The importance of bank profitability and bank capital for monetary policy

The financial and sovereign debt crisis has now also increasingly shifted the banking system's capital and profitability towards the centre of monetary policy analysis as both factors are closely linked to monetary policy. On the one hand, weak profitability, which implies a reduced ability on the part of banks to generate capital, can lead to more restrictive lending policies, thus reducing the impact of accommodative monetary policy measures. On the other hand, monetary policy can also influence banks' profitability and capital through interest rates and the term structure. Empirical studies illustrate the relevance of this bank capital channel. The net interest margins generated by banks, which constitute a significant part of their profitability, can come under pressure in prolonged periods of accommodative monetary policy and low interest rates. At the same time, low interest rates can also have a positive impact on profitability, eg in the form of reduced loan loss provisions; however, these effects may not be strong enough to compensate for decreasing net interest margins.

The relationship between monetary policy and bank profitability is particularly important if bank capital is already on the lower side, ie close to regulatory capital requirements, and if the ability to raise capital in the market is limited. Whereas the banking system's capital endowment has improved considerably over the past few years in the euro area, the stock of non-performing loans (NPLs) – despite a gradual decline at the current end – is still very high in some countries. The potential future losses resulting from this high volume of NPLs could entail implicit capital constraints.

In an environment of low interest rates, it is thus conceivable that a low level of bank capital could lead to a situation where accomodative monetary policy measures could, at least in the longer term, not stimulate but instead dampen lending. Hence, the impact of an accommodative monetary policy measure transmitted through the bank capital channel would weaken the desired policy effect. It is, therefore, of key importance for banks to have a good capital endowment, not only from a financial stability standpoint, but also from a monetary policy perspective.

Introduction

Increase in banks' capital requirements since the crisis

The financial and sovereign debt crisis in the euro area has left a clear mark on the European financial system. Since 2008, the environment in which monetary policy makers and banks have been operating has witnessed major change. Even today, many banks remain confronted with large stocks of non-performing loans (NPLs) on their balance sheets, which increase their capital needs by the same measure that additional loan loss provisions (LLPs) are required. Moreover, the implementation of Basel III has tightened regulatory capital requirements. In the past, it was the government which stepped in to address serious capital shortfalls in an emergency by introducing recapitalisation measures. However, with the entry into force of the European rules for the recovery and resolution of credit institutions (Bank Recovery and Resolution Directive, or BRRD) and the regulation establishing the Single Resolution Mechanism (SRM), this should no longer be possible in the same way.

Bank profitability and capital have become focus of monetary policy, …

Monetary policy makers, too, are now increasingly focusing on bank profitability and capital. These factors are important elements in the monetary policy transmission process, their role in maintaining the financial system's stability and proper functioning being just one reason. The currently low and, in some cases, negative interest rates – attributable, amongst other things, to the accommodative monetary policy – weigh on interest income and, all other things being equal, bank profitability and, consequently, their ability to internally generate capital from earnings.

… as banks have an important role to play in monetary policy transmission

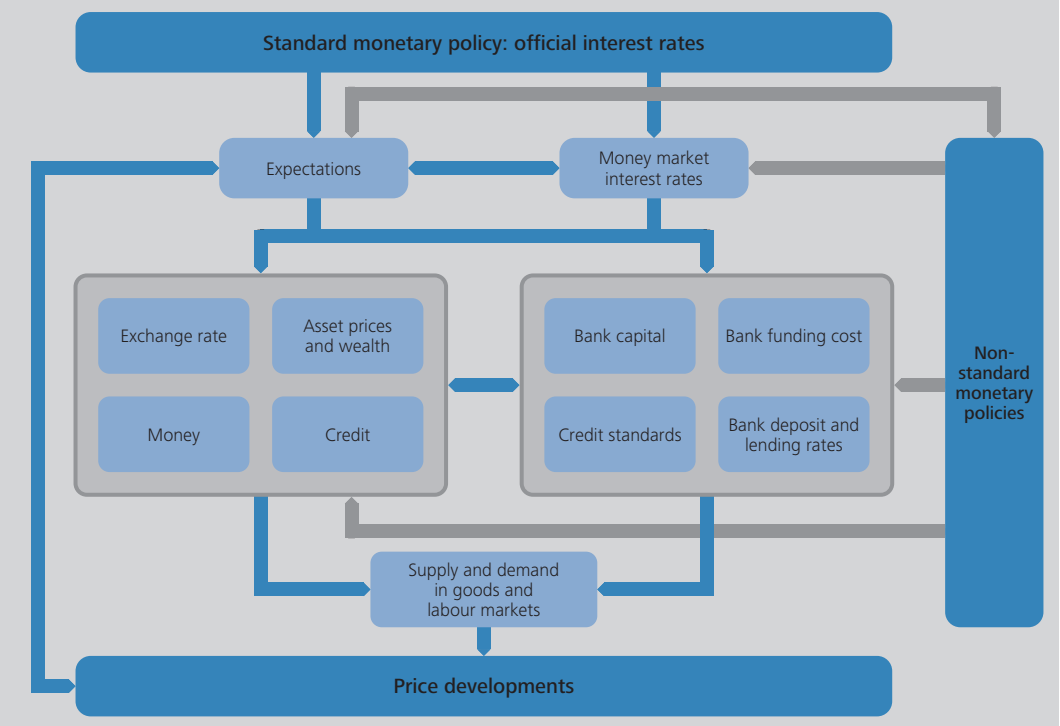
As exclusive monetary policy counterparties of the Eurosystem, banks play a key role in the transmission of monetary policy measures to the real economy and to inflation. Although alternative sources of funding have become increasingly relevant for non-financial corporations over the past few years, bank loans are of major importance in the euro area's primarily bank-based financial system as they provide external funds to the non-financial private sector.[1] However, a significant proportion of the non-financial private sector is still unable to substitute their bank loans in part or in full with other sources of funding. One of the main reasons for this imperfect substitutability is the information asymmetry that generally exists between lenders and borrowers.[2] Banks reduce this asymmetry in their function as lenders by checking and monitoring their borrowers and by establishing long-term customer ties, for example. At the same time, the relevance of banks in the realm of private sector financing goes beyond bank loans, also because banks provide funds to the private sector via other segments of the financial market.[3]

Banks' stability is therefore key to the effectiveness of monetary policy

Given the key role banks play in monetary policy, a stable and smoothly functioning banking system is essential to the effectiveness of monetary policy. Bearing that in mind, the primary responsibility for ensuring the stability of individual institutions and the banking system as a whole lies with microprudential and macroprudential regulators, eg by subjecting banks to binding minimum capital requirements. Conversely, however, standard and non-standard monetary policy measures also affect banks' economic environment and thus their financing costs, profitability and capital position. This, in turn, largely determines how banks conduct their business, including the setting of credit standards and interest rates. It is, indeed, likely that the overall impact of monetary policy measures on economic activity and inflation depend to a great extent on these relationships (see the chart on page 29).

1 See Deutsche Bundesbank, Developments in corporate financing in the euro area since the financial and economic crisis, Monthly Report, January 2018, pp 53-71.
2 Borrowers are typically better informed than lenders about the risks of the project to be financed and can, once they have received the funds, behave in a way that goes against the interests of the lender. For further information, see, for example, Deutsche Bundesbank, Bank balance sheets, bank competition and monetary policy transmission, Monthly Report, September 2001, pp 51-70.
3 For example, banks also acquire equities, bonds and secured loans. Moreover, they can sell parts of their credit portfolio by issuing securitised products.

Transmission mechanism of monetary policy



Source: A Beyer, G Nicoletti, N Papadopoulou, P Papsdorf, G Rünstler, C Schwarz, J Sousa and O Vergote (2017), The transmission channels of monetary, macro- and microprudential policies and their interrelations, ECB Occasional Paper Series No 191.
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Low capital endowment may lead to lending constraints

In order for capital to fulfil its guarantee and insurance function,[4] regulators require banks to hold a specified minimum amount of capital against outstanding loans which is positively linked to the riskiness of the loan exposures.[5] Besides these regulatory provisions, investor behaviour, too, substantially influences the scope of the capital endowment, in particular, say, when investors are not prepared to provide banks with external or own funds because they regard the bank's capital as insufficient. If bank capital is only just enough, or even insufficient, to cover losses, this may constrain bank lending.[6]

Capital can be built up in two ways: by retaining profits and by issuing equity instruments

From a bank's perspective, there are two ways to avoid lending constraints by building up capital. The first one is to retain earnings; the second is to issue equity instruments (eg shares).[7] As a general rule, both approaches have their limitations, which are influenced by monetary policy, amongst other things. Earnings can only be retained at the pace at which they are generated and investors are unlikely to be willing to purchase unlimited quantities of newly issued equity instruments.[8]

4 See K F Hagenmüller (1959), Bankbetrieb und Bankpolitik, Wiesbaden.
5 For arguments on the need for banking regulation, see, for example, T Hartmann-Wendels, A Pfingsten and M Weber (2015), Bankbetriebslehre, 6th edition, Berlin Heidelberg, pp 312 ff.
6 F Somary (1934) cites four functions of capital. First, to establish trust; second, to cover losses; third, to ensure access to capital and, fourth, to enable capital investment. See F Somary (1934), Bankpolitik, J C B Mohr, Tübingen, 3rd edition.
7 Generally speaking, this applies not only to banks but also to other firms.
8 Here, too, information asymmetries and incentive problems play a role, as banks are usually better informed about the quality of their assets and the sustainability of their business model than potential investors. As claims arising from equity instruments are limited to uncertain profit distribution, information asymmetries are particularly relevant in this type of financing. Non-financial corporations, too, face information problems when raising capital. See Deutsche Bundesbank, Developments in corporate financing in the euro area since the financial and economic crisis, Monthly Report, January 2018, pp 53-71.

Bank capital and risk-taking channel

Bank capital channel models transmission of monetary policy measures to bank capital through profitability

Of the bank-side transmission channels discussed in the literature, a particularly bright light has recently been shined on the bank capital channel as the main focus for monetary policy transmission through this channel is on banks' profitability and capital endowment. Here, it is postulated that monetary policy measures impact directly on bank profitability and thus also banks' ability to build up capital.[9] With the aim of maximising profits, banks in the bank capital channel adjust their lending volume according to the development of their capital position, provided that the latter constitutes a binding restriction.[10] By impacting on banks' profitability and capital position, monetary policy measures also affect banks' lending business (for a discussion of a theoretical model for analysing the role of banks' profitability and capital endowment on transmission in the context of a monetary policy purchase programme, see the box on pages 31 to 34).

