Quantifying interest rate risk and the effect of model assumptions behind sight deposits

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Have Austrian banks taken on higher interest rate risks amid the low interest rate environment? According to the interest rate risk statistics, which quantify the effect of the regulatory 200-basis-point interest rate shock, interest rate risk as reported by banks has not risen significantly since the beginning of the low interest rate period. However, in measuring interest rate risk, banks need to rely on model assumptions, especially with regard to the repricing dates they assume for customer deposits. Harnessing this room for maneuver, banks may compensate for longer fixation periods on the assets side (maturity transformation). In turn, a higher degree of maturity transformation and interest rate sensitivity might not be fully reflected in the reported interest rate risk. Analyzing this room for maneuver, we calculate Austrian banks' interest rate risk level over time while assuming standardized and conservative repricing dates. Under these conservative repricing dates, a different picture on interest rate risks emerges especially for large banks. We conclude that large banks in Austria have seen a marked increase in maturity transformation over time, which was mirrored by small and medium-sized banks to a lesser extent. It follows that interest rate risk in the banking book, and its quantification, is now more relevant for evaluating banks' business models and capital adequacy than was the case before the start of the low interest rate phase.

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Since the European Central Bank (ECB) embarked on its current monetary policy stance (negative interest rates, sovereign and corporate bond purchases), one question has come up time and again: what effect does this accommodative stance have on the profitability of banks in the euro area? Given that this issue is highly relevant for monetary policy makers and bank supervisors, it has been discussed regularly by the Oesterreichische Nationalbank (OeNB). Kerbl and Sigmund (2016) examine the empirical relationship between low interest rates and net interest margins, simulating the asymmetric effect of negative interest rates on profitability. They show that the low and negative interest rate environment adversely affects banks' net interest income (see e.g. also Drescher et al., 2016; Eggertsson et al., 2019; Genay and Podjasek, 2014; Gros, 2018).

This effect is less evident with large banks, as shown by Kerbl and Sigmund (2016), and is possibly explained by banks (partly) compensating for this by (a) higher credit volumes, (b) higher credit risks or (c) higher interest rate risks. The positive link between higher interest rate risks and a higher net interest margin has been corroborated, among others, by Angbazo (1997) and Entrop et al. (2015; see also the discussion in Bologna, 2018).

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Yet, when the interest rate risk as reported by banks is considered (see also chart 2), then no increased interest rate risk is observable during the period of accommodative monetary policy.

For this reason, OeNB bank examiners, when they started carrying out business model-related on-site inspections at the end of 2017, focused, inter alia, on interest rate risk. What they observed was that banks were engaging more and more in maturity transformation due to its positive effect on net interest income. In other words, banks were striving to compensate for the contracting net interest margin by making longer-term investments (i.e. longer interest rate fixation periods), which, according to the banks, also tied in with the customers' demands. Nevertheless, the higher degree of maturity transformation was not reflected by an increase in the risk reported.[2] We assumed that the respective banks continuously raised the (fictitious) interest rate fixation period of sight deposits and hereby offset the longer interest rate fixation periods on the assets side. In this study, we confirm this hypothesis.

1 Interest rate risk – basic facts

According to classical finance theories (see e.g. Hicks, 1946), maturity transformation is an integral part of the banking business: in other words, credit institutions extend long-term finance (by granting long-term loans) and engage in short-term funding (by taking in short-term or sight deposits). This denotes maturity transformation from a *liquidity perspective*.

Another form is maturity transformation from the *interest rate perspective*. Interest rate fixation periods may deviate from liquidity deadlines both on the assets side (e.g. variable rate loans) and on the liabilities side (e.g. deposits with a floating rate).

A bank's net interest income depends, inter alia, on the difference between the risk-free interest rate applicable to assets and liabilities.[3] With a "normal" upward sloping yield curve, the long-term interest rates exceed the short-term interest rates. Credit institutions earn a structural contribution if the interest rate fixation period of their lending business is higher than that of their deposit business.

Chart 1 displays the yield curves in the euro area (for AAA-rated sovereigns) from year-end 2007 to year-end 2018. For readability, we only show the yield curve for every other year, with the exception of 2017 and 2018. We see that (1) the yield curve was upward sloping during the whole period (least pronounced in 2007), and that (2) especially after 2013, yields were substantially compressed over the entire maturity range. The first observation implies that banks can increase net interest income by means of maturity transformation, and the second – in combination with depressed margins in times of low rates (see the literature section above) – that banks have a stronger incentive to do so.

