Monetary policy in a prolonged period of low interest rates – a discussion of the concept of the reversal rate

Since the financial and sovereign debt crisis, interest rates in the euro area have been at a low, sometimes even negative, level. This prolonged phase of low interest rates raises a question for monetary policymakers: could the effect of expansionary monetary policy measures on banks' lending reverse itself? The interest rate level at which such a reversal occurs is referred to in the literature on the subject as the "reversal rate". To hit a reversal rate, two conditions have to be met. First, the expansionary monetary policy measures must constrain the profitability and thus also the capital ratios of banks. Second, squeezed capital ratios must manifest themselves in reduced lending. If both conditions are satisfied, banks could respond to expansionary monetary policy measures by curtailing their lending.

During the period of low interest rates, expansionary monetary policy measures contributed to reducing the interest rate level in the euro area still further. Empirical studies show that a falling interest rate level depresses the net interest margin and thereby the profitability of banks above all when interest rates are already low. This kind of negative effect exerted on net interest margins by expansionary monetary policy measures can be offset by opposing effects, however. Falling interest rates tend to bolster macroeconomic developments, bringing down credit default risks and stimulating credit demand. While the negative effect on the net interest margin increases over time, this is unlikely to be the case for the positive effects. This is why the longer interest rates stay low, the greater the probability that expansionary monetary policy measures will exert a negative overall effect on the profitability and thus the capital ratios of banks. The first condition for the existence of a reversal rate is therefore more likely to be met the longer the period of low interest rates lasts.

The key factors for the second reversal rate condition are the banks' capital ratios and the regulatory capital requirements that they have to fulfil: if banks have capital ratios well in excess of the regulatory requirements, it is unlikely that a fall in those capital ratios will lead to a contraction in lending. This is because banks are most likely to respond to reduced capital ratios by cutting back on lending when they are operating with ratios only just over the requirements. In a banking system where the capital ratios of many banks lie barely above what is required by regulators, hitting the reversal rate is thus a possibility.

The reversal rate is unobservable and time-varying. It is therefore not possible to precisely quantify the reversal rate for the present situation. Nevertheless there exist indicators which allow us to assess whether the reversal rate has been encountered in the past. In particular, the evolution in the headroom between banks' capital ratios and regulatory requirements is of pivotal importance in this regard. Developments in this gap and additional indicators show no signs so far that the reversal rate has been reached before, in Germany or the euro area.

Introduction

Very low interest rates in the euro area since the financial crisis

In view of the financial and sovereign debt crisis and the very low rates of inflation in the euro area, the Governing Council of the European Central Bank (ECB) made multiple cuts to its policy rates in the years from 2009 to 2019. In June 2014, the deposit facility rate in the Eurosystem entered negative territory for the first time. Alongside this, the ECB Governing Council implemented additional monetary policy measures which contributed to a low general level of interest rates in the euro area. These include the various asset purchase programmes, such as the expanded asset purchase programme (APP) and the pandemic emergency purchase programme (PEPP) as well as the three series of targeted longer-term refinancing operations (TLTROs). The excess liquidity generated by these measures was a key driver behind money market rates following the interest rate on the deposit facility deep into negative territory. The APP also contributed to the lowering of long-term capital market yields and thus had a flattening effect on the yield curve.[1]

Reversal rate: interest rate level at which the effect of monetary policy reverses

With interest rates sinking further and further and the period of low interest rates persisting for longer and longer, the question arose as to whether such a setting could, in fact, see the effect of monetary policy on banks' lending abating or even reversing. Based on the idea that the effect could end up working in the opposite direction, the term reversal rate was coined in the literature. It describes the interest rate level below which further monetary policy easing ceases to stimulate bank lending and instead constrains it. This article centres around explaining the concept of the reversal rate.

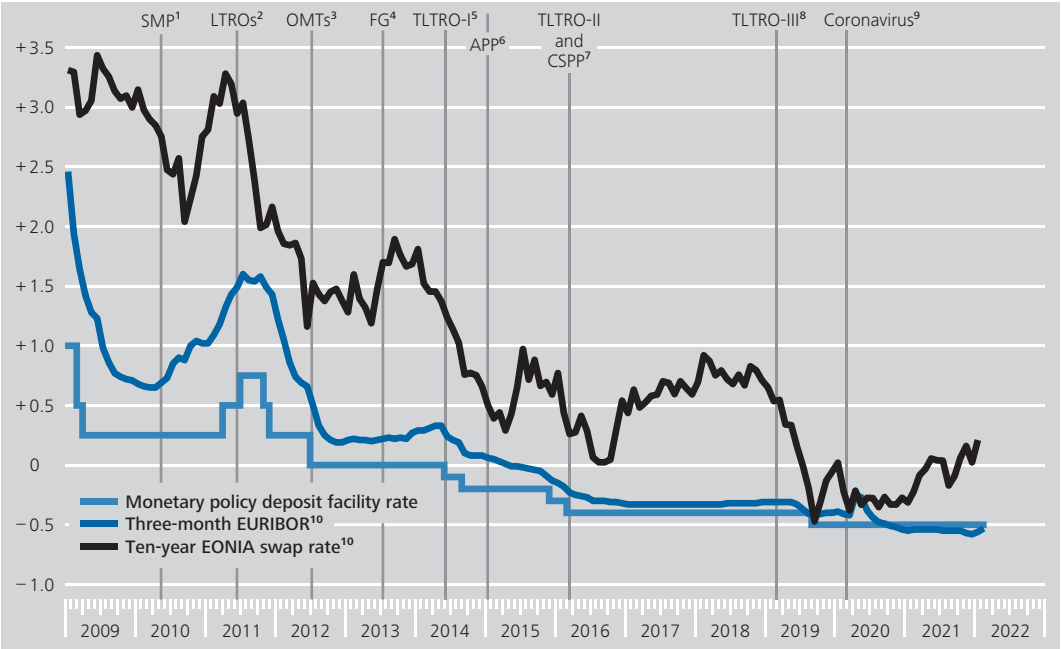
Monetary policy influences interest rate level across all maturities

Monetary policy's influence on the general level of interest rates tends to depend on the set of instruments involved: very short maturities (particularly money market rates) are influ-

1 See Deutsche Bundesbank (2020a), p. 27.

Selected interest rates in the euro area

% p.a.



1 May 2010: securities markets programme announced. **2** June 2011: longer-term refinancing operations announced. **3** July 2012: outright monetary transactions announced. **4** July 2013: start of forward guidance. **5** June 2014: first series of targeted longer-term refinancing operations announced. **6** January 2015: expanded asset purchase programme announced. **7** March 2016: second series of targeted longer-term refinancing operations plus corporate sector purchase programme announced. **8** March 2019: third series of targeted longer-term refinancing operations announced. **9** Start of coronavirus crisis and extensive monetary policy measures in response. **10** Monthly averages.

Deutsche Bundesbank

enced by the conventional interest rate policy, medium-term maturities by forward guidance and long-term maturities by the asset purchase programmes.[2] But a host of other factors alongside monetary policy also have an impact on the long-term interest rate of an economy. Examples of other determinants include households' propensity to consume or save, enterprises' propensity to invest and the propensity of economic agents to assume risks or to convert assets into liquidity without complications.[3]

Upshot of empirical literature: net interest margin declines when the interest rate level is very low

The fear that monetary policy could hit the reversal rate was kindled by findings in the empirical literature suggesting that a very low, possibly negative, interest rate level tends to have a detrimental impact on banks' profitability:[4] taken by itself, a period of low interest rates depresses banks' net interest margin[5] and thereby their net interest income (the difference between interest income and interest expenditure) as bank interest rates decline more sharply on the income side than on the expenditure side. This is because banks tend to be reluctant to apply negative interest rates to customers' deposits. Where the interest rate level is very low and the period of low interest rates persists for longer and longer, there comes a point as of which deposit rates all but cease to be adjusted while lending rates continue to fall. The theoretical literature, too, shows that a key element increasing the probability of a reversal rate scenario is the fact that banks' funding costs decrease less than the income side.[6]

If banks do not compensate for the decline in their net interest margin, their profits fall, ceteris paribus

If banks are unable to compensate for the decline in their net interest margin through other revenue or cost components and/or higher lending, their profits decrease, ceteris paribus. This, in turn, makes it harder for banks to build up capital through retained earnings.[7] The empirical literature shows that the longer the period of low interest rates lasts, the more net interest margins are squeezed.[8] If the period of low interest rates persists over a long time, banks thus need to make greater and greater adjustments to their business strategy if they wish to offset the influence of the decreasing net interest margin on their profitability.