Bank capital channel effective when access to capital on the market is limited and initial capital endowment is low

The transmission mechanisms described by the bank capital channel become relevant from a macroeconomic perspective when capital endowment becomes a binding constraint on lending for a sufficiently high share of banks. This is the case when banks' capital endowment is initially small and information asymmetries between banks and potential investors are so strong that building up capital by issuing equity instruments is constrained or, in some cases, even altogether impossible. The model developed by Van den Heuvel (2007) uses a partial analysis to explain the potential relationship between banks' capital endowment and the strength of the bank capital channel.[11] The decisive factor is the size of the excess capital buffer at the time when the monetary policy measure is introduced. The excess capital buffer is the difference between the actual capital ratio and that required by regulators, with the latter depending on the volume of loan exposures. If the initial excess capital buffer is low, banks are bound by capital constraints.[12] The excess capital buffer is not static in the model; instead, it reflects banks' past performance.[13] Since a bank's net lending is restricted by its buffer, it is unable to grant new loans if it has only a very small buffer or none whatsoever. Therefore, in the case of a poorly capitalised bank, an accommodative monetary policy measure will have no effect in the short term. However, there is a certain likelihood that, by retaining profits, the capital position of a poorly capitalised bank will recover in the medium term; in principle, this should enable the bank to grant (more) loans again. This likelihood changes with a monetary policy measure's impact on profitability. Conversely, in the case of well capitalised banks, the effect of a monetary

9 In addition, bank capital is regarded as an important determinant of banks' funding costs. Hence, a worse (better) capital position increases (decreases) a bank's credit risk and correspondingly leads to higher (lower) risk premiums to be paid by the bank when acquiring funds. Borrowing funds becomes more costly if banks pass on the higher risk premiums to borrowers. See also P Disyatat (2011), The bank lending channel revisited, Journal of Money, Credit and Banking 43 (4), pp 711-734.
10 See S J Van den Heuvel (2007), The bank capital channel of monetary policy, Working Paper, Wharton School, University of Pennsylvania. See also the following papers where the term "bank capital channel" is not explicitly mentioned, but which nevertheless describe a channel through which monetary policy measures are transmitted via the banking system's profitability and capital position, ie R Chami and T F Cosimano (2010), Monetary policy with a touch of Basel, Journal of Economics and Business 62, pp 161-175; and M Woodford (2010), Financial intermediation and macroeconomic analysis, Journal of Economic Perspectives, 24(4), pp 21-44; and P Disyatat (2011), op cit.
11 See S J Van den Heuvel (2007), op cit. The model is based on the assumption that capital is generated by retaining profits alone and not by issuing equity instruments.
12 Van den Heuvel demonstrates that capital constraints become binding before the buffer is actually exhausted. A higher or lower probability of falling below minimum capital requirements in the future may already affect lending in the present. See S J Van den Heuvel (2002), Does bank capital matter for monetary transmission?, Federal Reserve Bank of New York Economic Policy Review, May 2002, pp 259-265.
13 A key difference compared with the model logic of the bank lending channel is the development of the capital ratio. In the bank lending channel, the capital ratio is assumed to be exogenous and therefore does not change in response to a monetary policy measure. The adjustments to banks' lending volume as a result of a monetary policy measure occur in the form of changes in deposit holdings, above all by households. Monetary policy thus changes the opportunity costs of holding deposits. For more on the bank lending channel, see, for example, L Gambacorta (2005), Inside the bank lending channel, European Economic Review 49 (7), pp 1737-1759. For a comparison of capital in the bank capital channel versus the bank lending channel, see S Van den Heuvel (2002), op cit.

The role of the bank capital channel in the transmission of non-standard monetary policy measures

The bank capital channel will be examined from the perspective of a macroeconomic general equilibrium model with a fully fledged financial market.[1] The purchase of government bonds is considered a non-standard monetary policy measure in this context. For the sake of simplicity, it is assumed that the central bank makes these purchases unexpectedly within a specific period and then reduces the acquired stock again over time. Although the exact characteristics of the measures considered here differ somewhat from those of the Eurosystem's asset purchase programme (APP), the macroeconomic and financial variables respond in the same way.[2] There are, however, differences in the magnitude of the effects.

In the model presented here, households decide how much they want to work, consume, and save. They either invest their savings in interest-bearing bank accounts or purchase long-term government bonds. The banks finance themselves via equity and debt capital, with the debt capital corresponding to the households' deposits. They use these funds primarily to issue loans to non-financial corporations. However, like households, they can also purchase long-term government bonds and – to a lesser extent – bonds issued by non-financial corporations.[3] Non-financial corporations invest their equity and debt in risk-bearing capital goods, which are processed into intermediate goods using the labour supplied by households. Typically, this type of model is based on the assumption that the producers of intermediate goods and suppliers of labour services have (limited) market power in their sectors, and can therefore influence the price of their goods and their wage rate respectively, although this may occur with a slight time lag in some cases.[4]

An important building block in this model is that debt contracts are concluded between non-financial corporations and banks as well as between banks and households. The debt contracts between non-financial corporations and banks are characterised by the fact that borrowers (non-financial corporations) are generally better informed about "their" project than lenders (banks). This means that information about the project is distributed asymmetrically. Under these circumstances, lenders would have to bear a significant financial burden to investigate the reasons for a potential payment default. Another feature of debt contracts is that it can be very costly, or even impossible, to recover arrears using coercive measures. Such a loan agreement is concluded between banks and households in the model. In both cases, loans are there-

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1 A New Keynesian dynamic stochastic general equilibrium (DSGE) model, as described in Kühl (2016), is used. See M Kühl, The effects of government bond purchases on leverage constraints of banks and non-financial firms, Deutsche Bundesbank Discussion Paper, No 38/2016.

2 The quantitative effects of the APP were examined in the Deutsche Bundesbank's June 2016 Monthly Report. See Deutsche Bundesbank, The macroeconomic impact of quantitative easing in the euro area, Monthly Report, June 2016, pp 29-53.

3 In the model, there are two different groups of capital producers. The first group exclusively uses bank loans as debt capital, while the second group only issues corporate bonds.

4 The real sector therefore resembles a typical New Keynesian dynamic stochastic general equilibrium model. In this context, the producers of intermediate goods and suppliers of labour are only able to set their profit-maximising price with a certain level of probability (known as Calvo pricing). See F Smets and R Wouters (2003), An estimated dynamic stochastic general equilibrium model of the euro area, Journal of the European Economic Association, 1 (5), pp 1123-1175.

fore usually only issued if borrowers contribute their own funds to the project. This means that leverage is a key variable for both issuing bank loans as well as the willingness to hold deposits.[5] For these reasons, the economic agents in the present model – the owners of banks and non-financial corporations – must contribute their own capital.[6] The higher the leverage of the non-financial corporation, the higher the lending rate will be, as the lender would want to offset any potential losses.[7] The accounting scope of the financial and non-financial corporations is therefore limited (balance sheet constraint). If the banks' leverage in the model increases – triggered perhaps by a decline in capital – this leads to the households withdrawing part of their deposits from their accounts.[8] The liabilities side of the banks' balance sheets erodes and, inversely, the banks must reduce their total assets. A process of deleveraging takes hold.

The specific impact of unexpected asset purchases by the central bank within this model will be explored further below. As an initial reaction to the additional demand from the central bank, the prices of government bonds rise and their yields fall accordingly.[9] As securities are marked to market, thereby increasing the volume of assets on the balance sheet, the amount of capital on the liability side of the banks' balance sheets also grows. Due to the falling leverage, the households are now more willing to hold deposits with the banks. Banks respond to the changed structure of prices and balances by rebalancing their portfolios (see chart on page 42). The banking sector as a whole offers an increased volume of loans to non-financial corporations, and at better borrowing conditions than before the asset purchases began, as the market for loans would otherwise not be cleared.[10] This enables non-financial corporations to more easily service debts through decreased lending rates. Their profit and capital increase, initially allowing them to finance new investment projects primarily with these own funds.[11] Consequently, there is no substantial change in lending to the non-financial corporations in the period immediately following the asset purchases.

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5 Leverage is defined as the ratio of total assets to capital. An increase in leverage therefore increases total assets relative to capital, which ultimately implies a rise in the relative significance of debt capital.

6 The modelling of financial frictions in non-financial corporations is based on B S Bernanke, M Gertler and S Gilchrist (1999), The financial accelerator in a quantitative business cycle framework, in J Taylor and M Woodford (eds.), Handbook of Macroeconomics, pp 1341-1393, while the financial frictions in the banking sector follow M Gertler and P Karadi (2011), A model of unconventional monetary policy, Journal of Monetary Economics, 58, pp 17-34.

7 Ultimately, higher leverage means that loans are financed by less capital.

8 The inflow or outflow of deposits also plays a crucial role in another monetary policy transmission channel – the bank lending channel. However, in this case, it is triggered by changes in the opportunity costs of holding deposits or by a shortage of central bank reserves. Within the context of the model discussed here, the inflows and outflows are, by comparison, predominantly the result of changes in bank leverage. Therefore, it is investors – rather than, say, supervisors – who ultimately force the bank to comply with minimum capital requirements in the model.

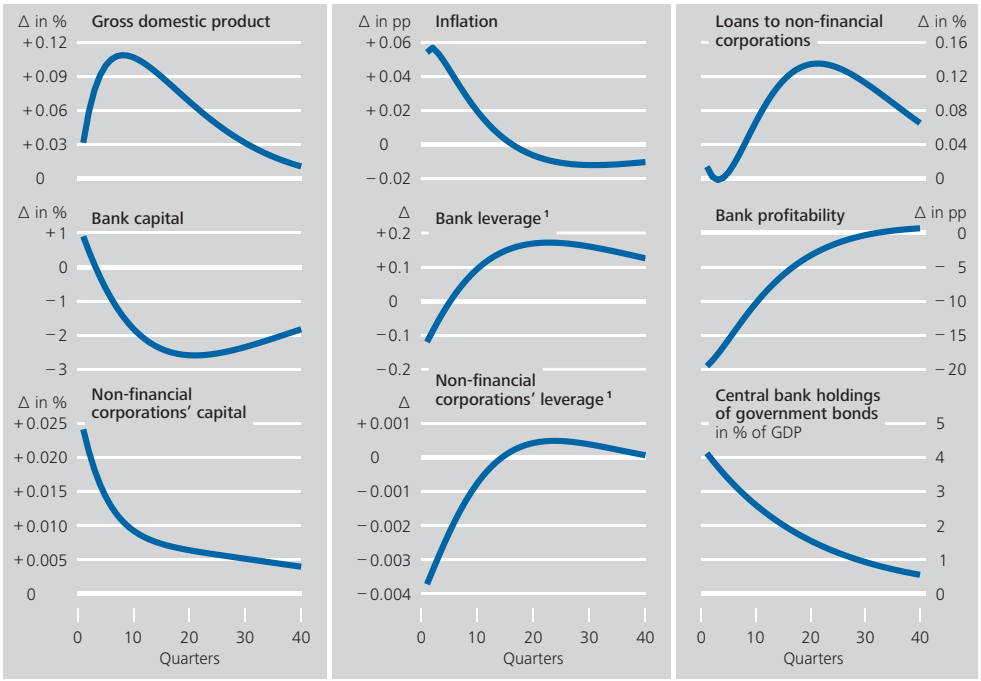
9 In this model, government bonds and other assets are imperfect substitutes, ie they differ in terms of transaction costs and degree of liquidity, for example. In this case, there are limits to arbitrage, which allows sustainable price reactions to be triggered (contradicting the assumptions of Wallace neutrality). An account of this topic can be found in H Chen, V Cúrdia and A Ferrero (2012), The macroeconomic effects of large-scale asset purchase programmes, The Economic Journal, 122, pp F289-F315; as well as in Deutsche Bundesbank (2016), op cit, pp 36-37.

10 In the model, assets are purchased regardless of developments in the real economy. This modelling approach makes it possible to measure the impact of asset purchases directly. In the real world, the central bank reacts to economic developments using non-standard measures in order to achieve its objectives. It may therefore be the case that any excess demand for loans is mitigated by portfolio rebalancing. However, the effects outlined here must be considered solely in relation to the underlying scenario.

11 In the case of old loans with longer maturities, this effect occurs with a time lag, as the lower lending rates only apply to new loans. The effect described in the main text is not fundamentally changed by this, but merely softened. See M Andreasen, M Ferman and P Zabczyk (2013), The business cycle implications of banks' maturity transformation, Review of Economic Dynamics, 16 (4), pp 581-600.

Effects of an asset purchase programme on the real economy and the financial sector*

Impulse response functions, deviations (Δ) from long-term steady state



* Based on M Kühl (2016), The effects of government bond purchases on leverage constraints of banks and non-financial firms, Deutsche Bundesbank Discussion Paper, No 38/2016. **1** Leverage is defined as the ratio of total assets to bank capital.

