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## Behavioural Aspects of Benchmark Quotation – the WIBOR Case

**Abstract:** In the post-crisis environment, market indices are one of elements of the financial market which have to be reformed. The EU Regulation on indices used as benchmarks in financial instruments reflects a need for the reform of benchmark determination in order to make indices transparent, representative and resistant to manipulation. The reform changes the conduct of rate contributors (the so-called panellists). The article analyses behavioural reactions of WIBOR panellists by indicating sources of the growth of inertia and the drop of dispersion of published benchmarks. Those reactions decrease the risk of banks and, at the same time, increase the divergence between an index and the actual cost of funds, which may threaten the stability of the financial market.

**Keywords:** money market, market indices, behavioural finance

**JEL:** G01, G14, G15

# 1. Introduction

Financial benchmarks, also called market indices or reference rates, constitute a key source of information about the financial market. They are used to determine a value of flows from financial instruments and to measure portfolios made of those instruments. For example, IBOR<sup>1</sup>-type rates are used to define the size of coupon flows for most variable-interest bonds and variable-rate loans (e.g.: mortgage loans). In the market of derivative instruments, IBORs are a key component that determines flows of interest swaps or settlements of FRA-type<sup>2</sup> contracts (Flavell, 2002; Kirti, 2017). In turn, currency fixings can be used to value settlements for NDF-type<sup>3</sup> contracts. Stock-exchange indices are used to calculate the settlement of futures contracts. Moreover, financial benchmarks are sometimes used as an objective measure of a value of financial portfolios, e.g.: for future flow discounting or present value estimating as at the end of the day (e.g.: bond fixing).

Thus, the information quality of benchmarks determines whether the reported value of financial instruments is true and whether liabilities and receivables of counterparties to financial contracts are adequate. The proven manipulation of financial benchmarks (e.g.: LIBOR<sup>4</sup>, EURIBOR<sup>5</sup> or currency fixing for currencies of developed countries) made regulators develop new rules for the determination of benchmarks (Abrantes-Metz et al., 2012; Hou, Skeie, 2014; Gandhi et al., 2015; Mielus, 2016). Those rules, having the form of recommendations and statutory acts (at the national and EU level), set out obligations of administrators and rate contributors by providing for a necessary set of procedures that must be followed during index preparation and publication.

Financial benchmarks can be created through the calculation of an average market price in a given time window (e.g.: stock-exchange indices, WM/Reuters currency fixing, ONIA-type<sup>6</sup> indices), can be defined by an administrator on his/her own based on the evaluation of the market (currency fixing of the ECB or NBP<sup>7</sup>) or can come from panellists participating in index fixing (IBORs). WIBID and WIBOR<sup>8</sup> are declarative reference rates. Declarative benchmark quotation means that a bank participating in the panel quotes, in accordance with the fixing rules,

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<sup>1</sup> IBOR – Inter Bank Offer Rate, the most common interest rate benchmark referencing the price of unsecured term deposits in the interbank market.

<sup>2</sup> FRA – Forward Rate Agreement, a derivative in which an IBOR rate is the underlying asset.

<sup>3</sup> NDF – None Deliverable Forward, cash settled foreign exchange forward.

<sup>4</sup> LIBOR – London IBOR regarding a few major currencies (USD, EUR, CHF, GBP, JPY).

<sup>5</sup> EURIBOR – European IBOR regarding EUR in the Eurozone.

<sup>6</sup> ONIA – Overnight Index Average, the most common benchmark for the one-day unsecured deposit market.

<sup>7</sup> ECB – European Central Bank, NBP – National Bank of Poland.

<sup>8</sup> WIBID, WIBOR – IBOR in the Polish market regarding PLN deposits (WIBID for borrowed cash, WIBOR for lent cash).

a rate that it finds relevant by taking into account the market condition and the bank's liquidity position. If there are no transactions, which is the case in the market of unsecured interbank deposits, the quoted rate is based on the panellist's subjective evaluation. Therefore, the final index is not dependent on an objective market condition, but on a decision of dealers that submit fragmental quotations for fixing purposes. This means that the research of the decision-making process of banks participating in the panel is important for the economic analysis of the rate level and the extent of rate volatility.