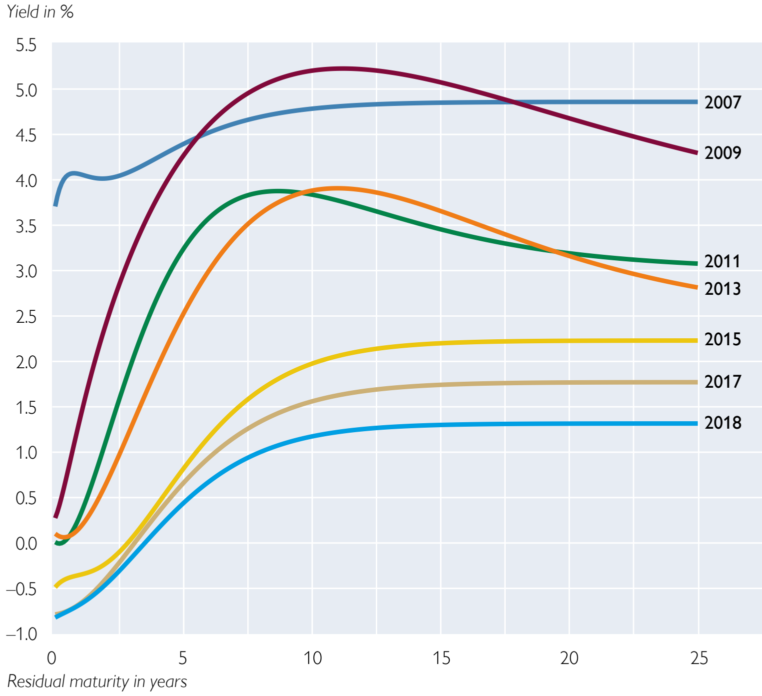
[2] *As explained in section 2, the interest rate risk statistics are part of a bank's reported "asset, income and risk statement" under statutory law. At the unconsolidated level, credit institutions submit quarterly reports in line with Annex A3b of the Regulation on Asset, Income and Risk Statements; at the consolidated level, banking groups pursuant to Article 59 and Article 59a Austrian Banking Act submit quarterly reports in line with Annex B3b and C3b of the Regulation on Asset, Income and Risk Statements.*

[3] *Another important driver is the margin contribution, which equals the difference between the credit institution's credit spread (margin contribution on the liabilities side) and its customers (margin contribution on the assets side). The relationships are presented here in a simplified manner.*

There is no reward/return without risk, which is why this type of maturity transformation carries interest rate risk: if interest rates increase along the entire yield curve, the present value of long-term positions declines more strongly than that of short-term positions. The risk of a decline in the present value of banks' own funds results from the contribution (= return) of maturity transformation.

Chart 1

Yield curves in the euro area, 2007–2018



Source: ECB.

While no capital charge is applied to this risk under Pillar 1 of the Basel framework, limiting the exposure of banks to interest rate risk falls into the responsibility of – in this order – the banks' management, the auditors and the supervisory authority (BCBS, 2016; or pursuant to Article 69 para. 3 Austrian Banking Act). The supervisory authority must take measures if the interest rate risk calculated using the standardized approach (i.e. the risk that a bank's present value declines as a result of a sudden and unexpected change in interest rates) exceeds a particular threshold, which, according to statutory law, has been set at 20% of the bank's eligible own funds. In addition, greater attention has been paid in the past few years to interest rate risk under Pillar 2.[4]

In essence, interest rate risk is measured by calculating the value of assets and liabilities under the assumption of an increase (or decrease) of the interest rate level, i.e. a parallel shift of the yield curve. The value of financial instruments with long-term interest rate repricing frequencies (such as fixed rate mortgages) declines more strongly than that of instruments with short-term interest rate repricing frequencies (such as money market loans).

With sight deposits, it is necessary to make assumptions. Interest rate risk is not just underpinned by objective factors: the above-said would presuppose that the rate fixation period is clearly determined for all types of a bank's business, but this is not true for products whose rates are not contractually fixed. Sight deposits are the most prominent case in point. On the one hand, the interest rates applied to sight deposits may deviate from money market interest rates, and on the other hand, customers may withdraw money on a daily basis without prior notice. This is important not only from a liquidity risk perspective, but also from an interest rate risk perspective, because should rates rise, banks must substitute deposits withdrawn by customers with higher market interest rates. For this reason, banks model rate fixation periods for products and activities without contractual interest

[4] *See e.g. European Banking Authority (EBA, 2018).*

rates (hereinafter referred to as non-maturity deposits[5] – NMDs) when they measure their interest rate risk. In this study, we take a closer look at these modeling assumptions.