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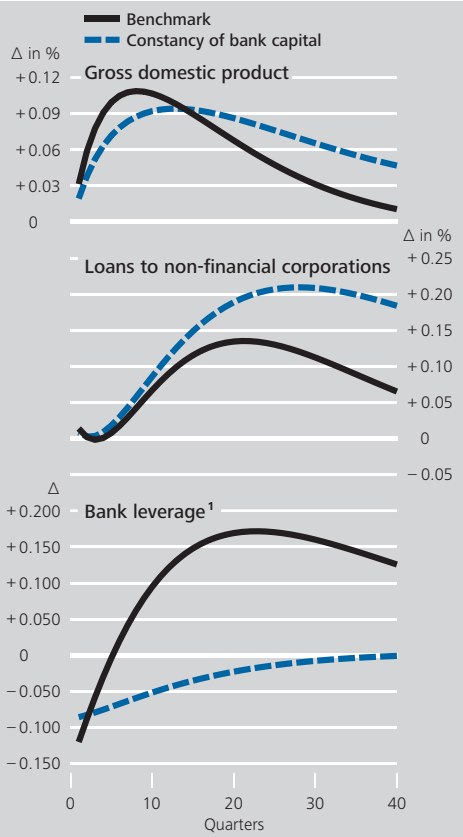
In the case of the banks, declining credit and capital market rates cause a fall in the net interest margin – the difference between the interest received on their assets and the interest paid on their debt.[12] Thus, after the initial positive stimulus, bank capital is weakened and even drops relatively quickly in the medium term to below its starting level. Their leverage rises accordingly. The mechanisms of the bank capital channel described above now operate in the opposite direction. The banks' liability-side business comes under pressure as the households are less willing to hold deposits with the banks. In this way, the households prevent a constant rise in bank leverage. The banking sector then needs to scale down its total assets to a greater extent. In the present model, it does this solely by reducing its stocks of government bonds.[13] The net interest margin goes back up and lending slowly increases. The main reason behind this development is non-financial corporations' now increased demand for credit. An expansionary stimulus on gross domestic product and inflation is the ultimate, indirect outcome of asset purchases in this model framework. At the same time, the model simulations also show that asset purchases reduce interest margins and thereby put a strain on bank capital (see above chart).

Initial experiences of the APP in practice indicate that this is not just the case in theory.[14] For the monetary policy analysis, it is therefore all the more important to assess the significance of the bank capital channel

12 Once again, it should be stressed that the effects weaken only if a maturity structure is assumed and the interest rate effect only applies to new loans.
13 As the assets on the banks' balance sheets are imperfect substitutes, the APP leads to a reduction in total assets in the model. This effect is now even more pronounced.
14 See the ad hoc questions on the APP contained in the European Central Bank's Bank Lending Survey for 2015 Q3, 2016 Q1, 2016 Q3, 2017 Q1, and 2017 Q3.

Significance of bank capital for the transmission of an asset purchase programme*

Impulse response functions, deviations (Δ) from long-term steady state



* Based on M Kühl (2016), The effects of government bond purchases on leverage constraints of banks and non-financial firms, Deutsche Bundesbank Discussion Paper, No 38/2016.
1 Leverage is defined as the ratio of total assets to bank capital.

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described above for the transmission of monetary policy stimulus. A counterfactual analysis is appropriate here. This type of analysis is a notional experiment in which a monetary policy stimulus acts on model variables, but its effect on capital is eliminated. The "actual" and "counterfactual" results described above are then compared (see chart above).[15] There are signs that, above all, the credit volume is highly sensitive to changes in bank capital in the medium and long term. In terms of the constancy of capital, the credit volume rises not only more strongly but also more persistently – almost doubling at its peak.[16] Gross domestic product also exhibits a different reaction. The initial rise in real economic activity is indeed less pronounced, but continues for a significantly longer period of time.

The present model provides crucial insight into the extent to which (non-standard) monetary policies are transmitted to bank capital and leverage as well as the magnitude of their effects on the real economy and inflation. However, the model does not contain all of the variables and channels that matter in the real world. For instance, even before the start of the APP, the Eurosystem had already introduced measures that affected bank liabilities.[17] The introduction of negative interest rates on central bank reserves is also not taken into consideration. Finally, neither regulatory policy concerns regarding asset purchases nor political-economic aspects are reflected in the framework presented in this article.

15 Bank capital remains constant in as much that anticipated shocks prevent change. A transfer of resources in order to keep bank capital unchanged therefore does not take place. The model also remains unchanged.
16 In terms of the constancy of capital, there is now a persistent decline in leverage in the banking sector. Admittedly, the profit margins in the banking sector continue to shrink. By nature, however, there is no negative effect on capital in the medium term. This ultimately prevents an increase in leverage. While there are hardly any differences in lending shortly after the start of the asset purchase programme, there are, as is the case with leverage, larger deviations in the medium term. This is due to the fact that, during this period, the non-financial corporations finance their increased investing activities predominantly using their own funds.
17 See Deutsche Bundesbank (2016), op cit.

policy measure on profitability has hardly any bearing on bank lending, as those banks are unlikely to fall short of the regulatory capital requirements, at least in the short term (for details on the importance of capital and the excess capital buffer from an economic and monetary policy point of view, see the box on pages 36 and 37).

Risk-taking channel captures monetary policy transmission through perception and tolerance of risk

The bank capital channel is closely linked to what is known as the risk-taking channel. The underlying assumption is that risk perception or tolerance by economic agents – and thus also banks – varies with interest rates, amongst other factors.[14] These economic agents may be willing to tolerate greater risks to compensate for any negative effects on profitability stemming from low interest rates, thus helping to achieve certain profitability or return objectives. In this case, the low-interest-rate environment affects risk tolerance via profitability.[15] An elevated risk tolerance by banks can, for instance, be reflected in an expansion of the lending volume to riskier borrowers or in the tolerance of higher interest rate risk. In conceptual and empirical terms, there is not always a clear separation between the risk-taking channel and the bank capital channel. The willingness to take on greater risk in the form of granting more loans as a result of a monetary policy-induced improvement in the capital position, which, from a macroeconomic perspective, can have repercussions for the pricing of risk, can be understood as a manifestation of the risk-taking channel as well.[16]

Non-performing loans and bank capital: situation in the euro area

Capital endowment has improved since the crisis, while capital requirements have become stricter …

Bank capital ratios in the euro area have been improving continuously since the global financial crisis of 2008-09.[17] Against this backdrop, it could be assumed that the banking system has extricated itself from a situation where capital constraints are relevant for the effectiveness of monetary policy. However, more stringent regulatory requirements were another factor in improved capital ratios. Whether or not capital constraints are in place cannot necessarily be directly derived from the capital ratio; instead, a comparison of the actual capital ratio and the regulatory capital ratio is needed. An increase in capital ratios is thus not a direct indicator of any existing capital constraints being mitigated.

… and the stock of NPLs has increased

In addition, the increase in capital ratios occurred at a time when the stock of NPLs grew significantly, particularly in the southern euro area countries. NPLs affect banks' capital ratios in a number of ways. For one, they have a direct adverse effect on profitability, reducing the ability to build up capital.[18] A burdening effect on profitability occurs when loans stop performing because the borrower is no longer able to meet interest payments and principal repayments in full, causing the loan to drop in value.[19] This loss in value is reflected in loan loss reserves, the amount of which is deducted from the loan's book value in the balance

14 See C Borio and H Zhu (2012), Capital regulation, risk-taking and monetary policy: A missing link in the transmission mechanism?, Journal of Financial Stability 8, pp 236-251; and Deutsche Bundesbank, The importance of macroprudential policy for monetary policy, Monthly Report, March 2015, pp 39-72.
15 See, inter alia, C Memmel, A Seymen and M Teichert (2017), Banks' interest rate risk and search for yield: a theoretical rationale and some empirical evidence, German Economic Review, forthcoming.
16 For details, see T Adrian and H S Shin (2010), Financial intermediaries and monetary economics, in: B M Friedman and M Woodford (eds), Handbook of Monetary Economics, Vol 3, pp 547-599.
17 See, for example, European Central Bank, Report on financial structures, October 2017.
18 This applies to strengthening the capital position by retaining profits. Yet the ability to strengthen the capital position by issuing equity instruments is likewise contingent on profitability. Weak profitability tends to go hand in hand with a lower market value and thus also with a reduced ability to consolidate the capital position in this way. For more information on this topic, see, for example, European Central Bank, Financial Stability Review, November 2017.
19 According to the definition by the European Banking Authority (EBA), non-performing exposures are those that are more than 90 days past due in terms of a debtor's interest and/or principal payments or those where the debtor is unlikely to pay its credit obligations in full in the future. For more information, see European Banking Authority (2013), Final draft implementing technical standards on supervisory reporting on forbearance and non-performing exposures under article 99(4) of Regulation (EU) No 575/2013; and Commission Implementing Regulation (EU) 2015/227.

Bank capital

Capital is not only a source of funding but also plays an important role in insuring any losses that occur. The higher the leverage of a firm, the more prominent capital's function as insurance becomes, at the expense of the original function of providing finance. For banks, unlike non-financial corporations, it is not capital's funding function which is more important, but rather its guarantee and insurance function. In a normal business environment, it primarily instils confidence, enabling a bank to borrow the funds it needs.[1] Whereas, for any given bank, an individual target ratio of equity to debt finance can thus be derived from capital's business management functions, this ratio is additionally dependent on the regulatory, tax and macroeconomic environment.

Seen from an economic perspective, high capital ratios are beneficial when taken in isolation, especially since they strengthen banks' ability to absorb losses and reduce the likelihood of distressed banks and the need for government rescue measures.[2] Here, the steering function of capital requirements is the most prominent feature: given limited opportunities to procure capital, high capital requirements, so the reasoning goes, would naturally constrain the bank's size and contain the distortionary impact of guarantees and subsidies.[3] It is only the reported capital ratio that is relevant to banks' ability to absorb losses caused by negative price and profitability shocks; this metric provides for a given ratio of equity financing irrespective of the assets' risk. Over time, this ratio remains relatively stable and generally rises in line with regulatory capital requirements. This would appear to indicate that banks generally attempt to maintain a given buffer in excess of regulatory capital requirements, ie they strive for a higher internal target capital ratio.[4]

The size of this excess capital buffer is not shaped by stricter regulatory requirements but is chosen freely by banks within the framework of their business decisions. There are at least three reasons for them to maintain such buffers: first, in order to be able to take advantage of sudden lucrative investment opportunities,[5] second, as "insurance" against adverse capital shocks[6] and third, owing to existing market pressure and to signal the bank's own solvency.[7] The first two reasons are largely independ-

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1 See J v Köppen (1964), Das Eigenkapital der Kreditinstitute, Frankfurt a. M., pp 165-171.
2 One very prominent proponent of this line of argument is M Hellwig. See A Admati and M Hellwig (2013), The bankers' new clothes, Princeton and Oxford; see also A N Berger, R J Herring and G P Szegö (1995), The role of capital in financial institutions, Journal of Banking & Finance 19, pp 393-430.
3 See A Admati and M Hellwig (2013), op cit, pp 217-224.
4 This part of capital is usually referred to in the literature as "excess capital" or "capital buffer". See, for example, L Gambacorta and P Mistrulli (2004), Does bank capital affect lending behaviour?, Journal of Financial Intermediation, 13, pp 436-457, and I Alfon, I Argimon and P Bascuñana-Ambrós (2004), What determines how much capital is held by UK banks and building societies?, FSA Occasional Paper Series 22.
5 See S J Van den Heuvel (2007), The bank capital channel of monetary policy, Working Paper, Wharton School, University of Pennsylvania, and J Coffinet, V Coudert, A Pop and C Pouvelle (2011), Two-way interplays between capital buffers, credit and output: evidence from French banks, Banque de France Document de Travail, No 316.
6 C Furfine (2001), Bank portfolio allocation: The impact of capital requirements, regulatory monitoring, and economic conditions, Journal of Financial Services Research 20(1), pp 33-56; I Alfon, I Argimon and P Bascuñana-Ambrós (2004), op cit; K-G Lindquist (2004), Banks' buffer capital: how important is risk, Journal of International Money and Finance 23, pp 493-513; and J Coffinet et al (2011), op cit.
7 I Alfon, I Argimon und P Bascuñana-Ambrós (2004), op cit; Lindquist (2004), op cit; and M J Flannery and K P Rangan (2008), What caused the bank capital build-up of the 1990s?, Review of Finance 12(2), pp 391-429.

ent of the amount of the regulatory capital requirements. Put differently: banks probably keep their buffers constant even given higher regulatory requirements. If market pressure declines as regulatory capital ratios increase, the third reason might actually tend to argue in favour of reducing the excess capital buffer. One example where this could be the case is if market participants regard a certain reported capital ratio as being adequate for the bank and stricter regulatory requirements lead to this ratio being achieved, on the whole, even with a lower excess capital buffer.