Based on the benchmark for the money market in Poland, i.e. WIBOR, this article describes changes in behaviours of entities contributing their data to indices under the influence of numerous regulatory events in recent years. The index for the analysis is not chosen by accident. Firstly, money market indices are based on quotations of banks participating in the panel and not on prices of transactions in the financial market (similarly to stock-exchange indices or some currency and commodity indices). Thus, the rate is mostly shaped by individual decisions of dealers quoting the index, which are based on expert judgement. Secondly, WIBOR is critical for the Polish economy, given a prevailing share of variable-interest loans and the dependence of the banking sector on WIBOR-based derivative instruments (IBnGR, 2015). Thirdly, WIBOR is subject to specific rules under which banks are obliged to quote both sides of the transaction (WIBID for deposits received and WIBOR for deposits granted) and to make transactions at the quoted rate within the defined time window (which makes them different from other IBOR-type indices) (ACI Polska, 2013). Fourthly, there are several reference points for WIBOR indices which enable to assess the quality of the rate and the degree to which the rate represents the market it describes (e.g.: the cost of deposits from non-banking entities, a rate implied from FX swaps, OIS<sup>9</sup> curve, etc.).

The purpose of the article is to verify the thesis that the observed economic and legal factors influence decisions made by entities shaping the benchmark by determining its level and volatility. To verify that problem, the author analysed legal conditions by indicating regulatory changes providing for frameworks of operation for the administrator and panellists. Attention is also turned to economic structural changes in the post-crisis environment which had an impact on the level and stratification of yield curves for reference money markets. Then, fragmental quotations of individual panellists are analysed and factors determining the dispersion and inertia of quotations are indicated. An attempt is made to analyse behaviours of fixing participants on the basis of a behavioural analysis. The behavioural analysis is based partly on the theory of thought contagion (Lynch, 2000) which results in behavioural coarsening (Shiller, 1995). The coarsening has a strong influence on asset pricing and conduces to divergence of prices from its economic value (Avery, Zemsky, 1998). The phenom-

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<sup>9</sup> OIS – Overnight Index Swap, a derivative based on the ONIA rate.

ena observed in the financial market aim mainly at higher profits. Contrary to this, the study focuses on the minimisation of compliance (regulatory) risk that shapes the specific behaviour of WIBOR panellists. Finally, possible changes that will convert financial benchmarks to be in line with market regulations are presented.

The article is made of three chapters which describe the aforementioned elements of the analysis. In the first part, the author points out changes in the economic and legal environment which influence the behaviour of banks-panellists. In the second part, a simple quantitative analysis of the data is presented. In the third part, the author attempts to describe the behavioural decision-making process of the panellists which shapes the published index. Conclusions from the survey are presented in the summary of the article.

## 2. Economic and legal environment

The first document which reflected sources of manipulation and presented defects in the existing shape of benchmarks was Wheatley's Report on LIBOR (Wheatley, 2012). Financial market regulators published their recommendations (EBA/ESMA, 2013; IOSCO, 2013; BIS, 2013; IOSCO, 2014; FSB, 2014; MPG, 2014; WIBOR Council, 2015) including a set of best practices that must be applied during the development of indices and setting out preferable ways of the benchmark reform. At the same time, the European Parliament commenced the work on the implementation of a regulation providing for rights and obligations of entities involved in the development and use of benchmarks ("EU Regulation on indices used as benchmarks in financial instruments and financial contracts", hereinafter referred to as the BMR). The first draft of the regulation was published for consultation in September 2013. The final text of the act came into force on 1 July 2016, but all provisions will become effective as of 1 January 2018 (EP, 2016).

Benchmark administrators started adapting themselves to the new regulations. As far as money market benchmarks are concerned, the changes covered an entity responsible for publication (an administrator), an increase in the use of transaction sources in benchmark determination, an introduction of benchmark verification procedures, tightening the benchmark submission process at the side of banks-panellists (for example, by liquidating the conflict of interests) in order to prevent manipulations, as well as methodological changes to have an index better map current market conditions. For LIBOR, index administration was transferred from the BBA to the ICE<sup>10</sup>, which established a new entity: the ICE Benchmark Administrator (IBA)<sup>11</sup>. In turn, for EURIBOR, the EBF established the EMMI<sup>12</sup>,

<sup>10</sup> BBA – British Bankers' Association, ICE – Intercontinental Exchange.

<sup>11</sup> The ICE adopted LIBOR on 1 February 2014.

<sup>12</sup> EBF – European Banking Federation, EMMI – European Money Market Institute.

which became the index administrator<sup>13</sup>. For WIBOR, the present rate owner, ACI Polska, transferred index administration to the Warsaw Stock Exchange, which established a new entity: GPW Benchmark<sup>14</sup>.

