adequately delivered input data, an obligation was introduced to provide Administrator with transaction data.

Pursuant to Section 27 of the Code of Conduct, the Fixing Participant is obliged to provide the Administrator with clearly defined and classified groups of transaction data. The manner of fulfilment of this obligation is set out in the DDP.

The rationale and objectives for obtaining data from data contributors are defined in Section 2 of the Procedure. The contribution of data is required for the Administrator to carry out its obligations as defined in BMR, i.e., to monitor and validate the method and to carry out analytical procedures and other measures related to the preparation of the process for the provision of alternative benchmarks by the Administrator (Section 2.2 of the DDP). For the avoidance of any doubt, it should therefore be noted that whenever the term “data contributor” is used in the Paper, it should be understood to mean a bank acting as a WIBID and WIBOR Reference Rates Fixing Participant which has expressed preliminary interest in acting as a data contributor for the provision of alternative interest rate benchmarks. During consultations with the WIBID and WIBOR Fixing Participants, 9 out of 10 banks expressed their willingness and ability to cooperate in this project.

In the course of work on adjustment of the WIBID and WIBOR Reference Rates, money market segments were grouped, allowing to initiate the process of preparations for the provision of alternative interest rate benchmarks. Considering the structure of the domestic money market, as well as trends on global financial markets concerning the construction of benchmarks, including for instance the positive outlook of the segment of conditional transactions, the scope of transaction data contributed by Fixing Participants was defined broadly. It takes into account recommendations of certain institutions concerning the inclusion of specific segments, including for example the segment of deposits of institutions other than credit institutions and financial institutions. Therefore, the DDP ensures the contribution of data on unsecured deposits from the segments of credit institutions,
financial institutions, companies, as well as conditional transactions concluded by data contributors with other data contributors and with financial institutions. The final breakdown into data segments allows for the identification of Financial Institutions and Other Financial Institutions and for the distinction between Large Companies and Small and Medium Enterprises (SME). A description of the transaction data structure is presented in detail in Table 1.
### Table 1. Definitions of the classification of transactions by segment and by group

<table>
<thead>
<tr>
<th>Index</th>
<th>DDP type</th>
<th>Group</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WIRD</td>
<td>3.1.1</td>
<td>-</td>
<td>data of Deposit transactions concluded on the money market with other Fixing Participants</td>
</tr>
<tr>
<td>WRF</td>
<td>3.1.4</td>
<td>-</td>
<td>data of PLN fixed rate Deposit transactions concluded by a Fixing Participant with credit institutions which are not Fixing Participants, and NBP</td>
</tr>
<tr>
<td></td>
<td>3.1.5</td>
<td>-</td>
<td>data of PLN fixed rate deposit transactions concluded by a Fixing Participant with credit institutions – loro, financial institutions – foreign banks, non-monetary financial institutions, mortgage banks, co-operative banks, and co-operative savings and credit unions</td>
</tr>
<tr>
<td></td>
<td>3.1.10</td>
<td>-</td>
<td>data of PLN fixed rate deposit transactions concluded by a Fixing Participant with other non-monetary financial institutions</td>
</tr>
<tr>
<td></td>
<td>3.1.14</td>
<td>Large companies</td>
<td>data of PLN fixed rate deposit transactions concluded by a Fixing Participant with enterprises classified as Large Companies</td>
</tr>
<tr>
<td></td>
<td>3.1.14</td>
<td>SME¹</td>
<td>data of PLN fixed rate deposit transactions concluded by a Fixing Participant with enterprises classified as SMEs</td>
</tr>
<tr>
<td></td>
<td>3.1.7</td>
<td>CFIM²</td>
<td>data of repo securities transactions and reverse repo securities transactions concluded by a Fixing Participant with credit institutions</td>
</tr>
<tr>
<td></td>
<td>3.1.7</td>
<td>FIM³</td>
<td>data of repo securities transactions and reverse repo securities transactions concluded by a Fixing Participant with non-monetary financial institutions, mortgage banks, co-operative banks, co-operative savings and credit unions, credit institutions – loro, and financial institutions – foreign banks, and NBP</td>
</tr>
<tr>
<td></td>
<td>3.1.8</td>
<td>CFIM</td>
<td>data of Buy/Sell Back securities transactions and Sell/Buy Back securities transactions concluded by a Fixing Participant with credit institutions</td>
</tr>
<tr>
<td></td>
<td>3.1.8</td>
<td>FIM</td>
<td>data of Buy/Sell Back securities transactions and Sell/Buy Back securities transactions concluded by a Fixing Participant with non-monetary financial institutions, mortgage banks, co-operative banks, co-operative savings and credit unions, credit institutions – loro, and financial institutions – foreign banks, and NBP²</td>
</tr>
</tbody>
</table>

¹ Small and Medium-sized Enterprises  
² Credit and Financial Institutions Market  
³ Credit Institutions Market  
⁴ Financial Institutions Market

Table 1 also presents the rules for assigning DDP groups to defined segments, used in the case of O/N index concepts, which determine the definition of the reference market of an index.

As described in Section 1b, a methodological concept has been developed for three O/N interest rate benchmarks (according to the categories defined in the DDP):

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² In the case of data of transactions with the National Bank of Poland, the rules set out in the Data Delivery Procedure apply (delivered only if agreed by the NBP – currently, no agreement was provided).
(1) Warsaw Index for Financial Market – WIRF, defined as a transactions-based index provided on the basis of deposit transactions concluded by data contributors with Credit Institutions, Financial Institutions, and Other Financial Institutions, which are collectively referred to as financial institutions.

(2) Warsaw Index for Deposit Market – WIRD, defined as a transactions-based index provided on the basis of deposit transactions concluded by data contributors with Credit Institutions, Financial Institutions, and Other Financial Institutions, which are collectively referred to as financial institutions, and with Large Companies.

(3) Warsaw Repo Rate – WRR, defined as a transactions-based index provided on the basis of conditional transactions concluded by data contributors with Credit Institutions and Financial Institutions.

The above groups of segments represent a presentation of the reference market which each index intends to measure. The reference market of the WIRD index is the broadest, while the WIRF and WRR indices have a narrower definition of the reference market than the WIRD index.

In the case of the reference market for the WRR index, which is based on conditional transactions, the Paper presents two approaches to the definition of its scope of subjects. In the course of preparing the WRR index methodology, the following were defined: (1) Credit Institutions Market, and (2) Credit and Financial Institutions Market. The choice of the Credit and Financial Institutions Market resulted from a comparison of the information pool of the sets so defined. The pool of statistics on the number and volume of transactions in 2016-2020 for the Credit and Financial Institutions Market was several times larger than for the Credit Institutions Market. Similar decisions regarding the WRR index method were made with respect to the objective scope: the reference market of the index including repo (reverse repo) transactions was extended to include buy/sell-back (sell/buy-back) transactions, as mentioned in Section 1b.

2b. Input data delivery conditions

The processes involved in the preparation and delivery of the input data must comply with the BMR requirements and with the applicable Delegated Regulations. A key feature of the data delivery process is that it should ensure security, integrity, as well as effectiveness of process monitoring. In order to ensure the security of input data delivery, data contributors have implemented systems which not only allow to automate certain processes concerning preparation and delivery of certain type of input data, i.e. Model Quotes, in accordance with the Reference Rates method but also fulfil a range of obligations arising from the Data Delivery Procedure, which allowed the Administrator to prepare a methodology of indices based on actual transactions.

What is important from the point of view of security and conformity of transaction data is that all types of transaction data are delivered on a daily basis and are subject to ongoing verification and control, with an important role played by the construction principles of such automated systems of data

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3 In 2022, after the end of the Analysis Period, as a result of the introduction by KDPW_CCP of the clearing of repo transactions concluded on BondSpot (TBSP) as of 25 April 2022, the DDP segment comprised of a part of the transactions of Other Financial Institutions will be added to the scope of the segments which define the reference market of the WRR index.
Contributors as well as GPWB. All delivered transaction data are fed into the WIBIX system and are maintained by the Administrator in accordance with the BMR guidelines.

2c. Data quality, analysis period

The existing rules of the data delivery process and, consequently, the high quality of transaction data delivered by data contributors are the result of long-term cooperation between Fixing Participants which contribute data and GPWB. The establishment of the existing mode and quality of data contributions was a multi-stage process which required not only the introduction of policies and procedures for the automatic delivery of transaction data, i.e., operational, supervisory, and compliance measures, but also multilateral and bilateral transaction verification processes in order to set up single rules for data contribution by all the entities involved in the project.

The Analysis period for the research and analyses presented in this Paper is defined as the period from the beginning of January 2016 to the end of December 2021. The last Section has been extended to include some information from 2022, particularly with regard to the presentation of the performance of the indices according to the initial parameters of their method set by GPWB.

The choice of the analysis period was driven by the intention to use the best possible quality of transaction data delivered by data contributors. In the first step, defined as the period 2016-2019, effectively until 3 February 2020, the data contributed by WIBID and WIBOR Fixing Participants were related to the adjustment of the Reference Rates. Data prior to 2016 did not allow for thorough analysis as they did not meet the Administrator’s minimum quality requirements. This part of the analysis period ends on the date when the amended Reference Rates documentation and the rules for the delivery of data via the WIBIX system entered into force. As of 4 February 2020, clarified rules for the delivery of transaction data apply, including among other things the rounding of interest rate values in the delivered transaction data to a minimum of 6 decimal places for secured transactions and the definition of negotiated and non-negotiated transactions.

The period 2020-2021 was a period of verification of the data contributed by the entities (the banks also carried out bilateral consultations regarding the correctness of the attributes of the transactions concluded between them in that period) and their update in the WIBIX system. This process was completed at the beginning of 2022.

Data transferred to WIBIX is subject to verification according to attributes set depending on transaction type and money market segment in order to ensure correctness defined as adequacy and compliance with the requirements set by the Administrator. The attributes are checked using validation filters in WIBIX. The filters check the correctness of the values of a number of characteristics assigned to each of the defined segments and data types in order to eliminate potential non-compliances with the specification. The implemented procedures ensure that the data are delivered on a daily basis, at specific times, and under conditions of adequacy, completeness, accuracy, and actuality.

An important aspect related to the adequacy and compliance of input data is to ensure ongoing checks of the reliability of input data, for which the Administrator has established appropriate mechanisms. The mechanisms are primarily designed to identify circumstances in which input data no longer meet the standards necessary for the accurate and reliable calculation of indices and benchmarks and the performance of analytical processes. They include both the operational standards defined in the WIBIX system and the ability to undertake investigations with the entity which contributed the transaction data.

The high quality of transaction data assured by the data contributors as of 4 February 2020 implies that the data can, to the extent consistent with the index method, constitute input data within the
meaning of BMR in the pre-implementation period. This allows to provide more than 2 years of history for each of the indices presented in the Paper, ensuring that their quality is compliant with the requirements of the method. As for data prior to that date, GPWB points out that such data are highly acceptable but should not be treated as input data. The analyses performed on their basis are treated as high-quality simulations which adequately illustrate the performance of the index but should not be used for instance as a binding basis for the pricing of instruments or for model validation.