Whereas the aforementioned reasons could be an argument for banks to choose a relatively large buffer, tax incentives militate against the idea of banks voluntarily setting a high buffer. By distorting banks' funding costs, the tax advantage of debt financing over equity financing is currently diminishing banks' incentive to use capital to fund their assets.[8] Other risk mitigation measures taken by banks, too, reduce their desired target capital ratio. Risk sharing (diversification: by type of asset, location, or organisationally), risk compensation (through hedging) and transfer of risk to third parties (derivatives) are strategies typically employed by banks to reduce the amount of capital deemed necessary.[9] The larger the bank, the better able it is to use these risk mitigation measures.

Banks' excess capital buffers matter for monetary policy. Since higher buffers give banks more leeway and also boost the markets' confidence, they reduce cyclicality in the financial system.[10] Theoretically, the benefits to monetary policy of larger buffers could, for instance, be motivated via the bank capital channel.[11] Monetary policy is most likely to be able to act independently of profitability in the banking system if the banks are far removed enough from a situation in which they are constrained by capital requirements.

The concept of equity which "breathes" over the business cycle is also the basis for the counter-cyclical capital buffer as part of the toolkit of macroprudential instruments, which is designed to enhance resilience to systemic risks created by excessive lending and thus to mitigate the risk of financial crises.[12] Empirical studies provide evidence that a better capital base of banks impacts positively on lending.[13]

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8 See G Schepens (2016), Taxes and bank capital structure, Journal of Financial Economics, pp 585-600.
9 For an explanation of risk reduction strategies from a bank perspective, see J v Köppen (1965), op cit, pp 343ff. For a critical review of the role of derivatives, see A Admati and M Hellwig (2013), op cit, pp 69-74.
10 Using a DSGE model, Meh and Moran (2010) demonstrate that an economy with more bank capital is better able to absorb negative shocks. See CA Meh and K Moran (2010), The role of bank capital in the propagation of shocks, Journal of Economics Dynamics & Control 34, pp 555-576.
11 See L Gambacorta (2005), Inside the bank lending channel, European Economic Review 49, pp 1737-1759; and S Van den Heuvel (2007), op cit.
12 See L Gambacorta and P Mistrulli (2004), op cit; and M Brei and L Gambacorta (2016), Are bank capital ratios pro-cyclical? New evidence and perspectives, Economic Policy Volume 31, pp 357-403.
13 For more on the positive impact of a higher excess capital buffer, defined alternatively as the difference between actual and regulatory capital or as the difference between actual capital adequacy and banks' desired capital adequacy, see L Gambacorta and P Mistrulli (2004), op cit; W Watanabe (2007), Prudential regulation and the "credit crunch": Evidence from Japan, Journal of Money, Credit and Banking 39 (2-3), pp 639-665; and JM Berrospide and RM Edge (2010), The effects of bank capital on lending: What do we know, and what does it mean?, International Journal of Central Banking, 6 (4), pp 5-54. For more on the positive impact of actual bank capital, neglecting any explicit recognition of regulatory requirements or desired capital adequacy, see, for instance, L Gambacorta and HS Shin (2016), Why bank capital matters for monetary policy, BIS Working Papers No 558.

sheet.[20] In turn, the loan loss reserves are recognised in profit or loss as LLPs, ie a component of profitability. Albeit to a lesser extent, NPLs also affect net interest income as the lack of interest income they cause represents a burden as well. Furthermore, NPLs affect risk-weighted assets and, by extension, the denominator of regulatory capital ratios given that other, often higher, risk weights should be used for the non-value-adjusted share of NPLs than for performing loans.

NPLs can be indicative of losses to be expected in the future

As long as any losses which might be caused by NPLs are fully covered at all times by appropriate loan loss reserves in the balance sheet, the repercussions of NPLs are already factored into the specified regulatory capital ratios. However, if further losses from these loans are expected to materialise in the future and have not yet been covered by loan loss reserves, then the stock of NPLs contains additional information with regard to potential future capital constraints. Banks could, for example, put off forming loan loss reserves for NPLs to avoid falling below the regulatory minimum capital requirements or the capital level tolerated by the markets. In this context, it is conceivable, for instance, that banks continuously roll over loans to borrowers who can, in reality, no longer be classified as creditworthy in order to avoid a default and the recording of losses this would entail (the box on pages 39 and 41 addresses the question of the extent to which NPLs influence banks' lending policies and monetary policy transmission when the reported capital ratio is taken into consideration).[21] In the euro area, the ratio of the stock of NPLs to the sum of capital and loan loss reserves for significant institutions under the direct supervision of the ECB came to just under 60% at the end of 2015, with some countries reaching values above 100%.[22] Although a gradual decline – not least due to various policy measures – in the stock of NPLs and thus a turnaround in dynamics has been observed since then, the level continues to be very high.[23] This demonstrates that potential losses arising from NPLs which are not yet included in reported capital may well entail capital constraints in the future and implicitly even in the present.

Impact of interest rates on bank profitability

Monetary policy influences an economy's interest rates …

The interest rate level and term structure are influenced by the use of monetary policy instruments. While it is not their sole driver, monetary policy can exert significant influence over interest rates in the money market, at least in the short term. Changes in short-term interest rates are accompanied by a parallel shift in the term structure if they are replicated by interest rates at the long end. If not, or if not to the same extent, the slope of the yield curve will change accordingly. In response to the financial and sovereign debt crisis, the Eurosystem augmented its set of standard monetary policy instruments with non-standard measures. After the zero lower bound had been reached at the short end, the purchase programmes, in particular, aimed at lowering the longer-term interest rate level.[24] A reduction in longer-term interest rates is passed through to banks via a range of channels (see the chart on page 42).

Both the level of interest rates and the slope of the yield curve influence the financial perform-

20 In the case of loan loss reserves, both the gross value of the original figure and the bank's value adjustment are recorded. Alternatively, the loan can also be amortised, eliminating this amount from the balance sheet.
21 In the literature, such practices are referred to as "evergreening" or "zombie lending". For evidence regarding Japan and the adverse effects on its real economy, see R Caballero, T Hoshi and A Kashyap (2008): Zombie lending and depressed restructuring in Japan, American Economic Review 98 (5), pp 1943-1977. Evidence for the euro area is given by M Storz, M Koetter, R Setzer and A Westphal (2017), Do we want these two to tango? On zombie firms and stressed banks in Europe, ECB Discussion Paper No 2104.
22 See European Central Bank, Financial Stability Review, May 2016. The ratio mentioned in the text is also referred to as the "Texas ratio". It is the ratio of the gross volume (before provisions) of NPLs to loss absorbency capacity, which is calculated as the sum of loan loss reserves and capital.
23 See European Central Bank, Financial Stability Review, November 2017.
24 See Deutsche Bundesbank, Monetary policy indicators at the lower bound based on term structure models, Monthly Report, September 2017, pp 13-34.

The impact of non-performing loans on the pricing of new loans

In the course of the financial and sovereign debt crisis, the stock of non-performing loans (NPLs) on the balance sheets of banks in the euro area increased sharply. As a result, the significance of NPLs as a potential obstacle to lending and to the functioning of monetary policy transmission came to the fore.[1] With this in mind, this box examines the impact of NPLs on the pricing of new loans to enterprises. Of interest here are the effects produced when explicitly the capital position of the surveyed banks is controlled for. Losses arising in connection with non-performing loans, which have already been reported by banks by means of a corresponding amount of loan loss provisions, are therefore filtered out of the analysis.

In order to obtain a more accurate picture of the importance of the above factors in the euro area, the interest rates on new loans to enterprises at the level of individual banks as a function of various bank-related factors – including the stock of non-performing loans and the capital position – were modelled in an econometric analysis.[2] The required data were sourced from the Eurosystem's individual MFI Interest Rate (iMIR) database, two private-sector data providers – Bankscope (now Orbis Bank Focus) and SNL (now S&P Global Market Intelligence) – and the Eurosystem's Centralised Securities Database (CSDB). The following equation is estimated:

$$LR_{i,t} = \alpha_i + \delta LR_{i,t-1} + \beta' NPL_{j,t-1} + \gamma' x_{i,j,t,t-1} + \varepsilon_{i,t}$$

According to this equation, the average lending rate on new loans to enterprises LR at bank i in year t is explained by its own history and by various other variables. The variables in the vector NPL capture the stock of non-performing loans of banking group j, to which bank i belongs, and the interaction of this stock with a short-term market interest rate (the one-year overnight index swap (OIS) rate). The gross value of NPLs is broken down into the net stock (that part not covered by loan loss reserves) and loan loss reserves (LLRs).[3] Owing to the potential endogeneity of the variables, values from the previous year are used in each case. The vector x contains not only the regulatory capital ratio lagged by one year but also further lagged balance sheet metrics of banking group j, macroeconomic determinants for the home country of bank i (either year fixed effects and various macroeconomic variables or year-country fixed effects) and the average interest rate fixation period for the new loans to enterprises granted by bank i. The vector x also contains the market funding costs of banking group j, which are not lagged by one year.[4,5] When interpreting the results, it should be noted that effects which the stock of one bank's NPLs could have on another bank's credit pricing policy are not modelled.[6]

1 See, inter alia, S Aiyar, W Bergthaler, J M Garrido, A Ilyina, A Jobst, K Kang, D Kovtun, Y Liu, D Monaghan and M Moretti (2015), A strategy for resolving Europe's problem loans, IMF Staff Discussion Note 15/19, and European Commission (2017), A macroeconomic perspective on non-performing loans (NPLs), Quarterly report on the euro area 16(1), pp 7-21.

2 The analysis can be found in S Bredl (2017), The role of non-performing loans in the transmission of monetary policy, mimeo.

3 The LLRs are the amount of loan loss reserves reported in the balance sheet which were booked as loan loss provisions in earlier periods in the profit and loss account.

4 Calculated as the average return on market-traded debt securities less the maturity-matched risk-free interest rate.

5 The structure of the data permits multiple banks to belong to the same banking group j. Therefore, the error term ε is clustered at the level of the particular banking group when calculating the standard errors of the coefficients.

6 It is thus conceivable, for example, that a bank L with a large stock of NPLs will adjust its lending rates upwards. Thanks to its competitor's measure, bank S, with a small stock, sees greater scope for price-setting and responds by likewise raising its lending rates. The analysis can only identify that particular effect of NPLs which is reflected in the difference between both banks' lending rates but not the higher level of lending rates overall caused by bank L's large stock of NPLs.

Estimation of the impact of non-performing loans on lending rates for new loans[o]

	Year-country fixed effects		Year fixed effects and macro-economic variables	
Explanatory variable	FE	System GMM	FE	System GMM
Lending rate (– 1)	0.340***	0.565***	0.427***	0.740***
Net NPLs (– 1)	0.051***	0.099**	0.042*	– 0.012
LLRs (– 1)	– 0.012	– 0.075	– 0.064*	– 0.037
Net NPLs (– 1)*OIS	– 0.014	0.000	– 0.038*	0.004
LLRs (– 1)*OIS	– 0.011	– 0.004	0.028	– 0.044
Tier 1 ratio (– 1)	– 0.004	– 0.008	– 0.001	– 0.036**
Liquid assets (– 1)	0.008	0.000	– 0.002	– 0.014**
ROA (– 1)	– 0.012	– 0.029	– 0.028	– 0.061
Funding costs	0.017	0.028	0.046	0.043**
Number of observations	778	778	725	725
Number of banks	145	145	132	132
Number of instruments	.	147	.	55
Hansen p-value	.	1	.	0.2374
AR2 p-value	.	0.7369	.	0.8725

o This table shows the results of regressions of the average interest rate on new loans to enterprises on their own lagged value, control variables specific to banking groups, year-country fixed effects or year fixed effects and macroeconomic variables, and the average interest rate fixation period for the loans granted. Two models are estimated: one with bank-specific fixed effects (FE) and the other using a system GMM estimation (System GMM). In the latter, the lagged endogenous variable and the variables specific to the banking group (except for the funding costs) are instrumented by their own further lagged values. For the system GMM estimates, the number of instruments, the p-value of the Hansen test of overidentifying restrictions and the p-value of the test for second-order autocorrelation of the residuals are shown. In both tests, a rejection of the null hypothesis (the p-value being below the critical value, typically 0.05) indicates a misspecification of the econometric model. Net NPLs stands for the net stock of non-performing loans as a percentage of total assets; LLRs for loan loss reserves as a percentage of total assets; *OIS for interaction with the one-year overnight index swap rate in %, Tier 1 ratio for the regulatory tier 1 ratio in %; Liquid assets for liquid assets as a percentage of total liabilities; ROA for return on assets in %; and Funding costs for the market financing costs (spread over risk-free interest rate in %). (-1) represents the value lagged by one year. The estimation is based on annual data, with the estimation period covering the years from 2010 to 2016. ***, ** and * denote, respectively, significance at the 1%, 5% and 10% level.

