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The growth-at-risk perspective on the system-wide impact of Basel III finalisation in the euro area

Contents

Abstract

This paper assesses the macroeconomic implications of the Basel III finalisation for the euro area, employing a large-scale semi-structural model encompassing over 90 banks and 19-euro area economies. The new regulatory framework will influence banks' reactions to economic conditions and, as a result, affect the ability of the banking system to amplify or dampen economic shocks. The assessment covers the entire distribution of conditional economic predictions to measure the cost and benefit of the reforms. Looking at the means of conditional forecasts of output growth provides an indication of the costs of the reform, namely a transitory reduction in euro area gross domestic product (GDP) and in lending to the non-financial private sector. Looking at the lower percentile of output growth forecasts, i.e. growth at risk, captures the long-term benefits of the Basel III finalisation package in terms of improved resilience and the ability of the banking system to supply lending to the real economy under adverse conditions. These permanent growth-at-risk benefits ultimately outweigh the short-term costs of the reform.

Executive summary

The finalisation of the Basel III framework will limit the potential for regulatory arbitrage arising from the use of internal models and reduce variations in risk estimates. The reform package was published at the end of 2017 (Basel Committee on Banking Supervision, 2017) and was expected, at that time, to result in an aggregate shortfall of about EUR 83 billion in terms of Common Equity Tier 1 (CET1) at European Union level (EBA, 2019). The introduction of the Basel III finalisation was postponed by one year in response to the impact of COVID-19 developments and is currently expected to come into effect by 1 January 2023, with the accompanying transitional arrangements for the output floor continuing until 1 January 2029.

This paper presents an assessment of the impact of the Basel III finalisation on the euro area economy from a growth-at-risk perspective. The impact assessment employs a large-scale semi-structural model reflecting the dynamics of 91 significant euro area banks and 19-euro area economies. The model captures the impact of the reforms on the banks' balance sheets, on their loan supply and on the real economy. The innovative part of the methodology is its focus on the full distribution of possible outcomes, reflecting uncertainty about future economic developments. The growth-at-risk (GaR) perspective means looking at the "tails" of the distributions of macro-financial variables to assess the resilience of the system.

The implementation costs of the Basel III finalisation amount to the deterioration in macroeconomic variables under normal economic conditions and compared to a scenario in which the Basel III finalisation was not implemented. Under normal macroeconomic conditions, the initial impact of the Basel III finalisation would be an increase in risk exposure amounts (REA) of around 25%. This increase in REA would translate into a reduction in the euro area wide CET1 ratio of 2.5 percentage points. Over a 10-year horizon banks would manage to fully close the gap in the CET1 ratio. The effect on the real economy would be contained. In the short term – namely in the first four years following the reform – it is anticipated that annual GDP growth would be around 0.2 percentage points lower under the new regime. However, the growth dynamic reverses thereafter, and GDP expands cumulatively by about 0.5 percentage points over the next five years. The long-term effect on the expected growth level of the euro area GDP would be zero.

The benefits would arise from the improvement in macroeconomic variables under adverse conditions, as measured by the lower percentiles of the output growth distribution akin to the GaR metrics. In the long term, adverse GDP growth outcomes, falling into the 10th percentile of the GDP growth distribution, were around 0.1 percentage points higher, reflecting a combination of both a lower likelihood of very deep recessions occurring and milder recession outcomes. Recessions would become shorter, shallower and less costly, with a median recession resulting in GDP losses being around 0.2 percentage points lower.

The analysis disentangles the main sources of both transitional costs and long-term benefits. In the first year following the introduction of the Basel III finalisation, around 20% of banks would experience a reduction in their actual capital ratio below their internal targets. Half of them (accounting for 28% of total banking sector assets) would experience a reduction in their actual capital ratio below regulatory targets. Banks with moderate capital shortfalls and strong profit-generation capacity could cover the additional capital needs by retaining earnings. On aggregate, retained earnings were twice as important for restoring CET1 capital ratio as a reduction in risk weighted amounts. Banks with a low initial level of capitalisation, or having low profitability, experiencing a strong impact from Basel III reforms were more likely to restore their capital ratios through deleveraging.

The revision of bank risk charges would result in a system-wide leverage ratio higher by around 0.6 percentage points in the long term. A broad-based but targeted increase in capital charges on multiple exposures would limit banks' ability to reduce the overall capital charge by re-optimising the composition of their portfolios. Consequently, the risk-weight intensity of bank portfolios would increase sustainably and improve their leverage ratios. Higher bank capitalisation would have positive implications for bank loss-absorbing capacity and funding costs. The ability to absorb losses resulting from, for instance, a deterioration of asset quality was likely to increase, system wide and in CET1 capital terms, by 15% ten years after the phase-in of the reforms. Improved bank capitalisation should also lead to a decrease in the premium required by wholesale investors and should have a positive effect on bank profitability in the longer horizon.

Most of the assumptions underlying the cost estimates are conservative. Some assumptions might lead to an overestimation of the overall scale of bank deleveraging. For example, it was assumed that banks did not anticipate changes in regulations. However, banks have several years to prepare and adjust before new rules come into force. It was also assumed that banks could not tap equity markets and were unable to raise capital by issuing new shares. Furthermore, the model incorporated the dynamics of the largest euro area banks only. Since the largest banks are expected to be those most impacted by the final Basel III rules, this assumption overstates the aggregate cost estimates. Last, capital requirements and buffers set by regulators were assumed to remain unchanged.

1   Introduction

The Basel III framework aims to build a more resilient financial system by addressing shortcomings in the pre-crisis regulatory environment. The Basel III standards were put forward in a two-stage process. The initial phase of reforms was announced in 2010 and incorporated into CRDIV[1]/CRR[2]. This initial set of Basel III solutions focused on strengthening the capital position of banks by shifting the focus to going-concern loss-absorbing capital (Common Equity Tier 1), increasing minimum capital requirements, and introducing macroprudential capital buffers. In essence, the first set of Basel III rules addressed concerns relating to calculation of the numerator for the capital ratio.

The final Basel III framework focuses on ensuring the comparability of risk-weighted amounts (RWAs) across banks and reducing their dispersion across banks. The framework was announced in 2017 and complements the previous round of regulatory changes. It introduces three measures to address the variability of risk weighted amounts: (a) increased robustness and risk-sensitivity of the standardised approach for credit risk, credit valuation adjustment (CVA) and operational risk; (b) additional constraints on the use of internal models for credit risk, and the removal of the internal model approach for CVA and operational risk; (c) more-robust and risk-sensitive floors to replace the existing Basel II floors. The Basel III finalisation also introduces a binding leverage ratio and an additional buffer to limit the leverage of global systemically important banks (G-SIBs).