3. Market characteristics

In order to provide clear information on the information pool of the various money market segments, the Section below presents the results of analyses which examine the average daily number and average daily volume of transactions by segment and by group. The benchmark method used in the economy must ensure resilience and take into account trends in the development of the market segment in question so as to ensure sustainability and robustness of the method. The analysis period 2016-2021 allows for the inclusion of phenomena and processes of great importance in the history of the financial market and the economy, as highlighted in this Section. What clearly follows from the historical analysis of the money market structure is the dominance of short-term transactions, including primarily O/N transactions.

3a. Market size and structure

Measurement of the average number and average volume of transactions for the purpose of benchmarks based on money market segments is critical in order to adequately assess the continuity of a given benchmark. The statistics chosen allow us to assess not so much the size of a given segment as its average ability to support the information pool for a given index and its average impact on the description of the given benchmark. The different segments differ in their individual characteristics, as discussed below. In particular, this is presented in the Section dedicated to the selection of the optimal volume threshold, which is a valuable addition to the information on the statistical characteristics grouped within the methodology of each money market segment index.
Table 2. Summary of market pools by segment and by group on an annual basis

<table>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Average daily number of transactions</td>
<td>Average daily transaction volume</td>
<td>Average daily number of transactions</td>
<td>Average daily transaction volume</td>
<td>Average daily number of transactions</td>
<td>Average daily transaction volume</td>
</tr>
<tr>
<td>3.1.1</td>
<td>-</td>
<td>5.30</td>
<td>1.29</td>
<td>4.45</td>
<td>1.03</td>
<td>4.85</td>
<td>1.13</td>
</tr>
<tr>
<td>3.1.4</td>
<td>-</td>
<td>17.98</td>
<td>1.79</td>
<td>18.13</td>
<td>2.00</td>
<td>16.02</td>
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<tr>
<td>3.1.1 and 3.1.4</td>
<td>-</td>
<td>23.27</td>
<td>3.08</td>
<td>22.58</td>
<td>3.04</td>
<td>20.88</td>
<td>3.00</td>
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<td>-</td>
<td>287.84</td>
<td>6.19</td>
<td>281.38</td>
<td>4.94</td>
<td>198.72</td>
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</tr>
<tr>
<td>3.1.10</td>
<td>-</td>
<td>147.91</td>
<td>1.12</td>
<td>199.06</td>
<td>1.11</td>
<td>128.54</td>
<td>1.21</td>
</tr>
<tr>
<td>3.1.1 and 3.1.10</td>
<td>-</td>
<td>435.75</td>
<td>7.31</td>
<td>430.43</td>
<td>6.05</td>
<td>467.26</td>
<td>6.57</td>
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<td>CIM</td>
<td>5.61</td>
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<td>2.76</td>
<td>0.14</td>
<td>2.71</td>
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<td>CFIM</td>
<td>5.00</td>
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<td>4.49</td>
<td>0.21</td>
<td>12.29</td>
<td>1.30</td>
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<td>CIM</td>
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<td>5.13</td>
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<td>3.1.8</td>
<td>CFIM</td>
<td>156.43</td>
<td>15.84</td>
<td>163.71</td>
<td>11.39</td>
<td>180.11</td>
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<td>50.27</td>
<td>5.27</td>
<td>45.12</td>
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<td>11.64</td>
<td>168.19</td>
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<td>3,767.12</td>
<td>4.77</td>
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<td>Large Companies</td>
<td>2,532.49</td>
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<td>2,334.19</td>
<td>12.66</td>
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<tr>
<td>3.1.14</td>
<td>-</td>
<td>6,299.60</td>
<td>17.68</td>
<td>5,671.02</td>
<td>17.03</td>
<td>4,885.28</td>
<td>16.26</td>
</tr>
</tbody>
</table>

Source: GPWB based on transaction data provided by potential data contributors for the calculation of risk-free rate benchmarks.

Table 2 confirms that, within the analysis period, the highest average volume and average number of transactions was recorded for the segment of companies. The lowest values were recorded on average for the interbank market segments. However, trends for individual segments and groups remain key.

In this respect, it should be noted that in segments 3.1.1 and 3.1.4, the average daily number of transactions decreased from an average of approx. 22 transactions in 2016-2019 to approx. 14

---

4 For the sake of clarity, each column is formatted separately using a colour scale: dark green indicates the highest recorded value and white indicates the lowest.

5 Definitions of the identified subgroups are presented in Section 2, Table 1.

6 Statistics of average daily volumes are presented in PLN billion.
transactions per day in 2020-2021. The decrease in the average daily number of transactions coincided with an increase of the average daily volume. As a reminder, due to the low number and volume of transactions in the interbank market, money market information from related markets selected on the basis of statistical analysis was used in compliance with BMR, as described in the second GPWB consultation paper. As regards the set characterised by the highest values of the parameters analysed in the table, i.e., set 3.1.14, it is noted that a high and relatively stable average daily number of transactions was recorded for Large Enterprises in 2016-2018. The average daily volume was also high in that period. The years 2019-2021 were a period of a marked decline in both the average daily number and volume of transactions for that group, which is attributable to the gradual reduction of the interest rates and changes in the corporate deposit policies of some credit institutions due to the COVID-19 pandemic.

As discussed in Section 2, information on the number and volume of transactions up to the end of 2019 may be subject to a qualitative risk due to changes in methodology and lack of validation processes and procedures, which have been in place following the entry into force of the new WIBID and WIBOR Reference Rates documentation on 4 February 2020. The key validation procedures have been followed by data contributors since the implementation of the automated system for the preparation and delivery of Model Quotes and transaction data in connection with the obligations under the DDP.

As regards contingent transactions, the information pool is the broadest for the combined set of transactions in segments 3.1.7 and 3.1.8 of the Credit and Financial Institutions Market (CFIM). In 2016-2019, the average number of transactions increased while the average daily volume remained relatively stable. Both of these statistics decreased in 2020, and both increased in 2021. An important feature of segments 3.1.7 and 3.1.8 is that buy/sell-back transactions dominate significantly over repo transactions in the mix of conditional transactions.

The statistics and trends are presented for the full set of transaction data by segment. An equivalent table taking into account a volume threshold for eligible transactions at PLN 1 million is presented in Annex 4 to the Paper.

In line with the logic underlying risk-free rate benchmarks, the method aims to reduce the extent of embedded risks of the index to a minimum, including by using only actual transaction data. As such, it is important for the construction of the benchmarks to verify the assumption that the index can indeed be constructed, including the possibility of building a forward curve. In order to verify the possibility of constructing a forward curve based on actual forward transactions, a relevant analysis has been carried out. Table 3 presents the average daily number and average daily volume of transactions for selected maturities.

---

7 WIBID and WIBOR under the Benchmark Regulation
8 The studies and simulations up to the end of 2019 have a high illustrative value as an approximate representation of the market; thanks to the full adaptation of the validation procedures of the data contributors and re-verifications by the administrator, the studies and simulations performed from February 2020 onwards capture the actual performance of the benchmark.
9 The current standard for the classification of transactions by maturity has been followed; see the 2019 Consultation Paper for comparison. The table shows the characteristics of the population of new transactions rather than the status of open transactions, which is important for assessing the representativeness of the index.
Table 3. Share of transactions of specific maturity in the total number and total volume of transactions by segment and by group

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>3.1.1</td>
<td>-</td>
<td>90.4%</td>
<td>89.0%</td>
<td>92.3%</td>
<td>92.7%</td>
<td>91.7%</td>
<td>93.7%</td>
</tr>
<tr>
<td></td>
<td>3.1.4</td>
<td>-</td>
<td>88%</td>
<td>69%</td>
<td>69%</td>
<td>70%</td>
<td>70%</td>
<td>70%</td>
</tr>
<tr>
<td>ON</td>
<td>3.1.5</td>
<td>-</td>
<td>64.8%</td>
<td>77.5%</td>
<td>85.3%</td>
<td>83.0%</td>
<td>85.0%</td>
<td>77.5%</td>
</tr>
<tr>
<td></td>
<td>3.1.2.10</td>
<td>-</td>
<td>14.4%</td>
<td>31.4%</td>
<td>17.6%</td>
<td>17.6%</td>
<td>18.1%</td>
<td>17.6%</td>
</tr>
<tr>
<td>ON</td>
<td>3.1.7</td>
<td>CFIM</td>
<td>93.6%</td>
<td>34.1%</td>
<td>84.6%</td>
<td>37.6%</td>
<td>38.1%</td>
<td>34.4%</td>
</tr>
<tr>
<td></td>
<td>3.1.1.8</td>
<td>-</td>
<td>7%</td>
<td>31.7%</td>
<td>93.6%</td>
<td>37.6%</td>
<td>38.1%</td>
<td>34.4%</td>
</tr>
<tr>
<td>ON</td>
<td>3.1.1.4</td>
<td>Large Companies</td>
<td>85.5%</td>
<td>86.1%</td>
<td>87.7%</td>
<td>88.1%</td>
<td>88.3%</td>
<td>88.4%</td>
</tr>
<tr>
<td>IM</td>
<td>3.1.1</td>
<td>-</td>
<td>5.0%</td>
<td>1.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td>3.1.4</td>
<td>-</td>
<td>1.0%</td>
<td>0.3%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>IM</td>
<td>3.1.5</td>
<td>-</td>
<td>26.5%</td>
<td>2.5%</td>
<td>2.0%</td>
<td>2.5%</td>
<td>1.4%</td>
<td>0.6%</td>
</tr>
<tr>
<td></td>
<td>3.1.2.10</td>
<td>-</td>
<td>0.6%</td>
<td>0.5%</td>
<td>0.7%</td>
<td>0.7%</td>
<td>0.9%</td>
<td>0.8%</td>
</tr>
<tr>
<td>IM</td>
<td>3.1.7</td>
<td>CFIM</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
</tr>
<tr>
<td></td>
<td>3.1.1.8</td>
<td>-</td>
<td>2.0%</td>
<td>2.9%</td>
<td>1.8%</td>
<td>1.9%</td>
<td>1.6%</td>
<td>1.6%</td>
</tr>
<tr>
<td>IM</td>
<td>3.1.1.4</td>
<td>Large Companies</td>
<td>0.4%</td>
<td>0.4%</td>
<td>0.4%</td>
<td>0.4%</td>
<td>0.4%</td>
<td>0.6%</td>
</tr>
<tr>
<td>GM</td>
<td>3.1.1</td>
<td>-</td>
<td>0.2%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td>3.1.4</td>
<td>-</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>GM</td>
<td>3.1.5</td>
<td>-</td>
<td>0.2%</td>
<td>0.1%</td>
<td>0.2%</td>
<td>0.1%</td>
<td>0.3%</td>
<td>0.3%</td>
</tr>
<tr>
<td></td>
<td>3.1.2.10</td>
<td>-</td>
<td>0.2%</td>
<td>0.1%</td>
<td>0.2%</td>
<td>0.1%</td>
<td>0.3%</td>
<td>0.3%</td>
</tr>
<tr>
<td>GM</td>
<td>3.1.7</td>
<td>CFIM</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td>3.1.1.8</td>
<td>-</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.2%</td>
<td>0.1%</td>
<td>0.2%</td>
<td>0.3%</td>
</tr>
</tbody>
</table>

Source: GPWB

Statistics on the average daily number and average daily volume of transactions by maturity confirm the dominance of O/N transactions for almost all of the groups presented.