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The estimation is performed both with bank fixed effects and using the system-generalised method of moments (GMM) approach, in which the lagged endogenous variable and the variables specific to the banking group (except for the funding costs) are instrumented by their own further lagged values. Macroeconomic factors are controlled for using year-country fixed effects or year fixed effects and various macroeconomic variables.[7]

The results are shown in the above table and in the chart on page 41. Whereas the net stock of NPLs is accompanied by higher lending rates in three of the four specifications, there tends to be a negative relationship between the LLRs and lending rates.[8] The overall impact of an increase in the net stock of NPLs and the LLRs – assuming that the ratio between these two metrics matches the average in the sample used – is not significantly different from zero. On the whole, therefore, the results indicate that a high level of non-performing loans, specifically in a scenario of low LLRs, is associated with higher lending rates. What the results also show, furthermore, is that the interaction terms between the short-term market interest rate and the net stock of NPLs and the LLRs, with the ex-

7 Although the year-country fixed effects specification appears to be more compelling, since it implicitly captures all macroeconomic factors, it entails the use of a large number of degrees of freedom, rendering the Hansen statistic, which tests the validity of assumptions made with regard to the instruments in the system GMM approach, unreliable.

8 Note that the net stock of NPLs and the LLRs are highly correlated, with a correlation coefficient of around 0.8. However, the results are relatively robust to a random variation of the sample. Moreover, the overall impact is more or less equivalent to the effect that results if, instead of the net stock of NPLs and the LLRs, only the gross stock (sum of the net stock of NPLs and LLRs) is used in the estimation.

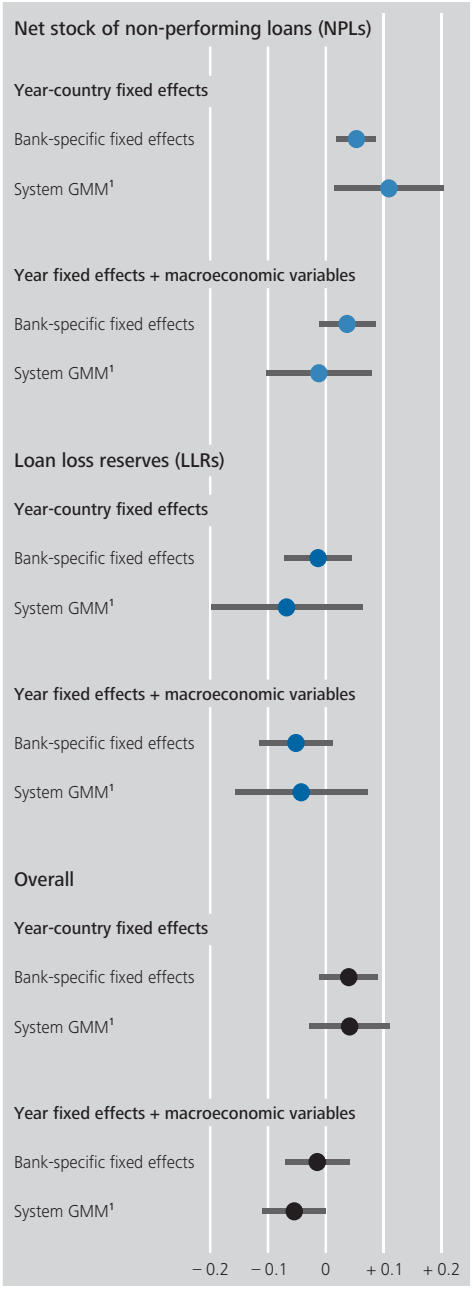
ception of one specification, are insignificant. This implies that the impact of monetary policy measures which pass through to market interest rates – defined as the difference between the lending rate in a situation with a measure and the lending rate in a hypothetical situation without a measure – is not constrained by NPLs in an analysis at the level of individual banks, in which macroeconomic factors are seen as given.[9]

The results of the estimates barely change when the funding costs specific to the banking group are excluded from the estimate. This suggests that funding costs are of little significance to the relationship between the stock of NPLs and the pricing of new loans. It should be borne in mind that macroeconomic effects are controlled for in the estimations. As a result, the funding costs variable predominantly captures the component of funding costs specific to the banking group and not the country-specific component. The potential impact of non-performing loans on lending rates brought about by the country-specific share of funding costs (which can be observed in macroeconomic variables such as the risk premium on government bond yields) is not included in the empirical study.

Overall, the results of the estimates indicate that banks make their lending conditions more restrictive if they fear that further losses may result from the stock of NPLs in future, and thus that the relevance of capital restrictions might increase later on. Provided a positive relationship can be identified between non-performing loans and lending rates, then this is attributable to the net stock of NPLs. Net NPLs ultimately indicate the extent to which further losses may be incurred in the future.

Effects of non-performing loans on lending rates for new loans*

Percentage points



***** This chart shows the effects of an increase in the gross stock of non-performing loans in relation to total assets of 2 percentage points (roughly equivalent to the average increase in the period from 2009 to 2015 in the sample used) on the lending rates for new loans to enterprises in the following year. It is assumed that LLRs amounting to 45% of the gross exposure volume are earmarked for loans which have become non-performing (broadly equivalent to the average level of coverage in the sample used). The chart shows the isolated effects of an increase in the net stock of NPLs and in LLRs as well as the overall impact. The point estimators and the 95% confidence interval are both depicted. The chart is based on the results presented in the table, where a value equal to the mean of the sample was used for the one-year overnight index swap (OIS) rate. **1** System-generalised method of moments.

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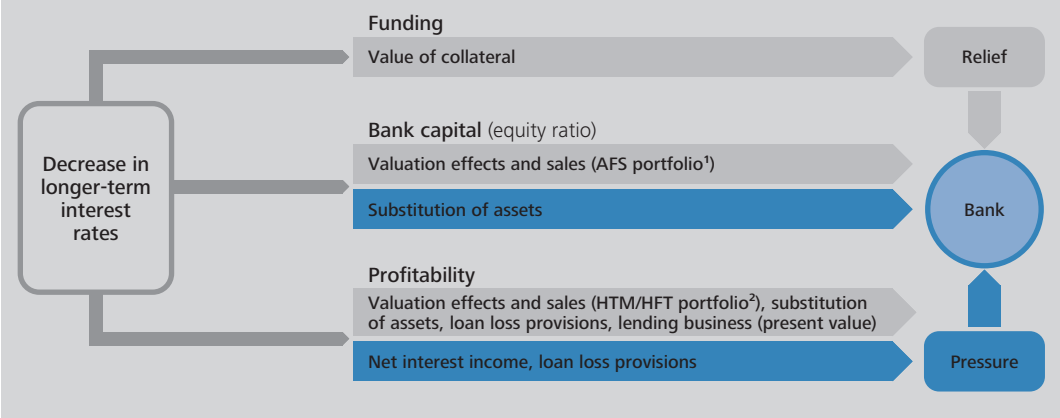
9 For more on this result, see also U Albertazzi, A Nobili and F M Signoretti (2016), The bank lending channel of conventional and unconventional monetary policy, Temi di Discussione Banca d'Italia No 1094.

Channels via which a decrease in longer-term interest rates is transmitted to banks



This chart is based on the IFRS (International Financial Reporting Standards) accounting standards for banks. **1** AFS = Available for sale. **2** HTM = Held to maturity; HFT = Held for trading.
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… and, hence, the profitability of banks

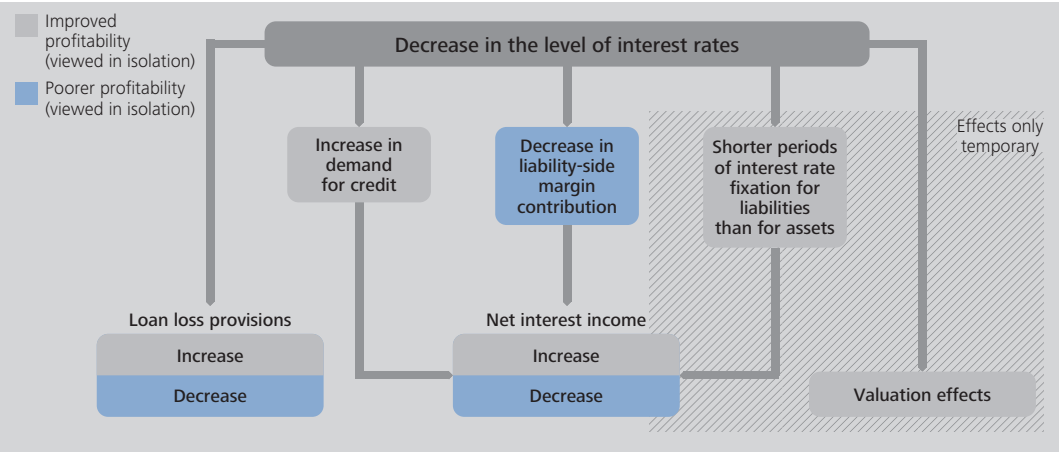
ance and profitability of banks.[25] In this context, developments in net interest income – calculated as the difference between interest received and interest paid – and in LLPs depend especially on the interest rates in an economy. For example, lower interest rates reduce borrowers' interest burden and increase the present value of their collateral, which should reduce aggregate credit default risk, thereby having positive effects on LLPs in banks' lending business (and *vice versa)*.[26] At the same time, however, the relation postulated in the risk-taking channel could also occur, according to which low interest rates raise banks' risk appetite, which ought to have a negative impact on their LLPs.[27] Furthermore, changes in the interest rate level have a one-off effect on the value of marked-to-market assets held by banks. A decrease in interest rates is typically associated with higher market values and therefore has a positive impact on profitability.

A bank's net interest income can be broken down into three components

Net interest income is the most significant component of operating income for the majority of banks in the euro area.[28] In general, banks generate their net interest income from three different sources: a mark-up on lending rates calculated using the potential yield for a comparable alternative money or capital market investment (asset-side margin contribution), a discount on deposit rates calculated using a comparable funding alternative via the money or capital market (liability-side margin contribution), and earnings from maturity transformation (structural contribution).[29] The latter item is the result of the typically longer interest rate fixation periods for loans issued and securities held by banks compared with those for their debt. Owing to the different maturities on the asset and liability sides of banks' balance sheets, the structural contribution has a positive dependency on the slope of the yield curve.