This paper looks at the system-wide costs and benefits of the Basel III finalisation package for the euro area through the lens of a large-scale semi-structural model and a growth-at-risk perspective. It derives the impact of the Basel III finalisation from the difference between the distributions of economic outcomes with and without the Basel III reforms. The costs of the package are proportional to the expected contraction of output growth on the mean path of the economy. The benefits in terms of resilience derive from the "tails" of output growth distributions that represent crisis and recession events. The assessment focuses on the effects of the Basel III finalisation package on euro area output, along with lending to the non-financial private sector, bank solvency and leverage. It rests on the same methodology, though on a different sample of banks and economies, as the impact assessment published by the European Banking Authority (EBA) in December 2019 (EBA, 2019a).

The complexity of the new Basel reforms poses significant challenges for modelling their economy-wide effects. First, a significant number of the proposals target the capital ratio denominator rather than its numerator. The immediate effect of

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the reforms would thus be a reduction in the actual capital ratios. So far, empirical literature has focused more on assessing the effects of an increase in the regulatory, or target, capital ratios. There is also little evidence on how an increase in risk weighted amounts might differ from the proportional increase in the target capital ratios. Second, the comprehensive design of the package means that its impact is likely to be very heterogeneous across banks depending, for example, on the degree to which they rely on internal models or on their balance-sheet structure. Lastly, some of regulatory limits proposed in the Basel III finalisation will only be occasionally binding and will tighten their grip in line with the economic or bank-specific situation. This applies to the leverage buffer and the output floor.

The macro-micro model (the Banking euro area Stress Test (BEAST)) combines bank behavioural responses to economic conditions with a detailed modelling of their balance sheets. BEAST is a large-scale semi-structural model encompassing 19-euro area economies and over 90 banks. The model looks at the banking book of banks to derive the exposure level country by country and calculates the credit risk charges at a similar level of granularity. It also supports the calculation of market and operational risk charges. A set of behavioural equations predicts bank behaviour in terms of profit distribution, lending, interest rates and adjustments in liability structures in response to regulatory requirements and economic conditions. Finally, it considers the fact that bank lending and interest-rate decisions in turn affect the dynamics of the economies within which the banks operate.

The model is employed to construct many economic scenarios, alternating between the assumption that the Basel III finalisation is and is not implemented. The model is well tailored to produce conditional forecasts for both banking-sector and real-economy variables and, through stochastic simulations, makes it possible to observe the effects of the regulation in highly adverse (or positive) economic conditions. The implementation costs of the Basel III package are measured as the expected deterioration in macroeconomic variables when the Basel III finalisation is implemented versus when it is not implemented.[3] The benefits arise from the improvement in macroeconomic variables under most adverse scenarios, in the lower percentiles of the output growth distribution, when the Basel III finalisation is implemented, as compared to a counterfactual situation in which the reforms are not implemented. The evaluation of both costs and benefits follows the same set of assumptions about bank behaviours and the real economy and involves identical sets of propagation channels.

The GaR perspective balances the costs and benefits of the regulation by looking at the whole distribution of economic outcomes. Looking at the reform-induced shifts in the lower percentile of the growth distribution, i.e. GaR metrics, provides an indication of the pre-emptive nature of prudential policies. Events in the

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[3]   The costs are measured against the assumption that the reforms will be phased-in average economic conditions. These costs would likely have been higher if the reform package were introduced in a recession, such as the one triggered by the Covid-19 pandemics. However, the decision of the Basel Committee's oversight body on 27 March 2020 to defer the introduction of the Basel III finalisation until 2023 confirms the determination of the Committee to avoid phasing-in of the reform in adverse economic conditions.

"tails" of the output distribution, though rare, are accompanied by greater financial vulnerabilities, reveal non-linear dynamics, and lead to disproportionately heavy output and welfare losses. It is precisely the close correspondence between financial stability concerns and lower percentiles of the distributions of economic variables, that gives the GaR concept its potency. Compared to the net benefit assessment of capital regulation based on the so-called Long-term Economic Impact approach (BCBS, 2010), the semi-structural GaR analysis does not rely on rare observations of crisis events and their costs. Compared to reduced-form GaR setups, such as quantile regressions (Adrian et al., 2016), the analysis provides information about the economic mechanisms underlying the results.

The costs of introducing the Basel III reforms appear to be moderate and transitory. Initially, bank solvency rates drop, triggering a reduction in the growth of lending to the non-financial private sector and a modest contraction in output. Within a few years, however, banks restore their solvency rates and reduce leverage, while lending and output growth rates rebound.

The resilience gains, in contrast, are permanent and accumulate over time. The analysis focuses on the 10th percentile of growth distribution, which represents sufficiently unfavourable circumstances while at the same time offering enough accuracy. The growth rate of the euro area economy in adverse circumstances with a completed Basel III reform is sustainably higher and the costs of future economic crises reduced.

The paper is structured as follows. The next section, Section 2, discusses the new reforms introduced by the Basel III finalisation package in more detail. Section 3 summarises the modelling approach. Section 4 looks at the costs of the Basel III finalisation reforms if the euro area economy will grow along its expected path, as in the early 2019. Section 5 elaborates on the benefits of the Basel reforms in terms of building banking sector and economy-wide resilience. Section 6 presents selected results in more depth to enrich the intuitive assumptions about main transmission channels. Section 7 concludes with some final remarks and policy implications.

2   Basel III finalisation

The final Basel III package of reforms announced in December 2017 complements the initial Basel III rules. The first package of Basel III rules was adopted as international standards by the Basel Committee on Banking Supervision (BCBS) back in 2010, and were mainly aimed at defining strengthened capital, liquidity and leverage ratio standards. The amendments included in the Basel III finalisation revise how risk-weighted amounts are calculated and limit banks' scope to quantify risks using their own internal models in order to improve the level playing field across institutions. The new standards were initially scheduled for implementation in 2022, with the phase-in for the output floor extending until 2027. The phase-in will ease the transition towards the new regulatory setting and will provide financial institutions with enough time to adapt while avoiding any potential disruptive consequence for the market.

The revision of the standardised approach for credit risk is aimed at enhancing the risk sensitivity of capital requirements and reducing bank reliance on external credit ratings. The biggest change concerns exposures secured by real estate, where the risk weight will depend on loan-to-value (LTV), with banks having the option to choose between granular LTV categorisation and the simplified risk-splitting approach. Exposures to small and medium-sized enterprises (SMEs) receive special treatment within the corporate segment with a common risk weighting of 85%. For exposures to other sectors, the revision of Basel standards requires greater involvement of banks in risk assessment and diminishes the use of external credit ratings. Beyond the higher granularity of exposures into the sectors mentioned above, the regulation entails separating exposures further into exposures to banks, specialised lending (such as project finance), and introducing a more detailed split between subordinated-debt and equity exposures.