---

10 The table presents information on the share of forward transactions with defined standard maturities. The statistics are calculated as their percentage share in the total set of transactions, which also includes transactions with non-standard maturities.
The dominance of O/N transactions is most evident for the interbank market. Moreover, for transactions in segments 3.1.1 and 3.1.4, the percentage share of transactions with other maturities is lower than 10% in each year for both statistics.

O/N transactions are also dominant in the case of transactions in segments 3.1.5 and 3.1.10 but the statistics are noticeably lower than in segments 3.1.1 and 3.1.4. However, as in the case of the interbank market segments, the percentage share of transactions with other maturities is less than 10% in each year for both statistics.

The set of segments of the unsecured deposits market includes the corporate segment. In the case of transactions in segment 3.1.14, and its Large Companies sub-segment, the share of O/N transactions in the number and volume of transactions is high and dominant in 2016-2020. A sharp decline was observed in 2021, when both the average number of O/N transactions concluded daily in that year and their average daily volume were noticeably lower than in previous years. At the same time, the share of transactions with maturities of mainly 1M, but also 3M and 6M, grew as both statistics increased. The remaining relatively high percentage of transactions that year was that of transactions with non-standard maturities.

Compared to the number and volume statistics for the other segments\(^{11}\), the share of O/N transactions for segments 3.1.7 and 3.1.8 (CFIM) is lower. A significant share of transactions are TN transactions, ranging from 8.4% to 17.8% for the average daily number of transactions and from 12.4% to 19.3% for the average daily volume. The remaining relatively high percentage of transactions was that of transactions with non-standard maturities.

### 3b. Interest rate distributions

The purpose of the analysis of the interest rate distributions for sets of transactions was to identify the characteristics of individual segments and to present their impact on the potential benchmark built on the basis of such transactions. Figure 3.1 presents the empirical distributions\(^{12}\) of the interest rates of O/N transactions in different market segments by year in the period 2016-2021. Several important conclusions can be drawn based on the shape and position of the distributions.

\(^{11}\) The exception to the rule is 2021 and segment 3.1.14 with transactions in the Large Enterprises group

\(^{12}\) The empirical distribution of a variable shows the frequency of occurrence of its values in the sample. In this analysis, it is illustrated by a kernel-estimated distribution density function.
First, the distribution of unsecured deposit transaction rates on the interbank market (segments 3.1.1 and 3.1.4) is very similar to the distribution of the rates of secured transactions (repo and buy/sell-back) between banks and between financial institutions and banks (segments 3.1.7 and 3.1.8). Importantly, both of these distributions are characterised by a strong concentration around the central value, which is particularly evident in 2016-2019. In this period, the distributions have a single dominant\textsuperscript{13} due to the fact that the NBP rates did not change in the period (in 2020-2021, the distributions were multi-modal due to changes in NBP rates: rate cuts in 2020 and rate hikes in 2021). Distributions standardised by daily mean and standard deviation, which eliminate the impact of exogenous factors such as changes in monetary policy parameters, are presented for comparison in Annex 1.

The distributions of deposit transaction rates on the remaining markets, i.e., segments 3.1.5 (deposits between banks and Financial Institutions), 3.1.10 (deposits between banks and Other Financial Institutions), and 3.1.14 (corporate deposits in banks; while the analysis of this segment was limited to deposits of Large Companies), show much greater dispersion. Of these, the rates of deposits between banks and Other Financial Institutions (3.1.10) have the greatest dispersion (and therefore the most flattened distribution), which is evidence of considerable fluctuations and the lack of a clear dominant in this case.

It is also noted that the relationship between the dominants of the distributions remains stable. The interbank deposit rates (3.1.1 and 3.1.4) and the repo and buy/sell-back rates (3.1.7 and 3.1.8) are concentrated to a similar degree, which is notably higher than in the other market segments. The dominant deposit rates between banks and Financial Institutions (3.1.5) are lower, and the dominant deposit rates of Large Enterprises (3.1.14) are yet lower. Due to the strong dispersion of the rates, segment 3.1.10 shows no clear indication of a dominant value relative to the other groups; however, its dominant is certainly positioned around that of segments 3.1.5 and 3.1.14, which is well below the interbank market.

The choice of a specific group of market segments for the construction of a benchmark impacts its average value; the greater the volume of a segment, the greater its impact. Figure 3.2 shows the

---

\textsuperscript{13} Dominant - one of the measures of central tendency of an empirical distribution, indicating the value that occurs most frequently in the sample.
distributions of O/N transaction rates in groups of market segments corresponding to particular types of alternative indices (WIRD: 3.1.1, 3.1.4, 3.1.5, 3.1.10, 3.1.14; WIRF - 3.1.1, 3.1.4, 3.1.5, 3.1.10; WRR - 3.1.7, 3.1.8).

Figure 3.2. Empirical distributions of O/N interest rates by group of market segments defined by indices

The distributions in Figure 3.2 are a derivative of the distributions within the individual market segments in Figure 3.1. The highest values and the highest concentration around the central value are observed for rates on secured transactions which are the basis of WRR, i.e., repo transactions (3.1.7) and buy/sell-back transactions (3.1.8). Rates of deposit transactions underlying WIRF are notably lower; it can be inferred from Figure 3.1 that the transactions between banks and Financial Institutions (3.1.5) and transactions between banks and Other Financial Institutions (3.1.10) bring rates “down”, while interbank deposits have rates close to those on repo and buy/sell-back transactions. On average, segments underlying WIRD have rates which are even slightly lower than those underlying WIRF: consequently, they are “lower” in comparison with WIRF due to the Large Companies deposit segment. From the point of view of the differences between WIRD and WIRF, note the year 2021, when the rate distributions of the corresponding market segment groups overlapped in view of a dramatic decline in corporate deposits in the domestic banking sector during the COVID-19 pandemic and under the resulting extremely loose monetary policy.

As regards the secured repo and buy/sell-back market segments, an important factor in the selection of a sample for the construction of an index methodology also by other administrators constructing indices on the basis of this type of data is the impact of special collateral (SC) transactions on the interest rate distribution. SC transactions are transactions whose objective is the short-term acquisition by one of its counterparties of a specific financial instrument (bond) which constitutes security for such a transaction. The intention behind a benchmark based on repo or buy/sell-back transactions is to measure the cash flow secured by a general collateral (GC) instrument, which implies that the type of security does not play an important role and that it is the cash flow that is the key. In an SC transaction, where one counterparty focuses on obtaining the security instrument from the other counterparty, the interest rate required for the liquidity may be significantly lower than in a GC transaction. As a result, the presence of SC transactions could lead to stronger left-skewness of the daily distribution of repo and buy/sell-back rates, as can be seen in Figure 3.3 showing the pooled
annual empirical distributions of O/N repo and buy/sell-back rates standardised by the daily mean and standard deviation\textsuperscript{14}.

Figure 3.3. Empirical distributions of O/N repo and buy/sell-back rates standardised by daily mean and standard deviation

In more detail, the scale of the left-skewness of the daily distribution of repo and buy/sell-back rates is shown in Table 3.1, which presents the values of the skewness coefficient\textsuperscript{15} of the distribution of rates standardised by the daily mean and standard deviation for each quarter of the 2016-2021 period.

Table 3.1. Skewness of the interest rate distribution of O/N repo and buy/sell-back transactions standardised by daily mean and standard deviation

<table>
<thead>
<tr>
<th>Period</th>
<th>Skewness coefficient</th>
<th>Period</th>
<th>Skewness coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016-Q1</td>
<td>-0.90</td>
<td>2019-Q1</td>
<td>-1.46</td>
</tr>
<tr>
<td>2016-Q2</td>
<td>-0.78</td>
<td>2019-Q2</td>
<td>-2.17</td>
</tr>
<tr>
<td>2016-Q3</td>
<td>-0.84</td>
<td>2019-Q3</td>
<td>-1.70</td>
</tr>
<tr>
<td>2016-Q4</td>
<td>-1.21</td>
<td>2019-Q4</td>
<td>-1.78</td>
</tr>
<tr>
<td>2017-Q1</td>
<td>-0.83</td>
<td>2020-Q1</td>
<td>-1.31</td>
</tr>
<tr>
<td>2017-Q2</td>
<td>-1.92</td>
<td>2020-Q2</td>
<td>-0.99</td>
</tr>
<tr>
<td>2017-Q3</td>
<td>-1.53</td>
<td>2020-Q3</td>
<td>-1.16</td>
</tr>
<tr>
<td>2017-Q4</td>
<td>-1.24</td>
<td>2020-Q4</td>
<td>-1.27</td>
</tr>
<tr>
<td>2018-Q1</td>
<td>-0.69</td>
<td>2021-Q1</td>
<td>-1.55</td>
</tr>
<tr>
<td>2018-Q2</td>
<td>-1.33</td>
<td>2021-Q2</td>
<td>-1.86</td>
</tr>
<tr>
<td>2018-Q3</td>
<td>-1.52</td>
<td>2021-Q3</td>
<td>-1.90</td>
</tr>
<tr>
<td>2018-Q4</td>
<td>-1.21</td>
<td>2021-Q4</td>
<td>-1.06</td>
</tr>
</tbody>
</table>

Source: GPWB.

\textsuperscript{14} As a result of standardisation by daily mean and standard deviation, the standardised rates are derived from daily distributions with the same mean and standard deviation (0 and 1, respectively), which enables their pooled analysis.

\textsuperscript{15} The skewness coefficient is a measure of the asymmetry of a statistical distribution. It takes on a zero value for symmetric distributions, negative values for distributions with left-handed asymmetry (elongated left arm of the distribution), and positive values for distributions with right-handed asymmetry (elongated right arm of the distribution).
The values of the skewness coefficient in Table 3.1 below the notional threshold of -1 in most of the analysed quarters indicate a strong left-skewness of the daily distribution of repo and buy/sell-back rates. Given that the left-skewness is to some extent due to the aforementioned SC transactions, which could distort the fundamental representation of the cost of money in repo and buy/sell-back operations by reducing the actual rates, the question of a possible adjustment should be considered. Such an analysis is presented below in this Paper, in the description of the methodology proposed by the Administrator for the calculation of the index based on repo and buy/sell-back rates, i.e., WRR (see Section 4d).