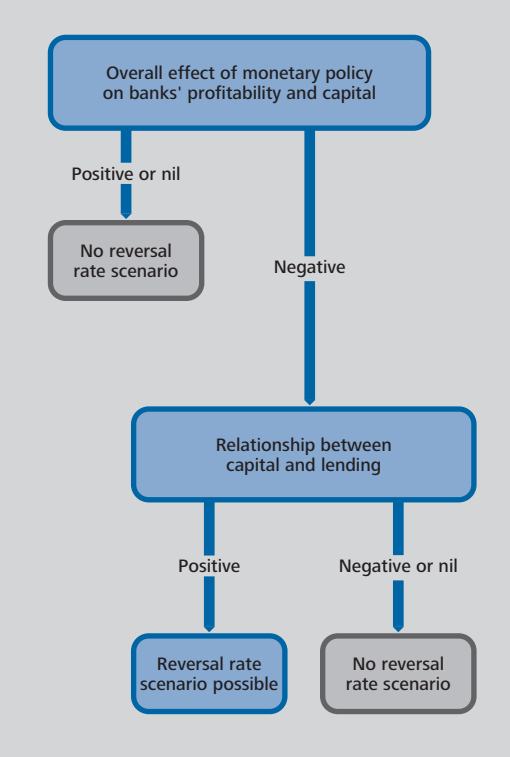
Banks operating close to the regulatory minimum capital requirement will be inclined to curtail lending

A bank's capital ratio – its capital[9] as a percentage of (risk-weighted) assets – is one of the factors determining its lending behaviour. One reason is because a change in the capital ratio will have an impact on the bank's funding costs. Empirical studies suggest that a lower capital ratio is associated with lower funding costs.[10] Funding costs, for their part, are a central component of the lending rate.[11] Another reason is that banks have to comply with regulatory minimum capital requirements. Falling short of these requirements triggers supervisory intervention. If a bank is operating with a capital ratio in close proximity to the regulatory minimum, then it may curtail its lending to prevent an undershooting of the requirement. There are studies based on bank-level data which show that it is primarily banks with low excess capital buffers – i.e. the difference between the actual capital ratio and the capital ratio required for regulatory purposes – that scale back lending.[12]

Banks reducing their lending in a period of low interest rates because they are capital-constrained does not necessarily mean that the reversal rate has been reached, however. The

2 See Altavilla et al. (2019) and Geiger and Schupp (2018).
3 See Deutsche Bundesbank (2017).
4 See Altavilla et al. (2018), Borio et al. (2017), Claessens et al. (2018) and Klein (2020).
5 The net interest margin is calculated as: (interest rate on assets * interest-bearing assets – interest rate on liabilities * interest-bearing liabilities) / interest-bearing assets.
6 See, inter alia, Brunnermeier and Koby (2019) and Repullo (2020).
7 Banks improve their capital ratios primarily through retained earnings. See, inter alia, Couaillier (2021) and De Jonghe et al. (2020).
8 See Altavilla et al. (2018) and Claessens et al. (2018).
9 In the regulatory context, the term "own funds" would be more precise than the term "capital". For simplicity's sake, however, this article uses the more commonplace "capital" throughout.
10 See Birn et al. (2020) and Miles et al. (2012).
11 See Illes et al. (2015).
12 See Imbierowicz et al. (2020); Bank for International Settlements (2021), pp. 31-33; Berrospide et al. (2021) and European Central Bank (2021), pp. 106-114.

Reversal rate channel



Deutsche Bundesbank

Reversal rate scenario: expansionary monetary policy measures responsible for curtailment of bank lending

academic literature only refers to this if the curtailment of lending can be attributed to the expansionary monetary policy stance. This means two conditions must be satisfied before we can say that a reversal rate scenario has occurred (see the chart above):

– the expansionary monetary policy stance weighs on profitability and thus banks' capital endowment and …

– … the erosion of the capital endowment causes banks to reduce their lending.

Looking at the two necessary conditions, this article discusses the concept of a reversal rate in the light of the existing theoretical and empirical literature and explores the monetary policy implications.

Discussion of the conditions required for the existence of a reversal rate

Monetary policy and banks' capital endowment

Reduction in net interest margin amplified in periods of low interest rates when interest rate level sinks further

The economic literature shows that monetary policy measures influence banks' capital endowment and thus potentially their lending choices by acting on the institutions' profitability.[13] This monetary policy transmission channel has grown in significance during the prolonged period of low interest rates in the large currency areas. According to results found in the empirical literature, the relationship between the interest rate level and banks' net interest margin depends on how high the interest level is. Especially when the interest rate level is low, the empirical literature finds that a further reduction in that level leads to a decreasing net interest margin.[14] This positive relationship between the interest rate level and the net interest margin also becomes stronger if the interest rate level falls still further,[15] for it is particularly when interest rates are low that income on the assets side of the bank's balance sheet will respond more sharply to the change in the interest rate level than the costs on the liabilities side.[16] This response of varying intensity is also extremely important in the highly regarded the-

13 For details on what is referred to as the "bank capital channel" of monetary policy, see Van den Heuvel (2007). See also Chami and Cosimano (2010) and Disyatat (2011); these papers do not directly make use of the term "bank capital channel" but still describe a monetary policy transmission channel through which monetary policy measures are propagated via the profitability and capital endowment of the banking system.
14 See Claessens et al. (2018) and Klein (2020).
15 See Borio et al. (2017), Altavilla et al. (2018) and Claessens et al. (2018).
16 See Claessens et al. (2018) and Klein (2020).

oretical model of Brunnermeier and Koby (2019) (see the box on pp. 22 ff.).[17]

Net interest margin decreases the longer the period of low interest rates lasts

Furthermore, the negative impact exerted by a low interest rate level on the net interest margin increases the longer the level stays low.[18] One reason is that, over time, older, higher-interest loans gradually mature and are replaced by new loans at lower rates of interest. The other reason is that interest rates on customer deposits do not fall to the same extent as lending rates. Experience during the period of low interest rates in the euro area shows that, in the aggregate, banks hardly ever apply negative interest rates to customer deposits: the volume-weighted interest rate aggregated across all customer deposits has settled at just over the zero mark in most euro area countries. This also reduces the income that banks generate on the funding side (liabilities-side margin contribution[19]). When interest rates are at a "normal" level, the interest on customer deposits averages out at lower than the interest rate on the interbank market, meaning that banks generate a profit through the liabilities-side margin contribution. However, this changes in a period of low interest rates: because the interest rate on customer deposits falls less sharply than interest rates in the interbank market, the liabilities-side margin contribution shrinks or even turns negative.[20] The longer the period of low interest rates lasts, the greater the contraction in both sources of revenue usually tapped in classical loan/deposit business – the net interest margin and the liabilities-side margin contribution.

Monetary policy affects banks' profitability via various channels

A negative effect of a low interest level on the net interest margin is a necessary, but not sufficient, condition for monetary policy to have a negative impact on banks' profitability and thus on their capital. This is because monetary policy has a positive impact on banks' profitability through various channels, for example via macroeconomic developments. The more favourable these developments are, the lower the average default risk. Lower credit risk, in turn, drives down banks' loan loss provisioning.[21] Lower levels of loan loss provisioning reduce banks' expenditure and therefore have a positive effect on their profitability.[22] In addition, favourable macroeconomic developments stimulate loan demand. This can enable banks to compensate for the decreasing net interest margin – at least in part – through a greater lending volume.