When modeling the rate fixation periods of NMDs, i.e. behavioral repricing dates, banks deal with regulatory caps: In 2015, the European Banking Authority (EBA) stipulated that the assumed behavioral repricing date is to be constrained to a maximum average of five years.[6] In 2018, the EBA released a revised guideline according to which the five-year cap applies individually for each currency.[7]

2 Interest rate risk statistics

"Interest rate risk statistics"[8] are meant to ensure that the calculation of interest rate risk in the banking book (IRRBB) using a standardized method is comparable and traceable across banks and to support the identification of the key bank-specific determinants of IRRBB. The 200-basis-point interest rate shift is the central measure in this respect; it estimates the drop in a bank's present value of own funds if the interest rate level increases or decreases by 200 basis points (the maximum reduction in the present value in both scenarios).

In simple terms, the 200-basis-point shift is calculated as follows: Balance sheet items on the assets and liabilities sides as well as long and short off-balance-sheet positions are slotted into different maturity buckets (modified duration buckets) according to their repricing dates and the currencies in which they are denominated. Derivative positions are evaluated at delta equivalents and likewise reported. In a next step, the sign of the net position is determined by a simple difference for each maturity bucket or duration bucket and currency. This net position is multiplied by a proxy for the net present value change[9] in the event of a (200-basis-point) change in the maturity-matching interest rate. Thus weighted, net negative and positive positions are then added together for each currency, and the resulting absolute values are thereafter summed up across currencies. The outcome of this analysis is independent from the calculation method via maturity or modified duration buckets provided that the positions have been allocated in line with the reporting guidelines.

Classical maturity transformation as applied by banks results in more assets at the long end (i.e. in the buckets with a long rate fixation period) and more liabilities at the short end (i.e. in the buckets with a short rate fixation period). This overhang of the assets side at the long end and the overhang of the liabilities side at the short end give rise to interest rate risk (IRR): a change in interest rates changes the present value of own funds. In the quantification of IRR, the size and the structure of the overhang are key.

With respect to NMDs, credit institutions have to model the repricing dates. Such model estimates are aimed at predicting the outflow of NMDs in the event of a 200-basis-point interest rate shock and under the assumption that the bank keeps

[5] *Apart from sight deposits, some employee pension claims fall into this category, but size-wise, such claims are underrepresented in our case.*

[6] *EBA (2015), para. 24(d).*

[7] *EBA (2018), para. 115(o).*

[8] *In the following, we do not consider trading book positions as capital charges apply to trading book interest rate risk.*

[9] *That is, this measure approximates the present value change of the position in the event of a +/–200-basis-point parallel shift of the yield curve. For the requirements for calculating more complex interest rate scenarios, see BCBS (2016).*

the interest rate on these NMDs unchanged. In turn, if the model estimates allocate NMDs to buckets with long rate fixation periods, this mitigates the long-end asset overhang that results from loans and bonds with contractually fixed repricing dates. Unlike, for instance, internal ratings-based (IRB) models, which have to be approved by the competent authority before they can be used, this modeling approach is not subject to such supervisory approval. While the validation of the assumptions may be challenged during relevant on-site inspections and the Austrian Financial Market Authority (FMA) or the ECB may impose pertinent requirements when following up on such inspections, there may be a significant time lag between the implementation of a new model (and its calibration) and the acknowledgment of the model by the supervisory authorities.

3 Objective

In this analysis, we aim to identify the extent to which banks took on more interest rate risk over the past few years, which, ceteris paribus, increased interest income. To this end, we draw on data reported by 482 (groups of) credit institutions[10] and adjust these data for the effect of model assumptions to compare the interest rate risk over time and across banks.

The analysis is meant to shed light on the question whether maturity transformation has been stepped up in the Austrian banking system since the beginning of the low interest rate period. In addition, by employing the method introduced in the next section, we also gain insights into the extent to which banks model sight deposits in order to identify any outliers and model risks.

4 Methodology

To reach the desired level of comparability, it is first of all necessary to neutralize the impact of the heterogeneous model assumptions behind sight deposits. Please note that modeling heterogeneity does not necessarily have to be an indicator of misquantification, since the economic interest rate sensitivity of sight deposits indeed varies depending on the respective bank's business model. An in-depth assessment may only be carried out by way of an on-site inspection.