The revision of the internal model approach for credit risk targets a reduction of divergences in the calculation of risk-weighted assets. In particular, the advanced internal ratings-based (IRB) approach is phased out. Only the foundation IRB[4] and standardised approaches are available for exposures to large/mid-sized corporates, banks and other financial institutions, while only the standardised approach can be adopted in the case of equity exposures. IRB approaches are additionally bounded by input floors for bank probability of default (PD) and loss given default (LGD) to ensure a mandatory minimum level of capital to cover credit risk.

The operational risk framework has been replaced with a single and streamlined risk-sensitive standardised approach to be applied by all banks. The pre-crisis rules proved unsatisfactory for two reasons: first, because the capital requirements appeared insufficient; second, because the nature of these kinds of

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[4]   While the advanced IRB approach allows banks to model not only PDs, but also LGDs and exposure at default (EADs), the foundation IRB keeps fixed values for both the LGD and EAD parameters, thus strongly reducing the sources of variability in calculation of risk-weighted assets.

loss – that are hardly predictable – does not make them particularly suitable for estimation with internal models. The new metrics thus relate banks' operational capital requirements to a measure of a bank's income and its historical operational risk losses.

The package likewise enhances the risk sensitivity and consistency of the credit valuation adjustment (CVA) framework. CVA risk was a major source of losses during the global financial crisis, and in order to cover this risk appropriately, the new capital requirements will depend on the size of derivative exposures. In this way, the updated Basel package tackles potential mark-to-market counterparty credit risk and realigns CVA risk with the BCBS fundamental review of the trading book (FRTB) rules (discussed in greater detail below). The CVA capital charges can be calculated only by applying the standardised or basic approach, while the option to use internal model approach is removed.

The Basel III finalisation package includes a leverage buffer for G-SIBs as well. The buffer complements a minimum leverage ratio requirement included in the initial Basel III rules and applied to all banks. The G-SIB leverage ratio buffer must be met with Tier 1 capital and is set at a level that is half of the G-SIB buffer. A breach of the buffer Tier 1 requirements will trigger profit distribution constraints and the associated minimum capital conservation requirements.

The new Basel III output floor, calibrated based on the standardised approach, limits the benefits that a bank can generate by using internal models instead of the standardised approach. More precisely, banks' risk-weighted assets have to be calculated at the value of (a) the total RWAs calculated according to the approaches approved by the bank's supervisor, or (b) 72.5% of the total RWAs if they were calculated using only non-modelling approaches for all the risk categories (credit risk, counterparty credit risk, CVA risk, securitisation, market risk, operational risk), whichever is the higher.

In parallel to the Basel III agreements, the BCBS worked on a revision of the market risk framework. The revised framework was published in 2016 and referred to as the fundamental review of the trading book (FRTB). In line with the spirit of the Basel III reforms, the new market risk framework aimed at improving the level playing field and comparability across banks, therein reducing the arbitrage opportunities that could arise from the interplay between credit risk and market risk. To this end, stricter criteria and classification guidelines were introduced to control the assignment of specific instruments to the trading book, and a stringent approach was adopted to govern the movement of instruments between accounting books. In addition, the internal model approach was substantially revamped, while the standardised approach was enhanced and made more risk sensitive.[5]

In 2019, the BCBS included a quantitative analysis on the impact of the Basel III finalisation as a part of their regular Basel III Monitoring Report (BCBS, 2019). The analysis is informed in a bottom-up fashion by banks' responses to so-

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[5]   Please note that the 2016 revision of market risk was followed by a further revision in January 2019, the objective being to amend some of the requirements and include certain clarifications with the aim of reducing the implementation burden of the changes.

called Quantitative Impact Study (QIS) questionnaires. It rests on the static balance sheet assumption and assumes full implementation of the reforms. It finds an increase of 21.3% in Tier 1 minimum required capital (MRC) for the largest and internationally active (Group 1[6]) banks from European BCBS member states.[7] The regular Basel III monitoring report by the EBA (2019b) rests on similar assumptions and methodology but includes a richer sample of European banks. It concludes that the Basel III finalisation will result in an increase of 19.3% in MRC for the average bank in the sample, and of 20.7% for Group 1 banks.

Additionally, in 2019 the EBA ran a quantitative analysis of the estimated impact of the Basel III finalisation in response to the European Commission's Call for Advice. This analysis relies on QIS questionnaires and on a sample of 189 European Union banks (EBA, 2019a, 2019c). The analysis shows that the minimum capital requirement (MCR) would increase by 23.6% on average. This increase in capital requirements implies an aggregate shortfall in total capital of about EUR 124.8 billion (EUR 83 billion in terms of CET1).

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6   A bank is classified into Group 1 if its Tier 1 exceeds EUR 3 billion and it is internationally active.

7   These include Belgium, Germany, Spain, France, Italy, Luxembourg, Netherlands, Russia, Switzerland, Sweden, Turkey, United Kingdom.

3 Methodology

3.1 The model

The exercise employs a large scale semi-structural model linking macro and bank-level data. The model captures the heterogeneous behaviour of individual banks and includes interactions between the financial sector and the real economy.[8] It covers 91 of the largest euro area banks with their individual balance sheets and profit and loss accounts and 19-euro area economies. The sample of banks covers broadly 65% of the euro area banking sector in terms of total assets, allowing for a detailed analysis of the reform's impact on banks across European jurisdictions.

The model looks at dynamic adjustments of banks and economies. The approach focuses on modelling bank adjustments of loan and other asset volumes accompanied by behavioural responses through their liability structure (see Chart 1). It also projects the evolution of loan pricing, funding costs and profit-distribution policies based on empirical bank-level evidence. Finally, the model aggregates the impact of these individual bank responses on credit supply and lending rates to the real economy, thus also capturing the dynamic interdependencies of aggregate real and financial variables.

