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Banks' interest rate setting and transitions between liquidity surplus and deficit

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Abstract

Assuming that a central bank is successful in steering money market interest rates, commercial banks' loan rate setting behaviour is not expected to change during a transition between liquidity surplus and deficit. However, this logic does not hold if a bank employs different money market instruments for the lending and borrowing activities. In this environment, it may be appropriate to adjust the loan rates when a bank transitions between liquidity surplus and deficit (i.e. switches between the benchmark money market rates). This strategy is fundamentally different from linking the loan rates to the average cost of funding (i.e. the average between retail and wholesale funding rates). The magnitude of such loan rate adjustment is limited by the (usually moderate) spread between the funding and investment money market rates.

JEL-classification: E43, E51, E58, G21, C63

Keywords: Excess reserves, Lending rates, Fund transfer pricing, Russia

1. Introduction

Transitions between surpluses and deficits of reserves in the banking system are not uncommon in countries across the world.[1] Although banks are generally regarded as borrowers on the money markets, liquidity surpluses arise when banks' working balances in accounts at the central bank persistently exceed the required level of reserves. In other words, surplus liquidity occurs when cash flows into the market for reserves continuously exceed cash flows into the central bank. Traditionally, in emerging markets the main drivers behind the fluctuations in liquidity are the central bank's foreign exchange operations and the functioning of sovereign funds. In such environments, banks begin to act as lenders on money markets rather than borrowers.

Clearly, the incidence of surplus liquidity may have important implications for the implementation of central bank interest rate policy. However, assuming that a central bank is successful in steering the money market interest rates, commercial banks' loan rate setting behaviour is not expected to change. The conventional view of banks' strategy for setting interest rates assumes that decisions about loan rates may be made independently from the structure of the banks' balance sheets. This is reflected in the standard theoretical models (usually based on the Klein-Monti approach[2]) as well as in the applied structural macroeconomic models (e.g., Gerali et al., 2010). The separation approach to interest rate determination is also considered state-of-the-art in actual banking practice (Grant, 2011). There are seemingly good reasons for such an approach, as the current liability structure is not directly affected by the volume of newly extended loans. Therefore, the current average cost of funding liability structure cannot be viewed as the marginal funding cost for new lending.[3]

Nevertheless, this logic is valid only if, for a given bank, the money market rate for funding equals the investment rate. This is not necessarily the case, in particular for emerging markets, where fragmentation of the financial markets is not uncommon. In this note we discuss how this circumstance may affect the setting of loan rates, using the Russian case as an illustration.

[1] See, e.g. Gray (2006) and Saxegaard (2006) for a review.
[2] See Klein (1971) and Monti (1972).
[3] On the other hand, a simple alternative assumption of a predetermined liability structure (in the spirit of Berlin and Mester, 1999) would justify a causal link between deposit and loan interest rates. However, this assumption may seem implausible, as it implies that the availability of deposits automatically increases (decreases) when more (fewer) loans are granted.

The remainder of this paper proceeds as follows. Section 2 discusses the theoretical considerations related to the problem. Section 3 presents stylised facts on banking liquidity and money market developments in Russia. Section 4 outlines the microsimulation model. Section 5 presents a model-based comparison of the performance of alternative loan rate setting strategies during a transition from liquidity surplus to liquidity deficit. Section 6 concludes the paper.

2. Balance sheet mechanics

Consider a bank that has loans (*L*), deposits (*D*), and net interbank liabilities (a residual item determined as *L*-*D*) on its balance sheet. Loans are remunerated at the loan rate i^L, deposits are remunerated at the deposit rate i^D, and interbank liabilities are remunerated at the money market (i.e., policy) rate i^M. The bank’s profit (Π) is determined as follows:

$$\Pi = i^L L - i^D D - i^M (L-D) \quad (1)$$

After rearranging, we group together the elements generated by the banks’ loan-extending and deposit-collecting activities:

$$\Pi = L\,(i^L - i^M) + D\,(i^M - i^D) \quad (2)$$

Accordingly, the loan rate may be optimised independently of the bank’s net position on the money market.[4] Specifically, the optimal loan rate is reached when the marginal revenue from loans is equal to the marginal investment return (i.e., the money market rate). This view is in line with the conventional Funds Transfer Pricing (FTP) approach, which mechanically links the loan rate to the benchmark money market funding rate.