Apart from legal changes, we witnessed structural economic changes which resulted from the financial crisis of 2007–2009. As indicated by Brousseau, Chailloux and Durre (2013), the growth of credit and liquidity risks contributed to changes in bank financing methods. A drop in the reliability of the banking sector (after the bankruptcy of Lehman Brothers) and a strong growth in demand for liquidity (resulting from the subprime crisis) contributed to natural resignation from transactions that are the most expensive in credit and liquidity terms, i.e. term deposits. In effect, unsecured interbank deposits of maturity exceeding several days disappeared.

Banks were not eager to freeze funds in other banks for a longer period because of credit and liquidity requirements. Firstly, an unsecured deposit granted to another bank blocks a credit line for the whole term of that deposit. The credit line is necessary to make transactions in the financial market and is more effectively used in the market of derivative instruments and secured loans. Secondly, the interbank deposit is ineffective in terms of liquidity and capital regulations because it cannot be treated as a stable source of funding and is burdened with a full risk weight.

As a consequence of those phenomena, the unsecured funding was replaced with secured deposits (repos and currency swaps) and banks departed from interbank financing in favour of other sources (from non-banking financial institutions and non-financial corporations to, in particular, stable retail deposits). For money market indices, that meant the loss of the reference base used by panellists to estimate the quotation of their contributed rates (Duffie, Stein, 2015).

As a result of the loss of the reference base, IBOR-type rates became fully declarative and their level and return distribution were generated by individual decisions of banks participating in fixing. Those decisions were influenced by the following factors:

- 1) the policy of central banks;
- 2) expectations about future interest rates;
- 3) the cost of financing from alternative sources.

As a consequence of the policy of negative interest rates, an effective term curve disappeared and there appeared disturbances connected with the incompatibility of the banking law to the negative yields environment. In effect, term deposits in the Eurozone disappeared both in the interbank market and in the non-banking segment. The market lost the underlying instrument for defining the cost of financing in the unsecured term deposit. Therefore, rates quoted by panellists started

<sup>13</sup> The EMMI adopted EURIBOR on 20 June 2014.

<sup>14</sup> GPW Benchmark adopted WIBOR on 30 June 2017, which was announced on 3 November 2016.

to reflect only expectations about the shape of the yield curve which were created by the policy of central banks. In consequence, IBOR-type rates were implied from FRA and IRS contracts and were dependent on the situation in the secured deposit (mainly repo) market.

Thus, the analysis of quotations of IBOR-type panellists must take into account the aforementioned limitations. Firstly, banks must adapt to regulations under which contributors must prove that their rates comply with market prices. Secondly, they cannot refer to unsecured deposit prices, which are theoretically described by the IBOR-type rate, because the market of those deposits does not exist anymore. Undoubtedly, this makes benchmark quotation more difficult and the contribution needs more intensive attention. The next chapter comprises an analysis how the money market reference index contribution changed after the crisis of 2007–2009 based on data available for the Polish market.

### 3. Analysis of panellists' quotations

To analyse quotations of banks participating in WIBID and WIBOR determination, fragmental quotations of banks active in the analysed period in benchmark quotation were collected. The data come from the calculation agent, Thomson Reuters<sup>15</sup>.

The time series refer to the period between 7 July 2009 and 10 March 2017 (previous data are not available). The data refer to fixing and fragmental quotations for WIBID and WIBOR for maturities of 1 month (1M), 3 months (3M), six months (6M), and 1 year (1Y). Selected maturities are prevailing benchmarks for loans and derivative instruments (in particular 3M and 6M).

Table 1 presents three basic statistics for WIBOR: average dispersion, dispersion range and daily standard deviation, calculated in accordance with the following formulas.

$$\text{Average dispersion} = \frac{\sum_1^n D_t}{N},$$

where:

$$D_t = \max(W_t^i) - \min(W_t^i), \quad (1)$$

<sup>15</sup> The data were cleaned of quotations which, by an order of magnitude, differed from quotations of other banks and prices of a given bank of  $D - 1$  and  $D + 1$  (the so-called bad ticks). As the data supplier informed, certain figures in time series had not been changed upon the erroneous delivery of wrong quotations by the data contributor, although they had been corrected directly in the benchmark calculation system.

$$\text{Dispersion range} = (\min(D_t); \max(D_t)), \quad (2)$$

$$\text{Daily standard deviation} = \sqrt{\frac{\sum_1^n (dW_t - \bar{dW}_t)^2}{N}}, \quad (3)$$

where:

$$dW_t = W_t - W_{t-1},$$

where:

$W_t$  – WIBOR fixing (for a given term) on the  $t$  day,

$W_t^i$  – WIBOR quotation of an  $i$  bank (for a given term) on the  $t$  day.