This notwithstanding, reporting data may be used to perform plausibility checks on a bank's model assumptions, especially for the purpose of peer group comparisons. The bolder the model assumptions are, the higher is the model risk of the respective bank. Model risk exists even in cases where the model assumptions are justified and have been validated accordingly. Reliable validation coupled with conservative model assumptions help reduce the resulting model risk[11].

To ensure a level playing field for banks regarding these model assumptions, we, for one thing, compute the IRR for all banks in the sample, using data reported in the interest rate risk statistics. For another thing, we edit the data reported by banks as follows: in line with their contractual maturity, we allocate NMDs to the time bucket with the lowest rate fixation period (i.e. less than one month). This represents the most conservative approach and the assumption of the shortest possible

[10] *To be precise, these data comprise all fully operating credit institutions at the highest level (i.e. consolidated in the case of groups) as at end-2017.*

[11] *For the provisions on how to consider these model risks, see EBA (2018) para.108(h,i).*

fictitious rate fixation period.[12] To keep it simple, we call the thus calculated change in present value given an assumed interest rate change of 200 basis points under level playing field assumptions "interest rate risk under level playing field assumptions" or IRR-LPF, to refer to the time series of the changes in the present value calculated in this way.

In a second step, we compare the IRR-LPF with the reported IRR over time to identify any trends. A rising IRR-LPF time series is indicative of a bank's increased maturity transformation. If the IRR-LPF time series rises more strongly than the reported IRR, the bank is likely to progressively model NMDs.

Finally, we sort and rank the results. We deem those credit institutions "model dependent" whose interest rate risk exceeds 20% of their own funds according to the IRR-LPF, i.e. banks that do not exceed the regulatory limit only thanks to model assumptions behind NMDs. In addition, we identify those institutions whose model assumptions on the fictitious maturity of sight deposits are more aggressive (longer duration) than the respective assumptions of the peer group.

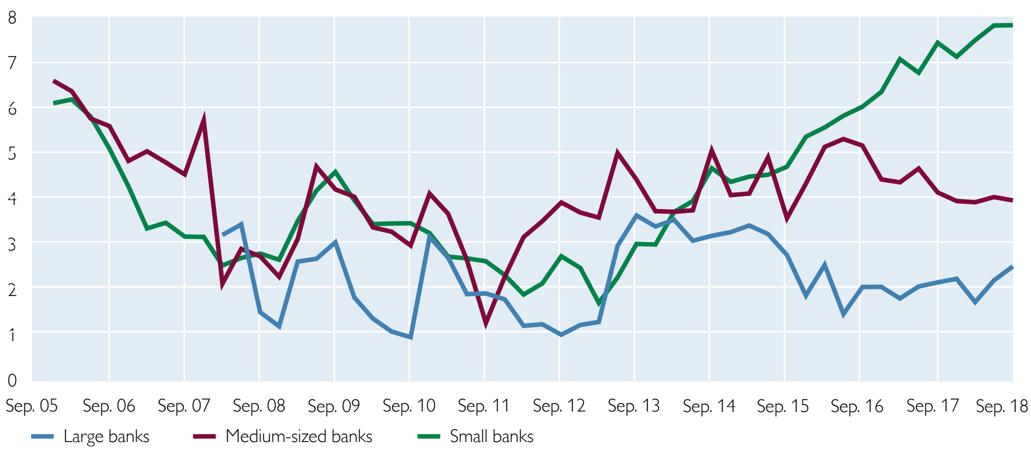
5 Outcome for bank aggregates

Chart 2 shows the interest rate risk reported by Austrian banks. It is evident from this chart that while small banks[13] systematically increased their interest rate risk, neither medium-sized banks nor large banks increased their interest rate risk as reported in the interest rate risk statistics during the indicated period. For the remainder of this study, note that whenever we refer to bank aggregates (small, medium-sized and large banks), we refer to an average bank representative of the given sample and do not mean every individual bank classified as small, medium-sized or large.

Chart 2

Volume-weighted average of the reported IRR of three bank aggregates

Impact of 200-basis-point shift in % of own funds



Source: Supervisory statistics, authors' calculations.