Expansionary monetary policy also positively affects banks' profitability through the positive impact on the economy

The low interest rate period seen in the euro area over the past decade tended to be characterised by favourable economic developments. Monetary policy accommodation is likely to have played a part in this development. In addition, one-off valuation gains on account of monetary policy easing improved banks' profitability. These positive effects of low interest rate policy on banks' profitability must be weighed up against the negative effect on the net interest margin, as a reversal rate can only be achieved if the overall effect of monetary policy measures on banks' profitability, and thus their capital, is negative.[23]

While the pressure on the net interest margin increases with the duration of the low interest rate phase, this is unlikely to apply to the positive effect on loan loss provisioning via eco-

---

17 Similarly to Brunnermeier und Koby (2019), in the model of König und Schliephake (2021) a reduction in the interest margin as a result of monetary policy easing causes a reversal rate to arise, too. In contrast to the model of Brunnermeier and Koby (2019), however, it is not the binding effect of a regulatory capital requirement which provokes such a scenario; rather, in the model of König und Schliephake (2021), the pressure on profitability leads banks to increase risk-taking and this, taken by itself, leads to higher lending rates and a reduction in lending. If risk appetite increases to a sufficient degree, a reversal rate can be reached in this model context as well.
18 See Altavilla et al. (2018) and Claessens et al. (2018).
19 The liabilities-side margin contribution is the spread between a customer deposit and wholesale funding with the same maturity.
20 See Deutsche Bundesbank (2018).
21 Lower credit risk also reduces banks' stock of risk-weighted assets. If the stock of risk-weighted assets declines, the denominator of the risk-weighted capital ratio falls and thus, taken in isolation, drives up the ratio.
22 At the same time, however, the relationship postulated in the risk-taking channel could also occur, according to which low interest rates raise banks' risk appetite, which is likely to push up their loan loss provisioning (see, inter alia, Borio and Zhu (2012)).
23 For information on the calculation of such a net effect for the euro area, see Boucinha and Burlon (2020).

Theoretical concept of the reversal rate

The concept of the reversal rate was developed in a model-theoretical paper by Brunnermeier and Koby (2019). In this model, the stylised bank holds loans and debt securities on the assets side of its balance sheet. On the liabilities side are customer deposits and equity capital. In the model, monetary policy is implemented by means of a single interest rate. The interest rate applied to debt securities always corresponds to this monetary policy rate, and is therefore a given from the bank's perspective. The bank sets both its lending and deposit rates with a view to maximising its profit. The volume of the bank's lending decreases given a rising lending rate, while deposits increase when the deposit rate climbs.

The bank's balance sheet structure must satisfy two conditions.

– First, the bank must hold debt securities in at least the amount of a predetermined share of its customer deposits. This can be interpreted as a provision put in place to guarantee liquidity.[1]

– Second, the bank must hold equity capital in at least the amount of a predetermined share of the loans that it grants. This condition reflects a regulatory capital requirement.

If one of these conditions restricts the bank's business policy, this condition becomes binding. This means that, in such an event, the bank must pursue a different business policy than it would in the absence of this binding condition. The amount of capital necessary to fulfil the second condition comprises two components: exogenous capital at the start of the period under review and the bank's net interest income at the end of this period. The latter is equivalent to the difference between interest income from lending and debt securities and interest expenditure on customer deposits. Net interest income thus results from investment activities decided upon by the bank during the period under review. This means that the bank's relevant capital endowment in this period is forward-looking, as it already includes income and expenditure stemming from investment activities in this period.[2]

If the monetary policy rate declines, so too does the interest income the bank receives via debt securities. This reduces net interest income and therefore the bank's capital endowment.[3] Provided that no binding effect results from the two aforementioned conditions, the bank reacts to a monetary policy rate cut by expanding its lending. This is because from the bank's perspective, granting loans becomes more attractive relative to holding debt securities when the monetary policy rate – and therefore the rate of interest on debt securities – decreases. The monetary policy rate ultimately represents the interest rate of the bank's only alternative investment instrument and thus depicts the opportunity costs of lend-

1 In reality, such provisions are more complex. In the European Union, for instance, the liquidity coverage requirement (LCR) and the net stable funding ratio (NSFR) are in force.
2 See also Repullo (2020).
3 In the model of Brunnermeier and Koby (2019), a monetary policy rate cut additionally results in valuation gains, which in turn increase the bank's capital endowment when taken in isolation. Theoretically, however, the volume of such gains could be assumed to be equal to zero without changing the underlying mechanism of the model. For more on this, see Repullo (2020). This channel is therefore excluded from the presentation of the model in the remainder of this box.

ing. The bank can expand its lending by lowering the lending rate. The interest rate on deposits is also lowered following a decline in the monetary policy rate as a response to decreased opportunities to generate interest income. Despite these adjustment reactions, the bank in the model cannot prevent its net interest income from contracting due to falling interest rates on debt securities and lending.

The sharper the decline in the monetary policy rate, the lower the bank's net interest income and thus its equity capital, too. At the same time, the bank will want to lend at higher volumes the sharper the decline in the monetary policy rate turns out to be. However, this requires the bank to have the necessary capital at hand. If the monetary policy rate falls below a certain level, the bank is no longer able to expand its loan volume to the desired extent, as it is constrained by its capital endowment. From this point onwards, capital requirements become binding, and the volume of loans that the bank is able to grant is determined solely by its capital endowment. The monetary policy rate at which this binding effect of capital requirements comes into play is the reversal rate. Below this interest rate, a further decline in the monetary policy rate results in a decreasing loan volume.

In Brunnermeier and Koby's model, the existence of a reversal rate is ultimately due to the fact that a declining interest rate level results in banks' income sinking faster than their expenditure. This asymmetry in the reactions of income and expenditure can also be seen in the empirical literature on the impact of the low interest rate environment,[4] which often justifies this observation by the fact that banks are hesitant to apply negative interest rates to customer deposits.[5]

In the model, however, the existence of this asymmetry is based on another assumption: namely that banks are required to invest in debt securities (assets side) but may not use them to finance themselves (liabilities side).[6] Debt securities are, in the model, the only bank asset for which the interest rate applied is directly determined from the monetary policy rate. A monetary policy rate cut thus implies that interest income generated by a bank's assets will decline. That being said, no corresponding decline in funding costs will occur, as these are directly determined only by the interest rate on customer deposits.

Repullo (2020) abandons this restrictive assumption with regard to the bank's funding structure. He analyses the consequences of the bank being granted the additional option of also financing itself via debt securities within the context of Brunnermeier and Koby's model. Overall, the existence of the reversal rate in the model is dependent on the bank's net position in debt securities,[7] as this net position dictates how a decline in the monetary policy rate will affect the bank's profits. If the bank finances itself via debt securities to a greater extent than it invests in them (net borrower in debt securities), a monetary policy rate cut in the model will decrease the bank's interest expenditure more significantly than its interest income. Consequently, the monetary policy

4 See, for instance, Busch and Memmel (2017), Claessens et al. (2018) and Klein (2020).
5 See, for example, Busch and Memmel (2017) and Heider et al. (2019).
6 In their paper, Brunnermeier and Koby indicate that a lower bound on the deposit rate is not essential for the existence of a reversal rate in the context of their model. If there is such a bound, however, the reversal rate is higher the higher the bound is set.
7 Other investment and funding options such as the interbank market can be substituted for debt securities here. The deciding factor is that the rate of interest applied to the investment and funding options examined is directly determined by the monetary policy rate and is a given from the bank's perspective.

rate cut boosts the profitability and therefore the capital endowment of a bank such as this. This is why there is no reversal rate for such a bank in the model. In this connection, then, the key role of the net position in debt securities is conditional on a number of assumptions in the model.[8] In reality, these are unlikely to be fully met. Generally, it can therefore be assumed that alongside the net position in debt securities, other factors are key when it comes to determining how a monetary policy rate cut will affect a bank's profits and whether or not a reversal rate exists.

Another core assumption made in Brunnermeier and Koby's model is that the bank cannot increase its capital through the issuance of equity instruments. In the model, the bank's capital endowment, which is key to the fulfilment of its capital requirements, is determined solely on the basis of an exogenously given initial capital endowment and the bank's net interest income. Repullo demonstrates that a lack of opportunities to issue equity instruments is decisive for the existence of a reversal rate. He considers a model in which the bank not only issues debt securities but is also able to raise capital via the market. It may do the latter to any extent it desires, as long as it generates the return required by the equity investors (shareholders). This is assumed to correspond to the monetary policy rate plus a constant mark-up.