Table 1. Periodical statistics of fragmental data for the WIBOR panel in 2009–2017 (in basis points)

WIBOR	07.2009–06.2013			07.2013–12.2015			01.2016–03.2017		
	Average dispersion	Dispersion range	Daily standard deviation	Average dispersion	Dispersion range	Daily standard deviation	Average dispersion	Dispersion range	Daily standard deviation
1M	6	0–39	1.93	5	1–13	1.45	4	1–10	0.25
3M	8	1–29	1.54	6	1–14	1.04	6	1–15	0.19
6M	9	1–42	1.28	6	0–16	0.95	5	1–13	0.18
1Y	9	1–38	1.21	6	1–18	0.93	5	1–11	0.20

Source: own calculations based on the data of Thomson Reuters

The statistics were calculated for three selected periods:

- 1) the period between the beginning of the sample to 30.06.2013;
- 2) the period between 30.06.2013 and 31.12.2015;
- 3) the period between 1.01.2016 and the end of the sample.

Final dates used to separate the above periods were determined by the following events:

- 1) on 30 April 2013, the board of ACI Polska adopted new Rules for WIBID and WIBOR Benchmark Fixing, which were prepared in cooperation with banks under the auspices of the Polish Financial Supervision Authority (KNF) and the National Bank of Poland (NBP) for the purpose of adjusting the regulations to the announced EBA/ESMA recommendations; the Rules came into force as of 1 July 2013;
- 2) on 30 December 2015, the Polish Parliament passed the Act on Tax from Certain Financial Institutions, which was signed by the President and published in the Journal of Laws on 15 January 2016 (the tax was applied for the first time in February 2016).

The first event meant that more restrictive supervision over benchmark publication was implemented. That supervision, on the one hand, is conducted by the KNF, which has the right to verify whether individual banks establish adequate

rates. On the other hand, the index as such and the administrator's operations are supervised by the newly established WIBOR Council. The dividing line of 2013 was introduced to check whether new inspection activities influenced the behaviour of banks-panellists during benchmark quotation.

As a result of the second event, interbank deposits, which, as mentioned above, form the basis for IBOR-type rates, were subject to taxation. The taxation of the deposits can be analysed from two points of view. Firstly, the deposit with another bank is the financial institution's asset, which means that it is subject to taxation. Secondly, the moment the deposit is accepted (i.e. a liability is created), funds that can be used flow to the bank. One of investment forms that is exempted from the tax is a Treasury bond, whose supply is limited. Therefore, both counterparties to the deposit transaction are potentially subject to taxation: one on an absolute basis (as a fund supplier) and the other on a highly-probable basis (as a fund receiver). It must be noted that the tax is calculated on the basis of the balance of assets as at the last business day of the month, which means that deposits that are active at the turn of the month are also taken into account. Thus, all deposits of the maturity of no less than one month are subject to the tax and deposits whose maturity is shorter are taxable only at the end of the month (e.g.: overnight deposits only as at the last day of the month). The dividing line of 2016 was introduced to analyse whether the tax had an impact on banks' decisions related to WIBOR quotations.

For each period, we obtained average dispersion of fragmental quotations of panellists, the dispersion range in a given period and daily volatility (calculated as standard deviation of daily changes). The periodical analysis of dispersion indicates to which extent the dispersion of rates changed as a result of changes in the rules and the implementation of the bank tax. In turn, the periodical analysis of volatility reflects a change in rate inertia as a result of the aforementioned events.

Based on the above statistics, the following regularities can be observed:

1. Dispersion of quotations dropped significantly as a result of the change in the rules in 2013, in particular for longer maturities. On the average, dispersion dropped by 17–33% or 2–3 times at the maximum. The implementation of the tax reduced dispersion to a minor extent.
2. The change in the rules contributed to a drop of volatility amounting to 23–32%, depending on the term. The tax had a much stronger impact, as the volatility was reduced by 78–83%.

On that basis, a conclusion can be drawn that the change in the rules mainly had an impact on the dispersion of quotations and the tax implementation affected index volatility. The latter conclusion must be, however, treated carefully because the tax, undoubtedly, was not the only factor influencing the volatility of WIBOR. The analysis of daily returns on WIBOR indicates that reference rate changes by the Monetary Policy Council constituted a major factor that influenced the rate

volatility in 2011–2015 (in that period, the benchmark was changed 15 times, including 5 upward and 10 downward changes). Notwithstanding the above, the volatility of WIBOR is strongly decreasing (Figure 1) and significantly differs from the volatility generated by time series represented by transactions made in the markets of short-term interest rates for PLN (Table 2).