[12] *In fact, this corresponds to the most conservative assumption under a +200-basis-point shift of the yield curve.*

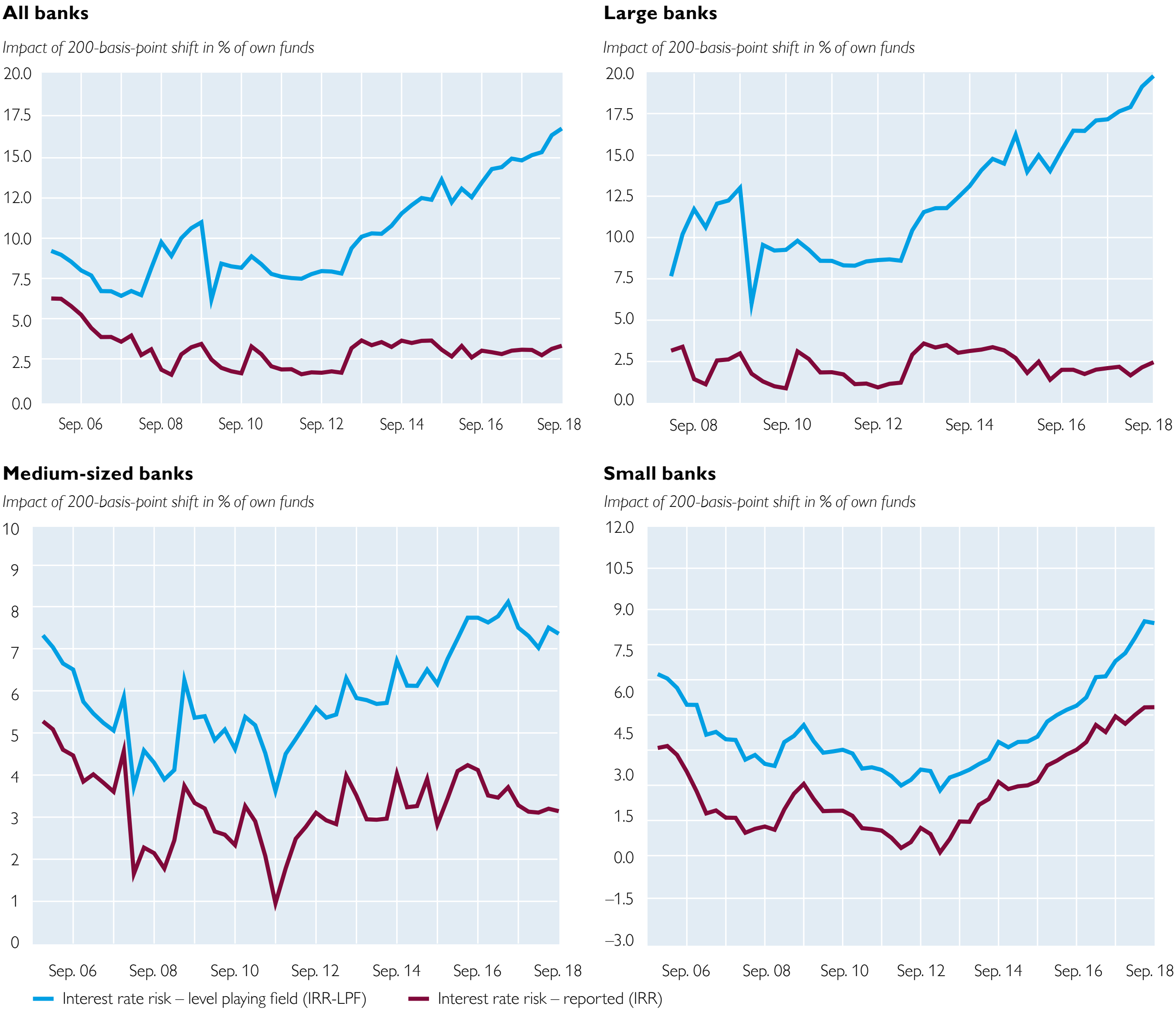
[13] *Small banks: total assets < EUR 1 billion; medium-sized banks: total assets < EUR 20 billion; large banks: total assets ≥ EUR 20 billion. "Large banks" include all systemically important institutions according to Article 23c Austrian Banking Act. For a further description of the data, see the subsequent sections.*

In the event of a +200-basis-point shift of the yield curve and based on the data reported by banks, the present value of large Austrian banks' own funds declines by less than 2% as of September 2018.