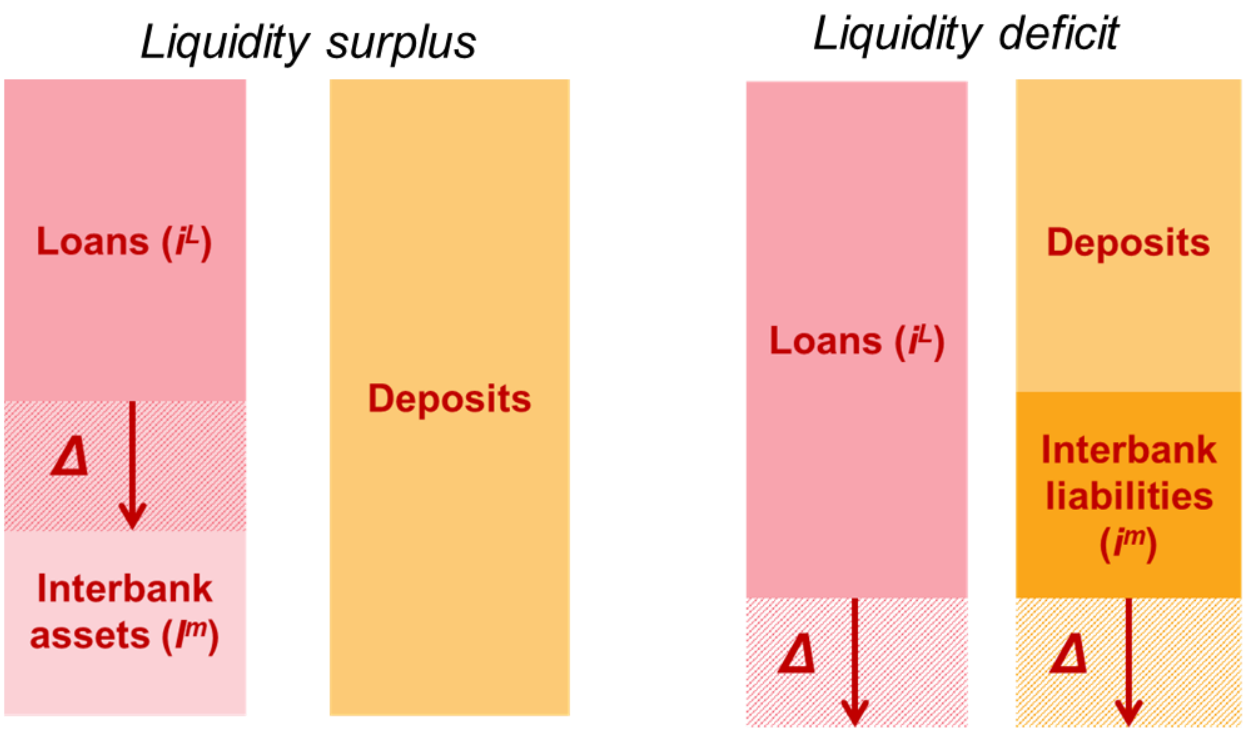
Consider the case when an amount of loans Δ is extended by a bank in liquidity surplus (left panel of Figure 1) and in liquidity deficit (right panel of Figure 1). In the former case, the bank replaces reserves with loans on the assets side of the balance sheet.[5] Accordingly, the incremental interest income generated by the extension of the loans amounts to $\Delta(i^L - I^M)$. In the latter case, granting new loans implies the extension of the bank’s balance sheet. The loans appear on the assets side of the balance sheet and

[4] Note, that the relationship between loan rates and volumes may not be trivial. The bank may have to take into account various long-term effects associated with variation in the market share when determining the optimal loan rate. Also the overhead costs need to be incorporated in the analysis in case they are linked to the loan or deposit volumes.

[5] In actuality, the newly extended loans create new deposits on the bank’s balance sheet (see McLeay et al., 2014). For simplicity, we assume that these deposits are moved to another bank as a result of the borrower’s subsequent transactions.

interbank liabilities appear on liabilities side. Nevertheless, the incremental interest income generated by the extension of the loans still amounts to Δ(i^L − i^M). Therefore, the optimal loan rate should not be different in cases of liquidity surplus and deficit, provided the funding money market rate equals the investment money market rate (I^M=i^M). This is a common assumption in the literature (see Schierenbeck et al., 2013, for a notable exception), although in fact it is not necessarily true.

Figure 1. Illustrative balance sheets for liquidity surplus and deficit

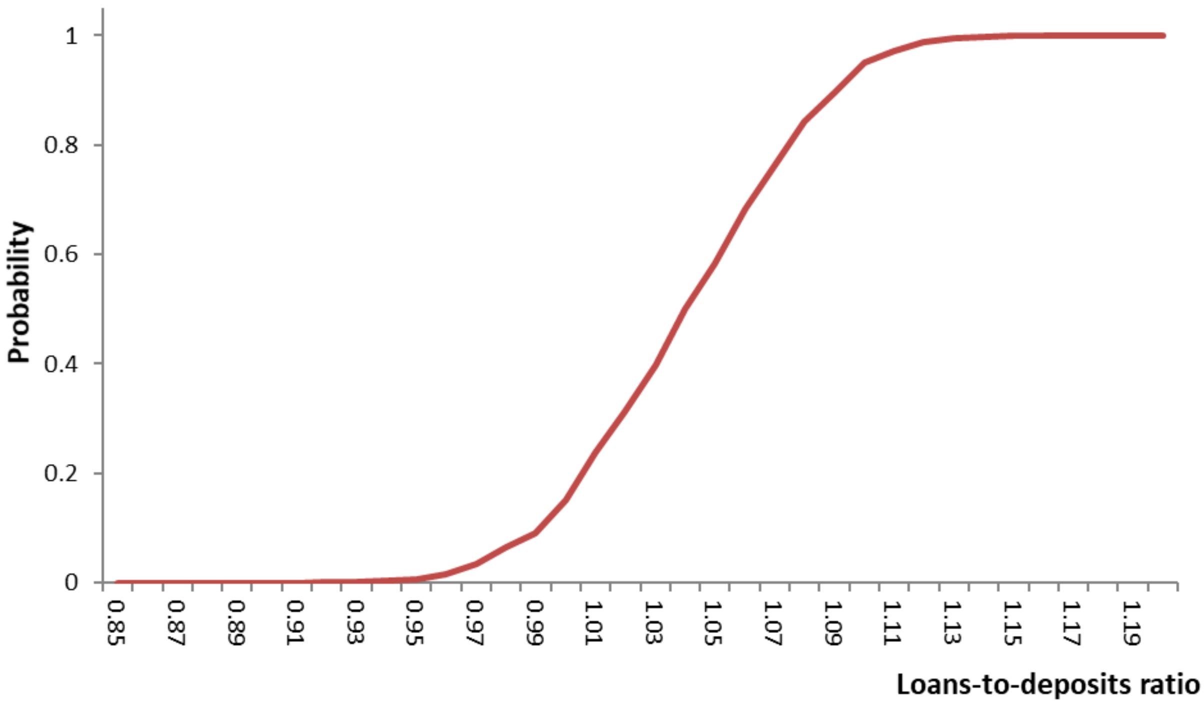


Consider a case when the money market funding rate available to a given bank is higher than the respective investment rate.[6] For the purpose of determining the loan rate, this bank will switch between money market benchmarks depending on whether its balance sheet is in surplus or deficit of liquidity. Assuming that it is impossible to revise the loan rate before the extension of every loan, the bank may adopt a smooth transition to a higher benchmark money market rate as the probability of ending up in liquidity deficit by the end of the next planning period increases. Naturally, such probability correlates with the bank's currently observed loan-to-deposit ratio (an example is provided in Figure

[6] We assume that the opposite case is unlikely as arbitrage opportunities arise.