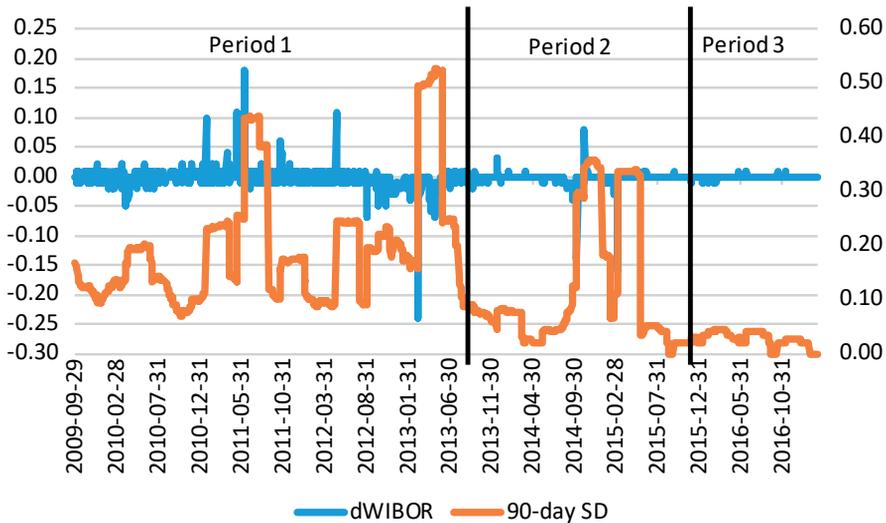


Figure 1. WIBOR 3M: daily change and three-month volatility per annum

Source: own calculations based on the data of Thomson Reuters

Table 2. Daily standard deviation of selected variables of the financial market in 2014–2017 (in basis points)

Rate*	WIBOR 3M	OIS 3M	FRA 3X6	FX IMP 3M	IRS 2Y	TB 2Y	ASW 2Y
Daily standard deviation	0.9	2.0	2.2	3.9	7.4	14	2.2

\* OIS – Overnight Index Swap, FRA – Forward Rate Agreement, FX IMP – FX Swap implied rate, IRS – Interest Rate Swap, TB – Treasury Bond (yield), ASW – Asset Swap.

Source: own calculations based on the data of Thomson Reuters

The change in the structure of WIBOR volatility is reflected by the analysis of the distribution of daily changes, given an example of the three-month index (Figure 2). In the following sub-periods, the share of changes that are close to zero increases (no change or a change by 1 basis point), while the share of significant observations as well as the scope of marginal observations decrease, which is reflected in Table 3.

Table 3. Range of daily changes of 3M WIBOR in selected periods

Period	Share of zero changes	Share of minimum changes (0–1 bp)	Share of significant changes (5 bp and more)	Maximum change in bp
07.2009–06.2013	54%	90%	1.3%	24
07.2013–12.2015	82%	97%	0.5%	16
01.2016–03.2017	96%	100%	0.0%	1