Chart 3 compares the reported IRR with the computed IRR-LPF. Especially large banks (total assets ≥ EUR 20 billion) show a notable rise in the IRR-LPF, i.e. the interest rate risk under an assumed short rate fixation period for NMDs. This strong increase in large banks' exposure to interest rate risk has an impact on the average of the entire banking sector given large banks' weight. For medium-sized banks, only a moderate increase is observed. In parallel to their IRR, small banks' IRR-LPF went up in recent years.

Chart 3

Volume-weighted averages of the reported IRR and the IRR-LPF of four bank aggregates



Source: Supervisory statistics, authors' calculations.

Note: For large banks, the x-axis dates back to 2008 only in order to keep changes in the composition of the respective bank aggregates over time to a minimum. Please note that the y-axis features different percentages in all four panels.

In contrast to small banks, large banks' increased exposure to interest rate risk is not reflected in the reported 200-basis-point shift (IRR, dark red line in chart 3) but becomes evident only once the model assumptions, which change over time, are neutralized (IRR-LPF). It is noteworthy that, compared with small banks, large banks develop models considering interest rate fixation periods much more frequently.

IRR reported by large banks invariably amounted to less than 5% of own funds; in contrast, interest rate risk adjusted for model assumptions behind sight deposits (IRR-LPF) came to around 19.8% of own funds. Under level playing field assumptions, large banks' exposure to interest rate risk is considerably higher than the reported interest rate risk. One presumption is that large banks use the room for maneuver they have in considering NMDs in interest rate risk calculations to keep the IRR to be reported relatively low.

For better comparability across the banking aggregates, chart 4 shows the IRR-LPF adjusted for assumptions behind sight deposits.

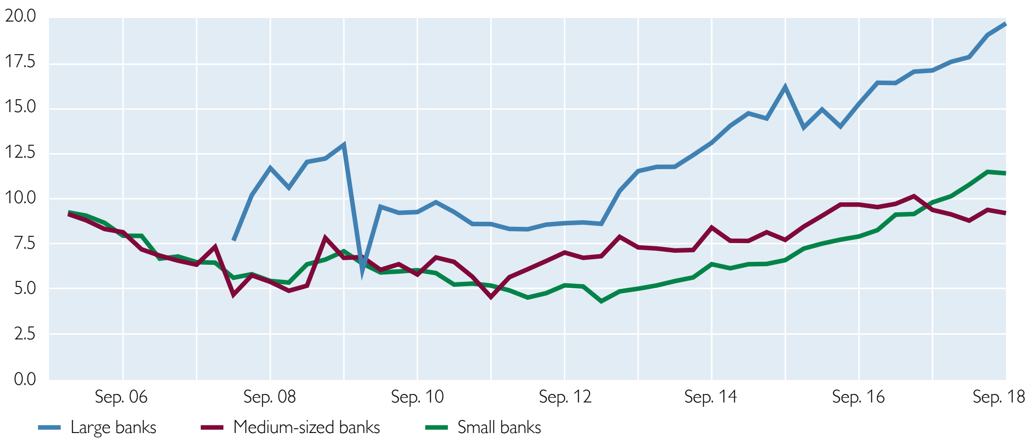
The rise in large banks' interest rate risk coincides with the beginning of the low interest rate period; it is also a manifestation of large Austrian banks' stepped-up recourse to maturity transformation to fight off interest income erosion. In a similar vein, albeit from a low starting level, medium-sized and small banks also show a marked increase in interest rate risk since the beginning of the low interest rate period, which reflects their attempt to maintain the net interest margin by taking on more interest rate risk. Medium-sized banks started earlier to take on interest rate risk and display a stronger reliance on model assumptions than large banks but a larger model reliance than small banks, as reflected by the respective differences in IRR and IRR-LPF in chart 3. Compared to small banks, medium-sized banks have not extended their maturity transformation as monotonically as small banks and not as drastically as large banks but still show a marked increase in the IRR-LPF from 5% in 2011 to 9% toward the end of 2018.

In the following, we take a closer look at a case study that illustrates the magnitude of this phenomenon. Before we do so, however, we mention one caveat: some

Chart 4

Volume-weighted averages of the IRR-LPF of three bank aggregates

Impact of 200-basis-point shift in % of own funds



Source: Supervisory statistics, authors' calculations.

banks provide behavioral economic reasons for their model assumptions in the risk management talks with bank supervisors. For instance, banks pointed out that, amid the prevailing low interest rates, depositors hardly pay any attention to the interest rate on their instruments. This is why not changing the interest rate on deposits in tandem with the market would hardly have an impact on the deposit volume. Moreover, banks allegedly dispose of data (but only for individual countries in Central, Eastern and Southeastern Europe) that corroborate this hypothesis. It remains to be seen, however, whether this reasoning still applies to a deposit market that, driven by technological advances, is becoming ever more efficient.