25 See P A Samuelson (1945), The effect of interest rate increases on the banking system, The American Economic Review 35(1), pp 16-27; M J Flannery (1981), Market interest rates and commercial bank profitability: an empirical investigation, The Journal of Finance 36(5), pp 1085-1101; and D Hancock (1985), Bank profitability, interest rates, and monetary policy, Journal of Money, Credit and Banking 17(2), pp 189-202.
26 In addition to the direct impact it has on LLPs, a lower interest rate level may also have indirect consequences – such as stronger economic growth induced by the decrease in interest rates.
27 See C Borio and H Zhu (2012), op cit.
28 In 2016, net interest income accounted for just over 60% of euro area banks' total operating income. For banking groups which rely mainly on traditional lending business, such as Germany's savings banks and credit cooperatives, this ratio is approximately 76%. See European Central Bank, Report on financial structures, October 2017; and Deutsche Bundesbank, The performance of German credit institutions in 2016, Monthly Report, September 2017, p 64.
29 See also C Drescher, B Ruprecht, M Gründer, M Papageorgiou, E Töws and F Brinkmann (2016), The crux of the matter with deposits: low interest rates squeezing credit institutions' margins, Deutsche Bundesbank Research Brief No 4.

Effects of a decrease in interest rates on selected components of bank profitability



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Impact of a change in interest rates on net interest income dependent on degree of maturity transformation

Changes in the interest rate level usually affect banks' lending rates as well as their funding costs. Since interest rate fixation periods on the liability side of banks' balance sheets are shorter than on the asset side, however, this means that these kinds of changes are reflected more quickly in interest paid than in interest received. When rates fall, this relieves pressure on net interest income to begin with, but over time, the "old", higher-interest loans expire and are increasingly replaced by lower-yielding loans. The shorter the interest rate fixation period is on the asset side, the faster the initial positive effect on net interest income is likely to wear off. Thus, the impact of lower interest rates on banks' loan portfolio depends on the banks' maturity transformation levels. While banks benefit from higher-yielding loan contracts with long interest rate fixation periods when interest rates fall, a rise in the interest rate level can put pressure on them.

Overall effect of interest rate decline also depends on deposit rates' sensitivity to market rates

The overall effect on net interest income of an increase in interest rates also depends on the different sensitivity of bank lending and deposit rates to market interest rates (see the above chart). For instance, the empirical literature shows that the pass-through of changes in the market rate is less complete for deposit rates than for lending rates; in other words, there is greater friction associated with the pricing of deposits.[30] Assuming a symmetrical incomplete pass-through – that is to say, irrespective of the direction of the change in the interest rate level – it follows that the liability-side margin contribution will contract with a decrease in interest rates.[31] One reason for the lagged reaction of deposit rates to a change in market interest rates is the long length of time deposits are actually held at the bank. Customer deposits are usually one of the most stable sources of funding for banks, despite depositors' ability to access them quickly and at low cost.[32]

30 For more information, see L Gambacorta (2008), How do banks set interest rates?, European Economic Review 52, pp 792-819; and S Claessens, N Coleman and M Donnelly (2017), "Low-for-long" interest rates and banks' interest margins and profitability: cross-country evidence, CEPR Discussion Paper DP 11842.

31 J C Driscoll and R A Judson (2013) demonstrate that, for the US banking sector, the degree to which deposit rate adjustments lag can vary depending on a number of factors, such as deposit type or bank size, when interest rates either rise or fall. See J C Driscoll and R A Judson (2013), Sticky deposit rates, Finance and Economics Discussion Series 2013-80, Board of Governors of the Federal Reserve System (US).

32 Drechsler et al (2016) offer another explanation for an incomplete interest rate pass-through to deposits. According to the theoretical model outlined in this paper, banks' market power in respect of setting deposit rates diminishes when interest rates fall, since the opportunity cost of holding cash declines and it becomes increasingly more attractive to hold cash than to hold deposits. This is reflected in a lower liability-side margin contribution – defined as the difference between deposit rates and market rates – and implies an incomplete pass-through of the reduction in market rates to deposit rates. See I Drechsler, A Savov and P Schnabl (2016), The deposits channel of monetary policy, NBER Working Paper Series No 22152.

Liability-side margin contribution weighs on net interest income in low-interest-rate environment

In a low-interest-rate environment, the liability-side margin contribution – at least in retail business – is under particular pressure, owing to the existence of a zero lower bound for deposit rates. For example, Busch and Memmel (2017) find that, in the case of German banks, the low-interest-rate environment of the past few years has caused margins for customer deposits to drop more steeply than in the pre-financial crisis period.[33] The results of the Bundesbank and the Federal Financial Supervisory Authority (BaFin) low-interest-rate survey among small and medium-sized German credit institutions show that a decreasing liability-side margin contribution weighs on profitability in a low-interest-rate environment.[34] When a zero lower bound exists for deposit rates, the liability-side margin contribution can even be an expense (rather than income), thus causing – in extreme cases – net interest income to erode (see the chart on page 45).[35] Banks may combat this risk in a low-interest-rate environment, *inter alia*, by factoring a mark-up into their lending rates, thereby strengthening the asset-side margin contribution, if competition permits, or generating higher profits from the structural contribution.[36] In this way, unhedged interest rate risks can stabilise profitability in the short term. In the current low-interest-rate environment, it is clear to see that some categories of banks have expanded their maturity transformation.

Aggregate demand for credit also influenced by interest rates

In addition, the interest rate level has an impact on aggregate demand for credit: when viewed in isolation, falling interest rates lead to a general rise in demand for credit.[37] Thus, banks are able to sell a higher volume of loans and raise their net interest income – all other things being equal – while the asset-side margin contribution remains constant. Banks could also use this higher demand to increase the asset-side margin contribution, although this is likely to dampen the boost in lending.

A low-interest-rate environment is exceptional not only with regard to the effect of interest rate decreases as a result of the zero lower bound on deposit rates, but also in terms of the impact of rising interest rates on net interest income. It appears that an increase in the level of interest rates, particularly coming from a low-interest-rate environment, has a positive effect on net interest income (see the box on pages 47 to 51). The reduction in income from maturity transformation resulting from the rise in interest rates is likely to have a narrowing effect on net interest income only in the short to medium term. The negative effect of subdued credit demand and the positive impact of an increase in the liability-side margin contribution on net interest income, however, prevail over the longer term. The positive impact of a higher liability-side margin contribution is likely to be significant, particularly following a period of persistently low interest rates. Overall, depending on the extent of banks' maturity transformation, an increase in interest rates should negatively affect net interest income in the short to medium term, but positively influence it over the longer term.[38]

Higher interest rates tend to have positive effect on net interest income over the long term

Net interest margin is net interest income over average earning assets

The net interest margin is typically at the centre of empirical analyses on the influence of the interest rate level on the profitability of banks. It is calculated as the ratio of net interest income to the volume of average earning assets.

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33 See R Busch and C Memmel (2017), Banks' net interest margin and the level of interest rates, Credit and Capital Markets, Vol 50, No 3, pp 363-392.

34 For more information, see C Drescher et al (2016), op cit; and http://www.bundesbank.de/Redaktion/EN/Pressemitteilungen/BBK/2017/2017_08_30_joint_press_release.html?nsc=true

35 See C Drescher et al (2016), op cit; and C Borio and B Hofmann (2017), Is monetary policy less effective when interest rates are persistently low?, BIS Working Paper No 628, pp 15-18.

36 Evidence that the zero lower bound on deposit rates also influences the setting of lending rates can be found in G B Eggertsson, R E Juelsrud and E G Wold (2017), Are negative nominal interest rates expansionary?, NBER Working Paper 24039.

37 Apart from interest rates' direct effect on demand for credit, they also impact on other variables, such as economic growth or the employment rate, which in turn influence the demand for credit.

38 For a corresponding study for Germany, see R Busch and C Memmel (2017), op cit. Equivalent results for the net interest margin are derived by P Alessandri and B D Nelson (2015), Simple banking: profitability and the yield curve, Journal of Money, Credit and Banking, Vol 47(1), pp 143-175.

$$Net\ interest\ margin_t = \frac{Average\ earning\ assets_t * Interest\ rate_t^{Assets} - Interest\text{-}bearing\ liabilities_t * Interest\ rate_t^{Liabilities}}{Average\ earning\ assets_t}$$

In empirical studies, average earning assets are often approximated by total assets or the lending and securities portfolios, since information is very limited as to the exact volume of non-trading-book assets from which banks generate interest income.[39] On account of the subdued demand for credit, average earning assets are expected to decline when interest rates rise, and *vice versa* when rates fall. If the reduction in net interest income (the numerator) outweighs the decline in average earning assets (the denominator), an interest rate hike would have a negative impact on the net interest margin in the short to medium term. However, an interest rate rise would have a positive impact on the net interest margin if either the average earning assets fell less sharply than net interest income or if the increase in interest rates were to raise net interest income, which would then cause the quotient to grow because the numerator and the denominator are moving in opposite directions. Where the volumes of average earning assets and interest-bearing liabilities are identical, the net interest margin would change solely on the basis of price adjustments by banks.

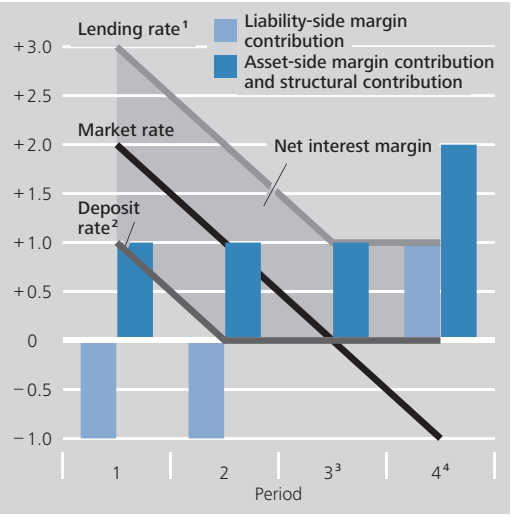
Positive relationship between net interest margin and both interest rates and slope of yield curve

In the majority of cases, recent empirical studies have found a positive relationship between the net interest margin and interest rate levels as well as the slope of the yield curve.[40] On top of this, some studies also look into the specific case of a low-interest-rate environment.[41] They reveal that the sensitivity of the net interest margin to market rates increases in a low-interest-rate environment, which suggests that the relationship between banks' net interest margin and the interest rate level in an economy is non-linear. The consensus of these studies is that a prolonged period of low interest rates, when viewed in isolation, erodes banks' profitability as measured by their interest business.

The impact of the interest rate level on LLPs is not clear *a priori* (see the chart on page 43).

Stylised view of the impact of low interest rates on banks' rate-setting behaviour given a zero lower bound for deposit rates

%



1 Lending rate equals market rate plus asset-side margin contribution and structural contribution. **2** Deposit rate equals market rate plus liability-side margin contribution. **3** If the market interest rate equals zero, the liability-side margin contribution is also equal to zero. **4** If the market interest rate is negative, the liability-side margin contribution is positive. In order to prevent a net interest margin of zero, banks increase their asset-side margin contribution and/or structural contribution.

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39 For the net interest income item in the profit and loss account, the relevant bank portfolios are those which are not marked to market in the balance sheet.

40 See U Albertazzi and L Gambacorta (2009), Bank profitability and the business cycle, Journal of Financial Stability, No 5, pp 393-409; W B English, S J Van den Heuvel and E Zakrajsek (2012), Interest rate risk and bank equity valuations, Finance and Economics Discussion Series, Board of Governors of the Federal Reserve System, pp 2012-2026; U Gunter, G Krenn and M Sigmund (2013), Macroeconomic, market and bank-specific determinants of the net interest margin in Austria, Oesterreichische Nationalbank Financial Stability Report 25, pp 87-101; H Genay and R Podjasek (2014), What is the impact of a low interest rate environment on bank profitability?, Chicago Fed Letter July, No 324; P Alessandri and B D Nelson (2015), op cit; C Borio, L Gambacorta and B Hofmann (2015), The influence of monetary policy on bank profitability, BIS Working Paper October, No 514; and J Bikker and T Vervliet (2017), Bank profitability and risk-taking under low interest rates, DNB Working Paper No 560.

41 See C Borio, L Gambacorta and B Hofmann (2015), op cit; R Busch and C Memmel (2017), op cit; and S Claessens, N Coleman and M Donnelly (2017), op cit.