2).[7] Therefore, the bank will set higher loan rates at a higher loan-to-deposit ratio (as suggested by Schierenbeck et al., 2013). Notably, this behaviour is driven solely by the difference in the interest rates the bank faces in its different roles on the money market, rather than being related to the necessity of steering the structure of the balance sheet to prevent a liquidity mismatch.[8]

Figure 2. Probability of a bank's balance sheet ending up in liquidity deficit conditional on the initial loans-to-deposits ratio



3. Interbank money market developments in Russia

We believe that the concept described above may be relevant to Russian banks given the substantial fluctuations in banking liquidity and the relative fragmentation of the interbank market. In this section we discuss these features in detail.

[7] The probabilities were calculated as the share of instances the loan to deposit ratio of a bank exceeds unity after a random balance sheet expansion takes place. The calculations were made for different starting values of the loan-to-deposit ratio. Naturally, these results are illustrative and the exact shape of the curve depend on the expected loans and deposits growth and its variance in relation to initial balance sheet size. The reported results are based on the default parameters of the microsimulation model employed in Section 4.

[8] See Disyatat (2011) and Grant (2011) for a discussion of these issues. Dermine (2013) describes how balance sheet management considerations may be incorporated into the FTP approach.

3.1 Banks' liquidity

Consider the Bank of Russia's balance sheet[9]:

$$LP + NFA = LA + R + SF + CC + OTHER \quad (3)$$

The left-hand side of the identity represents the Bank of Russia's assets and consists of claims on commercial banks via liquidity provision tools (e.g. REPO operations) *LP* and net foreign assets *NFA*. The right-hand side of the identity represents the Bank of Russia's liabilities and consists of liquidity absorbing tools (e.g. Bank of Russia bonds) *LA*, commercial banks' reserves (current accounts as well as required reserves) *R*, liabilities to the general government mainly in the form of sovereign funds *SF*, and currency in circulation *CC*. All other items are netted in the *OTHER* term. Rearranging, we express the liquidity deficit measure (*LP - LA*) as:

$$LP - LA = R + SF + CC - NFA + OTHER \quad (4)$$

Essentially, banks' demand for reserves and liquidity leakages into cash and due to the accumulation of sovereign funds contribute to liquidity deficit, while FX purchases by the Bank of Russia lead to liquidity surplus.

The development of the liquidity deficit measure (*LP - LA*) is presented in Figure 3. Changes in the liquidity deficit and its drivers are presented in Figure 4. Active fiscal and foreign reserves operations led to substantial fluctuations in the liquidity deficit. Notably, we observe a transition to liquidity deficit in late 2011 and back to liquidity surplus in late 2017.

[9] For illustrative purposes in this sub-section we discuss the aggregate measure of liquidity deficit while the bank-level measures are used in other parts of the paper.

Figure 3. Liquidity deficit (as ratio to reserve money)