6 Case study of a bank

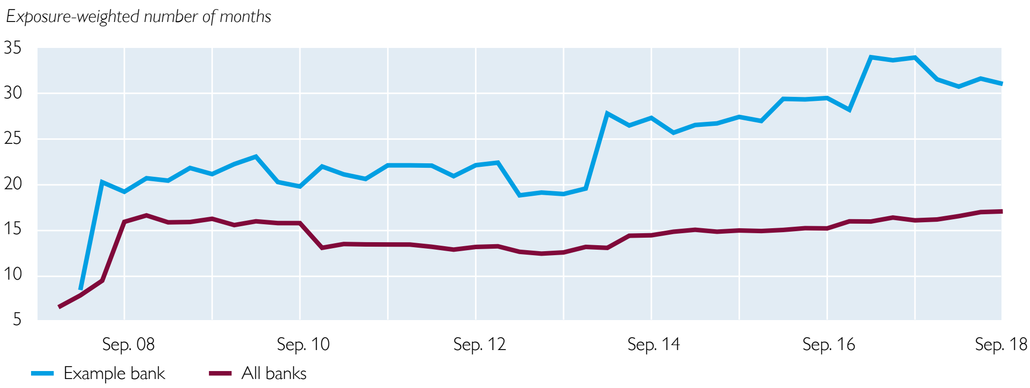
For a case study, we chose an example bank in order to illustrate that implications for financial stability would arise if several banks hypothetically followed an aggressive interest rate risk strategy. These insights allow us to recommend specific general policy action for safeguarding financial stability, which we present in the final section.

The example bank markedly increased its interest rate risk under level playing field assumptions in 2014 (when the zero interest rate period began), while at the same time reducing the interest rate risk reported in supervisory statistics. This difference may be traceable to two factors: (1) a fictitious rate fixation period for deposits in model assumptions which changes over time and (2) a rise in the deposit volume (quantity effect).

The first effect, the change in the assumptions about the interest rate sensitivity of sight deposits, is illustrated in chart 5. The chart shows the model assumptions this bank applies to sight deposits as compared with the volume-weighted average of all banks. At the beginning of 2018, the rate fixation period for sight deposits was assumed to be more than 30 months by the example bank in its model assumptions. The longer this assumed rate fixation period is, the greater is the deviation of the reported IRR from the IRR-LPF. The analogous average across all banks, and also of large banks, amounted to only about half that time. As to the example bank's assumptions, it is evident, on the one hand, that they were changed and, on the other, that they reached elevated values (> 2.5 years) as early as in 2013.

Chart 5

Comparison of the example bank's model assumptions behind sight deposits with all banks

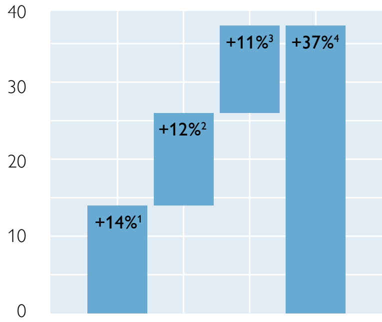


Source: Supervisory statistics, authors' calculations.

Chart 6

Factors determining the difference between the IRR-LPF and the reported IRR, as of 2018Q3

Impact of 200-basis-point shift in % of own funds



Source: Supervisory statistics, authors' calculations.

[1] Difference between LPF and modeling sight deposits at year-end 2011.
[2] Effect of changes to model assumptions between 2011Q4 and 2018Q3.
[3] Increase in deposits since 2011Q4.
[4] Total effect.

The computations underlying the second effect, the volume increase over time, are shown in chart 6. In the third quarter of 2018, the difference between the IRR-LPF and the reported IRR amounts to about 37% of own funds. This difference may be broken down as follows: the difference between the LPF model assumptions and the model assumptions used by the example bank for sight deposits at year-end 2011 accounts for some 14 percentage points (initial modeling effect). The effect of changes to the model assumptions for sight deposits between the fourth quarter of 2011 and the third quarter of 2018 equals some 12 percentage points (time-changing model assumptions). The increase in deposits recorded since the fourth quarter of 2011 accounts for some 11 percentage points (quantity effect).