Source: own calculations based on the data of Thomson Reuters

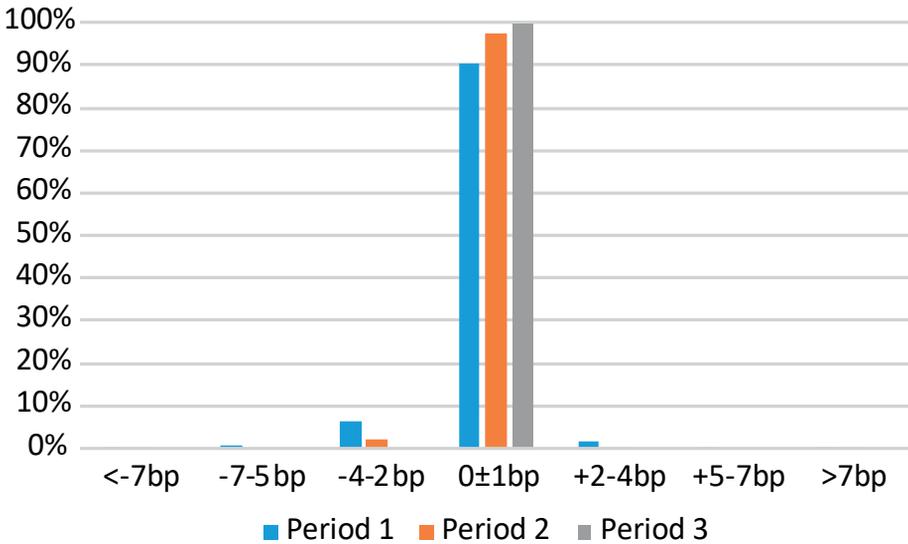


Figure 2. Distribution function of daily 3M WIBOR changes by analysed periods

Source: own calculations based on the data of Thomson Reuters

It is worth here conducting a probabilistic analysis of that market rate development. If we use the period before the change in the rules as a benchmark period for the volatility of 3M WIBOR, we can assume that the zero change in the rate takes place “in the normal market conditions” in 54% of cases. In turn, upon the announcement of the taxation changes, the share of days without any 3M WIBOR change was 96% (290 per 301 business days). Assuming, as Brousseau, Chailloux and Durre (2009: 27), that daily changes in IBOR fixing are independent observations and represent binominal distribution, the probability of a defined number of observations in the sample can be calculated in accordance with the following formula:

$$prop_{n,p}^k = C_n^k * (p)^k * (1 - p)^{(n-k)}, \tag{4}$$

where:

$$C_n^k = \frac{n!}{k!(n-k)!},$$

where:

$p$  – probability of zero observation,

$k$  – number of zero observations,

$n$  – number of all observations.

Assuming that the probability of zero observation is 54% and non-zero observation is 46%, we analyse what is the probability of 290 zero observations in the time series made of 301 elements and we receive:  $2.65 \cdot 10^{-62}$ . Thus, from the probabilistic point of view, the probability of that series generated by market processes is extremely small. Thus, the conclusion that changes in WIBOR in the recent period have been determined by non-market factors is reasonable, which will be explained in the following part of the article.

## 4. Behavioural decision-making process

The quotation of benchmarks is a variation of market making. This applies in particular to WIBOR, where, in accordance with the WIBOR Rules (2013), a quoting bank must make a transaction at its prices within the fifteen-minute window after the publication of the table of indices. Therefore, the market maker is exposed to three types of potential risks:

- 1) liquidity risk as it must provide funds for a strictly defined period;
- 2) interest rate market risk arising from a deposit of a fixed interest rate and a defined term;
- 3) credit risk arising from an unsecured deposit opened with a counterparty that can become insolvent as at the deposit repayment date.

The above shows that liquidity and credit risks are connected with fund depositing and market risk for both counterparties of the transaction. Those risks must be supplemented with the probability of the transaction in specific market conditions and the scale of threat arising from limitations set out in the Rules. The size of open risk is estimated in Table 4.

As the Rules set out that one counterparty can make no more than two transactions for various maturities with another counterparty and there have been 11 WIBOR panellists since August 2016, the maximum risk of an open position on a given business day is as follows: PLN 10,000 for market risk (in terms of BPV) and PLN 500 million for liquidity and credit risks (this is the maximum sum for two selected maturities if the transaction is made with all the remaining ten panellists).

Table 4. Risk generated by WIBOR panellists

Deposit term	Maximum transaction nominal value	BPV* of a single transaction	Total interest rate risk	Total liquidity (or credit) risk
ON	30 million	8	82	300 million
TN	30 million	8	82	300 million
SW	20 million	38	385	200 million
2W	20 million	77	769	200 million
1M	20 million	167	1667	200 million
3M	20 million	500	5000	200 million
6M	10 million	500	5000	100 million
9M	5 million	376	3759	50 million
1Y	5 million	500	5000	50 million

\* BPV (Basis Point Value) is a measure of market risk reflecting a change in the economic value when the yield curve is moved parallel by 1 basis point.

Source: own calculations based on the WIBOR Rules (2013)

That exposure, given limits set out by the Rules, is not significant from the perspective of a large financial institution<sup>16</sup>. In addition, it is necessary to take into account a small probability of the transaction which arises from the following premises:

- 1) given the observed coarsening of quotations and small rate volatility, motivation to make the transaction is strongly limited because the use of the counterparty's quotations means a loss due to the cost of spread (which is defined in the Rules and banks are not motivated to narrow the spread on the fixing);
- 2) when funds are lent, the interbank deposit does not improve liquidity ratios substantially because it is not considered a stable source of funds;
- 3) when funds are repaid, the interbank deposit is inefficient in capital terms because it generates credit risk equal to the nominal value of the transaction;
- 4) when the transaction is made for a longer term, the credit limit is blocked for the whole term of the deposit (the limit is burdened for the party that acquired funds);
- 5) if the transaction of the maturity falling in a month other than the present month is made, the taxable sum increases and the transaction is burdened with an additional cost that is not represented in the deposit price (which will be explained below).