3c. Structure of the risk-free rate index panel

The structure of the share of individual data contributors in the total volume of O/N transactions within the groups of market segments corresponding to WIRD, WIRF, and WRR may be an interesting element of the method for the provision of a benchmark or of the selection of the benchmark (see Figure 3.4.). The share of contributing banks in the total volume of transactions has been analysed in order to measure the potential impact of the loss of a particular contributor among the entities contributing data to the Administrator for the calculation of a benchmark and to identify those benchmarks where the impact of a single institution is the smallest. Data structure analysis is part of the method used by foreign administrators as it mitigates the risk of concentration of the information pool on the market that is being measured.

Figure 3.4: Modified\textsuperscript{17} share of contributing banks in the total volume of O/N transactions by group of market segments defined by WIRD, WIRF, and WRR

![Graph showing share of contributing banks](image)

Source: GPWB.

The analysis by volume shows that the largest dispersion of shares occurs in the group of segments corresponding to WIRD (standard deviation of 10.6 pps; the maximum share is recorded by BANK3 at 35.6%). A slightly smaller dispersion of shares is noted for the group of segments corresponding to WRR (standard deviation of 8.1 pps; the maximum share is recorded by BANK2 at 23.5%, BANK8 also stands out with a share of slightly over 16%). The smallest dispersion is observed in the segments corresponding to WIRF (standard deviation 5.5 pps; the maximum share is recorded by BANK3 at

\textsuperscript{16} According to a popular rule, an absolute value of the skewness coefficient below 0.5 indicates weak asymmetry, between 0.5 and 1 moderate asymmetry, and above 1 strong asymmetry.

\textsuperscript{17} The modification is that the volume of transactions of each contributing bank is used excluding transactions with other contributing banks. The share of a given bank so calculated indicates the scale of the potential decrease in the aggregate volume of transactions used to calculate the index due to the exclusion of such bank from the group of contributing banks (in this case, its transactions with other contributing banks are still contributed by the counterparties to the transactions and so the aggregate volume is not impaired).
19.4%), which would also indicate that the significant difference in concentration between WIRF and WIRD is due to the large variation in the shares of individual institutions in the segment of deposits of large enterprises. Consequently, WIRF shows the lowest risk to the representativeness of the index related to the potential exclusion of banks from the group of contributing banks while at the same time it mitigates the risk of concentration of the impact on the benchmark. WIRD shows the highest risk in this respect.
4. Methodology

This Section presents the elements of the proposed methodology for the calculation of the RFR index family. The RFR index will be calculated on the basis of data of O/N transactions concluded in specific market segments on a given day; it is a purely transactions-based index.

The final index calculation is preceded by adequate data processing. The processing includes, among others, the elimination of transactions not exceeding a certain volume threshold, the identification of potential duplicate transactions, known as matching (where a transaction is reported by two data contributors which are counterparties to the transaction), as well as an asymmetric or symmetric adjustment of the daily interest rate distribution.

The RFR index calculation process may include a fallback procedure which is triggered where transaction data are insufficient to calculate the index in accordance with the standard index determination method; as a result, the value obtained in accordance with a specific non-standard rule (e.g., use of the last determined and published value) is used as the index value for a given day.

4a. RFR methodologies globally

Many countries have already developed their own methodologies for calculating RFR-type interest rate indices. In developing the RFR index methodology for Poland, the Administrator has benefited from their experience and practices.

Table 4.1 presents a summary of the most important elements of the procedures for calculating risk-free rate (RFR) indices for selected countries, necessary to identify the key practices in this area currently followed around the world. The information presented in Table 4.1 constitutes a point of reference in the following Sections which introduce details of the methodology for the calculation of the Polish risk-free rate index proposed by the Administrator.

It is worth noting that unsecured transactions segments dominate as the markets benchmark are intended to measure with the exception of the US benchmark SOFR and the Swiss benchmark SARON, which is strongly related to the characteristics of these markets and identifies the most promising and representative segment of the money market.

Table 4.1: Methodologies for calculating RFR indices worldwide

<table>
<thead>
<tr>
<th>Country</th>
<th>Administrator</th>
<th>Transaction type</th>
<th>Scope of the reference market</th>
<th>Minimum transaction volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>EUR</td>
<td>ECB, BoE</td>
<td>Secured</td>
<td>EUR, JPY, CHF, CAD, SEK, NOK, GBP</td>
<td>EUR 1 million</td>
</tr>
<tr>
<td>JPY</td>
<td>BoJ</td>
<td>Unsecured</td>
<td>JPY, HKD, NZD, SGD, AUD, CNY</td>
<td>JPY 1 million</td>
</tr>
<tr>
<td>CHF</td>
<td>SNB</td>
<td>Secured</td>
<td>CHF, EUR, GBP, JPY, CAD, AUD, SGD</td>
<td>CHF 1 million</td>
</tr>
<tr>
<td>GBP</td>
<td>BoE</td>
<td>Unsecured</td>
<td>EUR, JPY, CHF, CAD, SEK, NOK, GBP</td>
<td>GBP 25 million</td>
</tr>
<tr>
<td>SEK</td>
<td>Riksbank</td>
<td>Secured</td>
<td>SEK, EUR, JPY, CHF, CAD, AUD, SGD</td>
<td>SEK 10 million</td>
</tr>
<tr>
<td>NOK</td>
<td>Norges Bank</td>
<td>Unsecured</td>
<td>NOK, EUR, JPY, CHF, CAD, AUD, SGD</td>
<td>NOK 10 million</td>
</tr>
</tbody>
</table>

Legend:
- **SOFR**: Secured Overnight Financing Rate
- **SONIA**: Sterling Overnight Index Average
- **EURIBOR**: Euro Interbank Offered Rate
- **SARON**: Swiss Average Reference Rate
- **SWESTR**: Swedish Short-Term Rate
- **NORIBOR**: Norwegian Overnight Interest Rate
The key elements of the preliminary preparation of transaction data include:
- Filter by market segment,
- Filter by counterparty type,
- Filter by security type,
- Filter by the time of the transaction,
- Filter by transaction size,
- Filter by quality of transaction data,
- Matching procedure,
- Filter by transaction volume threshold,
- Filter by maturity,
- Filter out outlier observations.

4c. Description of the filters used for input data preparation

4c.i. Filter by market segment
Concerning the market segment filter, each of the three types of RFR index (WIRF, WIRD, WRR) is based on a well-defined set of market segments:
- WIRF: 3.1.1, 3.1.4, 3.1.5, 3.1.10,
- WIRD: 3.1.1, 3.1.4, 3.1.5, 3.1.10, 3.1.14,
- WRR: 3.1.7, 3.1.8.

4c. ii. Filter by counterparty type
The filter by counterparty type only applies to corporate deposits (segment 3.1.14) used in the WIRD index procedure. The Administrator has chosen to limit the pool of transactions in this segment to deposits of large companies, which the Administrator considers to be more consistent with the other market segments considered as opposed to SME deposits\(^{18}\), which are eliminated using this filter.

4c. iii. Filter by type of security
The filter by type of security applies only to repo and buy/sell-back transactions (segments 3.1.7 and 3.1.8) where such collateral is used. This filter leaves only transactions secured by PLN domestic wholesale treasury securities in the pool for index calculation.

4c. iv. Filter by time of transaction
The filter by the time of the transaction is a qualitative element; in case of segments 3.1.1, 3.1.4, 3.1.5, 3.1.10 (excluding 3.1.14 due to the nature of the segment), it constitutes an element of verification of the completeness of contributed information\(^{19}\). In case of repo and buy/sell-back transactions (segments 3.1.7 and 3.1.8), it checks time conformity: only transactions whose recorded transaction time is earlier than the cut-off time, i.e., 18:00, are used in the index calculation.

4c. v. Matching procedure
The matching procedure is used to identify pairs of records in the transaction database which describe the same transaction. Such duplicate information occurs in the case of transactions where both counterparties are banks contributing their transaction data for the calculation of the RFR index. Since such a transaction is reported by each counterparty, it is represented by two records in the transaction database. This only occurs in segments 3.1.1, 3.1.7, and 3.1.8, i.e., where transactions may be concluded between two data contributors.

A pair of records identified in the matching procedure must refer to the same two banks as transaction counterparties (the contributing counterparty in the first record is the other counterparty in the second record and the contributing counterparty in the second record is the other counterparty in the first record); the records must be reported by the opposite transaction counterparties ('DEPO' and SME - small and medium-sized enterprises.

\(^{19}\) The calculation of WIRF and WIRD uses transactions over the whole business day.
'LOAN' for segment 3.1.1, 'REPO' and 'REVERSE REPO' for segment 3.1.7, 'BSB' and 'SBB' for segment 3.1.8); and the following data must match in both records:

- for transactions in segment 3.1.1: market segment, counterparty name or category, trade date, value date, maturity date, trade amount, interest rate;
- for transactions in segments 3.1.7 and 3.1.8: market segment, counterparty type, trade date, value date, maturity date, collateral ISIN code, collateral nominal amount, first leg, interest rate.

Crucially, the interest rate in both paired records must be identical when rounded to 4 decimal places. This caveat is made in view to differences in the accuracy of rate contributions between banks, which varies between 6 and 8 decimal places for secured transactions; rounding the rates being compared to 4 decimal places aims to eliminate these differences.

Once pairs of records corresponding to the same transaction have been identified, only one of the records in each such identified pair is left in the pool of transactions to be used for the index calculation, thus avoiding situations where the number and volume of transactions would be overstated by including the same transaction twice.

4c. vi. Filter by transaction volume

The next step in the preliminary processing of data is the elimination of transactions which do not exceed the established volume threshold in order to ensure the quality of the index and its representativeness. The selection and impact of the volume threshold are described in detail in Section 5.

4c. vii. Filter by maturity of transactions

Only O/N transactions are used for the calculation of RFR-type indices as a result of the RFR index concept. Consequently, transactions with maturities different than O/N are eliminated from the pool of transactions as part of the preliminary processing of data.

4c. viii. Filter out outliers

In order to identify and eliminate outliers in the index calculation (resulting from error, unusual transactions or manipulation), a filter is applied to filter out such rate observations in the preliminary processing of data. Transactions with a rate which is more than a certain acceptable symmetric distance away from the median transaction rate of the day are eliminated. The determination of the acceptable distance is described in Section 5 and it is a parameter of the index method.

4d. SC adjustment (asymmetric)

In view of the strong left-skewness of the daily distribution of repo and buy/sell-back rates, as described in more detail in Section 3b, which could result from special collateral (SC) transactions that would affect the cost of money by reducing the rates, the procedure for calculating the RFR index based on repo and buy/sell-back transactions (i.e., WRR) may include an asymmetric adjustment of the rate distribution which reduces the magnitude of its left-skewness.