Lower interest rate level tends to have positive effect on LLPs

Empirical studies indicate that the pressure on earnings from LLPs is relieved when interest rates fall, therefore running in the opposite direction to the factors depressing earnings with respect to the net interest margin.[42] LLPs are linked to banks' assessment of their credit risk, which may involve a certain degree of discretion when determining them. The pressure on banks' profitability following a decrease in the net interest margin could give them an incentive to make a more optimistic assessment of their credit risk in order to compensate for this pressure.[43] Overall, the findings of the relevant literature suggest that a decrease in the level of interest rates has a greater impact on the net interest margin than on the return on assets.[44] Some studies were no longer even able to identify an effect on the latter.[45]

Empirical analysis for the euro area of the relationship between the interest rate level and the net interest margin

Empirical analysis for the euro area focuses on the low-interest-rate environment

The empirical analysis presented in the box on pages 47 to 51 examines the link between euro area banks' net interest margin and short-term interest rates as well as the slope of the yield curve for the years 2007 to 2016, ie a period which was, for the most part, characterised by a low-interest-rate environment. The study does not break down the net interest margin into the previously mentioned components (asset-side and liability-side margin contributions and the structural contribution).

Positive relationship between interest rate level and net interest margin only when interest rates are low

The analysis concludes that the interest rate level and the slope of the yield curve have a positive impact on the net interest margin of banks in the euro area and that the relationship is concave. Thus, the positive relationship between short-term interest rates and the net interest margin exists only if the short-term interest rate level is low. This finding is consistent with the above-mentioned results in the empirical literature. According to the estimation results, a persistent low-interest-rate environment, all other things being equal, erodes the net interest margin, at least with respect to traditional lending and deposit business. This can be explained by the fact that an interest rate decrease pushes down the net interest margin over not only the short term but also the longer term, since the remaining stock of high-interest loans will increasingly be replaced by new loans at lower interest rates as time goes on. The longer the low-interest-rate environment persists, the more likely the zero lower bound on deposit interest rates is to weigh on the net interest margin. In addition, the analysis shows that the slope of the yield curve becomes even more significant for the development of the net interest margin, the longer the periods of interest rate fixation in the loan portfolio are.

Rate rises in a low-interest-rate environment thus have profit-boosting effect

The strong positive relationship between the interest rate level and the net interest margin in the low-interest-rate environment implies that rate rises have a positive impact on the net interest margin of euro area banks, despite the countervailing effect produced by subdued demand for credit. In other words, banks are able to increase their average net income per asset as a result of interest rate rises. Beyond a certain level of higher interest rates, however, this relationship is either no longer significantly different from zero or negative. Thus, interest rate rises would have a restrictive effect on banks' profitability when the interest rate level is

42 See U Albertazzi and L Gambacorta (2009), op cit; C Borio, L Gambacorta and B Hofmann (2015), op cit; and C Altavilla, M Boucinha and J L Peydró (2017), Monetary policy and bank profitability in a low interest environment, ECB Working Paper Series No 2105.
43 For evidence on the use of LLPs to smooth profits, see G Gebhardt and Z Novotny-Farkas (2011), Mandatory IFRS adoption and accounting quality of European banks, Journal of Business Finance & Accounting, Vol 38, No 3, pp 289-333. The authors come to the conclusion, however, that this smoothing practice has eased significantly since the IFRS accounting standards were introduced.
44 See C Borio, L Gambacorta and B Hofmann (2015), op cit; and H Genay and R Podjasek (2014), op cit.
45 See C Altavilla, M Boucinha and J L Peydró (2017), op cit; and C Claessens, N Coleman and M Donnelly (2017), op cit.

Empirical study on the impact of the interest rate level and the slope of the yield curve on euro area banks' net interest margin

The individual Balance Sheet Items (iBSI) microdatabase (the source of the individual balance sheet items) and the individual MFI Interest Rate (iMIR) microdatabase (based on which the net interest margin of outstanding business is calculated) are used to examine the impact of the interest rate level and the slope of the yield curve on euro area banks' net interest margin.[1] Since the iBSI and iMIR data are reported monthly, it is possible to calculate the net interest margin on a monthly basis rather than quarterly or annually. In comparison to the net interest margin from the profit and loss account, this admittedly comprises only traditional banking business; however, analysing the impact of the interest rate – a high-frequency variable – on the net interest margin at a more frequent interval is advantageous from an empirical perspective. As the analysis does not have to rely on data published in the annual financial statements of large banking groups, the sample also includes many smaller banks for which net interest income is typically by far the most relevant income component. Restricting this analysis to the traditional banking business is also not so critical because this is the focus of the theoretical literature and the discussions on the potential burden of the low-interest-rate environment (including loss of the liability-side margin contribution, for instance). However, there are no monthly data available that would enable total profitability to be analysed empirically.[2]

The benchmark model takes the following form:

$$y_{i,t} = \sum_{n=1}^{2} \beta_n Y_{i,t-n} + \lambda X_{i,t-1} + \omega Y_{j,t} + \gamma_1 \sigma_t + \gamma_2 r_t + \gamma_3 r_t^2 + \gamma_4 \theta_{j,t} + \gamma_5 \theta_{j,t}^2 + \vartheta_1,$$

where y_{it} represents the net interest margin for bank i in month t. The use of quadratic terms makes it possible to include certain types of non-linearities.[3]

Country-specific variables are indexed with j. Alongside the interest rate variables – r_t represents the three-month overnight index swap (OIS) rate and $\theta_{j,t}$ the country-specific slope of the yield curve[4] – the dynamic model is based on the first two lags of the net interest margin $y_{i,t-1}$ and $y_{i,t-2}$, on a vector $X_{i,t-1}$ of bank-specific variables (capital ratio, loan loss provisions[5] over average total assets, government bonds over total assets, customer deposits over liabilities and log total assets (excluding capital))[6], on a vector $Y_{j,t}$ of country-specific macroeconomic variables (Herfindahl concentration index, GDP growth rate, stock index growth

1 See M Klein and S Bredl (2018), The relevance of the level of interest rates for banks' net interest margin in the euro area, Mimeo.
2 Other studies use lower-frequency data to analyse total profitability; see, inter alia, C Altavilla, M Boucinha and J L Peydró (2017), Monetary policy and bank profitability in a low interest environment, ECB Working Paper Series No 2105.
3 See C Borio, L Gambacorta and B Hofmann (2015), The influence of monetary policy on bank profitability, BIS Working Paper No 514.
4 The difference between the ten-year country-specific sovereign bond yield and the three-month OIS rate represents the slope of the yield curve. The source of data on the ten-year sovereign bond yield is the ECB Statistical Data Warehouse; that of the three-month OIS rate is Thomson Reuters Datastream.
5 Loan loss provisions is a flow variable which, if positively signed, represents earnings (eg release of loan loss provisions) and, if negatively signed, represents an expense (eg formation of loan loss provisions).
6 Earnings and capital metrics (capital ratio, loan loss provisions over average total assets) are based on annual data (interpolated from monthly data) and are sourced from the S&P Global Market Intelligence (formerly SNL Financial) and Orbis Bank Focus (formerly Bankscope) databases. These data are linked to the iBSI and iMIR data at the level of the individual bank.

Regression results of the benchmark model[o]

Variables	Model 1	Model 2
Y_{t-1}	0.7573*** (0.0669)	0.7573*** (0.0774)
Y_{t-2}	0.1799*** (0.0606)	0.1799** (0.0716)
$GovBonds\_Assets_{t-1}$	– 0.0003 (0.0012)	– 0.0003 (0.0012)
log_Assets_{t-1}	0.0154 (0.0135)	0.0154 (0.0158)
$Dep\_Liabilities_{t-1}$	0.0004 (0.0004)	0.0004 (0.0004)
$CapitalRatio_{t-12}$	– 0.0021 (0.0018)	– 0.0021 (0.0020)
$LoanLossProvisions\_Assets_{t-12}$	0.0772** (0.0326)	0.0772** (0.0368)
Herfindahl_Concentration-Index	– 0.3455** (0.1589)	– 0.3455* (0.1862)
ΔGDP	0.0010 (0.0008)	0.0010 (0.0009)
ΔStockIndex	0.0002 (0.0002)	0.0002 (0.0004)
Vol_{OIS3M}	– 0.0701*** (0.0134)	– 0.0701*** (0.0188)
Short-TermRate	0.0416*** (0.0081)	0.0416*** (0.0123)
Short-TermRate^2	– 0.0056*** (0.0019)	– 0.0056 (0.0035)
YieldCurveSlope	0.0218*** (0.0046)	0.0218*** (0.0081)
YieldCurveSlope^2	– 0.0026*** (0.0005)	– 0.0026*** (0.0009)
Observations	12,045	12,043
Number of banks	174	172
AvgT	69	70
Bank FE	yes	yes
Cluster-robust standard errors at bank level	yes	yes
Cluster-robust standard errors at country * month level	no	yes

o Y_{t-n} represents the dependent variable, ie the net interest margin. The short-term interest rate is the three-month overnight index swap (OIS) rate. The slope of the yield curve is calculated from the ten-year country-specific sovereign bond yield minus the three-month OIS rate. Estimation period: August 2007 to December 2016. Cluster-robust standard errors in brackets: *** p<0.01, ** p<0.05, * p<0.1.

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rate)[7] and of the volatility of the short-term interest rate σ_t.[8] ϑ_i is the term for bank fixed effects which corrects for individual, time-constant and unobserved factors. The regressions were estimated using OLS (Within-estimator) and cluster-robust standard errors at bank level.[9,10] Owing to potential endogeneity between the dependent variables and the other bank-specific variables, the latter are fed into the estimation with a lagged term. In the case of the interpolated annual data, the first lagged observation is the preceding year. The estimation period runs from August 2007 to December 2016. Government authorities' responses to the financial and sovereign debt crisis, which occurred during this period, included enormous government rescue packages for banking sectors. By that token, the relationship between the capital ratio and the net interest margin in the empirical study is likely to be biased if there is no check for government recapitalisation measures.[11] The banks concerned are thus included in the regressions only after successful recapitalisation.[12] In addition, the dataset was adjusted to remove Greek, Cypriot and Estonian banks since either no data were available on long-term government bond yields or they took on extreme values over a lengthy period owing to the sovereign debt crisis. On the whole, the banking sample of

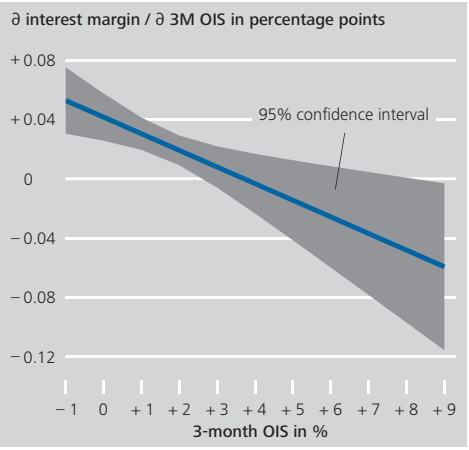
7 The data source for the Herfindahl concentration index is the ECB Statistical Data Warehouse; for seasonally adjusted GDP, Eurostat; for the stock index, Thomson Reuters Datastream.
8 The volatility of the short-term interest rate is the 12-month moving standard deviation of the three-month OIS rate.
9 To analyse for robustness, the estimation was also performed using two-way clustering (at bank level and, at the same time, using an interaction term (country * month)). The results remained virtually unchanged.
10 The Nickell bias could theoretically bias standard errors. However, for panel estimations with a large time dimension – where the average T of the model is 69 – this bias tends to be negligible. See, for example, J Breitung, The analysis of macroeconomic panel data, in B H Baltagi (2015), The Oxford Handbook of Panel Data, Oxford University Press, pp 453-492.
11 For more information on the effects of government rescue packages on bank lending, see M Brei, L Gambacorta and G von Peter (2011), Rescue packages and bank lending, BIS Working Paper No 357.
12 The time of recapitalisation was set using the European Commission's state aid database (see http://ec.europa.eu/competition/state_aid/register/).

the estimation covers around 50% of the stock of loans granted to the private non-financial sector in the euro area.