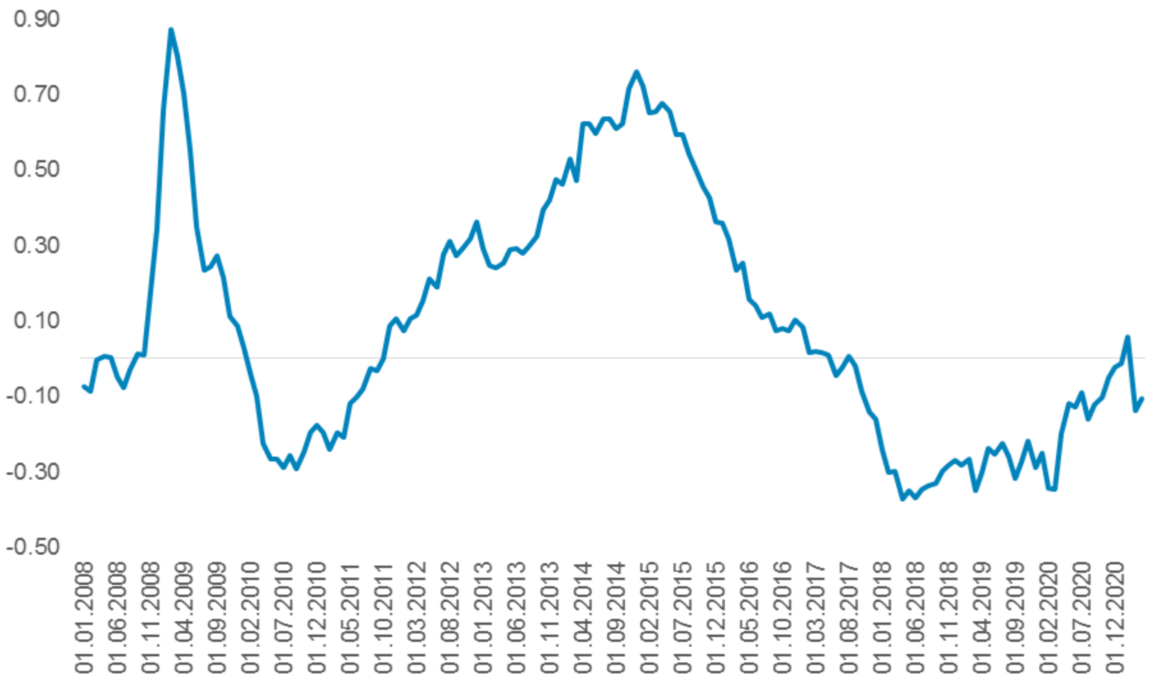
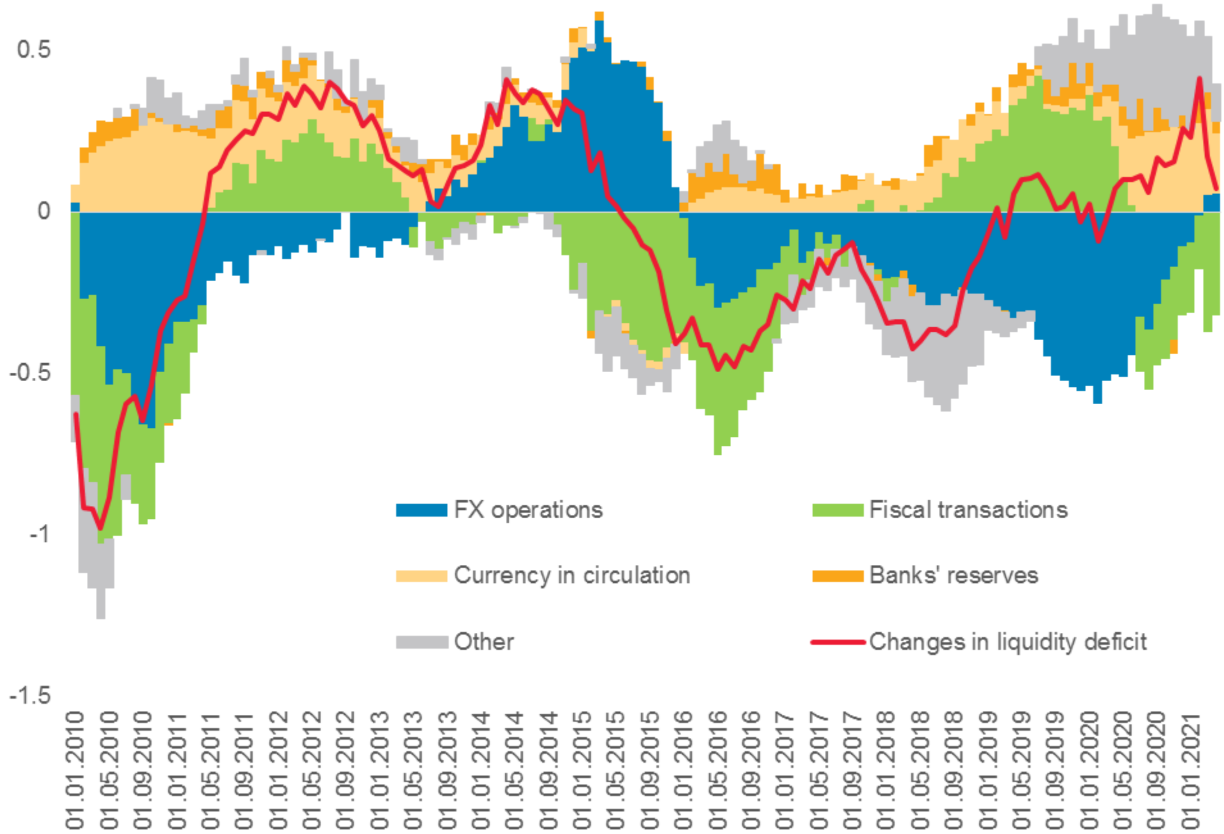
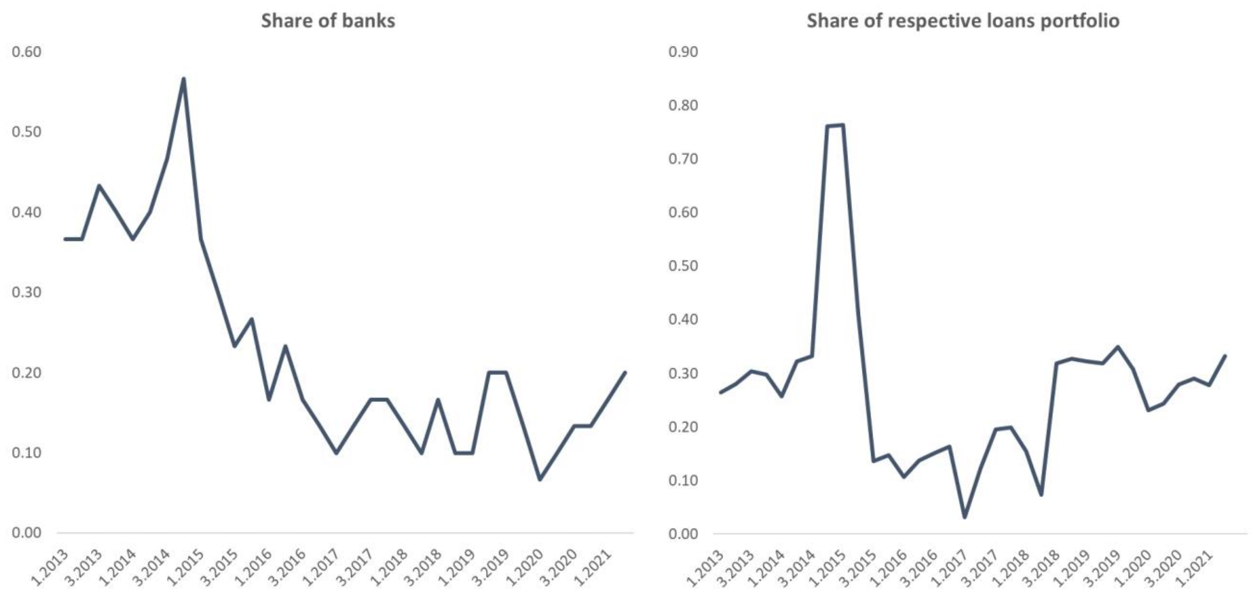


Figure 4. Liquidity deficit (as ratio to reserve money)