Chart 1
Schematic illustration of the BEAST
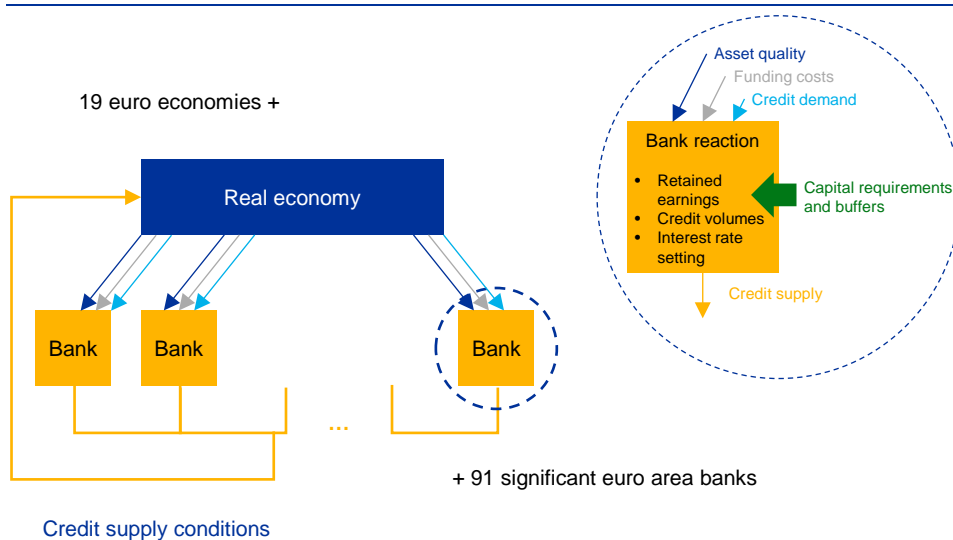
Bank assets are included based on a sectoral and geographical breakdown to reflect heterogeneous exposures to macroeconomic shocks. The model accounts for individual banking-book structures, distinguishing between bank exposures to sovereigns, the financial sector, the non-financial corporate sector,

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[8]   For a more detailed description of the model, see Budnik et al. (2020) and the earlier example of its use in Budnik et al. (2019).

household lending backed by real estate, and household loans for consumption purposes. For lending to the non-financial private sector, the model separates exposures by country of exposure. In addition, for each of these portfolios, the model replicates the International Financial Reporting Standard 9 (IFRS9) impairment stages with endogenous transition rates and the changes in risk weightings conditional on the macroeconomic developments. Credit-risk weightings are modelled separately for advanced foundation internal models (IRB) and for the standardised approach. The detailed representation of banks' risk-weighted assets supports the analysis of the detailed changes in risk-weighting requirements. Banks are also allowed to adjust their loan volumes within and across these sub-segments in response to loan demand conditions and depending on their own capital position, profitability or quality of assets.

The liability side distinguishes between equity, customer deposits and other debt funding. The evolution of term deposits from households, term deposits from non-financial corporations, sight deposits from households, and sight deposits from non-financial corporations is shaped mainly by general economic conditions, and to a lesser degree influenced by deposit margins offered by individual banks. Banks are assumed to fill the funding gap between equity and customer deposits, first with deposits from sovereigns and other financial institutions and, in the next stage, with wholesale funding. The cost of wholesale funding depends on endogenous maturity choices and the bank leverage ratio. This channel captures the effects of higher capitalisation on bank funding costs and its counterbalancing impact on profitability.

Regarding profits and losses, the framework dynamically models net interest income, loan-loss provisioning and net fee and commission income. Bank-level interest rates on new lending and deposit rates depend on economic conditions, banks' situation and monetary policy rates. Other components of the profit and loss statement, such as dividend income, follow simple dynamic rules linking them, for instance, to the change in the total assets of banks. The dynamics of trading-book assets and market-risk capital surcharge, dividend holdings of banks, and operational-risk capital charge follow similar simplified dynamics. Finally, it is presumed that banks adjust their profit distribution policies to retain their management buffer above regulatory requirements, including Pillar 2 Requirements (P2R) and Pillar 2 Guidance (P2G).

The macroeconomic module can be described as a reduced-form multi-country setup. The dynamics of individual euro area economies are represented by a structural vector autoregressive (VAR) model estimated in a panel setup. Each country VAR includes eleven variables and several structural shocks identified by zero and sign restrictions such as aggregate demand, aggregate supply of house price shocks. An additional block of cross-country trade spillovers links countries' import volumes to foreign demand variables, and their export prices to foreign price variables. In addition, the monetary policy interest rate is made subject to the zero-lower bound.

3.2 Modelling the implementation of the Basel III finalisation reforms

Many features of the final Basel III rules are directly mapped into extra model equations. Among the assumptions incorporated directly into the model mechanisms are those that will bind only occasionally. These include: (i) modified maximum distributable amount (MDA) rules to account for the binding 3% leverage ratio and the leverage buffer for globally systemically important institutions (GSII), (ii) input floors for the probability of default and loss-given-default parameters used in calculation of the IRB risk weightings, and (iii) the output floor. The output floor is assumed to be binding on a consolidated level. Other elements that take the shape of endogenous model formulas are: (iv) new standardised risk weightings for real-estate exposures that are more closely linked to the evolution of house prices, (v) the new standardised approach to operational risk, as well as (vi) the removal of the advanced IRB approach for calculation of credit-risk weightings for certain asset classes.

Other changes following from the Basel III finalisation are calibrated using the data collected by the EBA through the QIS data collection exercise. These include the rescaling of market risk capital charges to reflect the impact of the FRTB and the rescaling of the standardised credit-risk weightings for exposures other than those backed by real estate.

The effects of the Basel III finalisation package were tracked over a period of ten years. The package is assumed to enter into force in the first quarter of 2018 provided that at the time of preparing the analysis the most up to date bank balance-sheet information were end-2017 data. All the standards are deemed to become binding in 2018, except for the output floor. For the latter, two options were considered. The first option assumed a gradual phase-in over a period of 5 years, as envisaged in the Basel agreement (for the purpose of this analysis, this period is 2018-2022). It was contrasted with a scenario with the immediate frontloading of the output floor to illustrate the advantages of transitional arrangements. The analysis was conducted without regard to the national discretionary measures available and assuming that the capital requirements and buffers remain unchanged. Both assumptions are conservative.

3.3 Growth-at-risk perspective

The GaR concept is related to the value-at-risk approach in finance. The essence of GaR is to interpret the changes in the left tail of the projected GDP distribution as a downside economic risk (Wang and Yao, 2001) or as an indicator of financial-stability risks. The 2017 Global Financial Stability Report (IMF, 2017) observed that the current forecasting practices focused on expected mean or median growth without looking at the higher moments of the distribution. However, it was noted that changes in financial conditions are more powerful in signalling downside (left tail) economic risks than baseline or boom periods. The report proposes a panel quantile regression method to capture changes in the lower 5th percentile of the

distribution of expected GDP growth and determine how such moments can change over time. This methodology was subsequently adopted by Adrian et al. (2018) and applied in the context of IMF Country Surveillance (e.g. IMF, 2019).

Here, the GaR concept was applied to condense the costs and benefits of capital regulation into the same metric of the distribution of output. The analysis employed two sets of conditional simulations from a semi-structural model. First, the model was simulated many times with the current regulatory framework. Individual simulations relayed on different paths of country-specific structural shocks, all drawn from their estimated historical distributions, directly affecting macroeconomic variables in the macro block of the model. The simulations resulted in many possible GDP or bank-lending prospects, centred on the most likely forecast. Second, the model was simulated with the same set of scenarios but assuming that banks adopted the Basel III finalisation package. The impact of Basel III can be derived and decomposed by comparing the simulations with Basel III and the simulations where banks did not adopt the Basel III finalisation package.