In line with the results of the empirical literature, the results of the benchmark model show that the level of the short-term interest rate and the slope of the yield curve have a positive impact on euro area banks' net interest margin (see the table on page 48). The coefficients of the quadratic terms are also significantly different from zero. They are negatively signed meaning that the relationship between the interest rate level and the net interest margin is concave. The adjacent charts give a graphic representation of this development[13] using the first derivatives of the short-term interest rate and the slope. The relationship between the short-term interest rate and the net interest margin is positive only for lower values of the short-term interest rate. Borio et al (2015) ascertain similar findings in their analysis of globally active banking groups.[14] What is striking is the dependent variables' high degree of persistence, indicating that monthly new business only has a minor impact on the net interest margin. Moreover, during the financial and sovereign debt crisis, euro area banks took a rather cautious approach to new lending, which – all other things being equal – is likely to have increased the estimated persistence of the net interest margin compared to a non-crisis period.[15]

The negative relationship in the short run, which Busch and Memmel (2017) show empirically and Alessandri and Nelson (2015) show theoretically, suggests that there are temporal frictions in the pricing of loans due to the longer interest rate fixation periods, and these, in turn, suggest that the dynamics of the model are more complex

Effect of a change in the short-term interest rate on the net interest margin*



* The chart is based on the regression results of the benchmark model. The horizontal axis shows the three-month overnight index swap (OIS) rate. The vertical axis shows the first derivative of the net interest margin as a function of the short-term interest rate.

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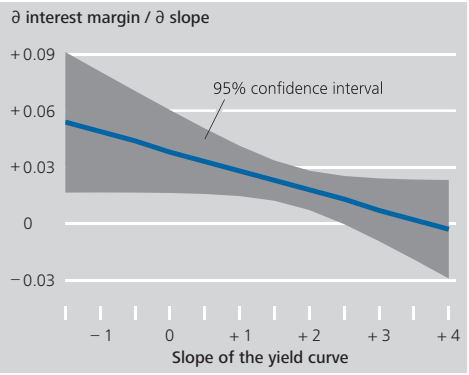
Effect of a change in the slope of the yield curve on the net interest margin*

Percentage points



* The chart is based on the regression results of the specification which contains only those countries where the banking system is characterised by long interest rate fixation periods for outstanding loans (BE, DE, FR, NL). The horizontal axis shows the country-specific slope of the yield curve. The vertical axis shows the first derivative of the net interest margin as a function of the slope (difference between the ten-year sovereign bond yield and the three-month overnight index swap (OIS) rate) of the yield curve.

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13 Concavity exists when the first derivative falls monotonically and the second derivative is negative. Both charts therefore implicitly show a concave relationship.

14 See C Borio et al (2015), op cit.

15 Persistence in empirical literature that uses quarterly and annual data is lower, but still the coefficient often lies between 0.8 and 0.9. For more information on credit growth in the euro area during the crisis period, see Deutsche Bundesbank, Recent developments in loans to euro-area non-financial corporations, Monthly Report, September 2015, pp 15-39.

Regression results of the robustness analyses[o]

Variables	Dynamic short-term interest rate	Stressed countries	Non-stressed countries	Countries with long interest rate fixation periods
Y_{t-1}	0.7559*** (0.0668)	0.9239*** (0.0188)	0.7092*** (0.0712)	0.6969*** (0.0716)
Y_{t-2}	0.1814*** (0.0605)	0.0208 (0.0193)	0.2226*** (0.0624)	0.2342*** (0.0621)
GovBonds_Assets$_{t-1}$	– 0.0002 (0.0012)	– 0.0003 (0.0012)	0.0002 (0.0019)	– 0.0011 (0.0026)
log_Assets$_{t-1}$	0.0161 (0.0134)	– 0.0090 (0.0134)	0.0436* (0.0222)	0.0553* (0.0282)
Dep_Liabilities$_{t-1}$	0.0004 (0.0004)	0.0007 (0.0004)	0.0001 (0.0007)	– 0.0003 (0.0009)
CapitalRatio$_{t-12}$	– 0.0017 (0.0019)	– 0.0025 (0.0023)	– 0.0004 (0.0031)	– 0.0003 (0.0044)
LoanLossProvisions_ Assets$_{t-12}$	0.0678** (0.0331)	0.0586 (0.0365)	– 0.0426 (0.0989)	– 0.0224 (0.1130)
Herfindahl_Concentration-Index	– 0.3690** (0.1620)	0.0158 (0.4952)	– 0.2103 (0.1577)	– 0.9670* (0.5457)
ΔGDP	0.0006 (0.0008)	0.0012* (0.0007)	– 0.0049** (0.0020)	– 0.0053* (0.0030)
ΔStockIndex	– 0.0002 (0.0002)	– 0.0001 (0.0002)	0.0004 (0.0003)	0.0005 (0.0004)
Vol$_{OIS3M}$	– 0.0554*** (0.0126)	– 0.0971*** (0.0114)	– 0.0825*** (0.0218)	– 0.0833*** (0.0248)
Short-TermRate	0.1409*** (0.0198)	0.0743*** (0.0089)	0.0278** (0.0115)	0.0304** (0.0136)
Short-TermRate$_{t-1}$	– 0.0919*** (0.0167)			
Short-TermRate^2	– 0.0070*** (0.0020)	– 0.0094*** (0.0023)	– 0.0047 (0.0031)	– 0.0065* (0.0035)
YieldCurveSlope	0.0165*** (0.0043)	0.0096* (0.0051)	0.0427*** (0.0089)	0.0384*** (0.0113)
YieldCurveSlope^2	– 0.0021*** (0.0005)	– 0.0013** (0.0005)	– 0.0065*** (0.0019)	– 0.0052* (0.0028)
Observations	12,045	4,381	7,664	5,812
Number of banks	174	60	114	82
AvgT	69	73	67	71
Bank FE	yes	yes	yes	yes

o Y_{t-n} represents the dependent variable, ie the net interest margin. The short-term interest rate is the three-month overnight index swap (OIS) rate. The slope of the yield curve is calculated from the ten-year country-specific sovereign bond yield minus the three-month OIS rate. Stressed countries are Spain, Italy, Ireland, Portugal and Slovenia. Countries where the banking system is characterised by long interest rate fixation periods are Belgium, Germany, France and the Netherlands. Estimation period: August 2007 to December 2016. Cluster-robust standard errors at bank level in brackets: *** p<0.01, ** p<0.05, * p<0.1.

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with regard to the interest rate variables.[16] To check the validity of the dynamics of the empirical model, the lagged interest rate variable is thus included in the regression by means of a robustness analysis. Furthermore, consideration is also given to the heterogeneity of the European banking sector, which also came to light in particular as a result of the crisis, by differentiating between those countries that were more affected by the sovereign debt crisis (Spain, Italy, Ireland, Portugal and Slovenia) and those that were less affected. Moreover, a separate specification is estimated for those

16 See P Alessandri and B D Nelson (2015), Simple banking: Profitability and the yield curve, Journal of Money, Credit and Banking, Vol 47(1), pp 143-175; and R Busch and C Memmel (2017), Banks' net interest margin and the level of interest rates, Credit and Capital Markets 50(3), pp 363-392.

countries where long interest rate fixation periods are highly dominant in banks' stock of loans (Belgium, Germany, France and the Netherlands).[17]

The significance of the coefficients of the lagged short-term interest rate and the lagged endogenous variable shows that the dynamics of the short-term interest rate provide additional explanatory content (see the table on page 50).[18] Overall, in terms of quality, the results are robust; the quantitative importance of the short-term interest rate and the slope of the yield curve for the net interest margin varies, however. For the countries affected by the crisis, where the banking system is characterised by variable interest rates and short interest rate fixation periods for the stock of loans, the impact of the short-term interest rate on the net interest margin, including the quadratic term, is – as expected – rather pronounced compared to the other specifications; conversely, the country-specific slope of the yield curve has virtually no impact on the net interest margin.[19] The structurally high share of long interest rate fixation periods in Belgium, Germany, France and the Netherlands is also reflected in the high importance of the slope of the yield curve. The relationship between the short-term interest rate and the margin of the banks in these countries, on the other hand, is much weaker and linear; the coefficient of the quadratic term is insignificant.

17 Data on the interest rate fixation periods for outstanding business are not available at individual bank level in the iBSI microdatabase.
18 Since the correlation between the contemporaneous short-term interest rate and its first lag is approaching one, caution should be exercised when interpreting the level of the estimated coefficient owing to multicollinearity.
19 In these countries (Spain, Italy, Ireland, Portugal and Slovenia), loans with short interest rate fixation periods and a variable interest rate make up around 80% of the stock of loans.

higher. This is consistent with the findings of Van den Heuvel (2007), who models the reactions of banks on the basis of interest rate levels of 5% and 6%.

Conclusion

Impact of monetary policy decisively dependent on banks' balance sheet situation

Bank profitability and capital have, for a number of reasons, been receiving greater attention of late, including from monetary policymakers. One reason for this is that banks play a central role in the transmission of monetary policy measures, and the stability and functioning of the banking system are therefore of key importance for monetary policy's effectiveness. Another is that recent research with differentiated modelling of bank-side transmission channels has revealed the existence of a two-way relationship between monetary policy and bank profitability and capital. By influencing the interest rate level and slope of the yield curve using their standard and non-standard measures, central banks have an impact on the development of bank profitability and capital. However, the balance sheet situation of banks (including their stock of NPLs and their capital endowment) as well as the prevailing interest rate level are decisive for the effectiveness of monetary policy.

In the low-interest-rate environment, decrease in interest rate level can negatively affect bank profitability

In light of the increased capital requirements of banks since the crisis and the persistent low-interest-rate environment, the finding presented in this article of a non-linear relationship between interest rates and banks' net interest margin is of particular interest. According to the empirical studies discussed, a strong positive relationship exists between the two variables when interest rates are at a low level, ie the net interest margin becomes even lower, the lower the interest rate level is. The net interest margin is closely tied to net interest income, which is generally the most significant component of operating income and is a key driver of a bank's overall profitability. In add-

ition, the latter is dependent on further components, such as LLPs or effects on the valuation of marked-to-market assets. While profitability is only impacted once by the effects on market prices induced by changes in the interest rate level, the effects on LLPs may also persist over the longer term. However, it is unclear whether these are sufficient to compensate for the narrowing of the net interest margin when the interest rate level is reduced in an environment of already low interest rates.

Bank capital channel can thus weaken monetary policy transmission in low-interest-rate environment

Hence, in a low-interest-rate environment, a situation may arise where expansionary monetary policy measures could, at least in the longer term, weigh on profitability, whereas restrictive measures would support profitability, impacting accordingly on banks' ability to build up capital and thus, in principle, also on lending. Ultimately, this means that, in the long term, the effect of a monetary policy measure transmitted through the bank capital channel would end up weakening the effect that was actually intended. This scenario is not consistent with previous analyses of this channel in the literature, which had considered the bank capital channel to be an amplifier of monetary policy. It should be emphasised, however, that these past studies did not factor the historically unusual environment of persistently low interest rates into their assumptions and they therefore postulated a contrasting relationship between monetary policy measures and the profitability of banks. On account of the demonstrated non-linear relationship, the empirical results of the analyses presented here show that when the general interest rate level is high, increases in central banks' official interest rates also have a restrictive effect. This is consistent with the findings of previous literature on the bank capital channel.

Good capital endowment in banking system crucial for monetary policy

The bank capital channel is likely to be particularly effective when banks' capital endowment is low – ie when they are operating at levels of capital close to those specified by regulatory requirements – and in addition, when access to capital in the market is constrained. It is precisely because the intended effects of monetary policy measures could be weakened by the bank capital channel in a low-interest-rate environment that good capital endowment – which is sufficiently above the regulatory minimum and which helps to ensure financial stability – is crucial from a monetary policy perspective. The worse the capital position of banks is, particularly in a low-interest-rate environment, the stronger any adverse reactions of the banks to monetary policy measures are likely to be, and the harder it will become for monetary policymakers to achieve their objective of maintaining price stability.