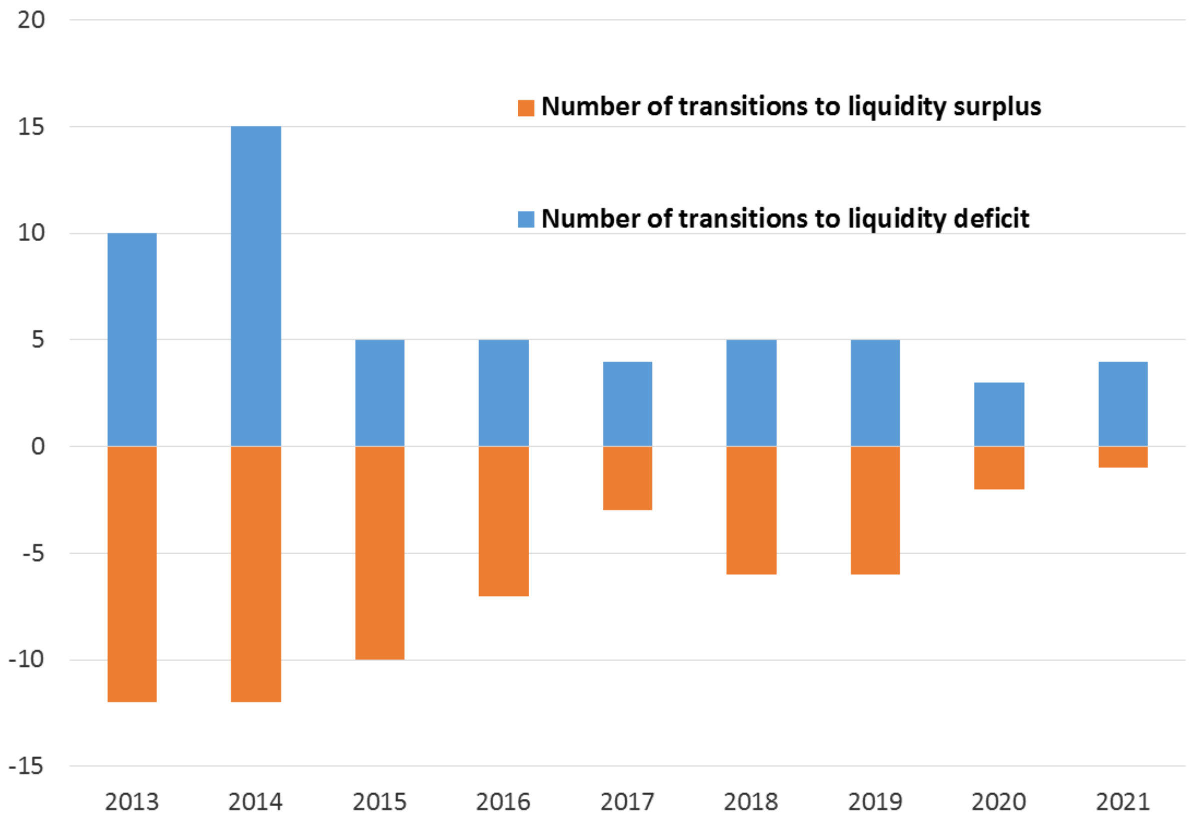
The indicator of liquidity deficit based on the central bank's balance sheet is an aggregate measure that does not necessarily reflect developments on the level of individual banks. In fact, the system is never fully in a liquidity deficit or surplus and transitions between these states occur perpetually at the level of individual banks.[10] We present the evolution of the share of banks (out of the 30 largest) and the share of their loan portfolios operating under liquidity deficit[11] in Figure 5 and the number of transitions[12] in Figure 6. These illustrations show that the fluctuation in banks' liquidity is an ongoing process and that the transitions of banks' balance sheets between the two states is a common event.

Figure 5. Share of banks (and respective loans portfolio) operating in liquidity deficit



[10] See Moiseev et al. (2012) and Gambarov and Vardanyan (2017) for a discussion of the roles that various types of banks consistently play on the interbank money market.
[11] We assume that a bank is in liquidity deficit if its stock of loans (denominated in rubles) exceeds its stock of deposits (denominated in rubles) and capital. Therefore, the developments presented in Figures 5 and 6 are not fully comparable with those presented in Figures 3 and 4.
[12] We compare banks' balance sheets at the beginning and at the end of each year.