The mean values of the output or lending growth distributions with and without the introduction of the Basel III finalisation reforms informed about the expected effects of the package under normal (or average) economic conditions. A negative difference, illustrated with blue thin lines in Chart 2, between the mean figures for economic output or lending would point to the economic costs of introducing the package.

Chart 2
Stylised representation of GaR based cost-benefit assessment

(y-axis: percentage of annual GDP growth rate; x-axis: time)
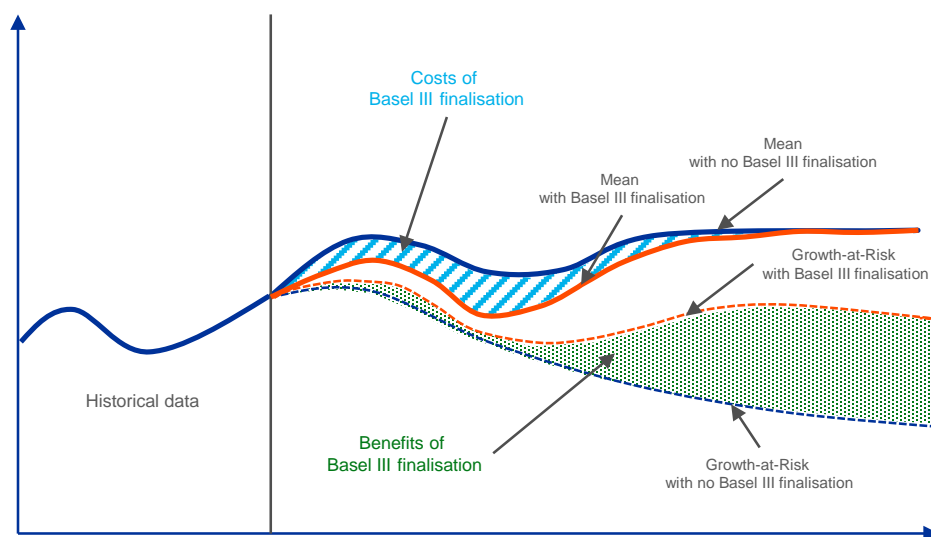
The lower percentiles of the distributions inform about the impact of the reforms in negative economic conditions. Here, the GaR measure compares the estimated GDP growth rates with and without the final Basel III rules at the 10th percentile of the annual growth rate distribution. The GaR measure is equivalent to

the "best outcome" of the adverse economic conditions. A positive difference between the 10th percentiles of the distributions (without and with the Basel III finalisation) would therefore show the benefits of the Basel III finalisation in terms of improved financial intermediation when the economy is hit by negative shocks or crisis. Such benefits are marked with green in Chart 2.

An alternative measure related to GaR is the expected growth shortfall (EGS). The EGS focuses on the "average" adverse conditions by comparing the average GDP growth below the GaR percentile. It is derived by integrating the annual growth rate within the first decile (i.e. the average of all estimated GDP growth rates that are at, or below, the 10th percentile).

The overall results in terms of net regulatory benefits come from the trade-off between the lower growth in the most likely circumstances and the less sharp contractions in output under adverse conditions. The latter are signalled by the shift in GaR which encapsulates both the reduction in the probability of negative systemic events as well as in their severity.[9]

To facilitate comparison of our estimates with estimates deriving from the long-term economic impact (LEI) analysis, we also determined the net benefit measure. This measure was calculated in a way that directly balanced the transition costs and longer-term benefits against each other, discounting both over time. For each scenario, we looked at the difference between GDP assuming the introduction of the Basel III finalisation and in the event of its absence. This difference was first discounted (by the discount rate proportional to the steady-state output growth in the model) and cumulated across time. The similarity to the LEI measure comes from looking at the cumulated output changes, but there are a few differences. The net benefit measure is horizon dependent (net benefits will tend to grow over time), is calculated for the many possible scenarios (rather than only crisis events) and is native to the model.

Box 1
A literature overview comparing the existing approaches to growth-at-risk assessment

In 2010, the BCBS proposed the long-term economic impact (LEI) approach to analyse the costs and benefits of the newly proposed Basel III regulation (BCBS, 2010). Since then, the LEI approach has become one of most popular methodologies (see Cline, 2017, BCBS, 2019, for references) for deriving the costs and benefits of higher levels of bank capital. It follows three steps. First, the expected costs are calculated in terms of decreased output due to changes in regulation. Second, the expected benefits of new requirements are approximated as changes in the reduction in the probability of a systemic banking crisis multiplied by the cumulated output losses in such a crisis. Third, the expected costs and benefits are compared to derive the net benefit estimate.

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[9]   Although such a comparison gives a generic idea of the costs and benefits, it does not account for the linked probability, i.e. the fact that the probability weighted cost of a downward deviation from the mean may be higher than the probability weighted benefit from an upward deviation from the lower percentile (10th percentile). It also leaves aside the degree of risk aversion of a decision-maker, which will be reflected in the higher weightings attributed to shifts in the lower percentiles.

Under the LEI methodology, the costs and benefits of regulation are commonly estimated employing different modelling techniques and assumptions. The LEI's cost component is derived from the assumption that banks counterbalance any decline in their return on equity by raising their lending spreads. The effect of such increases is translated into output losses using a variety of macroeconomic models (dynamic structural general equilibrium models, semi-structural and reduced-form models). The probability of systemic banking crises in the benefit component is derived from a range of discreet choice (probit, logit) models as well as portfolio credit-risk analyses that treat the banking system as a portfolio of banks. The expected macroeconomic costs of such crises are derived from academic studies of historical crisis experiences that again employ different calculation methods.

The LEI approach suffers from many caveats related to the nature of multiple-step methodology and the methods underlying the cost of crisis estimate. Given that the estimation of costs and benefits is based on different metrics and models, the comparability between the two is limited. This is magnified by the fact that while costs are derived only for the transitory period, the benefits are derived for the steady state only. The probability of a banking crisis in advanced economies is usually very low, thus hindering the identification power of the models used to estimate changes in this probability. The estimates of the costs of a crisis span a wide range of estimates (from a few to hundreds of percentage points) due to the lack or presence of discounting for future crisis events, or because sometimes they are measured as a long-term deviation from previous output levels, which could ultimately be infinite when cumulated. On the upside, by employing a range of models at each step, the LEI methodology attempts to minimise model uncertainty.