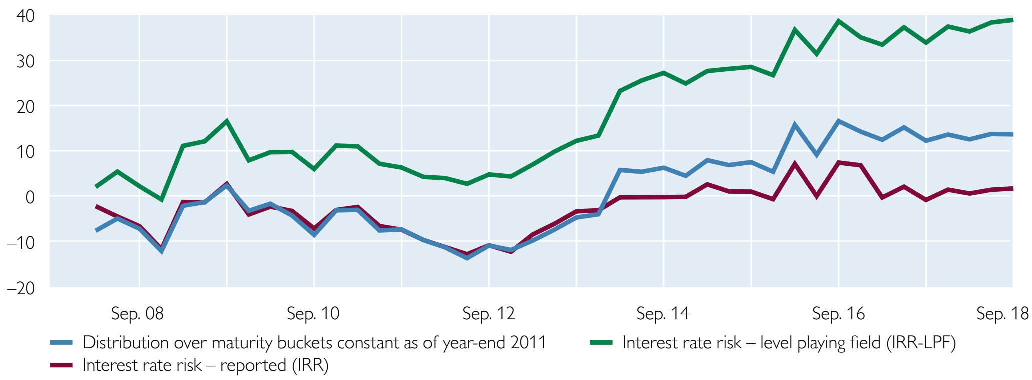
In addition to the calculated IRR-LPF and the reported IRR, chart 7 depicts the interest rate risk had the bank under review not adjusted the distribution of sight deposits over maturity buckets as of year-end 2011 (blue line). The difference between the latter and the reported IRR demonstrates that the bank lowered its reported interest rate risk by around 12% of own funds between the final quarter of 2011 and the third quarter of 2018 by changing the distribution across maturity buckets (time-changing model assumptions).

If the bank had not adjusted the distribution of sight deposits across maturity buckets as of year-end 2011, it would be exposed to interest rate risk of 14% instead of 2% of own funds at the end of the third quarter 2018.

Chart 7

IRR-LPF, reported IRR and constant distribution of sight deposits across maturity buckets

Impact of 200-basis-point shift in % of own funds



Source: Supervisory statistics, authors' calculations.

In the following, we explore whether this increase is ascribable to the bank's lending or derivative business (chart 8). As mentioned before, the reported IRR of the bank amounted to less than 2% of own funds in late 2018, while the IRR-LPF came to 39% of own funds. The interest rate risk inherent in that bank's derivative positions equaled about 30% of own funds. According to the reported data – where the interest rate sensitivity of on-balance and off-balance-sheet transactions is recorded separately –, the higher maturity transformation results not from on-balance-sheet lending, but from swap (i.e. derivative) positions.

While it is not relevant from the interest rate risk perspective whether the higher risk arises from the lending or from the swap business, it makes a difference from the liquidity risk perspective: swaps are subject to daily margin requirements. In a hypothetical case, increasing interest rates would trigger liquidity outflows. For example, at an interest rate sensitivity of the swap book of about 30% of own funds, such outflows could reach sizable dimensions. Under such scenarios, a bank's liquidity needs manifest themselves independent from the treatment in the balance sheet and in the interest rate risk statistics.

Chart 8

Reported IRR and IRR-LPF of the example bank and IRR of the derivative positions

Impact of 200-basis-point shift in % of own funds

Source: Supervisory statistics, authors' calculations.

7 Summary

In this study, we show that Austrian banks in aggregate increased their interest rate risk amid the low interest rate environment. The extent of such an increase becomes evident when the interest rate risk reported by banks is harmonized over time and across banks under conservative model assumptions for sight deposits which we introduced to ensure a level playing field.

From our analysis, we draw the following policy recommendations. First, it is important for supervisors to be aware of the general issue, namely that interest rate risk might be hidden under model assumptions on sight deposits. Financial stability experts should be knowledgeable about the general trend in interest rate risk and banking supervisors need to question banks' modeling assumptions and apply a harmonized approach in the supervisory review and evaluation process under Pillar 2.

Second, we could imagine that, in comparison with other euro area banks, Austrian banks are, generally speaking, not the only ones practicing interest rate risk modeling. Hence, we argue that, from a financial stability perspective, it might be worth taking a closer look at euro area banks' modeling choices for capturing depositor behavior. Third, we encourage further research to examine how much banks benefit from taking on more interest rate risk.

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