The SC adjustment consists in eliminating from the pool those transactions which correspond to rates occurring in the extreme left tail of the daily rate distribution. In other words, the transactions with the lowest rates on a given day are cut off, which reduces the left-skewness of the rate distribution and thus the potential effect of SC transactions causing the rates to be underestimated.

20 The median of the rates on a given day is calculated on the basis of transactions in the pool resulting from the application of the other preliminary data processing procedures, i.e., those described in Sections 4.c.i to 4.c.vii.
The SC adjustment procedure eliminates those transactions whose rates are below a certain quantile\textsuperscript{21} of the distribution of rates from a given day\textsuperscript{22}. The SC adjustment has a defined quantile threshold (e.g., 5\%) for which, on each day, a quantile value is determined which defines a minimum acceptable rate of transactions on the given day. The process of selecting an appropriate quantile threshold in the SC adjustment is described in Section 5. The type of SC adjustment proposed is an eligibility factor based on statistical analysis and reasonable, albeit theoretical, assumptions.

Thus, it should be noted that the SC adjustment raises the risk of eliminating, along with actual SC transactions, also general collateral (GC) transactions which have low rates with no connection to the security instrument. Their elimination may distort the representation of the market to be measured by overestimating the cost of money.

Regarding analogous procedures in risk-free rate index methodologies used around the world, a similar practice can be identified for the US index SOFR based on repo rates (see Table 4.1 in Section 4a). One of the three market segments from which the transactions used to calculate SOFR originate has SC repo transactions and therefore a filter is used for the transactions from this segment which eliminates some of the transactions with the lowest rates so as to eliminate the impact of SC transactions\textsuperscript{23}.

Importantly, in the case of SOFR, the asymmetric adjustment applies to only one of the three market segments used in the calculation; thus, despite the risk of eliminating low-rate GC transactions along with SC transactions, the other two segments provide sufficient information on GC transactions. As a result, the SC adjustment under the SOFR methodology generates a significantly lower risk in this regard than it could be the case for WRR designed for the Polish financial market.

Another country using repo transactions as a basis for the calculation of an RFR index is Switzerland; however, the Swiss index SARON lacks a procedure similar to the SC adjustment as only GC transactions originating from the regulated market are used for the index calculation.

### 4e. Main adjustment (symmetrical)

The calculation method of risk-free rate indices in many economies (e.g., eurozone, UK, Sweden) includes an adjustment which symmetrically narrows the daily interest rate distribution directly before calculating the chosen measure of its central tendency (see Table 4.1 in Section 4a). The same procedure, which the Administrator refers to as the main adjustment, is also used in the proposed methodology for the domestic risk-free rate index. The main adjustment is aimed at limiting the range of transactions used to calculate the volume-weighted mean (see Section 4f) so as to include only those transactions whose rate is relatively close to the average rate quoted on a given day, thus cutting off symmetrically less typical observations (including both relatively high and relatively low observations). The main adjustment is based on a set formed after cutting off some transactions by applying (if consistent with the specified methodology) a potential SC adjustment for indices based on conditional transactions.

Crucially, this adjustment is volume-weighted, meaning that transactions corresponding to a certain percentage of the total volume of all transactions for the day are cut off at both ends of the daily rate distribution. The most common cut-off point for each side of the distribution is 25\% (eurozone and UK); it is 12.5\% for the Swedish index SWESTR.

More specifically, the main adjustment process is as follows:

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\textsuperscript{21} A quantile of order \( p \) of the empirical distribution of a statistical characteristic in a sample is a characteristic value that divides the sample into two parts such that at least \( p \cdot 100\% \) of the units have a value equal to or lower than the quantile value and at least \((1-p) \cdot 100\% \) of the units have a value equal to or higher than the quantile value.

\textsuperscript{22} An alternative option is to eliminate transactions whose rate is lower than or equal to a specified quantile of the distribution of rates on a given day; however, the option of eliminating transactions with a rate lower than the quantile is used as the baseline.

\textsuperscript{23} Strictly speaking, those transactions are eliminated which have a rate below the volume-weighted 25th percentile, i.e., a quantile of the order of 25\% of the volume-weighted rate distribution, where the measure of the probability of a given rate value is the share of the volume of transactions with such rate in the sum of the volume of all transactions on a given day rather than the relative frequency of transactions with such rate.
- pool transactions of a given day into aggregates containing transactions at the same interest rate: the volume of an aggregate is the sum of the volumes of the transactions included in it,
- place the aggregates in order from the lowest to the highest rate,
- determine the volume to be cut off at the bottom and at the top of the distribution as the result of the cut-off threshold (e.g., 25%) and the total volume of transactions for the day,
- starting with the aggregate with the lowest rate, check whether its volume is smaller than the volume to be cut off at the bottom; if not, reduce the volume of the aggregate by the volume to be cut off at the bottom and finalise the bottom cut-off process; otherwise, cut off the aggregate in full (while at the same time reducing the volume remaining to be cut off at the bottom by the volume of the aggregate) and proceed to the next aggregate (in the order of ascending rates) to repeat the procedure,
- starting with the aggregate with the highest rate, check whether its volume is smaller than the volume to be cut off at the top; if not, reduce the volume of the aggregate by the volume to be cut off at the top and finalise the top cut-off process; otherwise, cut off the aggregate in full (while at the same time reducing the volume remaining to be cut off at the top by the volume of the aggregate) and proceed to the next aggregate (in the order of descending rates) to repeat the procedure.
Aggregates of transactions remaining after the main adjustment process are then used to calculate the volume-weighted mean interest rate.
The process of selecting the appropriate cut-off order in the main adjustment is described in Section 5.

4f. Measure of central tendency

The dominant global standard, i.e., the volume-weighted average rate (see Table 4.1 in Section 4a) is used as a measure of the central tendency of interest rates calculated on the basis of their daily distribution. It is used in the RFR index methodology in the eurozone, the UK, Switzerland, Japan, Sweden, and Norway, among others.
The volume-weighted mean rate is calculated on the basis of transaction aggregates determined in the main adjustment procedure\(^24\) as follows:

\[
\frac{\sum_i (r_i \times v_i)}{\sum_i v_i}
\]

where:
\(r_i\) - interest rate of the transaction aggregate \(i\),
\(v_i\) - volume of the transaction aggregate \(i\).

Importantly, however, the risk-free rate index methodologies of the aforementioned countries using volume-weighted average differ in the rounding precision of the central tendency measure calculated. Specifically, the rounding precision varies from 2 decimal places (Norwegian NOWA) to 6 decimal places (Swiss SARON).
For the Polish RFR index, the Administrator proposes rounding the volume-weighted average to 4 decimal places, i.e., to hundredths of a basis point\(^25\). Such accuracy is close to the average of solutions used in other countries.

\(^{24}\) See Section 4e.
\(^{25}\) An example of RFR index value with the proposed rounding: 1.1357%.
4g. Fallback procedure

As an indispensable element of the RFR index methodology, a fallback procedure applies in case the transaction data available for a given day do not meet the specified requirements.

In order to draft a fallback procedure, two key elements need to be defined:
- data requirements,
- a fallback method for calculating the index in the event that the requirements are not met.

Regarding the first element mentioned above, i.e., the requirements for transaction data in the fallback procedure, their overview for foreign RFR indices is shown in Table 4.1 in Section 4a. The requirements mainly focus on the appropriate quantity or structure of transaction data.

A simple and intuitive requirement, present in the methodology of the NOWA and SWESTR indices, is a minimum threshold of the total daily volume of transactions used to calculate the index (importantly, it is measured before applying any adjustments narrowing the daily rate distribution in the calculation process). The Administrator has decided to implement a similar mechanism in the methodology of calculation of the RFR index for Poland. The process of selecting the appropriate minimum threshold for the total daily volume is described in Section 5.

The other element of the fallback procedure is a non-standard index calculation method, which is used when the requirements mentioned above are not met. The Administrator proposes in such a case to determine the index as equal to the last available index value (i.e., index value for the previous business day), which is the simplest possible solution, used for instance in the SARON index methodology.

An argument could be made for the need to set a limit on the maximum number of consecutive days on which the fallback procedure can be applied so as not to publish an index that has been “frozen” for too long. However, it should be noted that, if such a limit were to be imposed, it could be impossible to publish the index for certain days, which could pose a serious problem for financial market participants who use the index. It is also worth noting that methodologies of foreign RFR indices described in Table 4.1 do not impose such a limitation (only in case of NOWA is the fallback calculation formula changed after 3 consecutive days of the fallback procedure; however, continuity of index publication is maintained)\(^\text{26}\).

In the Administrator’s opinion, when selecting an optimal benchmark it is important that the choice mitigates the risk of the index not being determined and of the need to use a fallback procedure. In the case of the Polish money market, this is crucial as the volatility on the domestic money market (see Figure 6.2) is such that the use of a fallback procedure could result in a significant mismatch between the index value and the reality of a given day and in inadequate pricing of instruments. Thus, the above considerations are in line with the goal of defining such an O/N risk-free rate index which, in view of the number and volume of transactions, is exposed to a limited risk of not being determined based on actual transaction data.

\(^{26}\) The Administrator has decided not to introduce such a solution in the methodology of the domestic risk-free rate index in the test version before understanding the opinions of financial market representatives expressed in the public consultation process.
5. Parameterisation of the method

The general principles and rules for the processing of a set of transaction data presented in Section 4 require appropriate parameterisation, i.e., determination of:

- the maximum acceptable distance of observations of the interest rate from the median of its distribution on a given day (i.e., the parameter for the outlier filter),
- the minimum volume threshold for a single transaction,
- the cut-off order in the SC adjustment,
- the cut-off order in the main adjustment,
- the minimum threshold for the total daily volume (i.e., the fallback condition).

We refer to the statistical analysis of the data and inference regarding the parameterisation of the index calculation procedure as a bottom-up approach. It has been applied to the determination of the outlier filter parameter, the minimum volume threshold for a single transaction, the cut-off threshold in the SC adjustment, and the minimum threshold for the total daily volume.

On the other hand, in the case of those parameters for which the statistical analysis of transaction data does not suggest specific preferred values, a top-down approach is applied, which consists in simulating the performance of indices based on historical data with different parameterisations and inference regarding the impact of the parameters on key index characteristics (e.g., average level, volatility). The top-down approach has been used in determining the cut-off threshold in the main adjustment, and partially in the analysis of the minimum volume threshold for a single transaction and the minimum threshold for the total daily volume.

5a. Filter for outliers

Regarding a filter which eliminates extreme outliers of interest rates, the preliminary processing of transaction data needs to determine the maximum acceptable distance from the median of the daily distribution; the filter methodology assumes that it is symmetric.