In Repullo's model, two variables determine the bank funding costs that are instrumental to lending: namely the return required by shareholders and the interest rate on the debt securities issued by the bank. If the monetary policy rate declines, both the interest rate on debt securities and the return required by shareholders fall, too. In response to declining funding costs, the bank lowers its lending rates and expands its lending. In Repullo's model, then, as long as the bank generates the return required by shareholders, a decrease in the monetary policy rate always results in an expansion of lending. A scenario matching that of Brunnermeier and Koby's model, in which a decline in the monetary policy rate can entail a decrease in banks' lending, is therefore precluded in Repullo's model.

In the event that the bank cannot generate the return required by the shareholders, however, it must exit the market in Repullo's model. The prerequisites for this are the monetary policy rate being lowered to a negative level, banks being unable to decrease their deposit rate to under zero and, at the same time, not being able to reject depositors. In such a setting, losses from deposit-taking may rise to the extent that it becomes impossible for the bank to obtain sufficiently high profits from lending to generate the returns required by the shareholders. In Repullo's model too, therefore, a monetary policy rate cut below a certain level could, in principle, have a contractionary rather than an expansionary effect on lending. However, the consequences of such an adverse scenario are very serious in this model: no more lending will take place at all as the bank has closed down.[9]

---

8 Here, the assumption that the volume of loans and deposits only depends on the lending rate or the deposit rate respectively, in particular, seems to be key. On the basis of this assumption, a bank that is a net borrower in debt securities can always improve its profitability in the event of a monetary policy rate cut. If it leaves its balance sheet structure unchanged, interest income and interest expenditure from lending and deposit business will remain the same. However, interest expenditure for debt securities issued declines more sharply than interest income on debt securities held. As a result, the bank's net interest income increases overall. If, by contrast, borrowers and depositors also react to a monetary policy rate cut when the interest rates on lending and deposits remain unchanged, the bank's profitability could deteriorate even if it is a net borrower in debt securities.

9 The bank under review in Repullo's model is a monopolist in a local market.

This result is attributable to the fact that the bank in Repullo's model first has to raise the entirety of its equity capital for the period under review. Alternatively, it can be assumed, as in the model of Brunnermeier and Koby, that the bank has a starting amount of capital carried over from the previous period at the beginning of the period under review. In this scenario, the bank would receive no new equity capital from its investors if it was unable to fulfil their requirements with regard to returns on their investment. The bank could, however, use equity capital from its initial capital endowment for lending purposes, meaning that it would not have to exit the market. A reversal rate scenario similar to that seen in the model of Brunnermeier and Koby would then be conceivable in principle: if the bank does not receive any new equity capital, it may potentially conduct less lending business following an interest rate cut than would otherwise have been the case. For if the monetary policy rate were higher, the loss incurred from deposit-taking would be lower. This could then make it possible for the bank to generate the return required by the shareholders, to obtain new equity capital and therefore to grant more loans than in the lower monetary policy rate scenario. If the loss entailed by deposit-taking activities was so high that the bank also recorded a loss overall, this would, in addition, exhaust the available capital over time. The bank would then have to successively scale back its lending even more over the following periods relative to a higher monetary policy rate scenario.

Likelihood of a negative overall effect of monetary policy increases the longer the period of low interest rates lasts

nomic developments. In addition, the valuation gains incurred with each interest rate cut only have a one-off positive effect on profitability. Therefore, the likelihood of a negative overall effect of monetary policy on banks' profitability, and thus on their capital base, increases with the duration of the low interest rate phase.

Significance of capital for lending

Two channels are key to the relationship between the capital ratio and lending

A bank's capital ratio can influence its lending and the lending rates it charges.[24] Two key channels can be distinguished here.

- The first channel operates via the bank's total funding costs (hereinafter referred to as the "funding costs channel").
- The second channel focuses on the binding force of regulatory capital requirements (hereinafter referred to as the "capital requirement channel").[25]

Funding costs channel

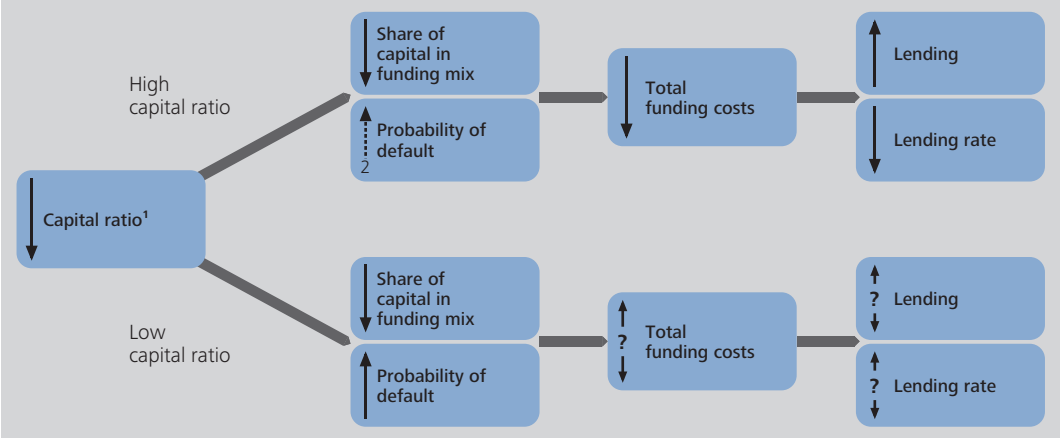
A bank's capital ratio influences its funding costs

The funding costs channel is derived from the influence of the capital ratio on the total funding costs[26] of a bank.

- A higher capital ratio reduces the risk of a bank failing, meaning that the costs per unit of equity and debt decrease. As a result,

24 The capital ratio is the ratio between the level of a bank's capital and the total assets or risk-weighted assets. Hereinafter the term "capital ratio" encompasses both possible definitions. By contrast, we will omit below the fact that different types of capital ratio exist, each differing in terms of which instruments are counted as capital in the numerator.
25 The regulatory capital requirement sets the size of the minimum capital ratio. The difference between the capital ratio and the regulatory capital requirement is the excess capital buffer.
26 Here and in the remainder of this article, the term "total funding costs" always refers to the ratio between total funding costs in absolute terms and total assets.

Significance of capital for lending: the funding costs channel



1 Ratio of capital to total assets. **2** Only a weak increase.
Deutsche Bundesbank

taken in isolation, the bank's total funding costs fall.

– A higher capital ratio also leads to a shift in the funding mix from debt to equity.[27] Given that equity is normally associated with higher costs for a bank than debt – since equity is riskier for investors than debt – this results in higher total funding costs for a bank when viewed in isolation.[28]

Relationship between capital ratio and funding costs likely to be non-linear

Which of the two relationships mentioned above is dominant – and thus determines whether the overall relationship between the capital ratio and the total funding costs is positive or negative – depends on the size of the capital ratio (see the chart above). If the capital ratio is low, a bank's risk of default is likely to rise more strongly as a result of a given drop in the capital ratio than in the case of a high ratio. Consequently, the costs per unit of equity and debt probably also increase more sharply in such a scenario, meaning that the relationship between the capital ratio and total funding costs is not linear. Arnould et al. (2020) do in fact find evidence of such non-linearity in the euro area.

Empirical studies mostly conclude that a lower capital ratio reduces total funding costs (this corresponds to the upper branch in the chart above).[29] However, they typically disregard effects that the capital ratio has on the costs per unit of debt as well as the non-linearity mentioned above. Therefore, their informative value for banks with low capital ratios is possibly only limited. For other banks, these empirical findings mean that their total funding costs decrease if their capital ratio falls.