4 Costs of the Basel III finalisation in normal economic conditions

The effects of the Basel III finalisation package are first assessed under normal economic conditions, at the means of the conditional simulations. Over the medium-term horizon, the growth rate of output, prices and interest rates in European economies would converge to rates equal to their two-decade averages. The euro area annual GDP growth rate would stabilise below 2%, the inflation rate at around 1.6% and the Euro Interbank Offered Rate (EURIBOR) at 1.4%. Under these conditions, the growth rate of lending to the non-financial private sector would fluctuate between 2% to 3%. Bank profitability, as measured by return on assets (ROA), would steadily increase over time, and stabilise at around 0.6%.

The initial impact of the Basel III finalisation assuming the front-loading of the output floor amounts to an increase in REA by around 25%. The major sources of an increase in REA are credit risk[10], market risk including CVA, and the output floor (Chart 3). Each of these components would contribute about 7 percentage points to an increase in REA as compared to the resulting REA without the regulatory change. The revised methodology for operational risk adds an additional 4 percentage points. The Basel III impact on REA, especially on credit risk component, would decrease over time due to a more moderate loan evolution under the Basel III finalisation.

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[10]   This includes all credit risk-related parts of the risk exposure amount: the standardised approach, IRB approach and securitisation.

Chart 3

Decomposition of the impact of the fully front-loaded Basel III finalisation on total REA[11]

The relative role of credit risk impact of the Basel III finalisation contribution decreases over time

- Credit Risk
- Market Risk and CVA
- Operational Risk
- Output Floor

**The initial increase in REA translates into a reduction in the euro area wide CET1 ratio of 2.5 percentage points.** Chart 4 contrasts the reduction in CET1 ratio for two options of phasing-in the output floor: (i) an immediate frontloading, and (ii) a gradual phase-in over a period of 5 years. The initial reduction of the CET1 ratio would be about 0.3 percentage points lower with a gradual implementation of the output floor.

Chart 4

CET1 ratio

Banks gradually restore their CET1 ratios until 2027

(CET1 ratio in percentages)

- Current regulation
- B3F – full
- B3F – gradual

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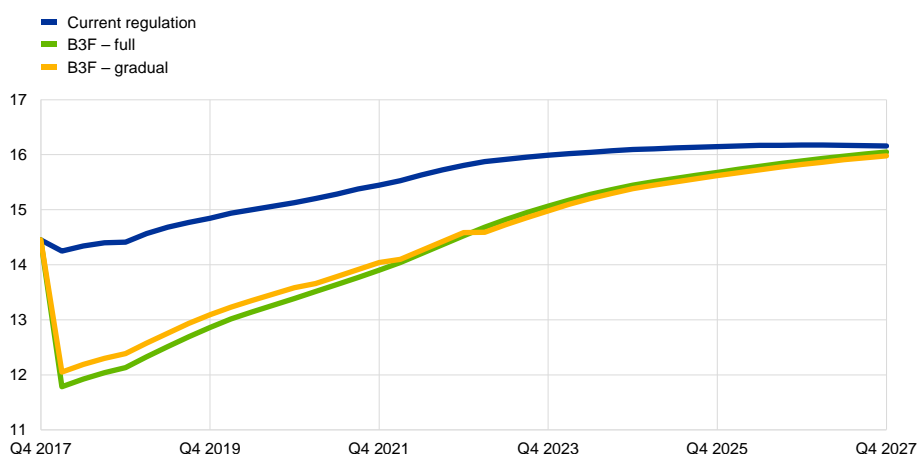
[11] The impact of Basel 3 Reforms is often measured in minimum required capital (MRC), which combines the impact of reforms on risk exposure amount and leverage ratio. The focus of this analysis is on the solvency ratio therefore the use of REA is more intuitive.

Banks would manage to close this gap in the CET1 ratio over a 10-year horizon. In the long term, the new regulation is expected to result in a more resilient banking system with CET1 capital being EUR 230 billion higher.

The impact of the Basel III finalisation would be higher for larger banks that predominantly rely on the Internal Rating Based (IRB) regulatory approach to credit risk (Chart 5). This relates to restrictions on the use of the advanced IRB approach ingrained in the new regulation and the binding of the output floor. Banks for which the output floor would bind see higher increases in REA, some twice as large as for banks using the standardised approach. The latter group of banks mostly sees an increase in their capital requirements due to the revision of the standardised approach for credit risk. Looking across banks, based on business models, the types most affected by the Basel III finalisation would be G-SIBs, sectoral lenders and universal banks.

Chart 5

The impact of the Basel III finalisation in 2018 on total REA of banks with differing use of IRB approach to credit risk

Banks that predominantly use IRB credit risk are most impacted by the Basel reform

(increase in total REA compared to current regulation in percentages)
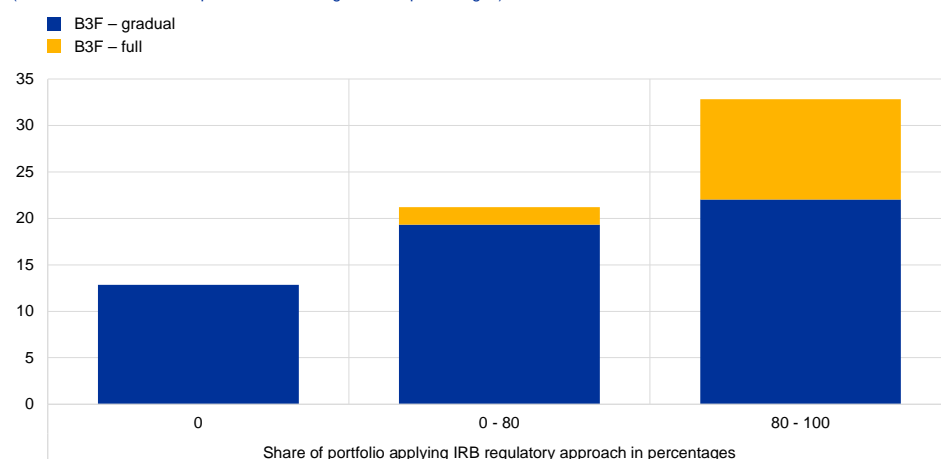

In order to restore their capital ratios, banks would retain a higher share of their earnings. When banks' CET1 ratio falls below the management buffers, they limit their pay-outs of dividends. This effect is substantial. As shown in Chart 6, in the absence of the regulatory changes the dividend pay-out ratio would be four times higher in 2018 and two times higher still in 2022.