Figure 6. Transitions of individual banks between liquidity deficit and surplus



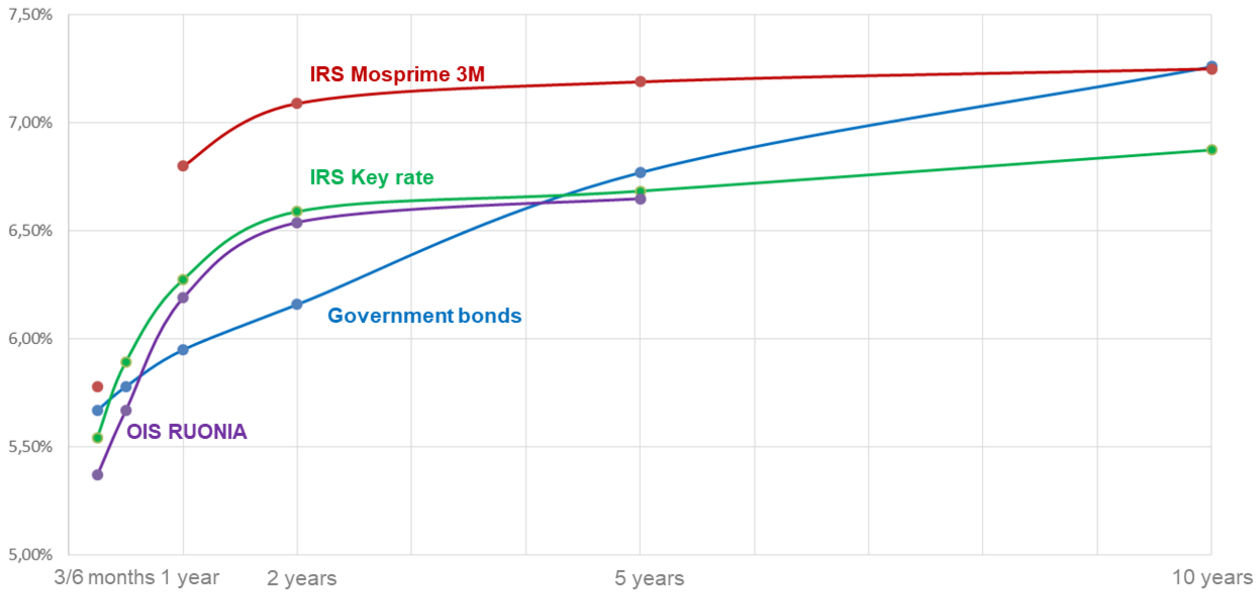
3.2 Fragmentation of the money market

There may be several causes for variation in the interest rates for a bank's borrowing and lending operations on the money market. The first source is the divergence of interest rates in different market segments. Typically, the literature assumes that if markets are efficient and the risk characteristics of financial instruments are taken into account, there is no reason why the price of bank reserves should differ across markets.[13] That is, the law of one price should hold. Under these conditions, market participants would exploit deviations in interest rates if they represented profit opportunities by borrowing in the market where the rates were lowest and lending to markets where rates were higher, until it was no longer profitable to do so. However, in reality, banks have broader balance sheet considerations that need to be taken into account as they optimise their balance sheets not only by funding themselves at the lowest possible rates to maximise profitability, but also for compliance with prudential regulation, maintenance of

[13] See Brennan (1971), Cheng (1980), Kruschwitz et al. (2019) and Cheung and Printant (2019) for notable exceptions that discuss this issue.

capital adequacy, and opportunity cost in asset allocation. Arguably, in the case of emerging markets, interest rate divergence may be an indication of their underdevelopment and relatively low liquidity.

Figure 7. Yield curves on various money market segments (as on 1 June 2021)

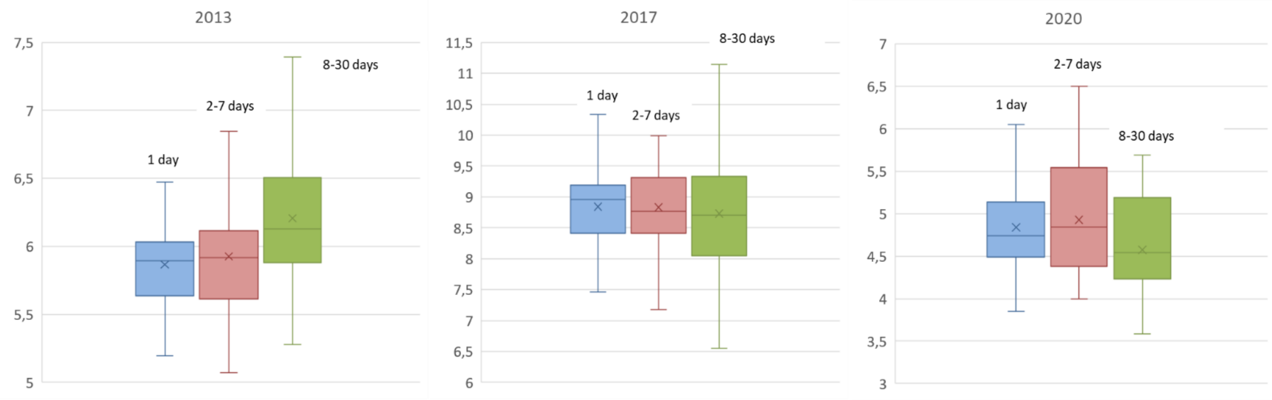


We illustrate this feature in Figure 7 by presenting the yield curves on alternative money market segments (sovereign bonds and interbank interest rate swap, IRS, market) that may be regarded as indicators of the risk-free rates. There is an observable difference in the interest rates. For example, for a bank that invests in the government bond market while in liquidity surplus and switches to using the IRS market rates as the benchmark when in liquidity deficit, the transition would imply an increase of almost 0.5 percentage points in the benchmark interest rate at 2 years' maturity.

Another potential source of changes in the benchmark money market rate after a transition to liquidity deficit/surplus is the heterogeneity of the banking sector and the ensuing risk premium. A bank in a liquidity surplus that operates in the money market by providing risk-free loans may not be able to get funding at the same rate after transitioning to a liquidity deficit.[14] In Figure 8, we show the distribution of interest rates on interbank liabilities and find that there may be considerable differences in credit terms across individual banks.

[14] Note that in case these developments affect the level of the aggregate interest rate indicator that is used as an operational target by a central bank (e.g. the average overnight interbank loan rate) this situation may entail a monetary policy response aimed at bringing the average rates back to the target level.

Figure 8. Interquartile distribution of average interbank loan rates for different maturities in 2013, 2017 and 2020.



4. Microsimulation model

We set up a microsimulation model to examine the performance of banks' alternative interest rate setting strategies. Arguably, the theoretical considerations outlined in Section 2 show that the optimal bank behaviour implies loan rate setting that is independent from the structure of liabilities. However, such formal analysis may seem detached from the actual heuristics banks use in reality (see Haldane and Turrell, 2018, for a discussion). Therefore, we set up a model that employs realistic bank behaviour corresponding to the real-world practice.

We use a partial equilibrium approach and focus on the credit market (i.e., endogenous loan interest rate setting), while other elements in the model are set exogenously. This is a simplistic setup, but it is generally in line with the Klein-Monti approach.

In the model world, there are *N* banks divided into three equal groups, each using an alternative interest rate setting approach.