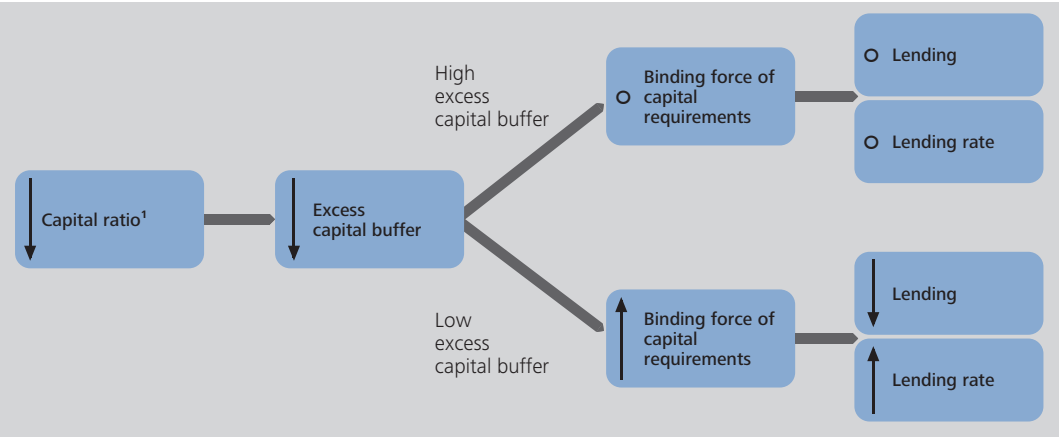
Empirical studies indicate positive relationship between capital ratio and funding costs

Since banks typically pass a change in their total funding costs through to borrowers, a falling lending rate tends to be expected if the capital ratio declines.[30] On account of the non-linearity mentioned above, however, the direction of this relationship could change if the capital ratio is sufficiently low.

Positive relationship between capital ratio and lending rate if banks pass changes in funding costs through to borrowers

27 This only applies to a capital ratio based on risk-weighted assets if the capital ratio based on total assets increases at the same time. This is the case if capital increases and/or total assets decrease.
28 The higher risk involved for equity providers stems from the fact that losses initially cause a reduction in capital. Debt is only affected once equity is exhausted. Moreover, equity funding is also more expensive for banks because, unlike debt funding costs, they cannot be deducted from taxable profits.
29 For more information on this topic, see, for example, Miles et al. (2012). See Birn et al. (2020) for an overview of the literature. According to this literature overview, empirical studies typically find that the decline in the costs per unit of equity only offsets up to around 50% of the increase in funding costs resulting from a rise in the share of equity in the funding mix.
30 For instance, Illes et al. (2015) find that banks in the euro area pass a large part of a change in their funding costs through to their customers by adjusting their lending rates. However, the funding costs observed here do not include capital costs.

Significance of capital for lending: the capital requirement channel



1 Ratio of capital to total assets or to risk-weighted assets. **O** Indicates that the variable does not respond to a change in the capital ratio.
Deutsche Bundesbank

Capital requirement channel

Binding force of regulatory capital requirements leads to constraints in lending

The capital requirement channel stems from the binding force of a regulatory capital requirement. Such a binding force exists if a bank lends less than it would in the absence of this requirement. If a bank's new loans exceed those that are repaid or default, its credit volume grows and thus the denominator of its capital ratio. Therefore, ceteris paribus, the capital ratio falls if lending increases. If a bank's excess capital buffer is low, it potentially has to cut back on its lending to avoid its capital ratio falling. In this context, banks do not wait until they would otherwise violate regulatory capital requirements to constrain their lending. Instead, it seems plausible that they strive for a target capital ratio above the regulatory capital requirement.[31] They could therefore already constrain their lending at the point where their capital ratio would otherwise fall below their target capital ratio. A target capital ratio provides a bank with a certain degree of flexibility: first, it creates scope for a potential expansion of lending in future. Second, a bank can thus hedge against unexpected events, meaning that losses do not immediately cause it to undershoot regulatory capital requirements.

The capital requirement channel is based on the assumption that banks are unable to issue equity instruments to stabilise their excess capital buffer. This is likely to be the case for many unlisted banks.[32] Yet, even for listed banks this way of raising capital is probably not always possible without any constraints (see also the box on pp. 22 ff.). It therefore also cannot be ruled out that these banks will cut back on their lending if their excess capital buffer is too low.

Capital requirement channel is conditional upon banks not issuing equity instruments to counter a low excess capital buffer

Capital requirement channel tends to suggest a positive relationship between the excess capital buffer and lending, …

Therefore, as a general rule: the lower a bank's excess capital buffer, the higher the likelihood that the regulatory capital requirement exerts a binding force on its lending.[33] A bank is likely to curtail its lending if its excess capital buffer falls below the target capital ratio.[34] The greater the extent to which the excess capital buffer undershoots the target level, the greater the restrictions on lending are likely to be. This results in a positive relationship between a bank's excess capital buffer and its lending below a cer-

31 See, inter alia, Berger et al. (2008), Deutsche Bundesbank (2018) and Couaillier (2021).
32 In Germany, unlisted banks – such as cooperative banks and savings banks – make up a significant part of the banking sector.
33 See Imbierowicz et al. (2020); Bank for International Settlements (2021), pp. 31-33; Berrospide et al. (2021); and European Central Bank (2021), pp. 106-114.
34 Here and in the rest of this article, it is implicitly assumed that curtailment (expansion) of a bank's supply of credit is associated with a curtailment (expansion) of its lending.

tain excess capital buffer level. For a given regulatory capital requirement, this implies, at the same time, that a falling capital ratio is associated with a decline in lending below a certain level of the excess capital buffer (see the lower branch in the chart on p. 27). By contrast, if the excess capital buffer is sufficiently high, lending does not respond to a change in the capital ratio according to this channel (see the upper branch in the chart on p. 27).

… and therefore a negative relationship between the excess capital buffer and lending rate

Since credit demand typically falls as the lending rate rises, a bank can cut back its lending by raising the lending rate. Consequently, a negative relationship between a bank's excess capital buffer and the lending rate can be derived from the above considerations if this buffer drops below a certain level. For a given regulatory capital requirement, a negative relationship consequently also exists between a bank's capital ratio and the lending rate if the capital ratio falls below a certain level.

The relationships outlined initially only apply to the capital requirement channel presented in this section. The overall relationship between a bank's capital ratio and its lending hinges on the interaction between the funding costs channel and the capital requirement channel. The overall impact of both channels will be discussed in the next section.

Joint examination of both channels

Both channels with reversed signs

The funding costs and capital requirement channels imply opposite signs for the relationship between the capital ratio and lending.

- The funding costs channel tends to give rise to a negative relationship between the capital ratio and lending, which is most likely to become apparent if the capital ratio is high.

- By contrast, the capital requirement channel gives rise to a positive relationship between the excess capital buffer and lending if the excess capital buffer is low. For a given regulatory capital requirement, this also results in a positive relationship between a bank's capital ratio and its lending.

Overall, both channels suggest a non-linear relationship between the capital ratio and lending

All in all, the relationship between the capital ratio and lending – and thus also the relationship between the capital ratio and the lending rate – therefore depends on the size of the excess capital buffer. If the excess capital buffer is sufficiently low, a decline in capital leads to a reduction in lending and to a rise in the lending rate. This is also suggested by the results of an empirical study conducted by the Bundesbank (see the box on pp. 29 ff.) For banks in Germany, these results indicate that a decline in the capital ratio tends to be associated with an increase in the lending rate on loans to non-financial corporations if banks' excess capital buffer is low. This relationship is reversed in the case of large excess capital buffers. The results of the study also suggest that the non-linear relationship has strengthened during the coronavirus pandemic, with a decline in the capital ratio during the pandemic resulting in a stronger rise in the lending rate for banks with a low excess capital buffer than prior to the pandemic. A decline in the capital ratio caused the lending rate for banks with a high excess capital buffer to fall more sharply than before the onset of the pandemic. A simple aggregate analysis does not provide any evidence to suggest that an increase in lending rates due to a decline in the capital ratios is currently likely in the German banking system. This is because banks' excess capital buffers are too high on average for a negative relationship to be expected. Thus, the empirical study shows no indication that German banks currently meet the second necessary condition for reaching a reversal rate.

Time variability of the reversal rate

Reversal rate time-varying and unobservable

Thus far, the article has identified two necessary conditions for a reversal rate to materialise.