This distance was determined by statistical analysis of transaction data, separately for O/N deposit transactions in the segments corresponding to WIRD\(^{27}\) (i.e., segments 3.1.1, 3.1.4, 3.1.5, 3.1.10, and 3.1.14 limited to large companies) and separately for O/N repo and buy/sell-back transactions in segments 3.1.7 and 3.1.8 corresponding to WRR.

For this purpose, the distance between the daily minimum/maximum and the daily median interest rate was calculated for each business day in the period 2016-2021, after which the maximum values of the distance in the period were selected. The results of the analysis are summarised in Table 5.1.

Table 5.1. Maximum distance between daily minimum/maximum and daily median interest rate

<table>
<thead>
<tr>
<th>Transactions range</th>
<th>Maximum distance between daily minimum and median (pps)</th>
<th>Maximum distance between daily maximum and median (pps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.1, 3.1.4, 3.1.5, 3.1.10, 3.1.14 (large enterprises)</td>
<td>5.0</td>
<td>4.2</td>
</tr>
<tr>
<td>3.1.7, 3.1.8</td>
<td>3.0</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Source: GPWB.

\(^{27}\) The same distance as for WIRD will be proposed for transactions in the segments corresponding to WIRF as they are a subset of the transactions in the scope of WIRD.
As there are no observations in the analysed dataset which the Administrator would classify as extreme outliers, it can be concluded from Table 5.1 that the value of an acceptable symmetric distance of rates from their daily median should be equal to at least 5.0 pps for deposit transactions and 3.0 pps for repos and buy/sell-back transactions.

Given that, in the event of a potential rise in interest rates to levels significantly higher than during the analysis period, their dispersion may increase markedly, the Administrator suggests that twice the distance suggested by Table 5.1 should be used as an acceptable distance in the outlier filter, which implies 10.0 pps for deposit transactions (WIRF and WIRD) and 6.0 pps for repo and buy/sell-back transactions (WRR).

In the event of a change in the monetary or structural conditions affecting the degree of dispersion, the Administrator will revise the parameter defined in the outlier observation filter on the basis of empirical research under the benchmark method monitoring procedure.

### 5b. SC adjustment

The SC adjustment procedure can be applied to repo and buy/sell-back rates (WRR) whose daily distribution is characterised by a left-skewness attributable to the occurrence of SC transactions. The SC adjustment removes from the pool of transactions those transactions whose rate is below a certain quantile of the rate distribution on a given day. To fully define the procedure, it is therefore necessary to determine the order of such quantile.

For this purpose, an empirical analysis of the data was carried out using the available set of data generating in a systematic way a left-side cut-off for the rate distributions standardised by the daily mean and standard deviation generated for each quarter of the period 2016-2021, which was designed to reduce the left-skewness. The concept of the experiment is that for a given distribution, a density function is estimated with which its minimum, maximum, and dominant are determined. Then the left tail of the distribution is cut off at the rate resulting from the subtraction from the dominant of the distance between the dominant and the maximum (the cut-off point is thus the result of the symmetric reflection of the maximum with respect to the dominant), after which the relative frequency is calculated of the observations eliminated as a result of the cut-off, which is interpreted as the order of the quantile determining the cut-off.

The next step of the experiment is to detain for further analysis only those quarters for which the above cut-off of the left tail of the distribution only reduces the left-skewness of the distribution but does not transform it into a right-skewed distribution, which would be an excessive cut-off. The appropriate data on the cut-off threshold for the set of quarters selected as described above are presented in Table 5.2; these are assumed to be acceptable cut-off threshold reducing the left-skewness of the rate distribution.

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28. To be precise, the density function of the rate distribution was kernel-estimated, which was then cut off on the left side at the point corresponding to the lowest rate for which the value of the estimated density function was greater than or equal to 0.01 and on the right side at the point corresponding to the highest rate for which the value of the estimated density function was greater than or equal to 0.01. In this way, for each quarter, a rate distribution was obtained characterised by 3 main parameters: minimum, maximum, and dominant (analogy with a triangular distribution).

29. The relative frequency of a random event is the ratio of the number of observations contained in that event (i.e., the number of observations meeting a specific criterion) to the number of all observations in the sample.
The median of the cut-off threshold in Table 5.2 is 3.7%. On this basis, the Administrator in its internal analytical work set the cut-off threshold in the SC adjustment at 3.5% (resulting from rounding down 3.7% to half a percentage point\(^3\).

However, given the risk inherent in the SC adjustment of removing, along with actual SC transactions, also those GC transactions which have low rates but have no connection to the security instrument (see discussion in Section 4d), the Administrator is inclined not to include the SC adjustment in the WRR index methodology. An important factor influencing the Administrator’s final recommendation is that the rate distribution of unsecured deposit transactions is also characterised by left-skewness (see Annex 2), although in that case there is no theoretical basis to justify a distribution curve shape adjustment similar to the SC adjustment for WRR.

Given that it is impossible to empirically verify the applicability of an SC adjustment, the Administrator concluded that there is no clear basis to apply an adjustment reducing the left-skewness of one of the types of proposed indices. The SC adjustment is not applied at the current stage; however, the Administrator may introduce an SC adjustment if relevant indications are identified, for instance during the review of the index method.

### 5c. Volume threshold

In the context of the selection of the minimum volume threshold for transactions, we will look at both the results of a statistical analysis of transaction data (bottom-up) and the conclusions of a simulation-based analysis (top-down).

Regarding unsecured deposit transactions (which underlie WIRF/WIRD-type indices), Figure 5.1 shows that the volume threshold for an individual deposit transaction at PLN 5 million leaves mainly interbank market transactions in the pool for WIRF/WIRD-type index calculations (segments 3.1.1 and 3.1.4), where the vast majority of the transactions have a volume above PLN 25 mn, while most transactions in the segment of financial institutions (66%), other financial institutions (78%), and large companies (83%) are cut off. Consequently, the threshold of PLN 5 mn results in a significant depletion of the information pool for the above segments in the WIRF/WIRD-type indices, which would significantly limit the ability of the benchmark to reflect its definition. Considering the above, the Administrator assumes that the target volume threshold for deposit transactions will take a value below PLN 5 mn.

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\(^{3}\) The rounding down is justified by the intention to mitigate the risk of information pool depletion when applying the filters, which the Administrator rounds to the nearest half percentage point for the sake of clarity of the process.
In turn, the simulation-based analysis of sensitivity to the volume threshold\textsuperscript{31} (see Figure 5.2) shows that the volatility\textsuperscript{32} of both WIRF and WIRD increases with an increase in the volume threshold; a stronger impact of the threshold increase is noted for WIRD as compared to WIRF (for WIRD, an increase in the threshold from PLN 0 to 50 mn results in an increase in the volatility measure by about 1.5 bps; it is approx. 0.75 bps for WIRF).

\textsuperscript{31} In the sensitivity analysis, simulations of the performance of the RFR indices (WIRF, WIRD, and WRR) in the period 2016-2021 were recalculated for different values of the minimum volume threshold (values ranging from PLN 0 to PLN 50 million were tested with an interval of PLN 2.5 million); a number of simulations were performed simultaneously for each threshold value using different values of the parameter determining the order of the symmetric cut-off in the main adjustment; this allowed for sensitivity analysis on both of these parameters (see Section 5d). Consequently, the average of the measures of index volatility calculated using a number of separate simulations (each simulation for a different order of the symmetric cut-off in the main adjustment) was taken as the measure of index volatility for a given value of the volume threshold.

\textsuperscript{32} The standard deviation of the difference in the index (i.e., the difference between the value of the index on a given day and its value on the previous day) was used as a measure of the volatility of the index.
Figure 5.2. Volatility of WIRF and WIRD measured by the standard deviation of their first difference (DIFF.SD) vs. minimum volume threshold

![Graph showing volatility vs. minimum volume threshold for WIRF and WIRD](image)

*Explanations: Black line – mean value of standard deviation of the first index difference, dashed blue lines – minimum and maximum value of standard deviation of the first index difference.*

*Source: GPWB.*

The top-down analysis thus shows the negative effects of increasing the volume threshold in the form of increasing index volatility. This result supports the conclusions of the bottom-up analysis, which also suggested selecting a relatively low volume threshold (i.e., well below PLN 5 mn).

In conclusion, the Administrator suggests that an adequate volume threshold for WIRF/WIRD is PLN 1 mn. This will, on the one hand, ensure that the smallest transactions, which may not be representative of the broad market, are cut off, and on the other hand, ensure adequate representation of all market segments covered by the index. Moreover, the above threshold will cause only a slight increase in index volatility compared to non-application of a volume threshold.

As for repo and buy/sell-back transactions (underlying WRR-type indices), they are on average significantly larger than unsecured deposit transactions, as can be clearly seen in Figure 5.3, which shows that even a volume threshold of PLN 10 mn would result in much less than half of the transactions being eliminated from the pool, which would be acceptable. Thus, there appears to be significantly more scope to filter out smaller transactions for WRR than for WIRF/WIRD. The problem, on the other hand, is that the number of repo and buy/sell-back transactions is highly volatile and can fall to critically low levels on some days. In this context, setting a high volume threshold increases the risk of having to eliminate transactions from the occasionally small pool, which would not be the preferred option as it would increase the frequency of the fallback procedure being triggered. In light of this, however, the volume threshold for WRR, as for WIRF/WIRD, should be as low as possible.
In turn, the simulation-based analysis of sensitivity to the volume threshold (see Figure 5.4) indicates that the volatility of WRR increases with an increase in the volume threshold from PLN 0 to 35 million (total increase in volatility of approx. 1 bps), and then decreases slightly with an increase in the threshold above PLN 35 mn (by approx. 0.5 bps), while this final change in the direction of the relationship does not undermine its predominantly upward profile. It is worth noting that a potential volume threshold of PLN 40 mn (i.e., a level at which volatility becomes relatively moderate) would cause significant depletion of the information pool for the secured transaction segment by removing between 43% and 65% of O/N repo transactions and between 63% and 72% of O/N buy/sell-back transactions (depending on the period analysed).
Figure 5.4. Volatility of WRR measured by the standard deviation of its first difference (DIFF.SD) vs. minimum volume threshold

Explanations: Black line – mean value of standard deviation of the first index difference, dashed blue lines – minimum and maximum value of standard deviation of the first index difference.
Source: GPWB.

Therefore, similarly as for WIRF/WIRD, the volume threshold should be relatively low also for WRR in the light of the simulation analysis taking into account the adverse increase in index volatility as a result of increasing the threshold. This result supports the conclusions of the bottom-up analysis which also suggested selection of a relatively low volume threshold for WRR.

The Administrator concludes that an adequate volume threshold for WRR is PLN 1 mn (similarly to WIRF/WIRD). On the one hand, this will guarantee that the least representative transactions are cut off, while on the other hand, it will not cause excessive limitation of the number of transactions used in the index calculation. Moreover, such a threshold will cause only a slight increase in index volatility compared to non-application of a volume threshold.