Apart from the risk analysis, in the study of determinants of panellists' behaviours, legal and economic conditions, as described in the first part of this article, must be also taken into account. Firstly, the panellist must act in accordance with

<sup>16</sup> Banks participating in fixing have assets of PLN 40–270 billion (data of Q4 2016).

the administrator's rules (WIBOR Rules) and take into consideration the legal environment developed by the EU regulations (BMR). Secondly, a bank taking part in fixing knows that for most terms quoted there are no transactions that could constitute a direct point of reference for prices sent to the administrator. Therefore, the bank bears the risk of proving that expert quotation is consistent with the market condition and does not include any elements of manipulation, i.e. elements that distort the actual cost of funding in the interbank market.

As stated in the previous chapter, as a result of the change in the Rules in 2013, the dispersion of quotations decreased. In legal terms, the change in the Rules did not enforce any significant modifications in the benchmark quotation, but it coincided with inspection processes conducted by the supervisor. As a result of the inspection whether banks follow the WIBOR Rules, EBA/ESMA Recommendations, and KNF individual recommendations, the new behavioural process for WIBOR quotation was developed. Panellists knew that they were observed and could bear negative consequences of their actions. Therefore, they tried to minimise the risk of the charge of manipulation. This would result in behavioural coarsening, which would be the sign of a strong drop of the dispersion of fragmental quotations observed in the WIBOR panel<sup>17</sup>.

In turn, the implementation of the tax coincided with a significant drop of the benchmark volatility. As mentioned in the previous chapter, the implementation of the tax on assets generated costs for both counterparties in the term interbank deposit market, which "crossed" the end of the month. For term deposits of no less than 1 month that cost was 0.44% p.a.<sup>18</sup> (tax rate per-annum) and was incurred whatever the transaction date. This means that the deposit price including the tax cost should be modified by 0.44% (both the BID and OFFER price). Banks participating in WIBOR fixing could not, however, take that cost into account because the maximum regulatory spread between WIBID and WIBOR quotation was 20 basis points (i.e. 4 times less than the minimum tax cost generated by the transaction). In effect, the banks tried to minimise the transaction risk, which resulted in a further drop of dispersion and a strong drop of benchmark volatility<sup>19</sup>.

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<sup>17</sup> The openness of fragmental quotations for fixing participants just before a rate announcement favoured the convergence of panellists' prices. That openness was liquidated only on 14 July 2014, when the calculation agent, Thomson Reuters, implemented the CIBORG system. Given the new method of sending prices for benchmark fixing purposes, quotations of other participants cannot be observed before benchmark publication. That change did not have, however, great importance for behavioural coarsening because fragmental quotations were known upon benchmark publication and, given small price volatility, the participants could foresee quotations of other participants with a high probability.

<sup>18</sup> For shorter deposits, the per-annum cost was much higher. For example, the equilibrium price for overnight deposits quoted as at the last day of the month was -13% BID, +13% OFFER.

<sup>19</sup> As a direct consequence of the tax, turnover for overnight deposits for the last business days of the month decreased. Turnover for deposits of longer maturities was not quoted when the tax was

Tax heterogeneity of the WIBOR panel as at the tax implementation made the situation even more complicated. Banks with assets smaller than PLN 4 billion (this does not apply to banks participating in WIBOR fixing), banks that have a remedy programme in place (2016: Bank BPH, which stopped being a fixing participant in November 2016) and state-owned banks (i.e. BGK) were exempted from the tax. Theoretically, the banks exempted from the tax could quote better prices for benchmark fixing purposes or make transactions by means of arbitrage (possible for an overnight rate on the last days of the month). In practice, prices quoted by banks subject to the tax and exempted from the tax were identical because the width of the permissible spread was limited and the probability of making the transaction during the regulatory time window was very low.

## 5. Conclusions

The article proves that regulatory and tax changes as well as the change in the bank financing model and the way banks perceived the risks distorted the benchmark creation process. The volatility and dispersion of quotations cannot be explained by pure market processes. Therefore, the author made an attempt to explain behavioural factors having an impact on the decision-making process of fixing participants.