Chart 6

Distribution of dividends

Banks distribute a lower proportion of profits under the Basel III finalisation framework

(dividend pay-out ratio in percentages)

- B3F – full
- B3F – gradual
- Current regulation
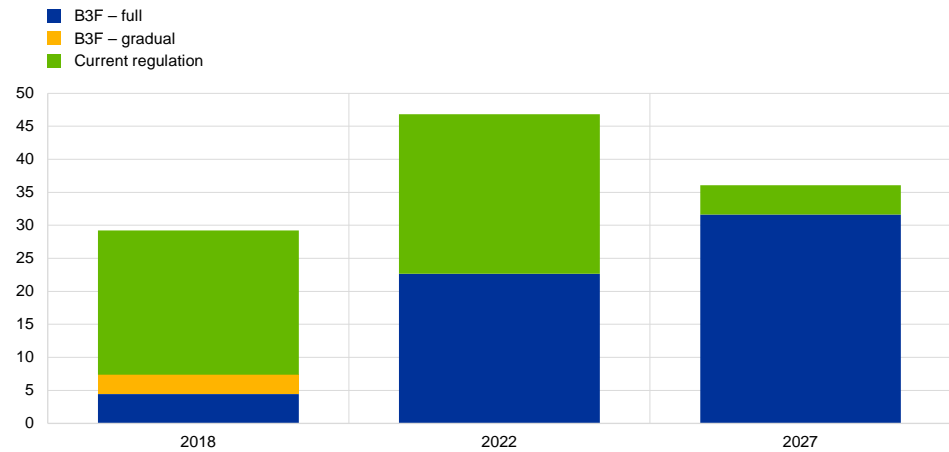
Some banks would reduce their total exposures, including lending to the non-financial private sector. With the implementation of the Basel III finalisation, at the end of the projected horizon the total cumulative growth in loans to the non-financial private sector is expected to be around 7 percentage points lower as compared to its dynamics under the current regulatory setup (Chart 7, right axis). The loan growth reduction is most pronounced in the first four years after the introduction of regulatory changes and gradually diminishes over time. The two lending segments that would be affected the most are non-financial corporate and household consumer credit. Loans for house purchase would be moderately, but positively, affected due to expected redirection of lending to segments with relatively lower regulatory capital charges.

Chart 7

Difference in loan growth compared to under the current regulation

Loan deleveraging is most pronounced in the first four years following the phase-in of the reform

(left-hand scale: difference in loan growth (y-o-y) in pp; right-hand scale: difference in loan growth (cumulative) in pp)
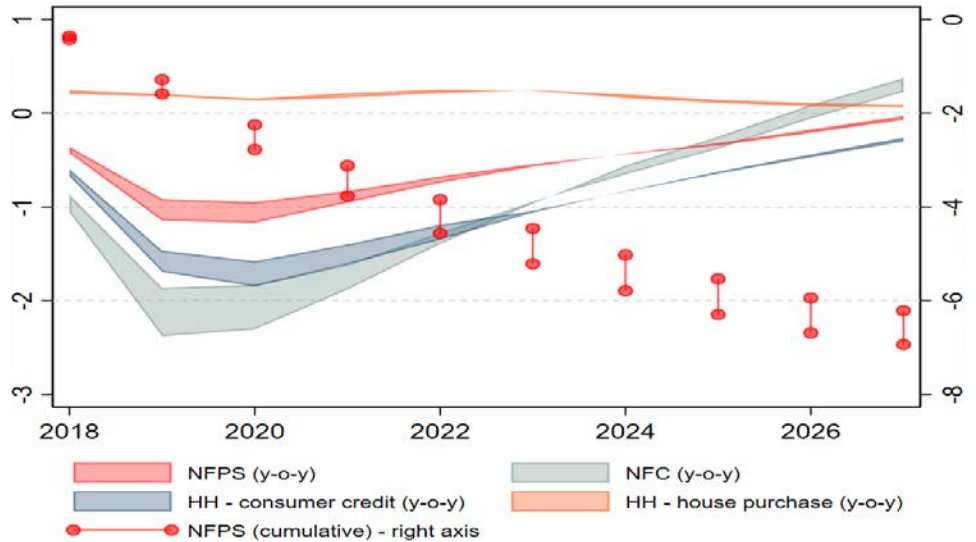
Notes: The areas show the range of outcomes for the front-loaded and gradual Basel III finalisation compared to growth rates under the current regulation. NFPS stand for non-financial private sector.

In addition to reducing their assets, i.e. deleveraging, banks would increase their lending margins Chart 8). In the first four years after the introduction of the Basel III finalisation, the relative shortage of bank capital would be also reflected in an increase in lending rates on new lending, marking along with the shrinkage of lending volumes, a contraction in credit supply following the tightening of regulatory standards. The positive effect on interest rates decreases a few years thereafter and is also weaker when the output floor is phased in gradually. Interest-rate margins increase the most for the consumer and corporate segments.

Chart 8

Difference in lending rates on new loans compared to under the current regulation

Lending rates reflect the contraction of lending supply

(difference in lending rate in bp)
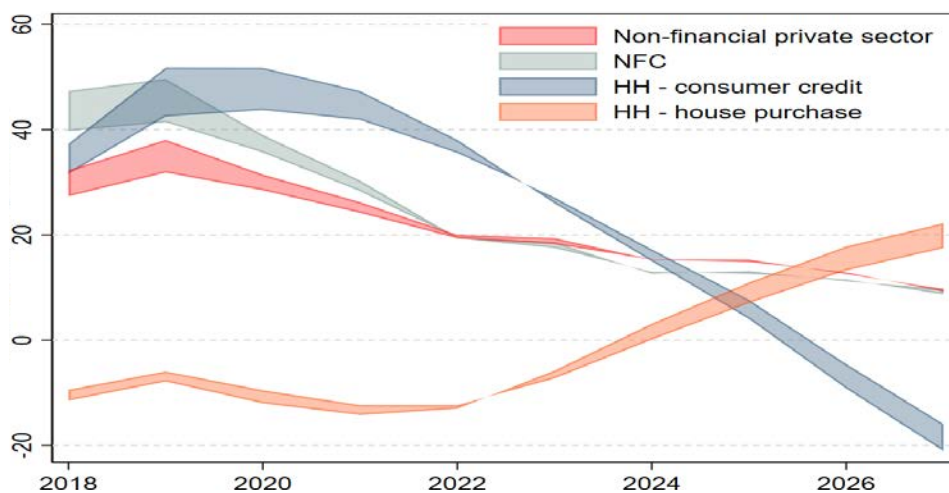
Note: The areas show the range of outcomes for the front-loaded and gradual Basel III finalisation compared to lending rates under the current regulation.

**The tightening in bank loan supply has a negative impact on output growth only in the first few years.** In the short term – until 2022 – cumulative GDP growth is expected to be around 0.8 percentage points lower under the final Basel III regime as compared to the change without the finalisation of Basel III (Chart 7). Later, the pattern reverses, and between 2023 and 2027 GDP expands by some 0.5 percentage points more with the Basel III finalisation. This evolution mirrors banks' adjustments and the gradual restoration of their capital ratios over time which gradually relaxes lending supply constraints.