5d. Main adjustment

The scale of the symmetric cut-off in the main adjustment was primarily determined based on a review of the global standards in combination with the conclusions of a simulation analysis of sensitivity to this parameter.

As regards other countries’ practices (see Table 4.1 in Section 4a) of symmetrically narrowing the rate distribution before calculating the volume-weighted mean, the most commonly used cut-off for each side of the distribution is 25% (eurozone and UK); it is 12.5% for the Swedish index SWESTR. A cut-off point of 25% seems fairly intuitive as it leaves for the index calculation aggregates corresponding to equally half of the total transaction volume before the main adjustment.
In turn, the simulation sensitivity analysis\(^{33}\) (see Figure 5.5) indicates that the volatility\(^{34}\) of each of the three indices (i.e., WIRF, WIRD, and WRR) increases with increasing cut-off point in the main adjustment; the increase is the fastest for WRR (by approx. 1.5 bps if the cut-off point is increased from 0% to 40%); slightly slower for WIRF (by approx. 1 bps); and the slowest for WIRD (less than 0.5 bps). These results suggest that the symmetric cut-off should not be too large as that would involve an adverse increase in index volatility.

Figure 5.5. Volatility of WIRF, WIRD, and WRR measured by the standard deviation of their first difference (DIFF.SD) vs. cut-off order in the main adjustment

![Graphs showing the volatility of WIRF, WIRD, and WRR](image)

Explanations: Black line – mean value of standard deviation of the first index difference, dashed blue lines – minimum and maximum value of standard deviation of the first index difference.

Source: GPWB.

Taking into account the simulation results and the prevailing international standards mentioned above, GPWB considers the symmetrical cut-off level of 25% as optimal, which means that half of the total volume is cut off in total. Considering the impact of the increase in the cut-off level on index volatility, it should be noted that the increase in volatility in case of a change in the cut-off order from 12.5% to 25% amounts to maximum 0.5 bps (this is the case for WRR; it is even smaller for WIRF/WIRD), which is not a significant deterioration.

5e. Fallback procedure

In order to fully define the fallback procedure, it is necessary to define a minimum threshold for the total daily volume of transactions used for the calculation of the index (measured before the adjustments which narrow the daily distribution of rates in the calculation process).

Table 5.3 and Figure 5.6 show statistics on the total daily volume of transactions in the market segments corresponding to each RFR index type (i.e., WIRD, WIRF, and WRR).

\(^{33}\) As part of the sensitivity analysis, simulations of the performance of the RFR indices (WIRF, WIRD, and WRR) over the period 2016–2021 were recalculated for different orders of the symmetric cut-off in the main adjustment (the following values were tested: 0%; 10%; 20%; 25%; 30%; 40%), with a series of simulations for each order of the cut-off performed simultaneously at different volume minimum thresholds, which allowed for a sensitivity analysis on both of these parameters (see Section 5c). Consequently, the average of the index volatility measures calculated on a series of separate simulations (each simulation for a different value of the minimum volume threshold) was taken as the measure of index volatility for a given order of the cut-off.

\(^{34}\) As with the volume threshold sensitivity analysis, the standard deviation of its first difference (i.e., the difference between the index value on a given day and its value on the previous day) was used as a measure of the volatility of the index.
Table 5.3. Characteristics of daily transaction volume for WIRD, WIRF, and WRR

<table>
<thead>
<tr>
<th>Index</th>
<th>Period</th>
<th>Average daily transaction volume (PLN bn)</th>
<th>Minimum daily transaction volume (PLN bn)</th>
<th>Average daily transaction volume on 3 days with the lowest volume (PLN bn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WIRD</td>
<td>2016-2021</td>
<td>14,433</td>
<td>2,259</td>
<td>2,589</td>
</tr>
<tr>
<td></td>
<td>H1-2021</td>
<td>5,642</td>
<td>2,259</td>
<td>2,683</td>
</tr>
<tr>
<td></td>
<td>H2-2021</td>
<td>6,715</td>
<td>2,924</td>
<td>3,422</td>
</tr>
<tr>
<td>WIRF</td>
<td>2016-2021</td>
<td>7,649</td>
<td>1,978</td>
<td>2,071</td>
</tr>
<tr>
<td></td>
<td>H1-2021</td>
<td>5,526</td>
<td>1,978</td>
<td>2,490</td>
</tr>
<tr>
<td></td>
<td>H2-2021</td>
<td>6,350</td>
<td>2,904</td>
<td>3,325</td>
</tr>
<tr>
<td>WRR</td>
<td>2016-2021</td>
<td>4,171</td>
<td>0,008</td>
<td>0,030</td>
</tr>
<tr>
<td></td>
<td>H1-2021</td>
<td>2,907</td>
<td>0,653</td>
<td>0,722</td>
</tr>
<tr>
<td></td>
<td>H2-2021</td>
<td>4,188</td>
<td>0,047</td>
<td>0,607</td>
</tr>
</tbody>
</table>

Explanations: Statistics refer to data after filtering out transactions with a volume below PLN 1 mn.
Source: GPWB.

As regards assessment based on the full period of analysis (i.e., 2016-2021), the largest average daily transaction volume (approx. PLN 14.4 bn) characterises WIRD, which is based on transactions in the largest number of market segments. The daily volume for WIRF is almost half that on average (approx. PLN 7.6 bn); however, it is worth noting that in 2021, the average volumes for WIRD and WIRF closely converged due to a very strong reduction in the number of corporate deposit transactions which account for the difference between the two indices.

Crucially, with reference to the fallback procedure, the minimum daily volume in the period 2016-2021 is in the region of PLN 2 bn for both WIRD and WIRF. In the Administrator’s opinion, this is sufficiently high, and thus guarantees the representativeness of the index, so that the minimum threshold for the total daily transaction volume should certainly not exceed this level; thus, these indices should not generate a significant risk of a fallback calculation. Taking the above into account, the Administrator proposes a minimum threshold for the daily volume for WIRD and WIRF at PLN 1 bn.

On the other hand, the case of WRR is more complex: the index is based on repo and buy/sell-back transactions whose total daily volume is significantly lower than that of the deposit transactions underlying WIRD and WIRF. Between 2016 and 2021, it averaged around PLN 4.2 bn, the key fact being that at the same time it showed very large fluctuations while its minimum over the period is only PLN 8 mn. The risk of the daily volume of secured transactions reaching such low levels, which in no way
guarantee the representativeness of the index calculated on the basis of such transactions, implies a very important role of the fallback procedure in the case of WRR as opposed to WIRD and WIRF. Thus, an analysis of the sensitivity of the RFR indices to the minimum daily volume threshold was carried out mainly in relation to WRR; the results are presented in Table 5.4.

Table 5.4. Fallback procedure frequency vs. minimum threshold for the total daily transaction volume

<table>
<thead>
<tr>
<th>Index</th>
<th>Minimum threshold for the total daily volume (PLN mn)</th>
<th>Percentage of days when fallback procedure is triggered (%)</th>
<th>Number of days when fallback procedure is triggered*</th>
<th>Maximum number of consecutive days when fallback procedure is triggered</th>
</tr>
</thead>
<tbody>
<tr>
<td>WIRD</td>
<td>100</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>WIRF</td>
<td>100</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>WRR</td>
<td>100</td>
<td>0.3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>0.5</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>0.9</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>2.9</td>
<td>44</td>
<td>2</td>
</tr>
</tbody>
</table>

* The analysis period is 2016-2021, comprising a total of 1515 working days.

Explanations: Simulations were run for the indices taking into account the minimum threshold for the volume of a single transaction at PLN 1 million.

Source: GPWB.

The following thresholds were tested in the sensitivity analysis: PLN 100, 250, 500, and 1000 mn.

Knowing the volatility range of the daily transaction volume for WIRD and WIRF, namely, a minimum at approx. PLN 2 bn, it is not surprising that there are no days on which the fallback procedure would be triggered for these indices as none of the thresholds under consideration exceeds the minimum. Thus, the highest of the thresholds under consideration, i.e., PLN 1 bn, can be safely adopted.

The case of WRR is completely different: for each of the tested thresholds, WRR reports days on which the fallback procedure is triggered; at the maximum tested threshold (i.e., PLN 1 bn), their percentage reaches nearly 3%, which is a disturbingly high result. The best choice in this case seems to be the lowest of the thresholds under consideration (i.e., PLN 100 mn): on the one hand, it reports only 0.3% of days on which the fallback procedure is triggered (thus the fallback procedure is triggered less frequently than once a year, which may be considered acceptable), and on the other hand, it is high enough to ensure the representativeness of WRR.

In summary, the Administrator proposes to set the minimum threshold for the daily volume at PLN 1 bn for WIRD and WIRF and PLN 0.1 bn for WRR.

However, it must be emphasised that the risk of unacceptably low daily volumes for WRR means that it will be a less resilient index compared to WIRD and WIRF.

Concerning the possible need to set a maximum for the number of consecutive days on which the fallback procedure can be triggered, this does not seem to pose a significant problem: even for the highest threshold under consideration (PLN 1 billion), there are no cases of a series of days on which the fallback procedure is triggered longer than 2 days (see Table 5.4 and the discussion in Section 4g).
6. Characteristics of selected RFR indices

This Section examines in more detail the three specifications for the RFR index proposed by the Administrator (one for each of the three index types: WIRD, WIRF, and WRR) resulting from the conclusions drawn from the parameterisation analysis carried out in Section 5.

The selected indices are:
- WIRD_1_0_25_25,
- WIRF_1_0_25_25,
- WRR_1_0_25_25.

Each of the above indices is characterised by a minimum threshold for a single transaction volume at PLN 1 million (symbol “1” in the index name), no SC adjustment (symbol “0” in the index name), and a symmetric main adjustment of 25% (symbol “25_25” in the index name).

6a. Value and volatility analysis

Figure 6.1 summarises the simulated historical performance of each of the three selected indices (i.e., WIRD_1_0_25_25, WIRF_1_0_25_25, and WRR_1_0_25_25) in the period 2016-2021.