Banks conduct several rounds of loan extensions and deposit collections. The timeline of events in each round is as follows.

4.1 Initial conditions

At the beginning of each round, each bank's initial balance sheet is generated. The balance sheet consists of deposits, loans and interbank assets and liabilities. Deposits (D_n) are defined as:

$$D_n = \mu S_n \Omega_1 \tag{5}$$

where μ represents demand for cash and Ω_1 is the scale parameter. In the initial phase, each bank is randomly assigned its default market share S_n. This parameter is generated in such a way that the composition of three groups is identical in terms of market share.

Loans (L_n) are defined as:

$$L_n = \Omega_1/n \tag{6}$$

Interbank assets and liabilities (IBA_n /IBL_n) are defined by the residual term:

$$IBA_n = D_n - L_n \tag{7}$$

The initial net income (π_n) is determined as:

$$\pi_n = L_n r^L + IBA_n r^{IBA} - D_n r^D - IBL_n r^{IBL} \tag{8}$$

where r^L, r^D, $r^{IBA}$and $r^{IBL}$are the default values of the loan, deposit and interbank asset and liabilities rates, respectively.

4.2 Interest rate setting

At this stage, the new, bank-specific values of the exogenous interest rates are determined. First, the common policy rate (R^P) is generated:

$$R^P = \varepsilon_1 \tag{9}$$

Next, the bank-specific deposit and money market rates are generated:

$$R_n^D = R^P + \varepsilon_{2,n} \tag{10}$$

$$R_n^{IBL} = R^P + \varepsilon_{3,n} \tag{11}$$

$$R_n^{IBA} = R^P + \varepsilon_{4,n} \tag{12}$$

For each bank, R_n^{IBA} is restricted not to exceed R_n^{IBL} and R_n^D is restricted not to exceed R_n^{IBA}.

The banks proceed by determining the loan rates (R_n^L).

The first group of banks employs a simple FTP approach that links loan rates to the money market funding rate irrespective of the structure of current liabilities:

$$R_n^L = \beta_1 + R_n^{IBL} \quad (13)$$

The second group of banks employs a modified FTP approach (FTP 2.0) which, depending on the structure of liabilities, uses a smooth transition approach between the money funding and investment rates:

$$R_n^L = \beta_2 + w_n R_n^{IBL} + (1 - w_n) R_n^{IBA} \quad (14)$$

$$w_n = 1/(1 + e^{\beta_3 - \beta_4 L_n/D_n}) \quad (15)$$

The third group of banks links the loan rate to the average funding rate:

$$R_n^L = \beta_5 + w_n R_n^{IBL} + (1 - w_n) R_n^D \quad (16)$$

$$w_n = IBL_n/(IBL_n + D_n) \quad (17)$$

Note that the β coefficients are calibrated in such way that the level of loan rates is on average (i.e. not conditionally on the exogenous variables) equal for all strategies and corresponds to the optimal value. Therefore, the differences in the performance of alternative strategies are driven by the reaction to variation in the exogenous funding rates and the structure of liabilities.

4.3 Loan and deposit markets

In this phase, new deposits are collected and new loans are extended.

The volume of new deposits is defined as:

$$\Delta D_n = \mu S_n \Omega_2 \quad (18)$$

where μ represents the demand for cash and Ω_2 is the scale parameter. In this phase, the market share of new deposits S_n is generated randomly.

The volume of new loans is defined as:

$$\Delta L_n = s_n \Omega_2 \quad (19)$$

where the market share in the loan market s_n is the result of the loan rate setting decision and is defined as:

$$s_n = (1 - \lambda(R_n^L - R^*))/n \quad (20)$$

where R^* is the median loan rate across all banks and λ is the sensitivity parameter. After determination via equation (18), the market shares are normalised such that the sum of all s_n equals one.

The change in interbank assets (liabilities) is calculated as

$$\Delta IBA_n = \Delta D_n - \Delta L_n \tag{21}$$

The incremental income (i.e. the difference in incomes generated by the expanded and by the initial balance sheets) is calculated as:

$$\pi'_n - \pi_n = \Delta L_n R_n^L - \Delta D_n R_n^D + \Delta IBA_n R_n^{IBA} - \Delta IBL_n R_n^{IBL} \tag{22}$$

We use the incremental income indicator to measure the performance of alternative strategies.

The parameters of the model are given in Table 3 in the Appendix.

5. Results

We conducted 10,000 independent simulation runs for the model and collected the realised loan rates, the volume of loans extended and the incremental income across the banks. The results for the alternative loan rate setting strategies are presented in Table 1.

Table 1. Baseline scenario (25/50/75 percentiles)

	FTP	**FTP 2.0**	**Average costs+**
Loan rate (deviation from policy rate)	3.3 / **3.3** / 3.3	3.15 / **3.3** / 3.36	2.6 / 3.**3** / 4.0
Return over assets	8.83 / **9.21** / 9.5	8.84 / **9.21** / 9.5	8.95 / **9.24** / 9.46
Loan-to-deposit ratio	0.94 / **1.051** / 1.19	0.95 / **1.05** / 1.19	0.96 / **1.06** / 1.17
Incremental income (deviation from FTP banks in pp)	0 / **0** / 0	-0.03 / **0.08** / 0.27	-1.37 / **- 0.59** / -0.05

By design, the average loan rates are on average the same under all strategies. The standard practice, consistent with the FTP approach, implies constant spreads between loan and policy rates, while the alternative interest rate setting strategies are more proactive. Banks using a primitive strategy based on the average costs tend to stabilise the loan-to-deposit ratio and have a higher return on assets,[15] but have lower overall net

[15] Calculated as the ratio of net income to the sum of loans and interbank assets.

income compared to standard FTP-based interest rate setting. On the contrary, the variation in loan spreads driven by the FTP 2.0 approach actually helps to increase banks' income.