The relationship between banks' capital and lending rates: econometric analysis based on AnaCredit credit data statistics

This box presents an analysis of the relationship between the capital ratios of banks in Germany and the lending rates they charge. The principal focus here is on whether this relationship exhibits non-linearities. The analysis is conducted at the individual loan level for the period from July 2019 to October 2021. AnaCredit credit data statistics, prudential reporting data and credit institutions' balance sheet statistics data serve as the data basis. The analysis focuses on interest rates on new loans to non-financial corporations.[1] The estimation sample comprises around 430,000 observations, of which approximately 150,000 are from 2019, 180,000 are from 2020 and roughly 100,000 are from 2021. Data from AnaCredit and the balance sheet statistics are available at the monthly level, the prudential data at the quarterly level.

To determine the empirical relationship, the interest rate on a loan is regressed on different loan and bank-side variables. The analysis takes place at the individual loan level and all loans are equally weighted in the estimation.[2] Fixed effects are included to control for borrower-side and macroeconomic influences on the lending rates. Formally, the estimation can be described by the following equation:

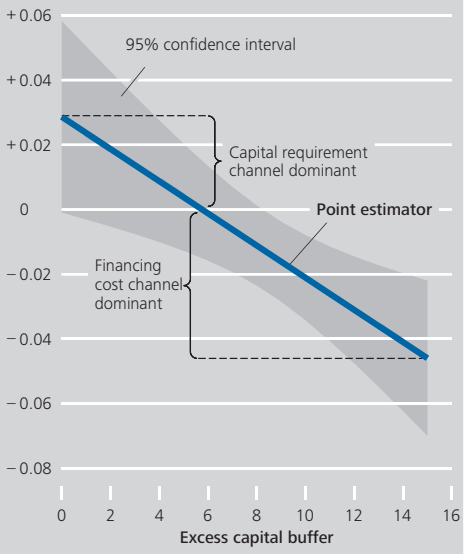
$$\begin{aligned} R_{i,b,f,m} = \; & \beta_1 * EK_{b,q-1} + \beta_2 * EK_{b,q-1}^2 \\ & + \beta_3 * Reg_{b,q} + \beta_4 * Reg_{b,q}^2 \\ & + \beta_5 * EK_{b,q-1} * Reg_{b,q} \\ & + \boldsymbol{\beta}_6' * \boldsymbol{b}_{b,q-1} + \boldsymbol{\beta}_7' * \boldsymbol{k}_{i,b,f,m} \\ & + \boldsymbol{\beta}_8' * Covid_m * \boldsymbol{k}_{i,b,f,m} + \lambda_{f,q} \\ & + \delta_m + \varepsilon_{i,b,f,m} \end{aligned}$$

$R_{i,b,f,m}$ is the interest rate on the loan i, which was newly granted in month m by bank b to an enterprise from group f (see below for a definition of this group). $EK_{b,q-1}$ is the capital ratio – lagged by one quarter – of bank b.[3] As outlined in the main text, it is to be expected that the relationship between the capital ratio and the lending rate is non-linear. To take this into account, the squared capital ratio $EK_{b,q-1}^2$ from the previous quarter $q-1$ is incorporated into the estimation. As a bank's excess capital buffer is likely to be paramount for the binding effect of regulatory capital requirements (see the main text), the regulatory capital requirement of the respective bank $Reg_{b,q}$ from the current quarter q is also incorporated into the estimation (the original and squared value, respectively).[4] In this way, the regulatory capital requirement is kept constant, which means that a rise (fall) in the capital ratio in the estimation model increases (reduces) the excess capital

1 The focus is on this loan category as lending to non-financial corporations, in particular, plays a key role from a monetary policy perspective.
2 Loans to enterprises from the sub-sector "Wholesale and retail trade and repair of motor vehicles and motorcycles" make up by far the largest share of new loans to non-financial corporations in terms of the number of loans granted. The results of the estimations presented here are therefore very sensitive to the (non-)inclusion of these loans in the estimation sample. The share of these loans in the underlying credit volume is, however, significantly smaller than their share in the number of loans granted. To prevent loans to this sector from having a decisive influence on the estimation results, they were removed from the estimation sample.
3 The capital ratio is calculated as the ratio of a bank's Common Equity Tier 1 (CET1) capital to its risk-weighted assets.
4 The term "regulatory capital requirement" here and below refers to the ratio of required CET1 capital to the bank's risk-weighted assets. The capital requirement used here includes (binding) capital add-ons under the Pillar 2 requirement and required buffers, but not (non-binding) capital add-ons under the Pillar 2 guidance. As (binding) capital add-ons and some of the buffer requirements are bank-specific, the requirement varies across the banks in the sample.

Effect of a reduction in the capital ratio on the lending rate*

Percentage points



* Reduction in the capital ratio of 1 percentage point depending on the size of the excess capital buffer. A constant regulatory capital requirement (ratio of required CET1 capital to risk-weighted assets) equal to the sample median is assumed. **1** Interest rate on new loans to non-financial corporations.

Deutsche Bundesbank

buffer by the same amount, ceteris paribus. In addition, the inclusion of the interaction term $EK_{b,q-1} * Reg_{b,q}$ takes account of the fact that the marginal effect of the capital ratio on the lending rate might depend on the size of the regulatory capital requirement. The vector $\boldsymbol{b}_{b,q-1}$ comprises other bank-side variables: the share of non-performing loans in total loans, the share of excess liquidity[5] in total assets as well as the size of the respective bank's total assets.[6] The vector $\boldsymbol{k}_{i,b,f,m}$ consists of the loan-side variables, including the volume, collateral, purpose[7] and maturity of the respective loan. The dummy variable $Covid_m$ takes the value of 1 after the outbreak of the coronavirus pandemic in March 2020, and the value of 0 beforehand. On account of the interaction between the vector $\boldsymbol{k}_{i,b,f,m}$ and the dummy variable $Covid_m$, the effects of the loan-side variables can vary before and after the onset of the coronavirus pandemic. Fixed effects are included to control for enterprise-side factors: for every quarter, a fixed effect $\lambda_{f,q}$ is incorporated for each group f of enterprises in the same sector that are of a similar size and from the same region.[8] The time-fixed effects at the monthly level δ_m collectively capture the influence on lending rates of all variables that vary over time but not across banks, firms and loans. This replaces the inclusion of a series of possibly relevant macroeconomic variables such as capital market yields, monetary policy rates or inflation rates. The variable $\varepsilon_{i,b,f,m}$ is an error term. When calculating the standard errors of the estimators, the error terms are clustered at the quarterly bank level.

The results of the analysis indicate that the effect a bank's capital ratio has on the lending rates it charges is indeed non-linear. The adjacent chart shows that a decline in the capital ratio tends to be accompanied by an increase in the lending rate if the level of the bank's excess capital buffer is low. However, this effect is not significantly different from zero. By contrast, if the level of the excess capital buffer is sufficiently high, then a decline in the capital ratio leads to a decrease in the lending rate.[9]

In a further estimation, the estimation period was limited to the period after the

5 In this context, only excess liquidity that exceeds the exemption allowance is taken into account.
6 Some of the variables in the vector $\boldsymbol{b}_{b,q-1}$ are available at a monthly frequency; these are lagged by three months.
7 Possible forms of the variable "purpose" are, for example, construction investment or the financing of working capital.
8 See Degryse et al. (2019). The results presented below are largely robust if, alternatively, for each quarter one fixed effect per enterprise is incorporated into the estimation.
9 Owing to the effect of the interaction between the capital ratio and regulatory capital requirement contained in the estimation, the straight line shown in the chart shifts if the requirement is fixed at a different level.

outbreak of the coronavirus pandemic.[10] The results suggest that the relationship between the capital ratio and lending rates has intensified with the pandemic. For both small and large excess capital buffers, there is a stronger effect in terms of absolute value than in the estimation for the entire period. The effect is also significantly different from zero for small excess capital buffers.