Firstly, it can be stated that as a result of the awareness of the strict supervision over quotations, the dispersion and variance of quotations made by banks-panelists decreased. Thus, we can say that the entity under scrutiny modifies its behaviour in relation to the circumstances in which the supervision over its actions is moderate. This is proven by the phenomenon we witnessed upon the implementation of the new WIBOR Rules: banks tried to quote like other fixing participants and modify their prices in relation to the previous day to the smallest possible extent. Banks were afraid that untypical quotation can arouse the regulator's interest. In turn, any change in the price had to be justified in the benchmark documentation. Therefore, behavioural coarsening and quotation inertia minimised the risk of regulatory problems<sup>20</sup>.

Secondly, it is reasonable to claim that the enforcement of the tax on assets contributed to the petrification of the disappearance of the interbank deposit market and deepened the coarsening and inertia of benchmarks. Quotation for WIBOR fixing purposes became fully "theoretical", i.e. not based on actual or even poten-

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implemented, thus the impact of the tax on those deposits cannot be identified.

<sup>20</sup> It must be pointed out that regulatory risk is connected with a risk of financial penalties imposed not only on the quotation institution, but on natural persons responsible for the determination of benchmarks, as well. Those penalties are set out both by the Benchmark Regulation and MAD/MAR regulations.

tial transactions. The marginal cost of granting and acquiring unsecured funds changed by the tax rate and, based on the WIBOR Rules, it was not possible to widen the transaction spread. Therefore, the transactional requirement for WIBOR fixing became completely fictitious because the probability of making a transaction with another panellist dropped to zero.

As a result of the declarative character of benchmarks, they are dependent on subjective decisions of panellists. Those decisions are made in the special regulatory environment and the relation between indices quoted and market reality disappears, which creates divergence between IBOR-type indices and real financing costs. A sign of that divergence is the disappearance of WIBOR volatility, as WIBOR becomes fully divergent from the natural volatility of interest rates based on the concluded transactions.

Given these conclusions, attention should be paid to the necessary reform of benchmark determination. To adjust benchmarks to regulatory requirements, market processes must be better reflected. This is particularly important in the light of the significance of WIBOR for the Polish financial system. The study conducted by the Gdańsk Institute for Market Economics (IBnGR) in 2015 indicates that WIBOR is a reference point for PLN 647 billion of loans and PLN 6.544 billion of derivative instruments. Therefore, taking into account the essential structural significance of WIBOR rates for the Polish economy, actions aimed at ensuring the stability of the financial system and a broadly understood PLN market must be taken.

These actions should comprise connecting the benchmarks with market data to a greater extent. They can be connected in two ways. Firstly, the benchmarks that are already published should be back tested and cross checked for the purpose of verifying their adequacy to present market conditions. Secondly, the benchmark should be connected with the existing transactions and, if not available, with the market segment combined with the one represented by the benchmark. Given the experience of administrators (IBA, EMMI), when the reference market disappears, the continuity and stability of currently published benchmarks is ensured solely by the only hybrid solution incorporating a clearly defined waterfall procedure.

To implement FSB recommendations (2014), the reform can contribute to the development of new indices which will replace the existing ones (by means of evolution). These indices should be developed with the use of data repositories which provide objective information and are insensitive to market manipulations. Therefore, both the administrator and panellists will bear a smaller legal risk and will incur a smaller cost of benchmark “production”. Advantages of this solution are the reduction of basis risks in the banking sector and the definition of benchmarks that are market-related, i.e. more convergent with the market and its regulations.

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**Behawioralne aspekty kwotowania stawek referencyjnych – przypadek stopy WIBOR**

**Streszczenie:** W postkryzysowym środowisku jednym z elementów rynku finansowego, które wymagają sanacji, są indeksy rynkowe. Rozporządzenie UE w sprawie indeksów stosowanych jako wskaźniki w instrumentach finansowych wskazuje na potrzebę reformy sposobu wyznaczania indeksów w celu zapewnienia ich przejrzystości, reprezentatywności i odporności na manipulacje. Proces reformy wprowadza zmianę zachowania po stronie podmiotów kontrybuujących stawki (tzw. panelistów). Artykuł analizuje behawioralne reakcje po stronie panelistów indeksu WIBOR, wskazując na źródła wzrostu inercji i zmniejszenia dyspersji publikowanych stawek. Reakcje te zmniejszają ryzyko banków, zwiększając jednocześnie dywergencję między indeksem a rzeczywistym kosztem pieniądza, co może stanowić zagrożenie dla stabilności rynku finansowego.

**Słowa kluczowe:** rynek pieniężny, indeksy rynkowe, finanse behawioralne

**JEL:** G01, G14, G15

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