To illustrate the mechanism behind these differences, we conducted another calculation based on alternative scenario assumptions. Specifically, we changed the value of the *μ* parameter from 0.95 to 0.75, representing of increase of deposit outflows into cash. This experiment illustrates the performance of different heuristics during transition to a larger liquidity deficit. The results are presented in Table 2.

Table 2. 'Deposit outflows' scenario (25/50/75 percentiles)

	FTP	**FTP 2.0**	**Average costs+**
Loan rate (deviation from policy rate)	3.3 / **3.3** / 3.3	3.34 / **3.36** / 3.37	3.43 / 4.11 / 4.75
Return over assets	8.07 / **8.49** / 8.91	8.07 / **8.51** / 8.92	8.38 / **8.73** / 9.02
Loan-to-deposit ratio	1.21 / **1.35** / 1.52	1.21 / **1.35** / 1.51	1.2 / **1.31** / 1.46
Incremental income (deviation from FTP banks in pp)	0 / **0** / 0	0.11 / **0.15** / 0.19	-1.72 / **- 1.03** / -0.46

Larger outflows of deposits lead to the alteration of the funding structure, driving banks deeper into liquidity shortage. The net interbank position of the banks deteriorates (i.e. net interbank liabilities increase, representing demand for the central bank's liquidity providing facilities). The banks using standard FTP do not react to these developments. Other types of banks increase their loan rates, but there is a substantial difference in their behaviour. The banks employing FTP 2.0 transition from using interbank investment rates to interbank rates as the benchmark. The change in the loan rate set by the banks employing the 'average costs+' strategy is determined by the transition of the average costs from deposits rate to the interbank funding rate. Therefore, the potential variation in the loan rates set by the banks of the latter group is substantially larger, which is reflected in the results.

In the alternative scenario, all banks earn smaller income, although the limited loan rate increase by banks using the FTP 2.0 strategy proves to be appropriate in a situation where banks tend to use the money market for funding rather than investing. Contrarily, the more aggressive hike in loans driven by the increased average funding costs is counterproductive. The banks using this strategy obtain the highest return on assets, but the loss of loan market share more than offsets the associated increase in income.[16] As the result, the performance of the banks employing the 'average costs+' strategy is the worst in terms of incremental income generated.

6. Conclusions

Fluctuations in the level of excess reserves in the banking system are not uncommon in countries around the world.[17] Assuming that a central bank is successful in steering the money market interest rates, commercial banks' loan rate setting behaviour is not expected to change during the transition between liquidity surplus and deficit. This assumption is in line with the conventional view of banks' strategies for setting loan rats as being independent from the banks' balance sheet structures. There are seemingly good reasons for such an assumption. The average price of funding cannot be viewed as the marginal funding cost for new lending, as wholesale funding availability (for an individual bank) is not directly affected by the volume of newly extended loans (by the individual bank). Therefore, only fluctuations in money market rate determine the changes in loan rates, irrespectively of whether a bank is borrowing or lending on the interbank market.

This logic holds as long as the same money market instrument is used by a bank for the lending and borrowing activities. This is not necessarily the case. Accordingly, there may be interest rate divergence in different market segments and/or substantial differences in risk premium across banks. In this environment, it may be appropriate to adjust the loan rates when a bank transitions between liquidity surplus and deficit (i.e. switches between the benchmark money market rates). Note that this strategy is fundamentally different from linking the loan rates to the average cost of funding (i.e. the average of retail and wholesale funding rates). The magnitude of such a loan rate adjustment is limited by the (usually moderate) spread between the funding and investment money market rates. Therefore, in practice, it is safe to assume that (as pointed out by e.g. Grishchenko et al. 2021) the variation in loan rates is fundamentally

[16] A by-product of slower loan portfolio expansion is lower loan-to-deposit ratios in the group of banks employing the 'average costs+' heuristic. Admittedly, in the real world, this may be an appropriate strategy aimed at limiting the liquidity mismatch and the associated risks. It is, however, important to acknowledge that this is done at the expense of income maximisation rather than for the sake of it.

[17] Recently, the prospects of the introduction of central bank digital currencies (CBDC) and the associated outflow of bank deposits and reserves have renewed interest in analysis of the consequences of changes in banking liquidity surplus (see e.g. Bank of England, 2020, for discussion).

determined by variation of the benchmark money market rates and the borrower-specific risk premium, whereas the strategy of incorporating the variation in average funding costs into loan rates is not valid.

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Appendix

Table 3. Benchmark parameters of the model

Description	Parameter	Value
Number of banks	N	30
Scale parameter (size of initial balance sheet)	Ω_1	100
Scale parameter (balance sheet expansion)	Ω_2	15
Demand for cash	μ	0.95
Initial values of interest rates	$r^L/r^D/\ r^{IBA}/\ r^{IBL}$	15/5/8/10
Policy rate generation	ε_1	~N(10,0.5)
Deposit rate generation **	$\varepsilon_{2,n}$	~N(-5,0.5)
Money market funding rate generation **	$\varepsilon_{3,n}$	~N(0,0.75)
Money market investment rate generation **	$\varepsilon_{4,n}$	~N(0,0.75)
FTP approach intercept	β_1	3.3
FTP approach 2.0 intercept	β_2	3.4
FTP approach 2.0 smooth transition parameter	β_3	9
FTP approach 2.0 smooth transition parameter	β_4	10
Average funding costs approach intercept	β_5	7.8
Loan demand sensitivity to interest rate	λ	0.25
Deposit market share*	S_n	~N(0.5,0.1)

* After being randomly generated, the market shares are normalised so that the sum of all S_n equals one. This parameter is generated randomly only for one group of banks (i.e. for *N*/3 agents) and replicated for the remaining two groups. Accordingly, the composition of the three groups is identical in terms of market shares.

** For each bank, the market investment rate is restricted not to exceed the market funding rate and the deposit rate is restricted not to the exceed market investment rate.