The results indicate that banks with small excess capital buffers may strive to stabilise their capital ratios and thus their excess capital buffers. They seem to respond to a decline in their capital ratios by increasing lending rates in order to slow their lending. This suggests that the regulatory capital requirement has a binding effect on banks with small excess capital buffers: affected banks seek to avoid a further decline in their excess capital buffers in order to reduce the risk of breaching the regulatory capital requirement. To that end, they adjust their lending policies to developments in their capital ratios. By contrast, for banks with large excess capital buffers, the binding effect of the regulatory capital requirement is likely to play a less significant role. According to the chart, these banks respond to a decline in their capital ratios by reducing lending rates. This is likely to reflect the positive relationship between funding costs and the capital ratio: a lower capital ratio tends to be accompanied by lower total funding costs (see the main text). The banks then pass on the lower funding costs to their customers in the form of lower lending rates.

This interpretation of the results is also consistent with the fact that the relationship between capital and lending rates intensified after the coronavirus pandemic began. First, banks' capital costs probably rose during the pandemic.[11] Therefore, the positive relationship between capital ratios and funding costs is likely to have intensified. Second, the heightened uncertainty triggered by the pandemic probably led banks with small excess capital buffers to respond more sensitively to a change in their capital ratios. If their capital ratios fall, these banks therefore seem to increase their lending rates more sharply than before the pandemic, despite the higher capital costs.

Based on the estimation results, the effect of the capital ratio on lending rates can be calculated for each bank.[12] The weighted average effect across all banks can then be calculated. The respective level of the outstanding volume of loans supplied to non-financial corporations acts as a weight. This means that those banks that play a bigger role in this loan segment are given a greater weight in the average. It turns out that the weighted average effect of a reduction in the capital ratio on lending rates is slightly negative. There is therefore no direct indication that a decline in German banks' capital ratios might currently prompt an increase in lending rates on loans to non-financial corporations on aggregate.

One caveat to be noted is that the analysis presented here is based on the assumption that a bank's capital ratio in the preceding quarter is exogenous. This implies that the bank gears its lending rates to this given

---

10 The dummy variable $Covid_m$ and the interaction terms formed with it are then eliminated from the estimation as the dummy variable, by necessity, takes the value 1 for all observations.
11 See Altavilla et al. (2021).
12 As described above, the squared capital ratio is used in the estimation. Furthermore, it is interacted with the regulatory capital requirement. For this reason, the effect of the capital ratio depends on the level of the capital ratio itself and the level of the regulatory requirement. As these variables differ from bank to bank, this results in an individual effect of the capital ratio for each bank. The bank-specific values for these variables from the third quarter of 2021 were used in the calculation.

capital ratio. In reality, however, the direction of impact might also be the reverse: a bank that wants to expand its lending might already increase its ratio beforehand by raising new capital in the market, for example. If so, lending possibilities today would be a determinant of the development of the capital ratio in the past. This would contradict the assumption that the capital ratio of the previous quarter is exogenous. Consequently, the actual effect of the capital ratio on lending rates might be systematically higher or lower than the effect identified here. It should also be borne in mind that the analysis outlined in this box does not capture any spillover effects between banks. Such spillover effects could mean that, on aggregate, a change in the capital ratios has a different effect than the results presented here suggest.

– Expansionary monetary policy weighs on banks' profitability and thus their capital endowment and …

– … the erosion of the capital endowment causes banks to reduce their lending.

The level of the reversal rate is neither directly observable nor fixed; it is time-varying and depends, in particular, on the size of the excess capital buffer. The smaller the excess capital buffer, the more likely it is that a reduced capital endowment will have a dampening effect on lending. The reversal rate thus materialises earlier when banks have a smaller excess capital buffer than when it is large. In other words, as the excess capital buffer falls, the reversal rate rises. Consequently, all factors that change the excess capital buffer also change the level of the reversal rate. These factors include not only the duration of the low interest rate period but also, for example, changed capital requirements and the business cycle.

Reversal rate rises with falling excess capital buffer, among other factors

In a cyclical downturn, credit risk typically increases. If this heightened risk translates into higher risk weights, this triggers a rise in risk-weighted assets.[35] Ceteris paribus, this reduces banks' capital ratio and thus also their excess capital buffer. Tighter regulatory capital requirements likewise lower the excess capital buffer, all other things being equal. In addition, the net interest margin decreases the longer the low interest rate period lasts.[36] Taken in isolation, the resulting downward pressure on bank profitability is likely to raise the reversal rate over time.

BLS results do not indicate that reversal rate has materialised in the euro area

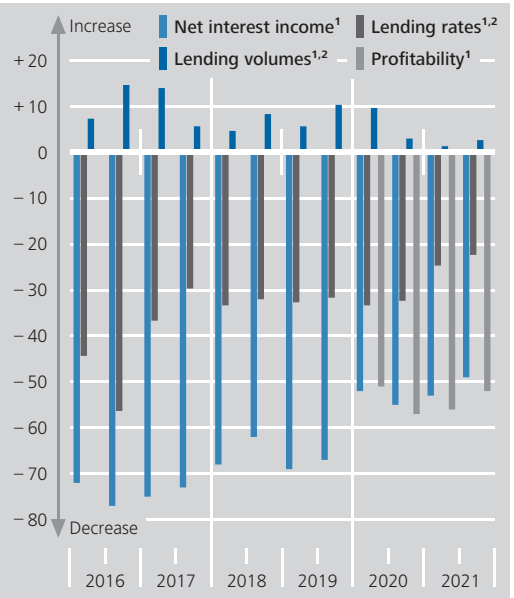
However, margin compression can also have an expansionary effect on lending as long as the reversal rate has not yet materialised. This is indicated by the results of the euro area Bank

35 Furthermore, credit defaults place a direct strain on capital and thus, ceteris paribus, reduce the excess capital buffer.
36 See Altavilla et al. (2018), Borio et al. (2017), Claessens et al. (2018) and Klein (2020).

Lending Survey (BLS) (see the adjacent chart). The participating banks responded to the downward pressure on their profitability from the negative deposit facility rate by expanding their lending, probably in an attempt to compensate for margin compression. The BLS results suggest that, despite the downward pressure on their margins, the participating euro area banks had sufficient scope in their capital endowment to expand their lending. The BLS thus gives no indication that a reversal rate has already materialised in the euro area.[37]

Impact of the negative deposit facility rate*

As a percentage of the responses given, semi-annually



* According to the Bank Lending Survey. **1** Difference between the sum of responses "Contributed considerably/somewhat to an increase" and the sum of responses "Contributed considerably/somewhat to a decrease." **2** Average for the loan categories "Loans to enterprises," "Loans to households for house purchase" and "Consumer credit and other lending to households."

Deutsche Bundesbank

Taken in isolation, capital endowment developments during the pandemic have not increased the likelihood of a reversal rate scenario in the euro area

The outbreak of the coronavirus pandemic led to concerns that pandemic mitigation measures would trigger a sharp increase in credit defaults in the hardest hit sectors. Banks would then have needed to increase their loan loss provisioning, resulting in downward pressure on their profitability and thus their capital endowment. This deterioration in banks' capital endowment would, ceteris paribus, have increased the likelihood of a reversal rate scenario in the euro area as it would have reduced the excess capital buffer in the banking system given the existing regulatory capital requirements. No such scenario materialised, however, partly because the regulatory capital requirements were temporarily loosened and fiscal policy support measures alleviated the impact of the pandemic.[38] In addition, supervisors asked banks to temporarily refrain from or limit dividends.[39] In reality, euro area banks' capital ratios have actually risen since the outbreak of the pandemic.[40] Excess capital buffers have also tended to increase in the quarters since the pandemic began.[41] To date, developments in the capital endowment do not indicate, in and of themselves, that a reversal rate scenario in the euro area has become more likely during the pandemic.

Implications for monetary policy

The indicators addressed in this article suggest that a reversal rate for the aggregated banking system has not yet materialised either in Germany or the euro area. The econometric analysis presented here does not give any indication that the German banking system is currently likely to experience lending constraints due to a decline in capital ratios. For the euro area, the BLS results show that, so far, banks have responded to the downward pressure on their margins due to the negative deposit facility rate by expanding their lending, not by restricting it. Furthermore, the capital endowment of euro area banks has improved since the outbreak of the coronavirus pandemic, which, ceteris paribus, has made a reversal rate scenario less likely.