Source: GPWB.
Table 6.1. Average value and volatility of WIRF, WIRD, WRR, and POLONIA rate

<table>
<thead>
<tr>
<th>Period</th>
<th>Index</th>
<th>Average value (%)</th>
<th>Standard deviation of the first difference (pps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016-2021</td>
<td>WIRD_1_0_25_25</td>
<td>0.8394</td>
<td>0.1161</td>
</tr>
<tr>
<td>2016-2021</td>
<td>WIRF_1_0_25_25</td>
<td>0.9344</td>
<td>0.1488</td>
</tr>
<tr>
<td>2016-2021</td>
<td>WRR_1_0_25_25</td>
<td>1.0279</td>
<td>0.1648</td>
</tr>
<tr>
<td>2016-2021</td>
<td>POLONIA</td>
<td>1.0120</td>
<td>0.1502</td>
</tr>
<tr>
<td>H1-2021</td>
<td>WIRD_1_0_25_25</td>
<td>0.0085</td>
<td>0.0099</td>
</tr>
<tr>
<td>H1-2021</td>
<td>WIRF_1_0_25_25</td>
<td>0.0080</td>
<td>0.0110</td>
</tr>
<tr>
<td>H1-2021</td>
<td>WRR_1_0_25_25</td>
<td>0.0138</td>
<td>0.0169</td>
</tr>
<tr>
<td>H1-2021</td>
<td>POLONIA</td>
<td>0.0140</td>
<td>0.0077</td>
</tr>
<tr>
<td>H2-2021</td>
<td>WIRD_1_0_25_25</td>
<td>0.3289</td>
<td>0.1047</td>
</tr>
<tr>
<td>H2-2021</td>
<td>WIRF_1_0_25_25</td>
<td>0.3396</td>
<td>0.1041</td>
</tr>
<tr>
<td>H2-2021</td>
<td>WRR_1_0_25_25</td>
<td>0.4196</td>
<td>0.1176</td>
</tr>
<tr>
<td>H2-2021</td>
<td>POLONIA</td>
<td>0.3634</td>
<td>0.0945</td>
</tr>
</tbody>
</table>

Source: GPWB.

The presented charts clearly show that, on average, the lowest value among the indices under consideration is that of WIRD; WIRF is notably higher; and the highest average index level is recorded for WRR. The latter index is at the same time the most similar in value to the POLONIA rate calculated by NBP35. The lower value of WIRD compared to WIRF is due to the fact that in addition to the deposit transactions concluded by banks with a wide range of financial institutions, which underlie the WIRF index, WIRD includes corporate deposit transactions which tend to have lower interest rates (as well as volumes) than deposit transactions in the financial sector.

The lower value of WIRF compared to WRR is due to the fact that the repo and buy/sell-back market is characterised by relatively large transactions required to satisfy the liquidity needs of one of the counterparties, which is conducive to negotiating a higher interest rate, while a large part of the market underlying WIRF (mainly segments 3.1.5 and 3.1.10, see Section 5c) is comprised of a large number of relatively small transactions usually concluded at the initiative of the depositor whose bargaining power is limited in such a case, which does not favour high interest rates.

It is worth noting that the period of extremely low rates (turn of 2020 to 2021) saw a convergence of all three indices to almost identical levels close to zero (averaging around 0.01%).

Detailed statistics on the mean value and volatility of the RFR indices are presented in Table 6.1. As for volatility (traditionally measured by the standard deviation of the index’s first difference), by far the smallest volatility is that of WIRD (11.6 bps), due to the fact that it is backed by the most broadly defined market and thus the largest volume of transactions, which stabilises its readings.

WIRF, whose underlying market is defined as slightly narrower than WIRD, reports significantly higher volatility (14.9 bps); it should be noted that it is very close to the volatility of the POLONIA rate (15.0 bps).

In contrast, the most volatile of the indices under consideration is WRR (16.5 bps), as expected, because it is backed by the narrowest market. Importantly, during the period of extremely low rates, all three indices saw a very large reduction in volatility due to the decelerating volatility at rates at nearly zero bound, while WRR still showed the highest volatility (1.7 bps) and WIRD the lowest (1.0 bps).

35 The POLONIA Reference Rate is determined by NBP as a volume-weighted mean of individual interest rates on unsecured interbank O/N deposit transactions concluded on a given business day until 4:30 pm.
6b. Comparison with foreign risk-free rate indices

Figure 6.2 compares a simulated performance of each of the three indices over the period 2016-2021 with the values of foreign RFR-type indices over that period.

Figure 6.2. WIRF, WIRD, and WRR vs. foreign RFR-type indices and POLONIA

Source: GPWB.
The comparison of domestic risk-free indices (i.e., WIRD, WIRF, and WRR) with foreign benchmarks indicates the relatively high volatility of the former. In this respect, only the American index SOFR is comparable with the Polish indices, while the Norwegian NOWA and the Swedish SWESTR show only occasional, albeit abrupt, changes in volatility. On the other hand, the UK SONIA, the pan-European ESTR, and the Swiss SARON are characterised by low volatility.

The Administrator points out that, from the point of view of volatility analysis, the POLONIA rate was similar to the three indices under consideration: WIRD, WIRF, and WRR. Consequently, it seems indisputable that high volatility of O/N transactions-based indices is a feature resulting from the characteristics of the Polish money market.

6c. Relations with the NBP reference rate

An important characteristic of the RFR index is its relation to the NBP reference rate\(^{(36)}\), which is the key tool of monetary policy conducted by the NBP. Figure 6.3 shows a comparison of the three proposed RFR indices with the NBP reference rate.

Figure 6.3. WIRD, WIRF, and WRR vs. NBP reference rate

(a) period Jan 2016 - Apr 2022

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\(^{(36)}\) NBP reference rate – yield on 7-day money bills issued weekly by the NBP, which are the main instrument used by the NBP to control the short-term cost of money on the interbank market.
In general, the NBP reference rate remains higher than all three RFR indices most of the time, which is not surprising as it has a longer maturity (7 days) than the (O/N) RFR indices, resulting in a higher term premium. The largest spread to the NBP reference rate in this case is evidently reported for the lowest of the indices, i.e., WIRD (on average 29.9 bps in the period 2016-2021); a slightly smaller spread characterises WIRF (20.4 bps); and the smallest spread is shown by WRR (11.1 bps).

In the period of extremely low rates, the spread of each index converged closely with the NBP reference rate. The indices were “trapped” in the narrow range between zero and the NBP rate, which implied a strong decrease in their volatility.

As regards how changes to the NBP reference rate impacted the RFR indices under consideration, Figure 6.3 shows that the pace of their convergence in this respect is quite similar. However, it should be noted that the magnitude of index changes resulting from NBP rate movements is notably larger for WRR than for WIRD and WIRF: WRR remains close to the NBP rate all the time while the spread between WIRD and WIRF and the NBP rate widens as the latter rate increases.

Figure 6.4 shows the volatility of the spread to the NBP reference rate for each of the three RFR indices.

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37 Indices calculated on the basis of transaction data under ACT/365; NBP money bill yields under ACT/360.
The lowest volatility of the spread to the NBP rate (measured by the standard deviation of its first difference) is reported for WIRD (on average 11.5 bps in the period 2016-2021); a slightly higher volatility is recorded for WIRF (14.8 bps); and the highest volatility for WRR (16.4 bps).

In the period of extremely low rates, a significant reduction in the volatility of the spread to the NBP rate becomes apparent, which is related to the aforementioned observation that the RFR indices were “trapped” in the narrow range between zero and the NBP rate.

6d. Examples of forward compound indices (3M, 6M) based on RFR indices

The next step in the development of the family of interest rate benchmarks is the construction of a term structure of interest rates. Taking into account the characteristics of O/N risk-free rate benchmarks, the first step is to create a term structure based on the concept of daily compounding. The introduction of this type of benchmarks will represent a change in the principles of how term indices are used in products and instruments compared to forward-looking benchmarks such as WIBOR.

The Administrator has calculated 3M and 6M indices based on O/N RFR indices (these indices are referred to as WIBON RFR 3M and WIBON RFR 6M). Defining the rules for the development of indices based on compounding O/N interest requires selection of a convention for the compounding of O/N indices to obtain backward-looking predefined term indices in arrears that would be optimal from the point of view of financial market participants. The backward-looking approach (in arrears) stems from the principle of constructing a term structure for interest rates based on actual past values of O/N risk free rate indices.

Importantly, the use of term rates based on actual past values of the O/N index that are compounded in arrears (backward-looking concept) in financial contracts and instruments can imply, among others, a delay in the propagation of monetary impulses, in this case changes in the central bank interest rates in the economy, compared to the situation in which the forward-looking WIBOR is used.

The visualisation of the lag of backward-looking indices (WIBON) vs. changes in the NBP reference rate and forward-looking benchmarks (WIBOR) is presented in Figure 6.5. The longer the maturity of WIBON, the greater the lag.
Figure 6.5. WIBON benchmark based on selected RFR indices (WIRD, WIRF, WRR) vs. WIBOR and NBP reference rate
(a) 3M

(b) 6M

Source: GPWB.

A long-term perspective on the performance of the term compounded in arrears index based on the O/N rate is presented in Annex 3. The Annex contains a chart showing a simulation of the WIBON 6M index based on the POLONIA rate\(^{38}\) vs. the WIBOR 6M index for the period starting from 2005, i.e., the period covering several cycles of central bank reference rate hikes and cuts.

The implementation of this type of benchmarks and a backward-looking curve, i.e., a curve based on actual past values of O/N index that is based on actual O/N transactions, will represent a change in the structure of risks in the financial sector and the principles of creation of financial instruments and constructing credit agreements. Such an implementation will require a coordinated action. Such backward-looking approach is an interesting and progressing proposal enabling the use of indices based solely on actual transactions while limiting the range of risks incorporated in the index.

\(^{38}\) The choice of the POLONIA rate as the basis for determining the long-term simulation of the term benchmark WIBON 6M is driven by the availability of a sufficiently long series of historical data of the POLONIA rate (i.e., starting from 2005).
Annex 1. Empirical distributions of O/N interest rates standardised by daily mean and standard deviation by market segment (a) and by group of market segments defined by the indices (b)

Source: GPWB.
Annex 2. Skewness of the distribution of interest rates on O/N transactions standardised by daily mean and standard deviation by group of market segments defined by the indices

<table>
<thead>
<tr>
<th>Period</th>
<th>Skewness coefficient</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WIRD</td>
<td>WIRF</td>
<td>WRR</td>
</tr>
<tr>
<td>2016</td>
<td>-0,84</td>
<td>-1,00</td>
<td>-0,93</td>
</tr>
<tr>
<td>2017</td>
<td>-0,88</td>
<td>-0,94</td>
<td>-1,40</td>
</tr>
<tr>
<td>2018</td>
<td>-0,93</td>
<td>-0,71</td>
<td>-1,20</td>
</tr>
<tr>
<td>2019</td>
<td>-0,63</td>
<td>-1,09</td>
<td>-1,82</td>
</tr>
<tr>
<td>2020</td>
<td>-0,22</td>
<td>-0,41</td>
<td>-1,19</td>
</tr>
<tr>
<td>2021</td>
<td>-1,05</td>
<td>-0,99</td>
<td>-1,52</td>
</tr>
</tbody>
</table>

Source: GPWB.
Annex 3. POLONIA-based WIBON 6M vs. WIBOR 6M and NBP reference rate

Source: GPWB, NBP.
## Annex 4. Market information pool by segment and by group, by year, after applying the volume threshold for a single transaction at PLN 1 million

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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Source: GPWB
Annex 5. Percentage share of transactions with a specified maturity by segment and by group, by year, after applying the volume threshold for a single transaction at PLN 1 million

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Source: GPWB