Indicators suggest that the reversal rate has not materialised so far in the euro area as a whole

37 This assessment is consistent with the results of Rostagno et al. (2019) and Darracq Pariès et al. (2020).
38 See Deutsche Bundesbank (2020b).
39 See European Central Bank (2020) and Federal Financial Supervisory Authority (2020).
40 See European Central Bank (2021), p. 74.
41 See European Central Bank (2021), pp. 106-114.

Reversal rate cannot be quantified for the current end …

The reversal rate probably has not yet materialised in the euro area. However, it is impossible to tell how far the banking system is from the reversal rate at present because its level at the current end cannot be determined precisely enough. The level of the reversal rate changes all the time because the macroeconomic and/or regulatory environment also change. As a result, the analyses and indicators presented in this article do not allow the reversal rate to be quantified at the current end.

Nonetheless, the article illustrates which metrics can be helpful in assessing the potential risk of hitting the reversal rate at the current end. One key metric is banks' excess capital buffer: its size is a crucial factor in banks' lending and thus also in the probability of a monetary policy measure triggering a reversal rate scenario. The concept of the reversal rate is therefore useful in monetary policy discussions as it shows which mechanisms can potentially lessen the impact of monetary policy in a period of low interest rates. It thus provides valuable insights into the indicators and factors that warrant closer attention from monetary policymakers in a low interest rate environment.

… but concept still useful in monetary policy discussions

List of references

Altavilla, C., P. Bochmann, J. De Ryck, A.-M. Dumitru, M. Grodzicki, H. Kick, C. Melo Fernandes, J. Mosthaf, C. O'Donnell and S. Palligkinis (2021), Measuring the cost of equity of euro area banks, ECB, Occasional Paper Series, No 254.

Altavilla, C., L. Brugnolini, R. S. Gürkaynak, R. Motto and G. Ragusa (2019), Measuring euro area monetary policy, Journal of Monetary Economics, Vol. 108, pp. 162-179.

Altavilla, C., M. Boucinha and J.-L. Peydró (2018), Monetary policy and bank profitability in a low interest rate environment, Economic Policy, 33 (96), pp. 531-586.

Arnould, G., C. Pancaro and D. Zochowski (2020), Bank funding costs and solvency, ECB, Working Paper Series, No 2356.

Bank for International Settlements (2021), Early lessons from the Covid-19 pandemic on Basel reforms, Basel Committee on Banking Supervision.

Berger, A. N., R. DeYoung, M. J. Flannery, D. K. Lee and Ö. Öztekin (2008), How do large banking organizations manage their capital ratios?, Journal of Financial Services Research, 34, pp. 123-149.

Berrospide, J. M., A. Gupta and M. P. Seay (2021), Un-used Bank Capital Buffers and Credit Supply Shocks at SMEs during the Pandemic, Finance and Economics Discussion Series, 2021-043, Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2021.043.

Birn, M., O. de Bandt, S. Firestone, M. G. Girault, D. Hancock, T. Krogh, H. Mio, D. P. Morgan, A. Palvia, V. Scalone, M. Straughan, A. Uluc, A. H. von Hafften and M. Warusawitharana (2020), The Costs and Benefits of Bank Capital – A Review of the Literature, Journal of Risk and Financial Management, Vol. 13, pp. 1-25.

Borio, C., L. Gambacorta and B. Hofmann (2017), The influence of monetary policy on bank profitability, International Finance, Vol. 20, pp. 48-63.

Borio C. and H. Zhu (2012), Capital regulation, risk taking and monetary policy: A missing link in the transmission mechanism?, Journal of Financial Stability, Vol. 8, pp. 236-251.

Boucinha, M. and L. Burlon (2020), Negative rates and the transmission of monetary policy, ECB Economic Bulletin, Issue 3, pp. 61-84.

Brunnermeier, M. K. and Y. Koby (2019), The Reversal Interest Rate, https://scholar.princeton.edu/sites/default/files/markus/files/25b_reversalrate.pdf.

Busch, R. and C. Memmel (2017), Banks' Net Interest Margin and the Level of Interest Rates, Credit and Capital Markets, Vol. 50 (3), pp. 363-392.

Chami, R. and T. F. Cosimano (2010), Monetary policy with a touch of Basel, Journal of Economics and Business, Vol. 62, pp. 161-175.

Claessens, S., N. Coleman and M. Donnelly (2018), "Low-for-long" interest rates and banks' interest margin and profitability: Cross-country evidence, Journal of Financial Intermediation, Vol. 35 (part A).

Couaillier, C. (2021), What are banks' actual capital targets?, ECB, Working Paper Series, No 2618.

Darracq Pariès, M., C. Kok and M. Rottner (2020), Reversal interest rate and macroprudential policy, ECB, Working Paper Series, No 2487.

De Jonghe, O., H. Dewachter and S. Ongena (2020), Bank capital (requirements) and credit supply: Evidence from pillar 2 decisions, Journal of Corporate Finance, Vol. 60.

Degryse, H., O. De Jonghe, S. Jakovljevic, K. Mulier and G. Schepens (2019), Identifying credit supply shocks with bank-firm data: Methods and Applications, Journal of Financial Intermediation, Vol. 40.

Deutsche Bundesbank (2020a), Eurosystem asset purchases and euro area portfolio duration by investor group, Monthly Report, April 2020, pp. 25-27.

Deutsche Bundesbank (2020b), Financial Stability Review 2020.

Deutsche Bundesbank (2018), The importance of bank profitability and bank capital for monetary policy, Monthly Report, January 2018, pp. 27-52.

Deutsche Bundesbank (2017), The natural rate of interest, Monthly Report, October 2017, pp. 27-42.

Disyatat, P. (2011), The bank lending channel revisited, Journal of Money, Credit and Banking, Vol. 43 (4), pp. 711-734.

European Central Bank (2021), Financial Stability Review, November 2021.

European Central Bank (2020), ECB asks banks to refrain from or limit dividends until September 2021, press release of 15 December 2020, https://www.bankingsupervision.europa.eu/press/pr/date/2020/html/ssm.pr201215~4742ea7c8a.en.html.

Federal Financial Supervisory Authority (2020), BaFin bekräftigt ihre Erwartung an Institute, auf Dividendenzahlungen zu verzichten, press release of 30 March 2020, https://www.bafin.de/SharedDocs/Veroeffentlichungen/DE/Pressemitteilung/2020/pm_200330_corona-krise_verzicht_dividendenzahlungen.html.

Geiger, F. and F. Schupp (2018), With a little help from my friends: Survey-based derivation of euro area short-rate expectations at the effective lower bound, Deutsche Bundesbank Discussion Paper, No 27/2018.

Heider, F., F. Saidi and G. Schepens (2019), Life below Zero: Bank Lending under Negative Policy Rates, The Review of Financial Studies, Vol. 32 (10), pp. 3728-3761.

Illes, A., M. Lombardi and P. Mizen (2015), Why did bank lending rates diverge from policy rates after the financial crisis?, BIS Working Paper No 486.

Imbierowicz, B., A. Löffler and U. Vogel (2020), The transmission of bank capital requirements and monetary policy to bank lending in Germany, Review of International Economics, Vol. 29, pp. 144-164.

Klein, M. (2020), Implications of negative interest rates for the net interest margin and lending of euro area banks, Deutsche Bundesbank Discussion Paper, No 10/2020.

König, P. J. and E. Schliephake (2021), Bank risk-taking and impaired monetary policy transmission, Deutsche Bundesbank Discussion Paper, No 42/2021.

Miles, D., J. Yang and G. Marcheggiano (2012), Optimal Bank Capital, The Economic Journal, Vol. 123, pp. 1-37.

Repullo, R. (2020), The Reversal Interest Rate: A Critical Review, CEPR, Discussion Paper, 15367.

Rostagno, M., C. Altavilla, G. Carboni, W. Lemke, R. Motto, A. S. Guilhelm and J. Yiangou (2019), A tale of two decades: the ECB's monetary policy at 20, ECB, Working Paper Series, No 2346.

Van den Heuvel, S. J. (2007), The Bank Capital Channel of Monetary Policy, Wharton School, University of Pennsylvania, Working Paper.