Chart 9

Cumulative GDP changes

The implementation of the Basel III finalisation reduces GDP growth only in the short term

(cumulative GDP growth in percentages)
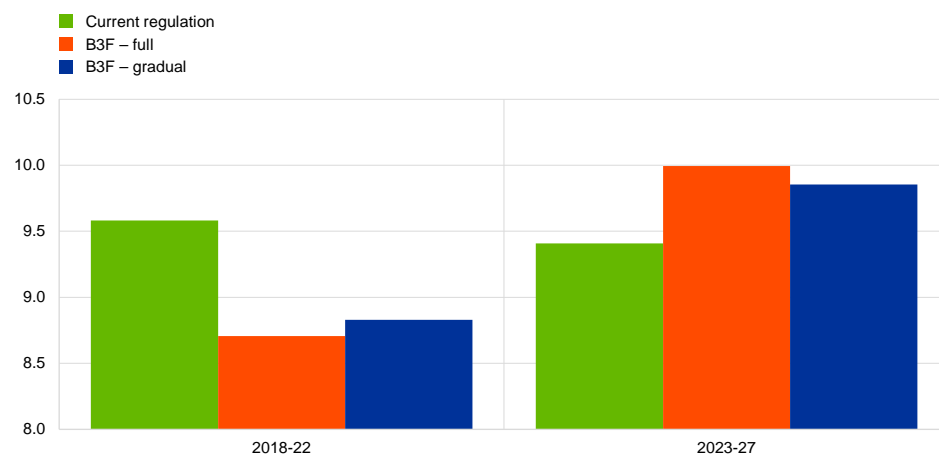
**Higher capital accumulation, facilitated by the Basel III finalisation, increases the leverage ratio, and reduces bank funding costs (Chart 10).** Capital accumulation triggered by banks' intention to restore their risk-weighted capital ratios results in a rise in the non-risk-weighted capital ratios, including the Tier 1 leverage ratio. Over a 10-year horizon, the aggregate leverage ratio would increase by more than 1 percentage point more than under the Basel III regime. This higher capitalisation has positive implications for bank funding costs. Improved bank resilience leads to a decrease in the premium required by wholesale investors, which in turn has a positive effect on banks' profitability and their ability to provide loans to the real economy.

Chart 10
Difference in leverage ratio, funding costs and ROA in 2027 compared to under the current regulation

A higher leverage ratio pushes down funding costs and increases bank profitability
(difference to under current regulation in pp)
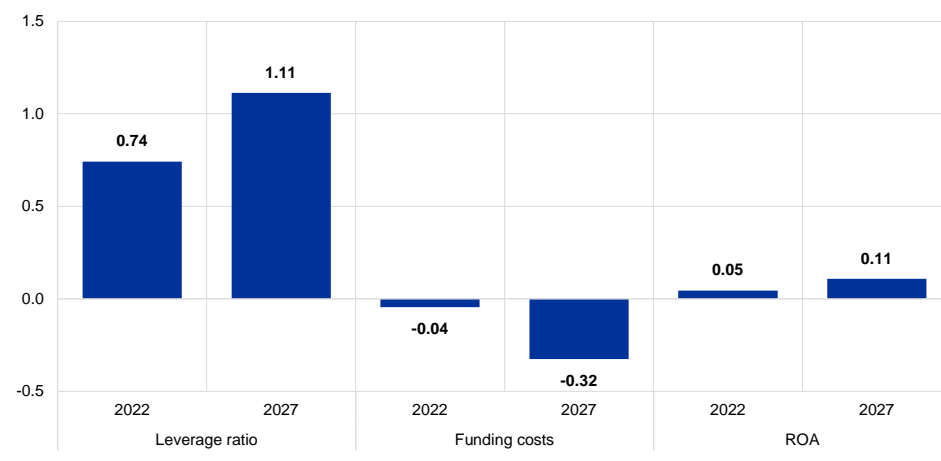
Box 2
Revision in risk weighted amounts (RWA) versus the equivalent revision of regulatory capital ratios

The medium-term impact of the revision in RWAs is expected to differ from that of a proportional revision in regulatory capital ratios. This box compares the results where the capital requirements are increased through an increase in RWAs - as in the Basel III finalisation with the same increase that - would have been achieved through the regulatory target CET1 ratios. The effect of an increase in RWA is illustrated by red lines in Chart A and contrasted with the effect of a proportional increase in regulatory capital ratios marked by blue lines in the same Chart.

Chart A

CET1 ratio and regulatory capital target as percentage of RWA

Banks adjust their behaviour in model differently in case of a broad-based revision of risk weights compared to the revision of regulatory capital ratios

(CET1 ratio and regulatory capital requirements as percent of RWA)
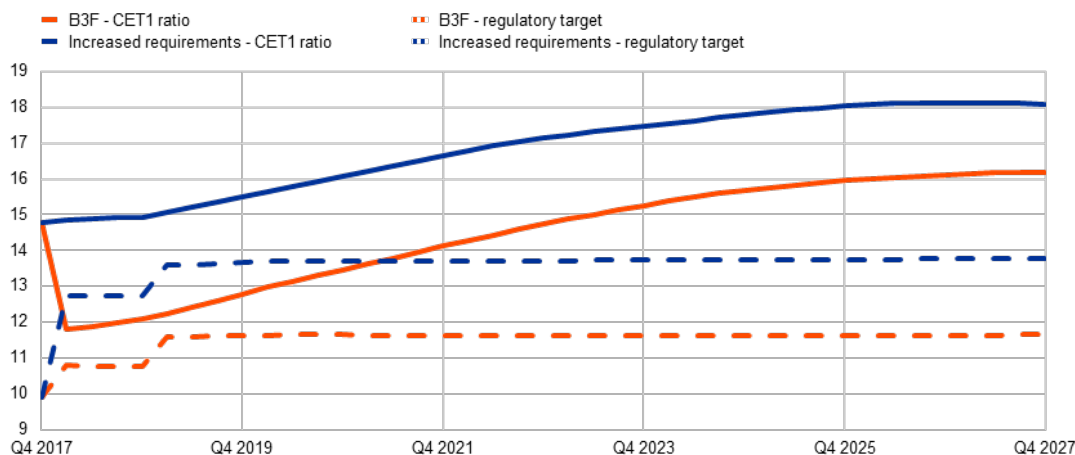
An increase in RWA or a proportional increase in regulatory capital ratios both lead to a gradual build-up of banks' capital ratios. Although an increase in capital ratios is more contained in the case of the revision of RWA, the actual capital ratios in both cases become occasionally higher than the starting levels.

Chart B

Different impact on leverage ratio, funding costs and profitability

Higher leverage ratio, lower funding costs and higher profitability with RWA revision

(difference to exercise with increased requirements in pp)
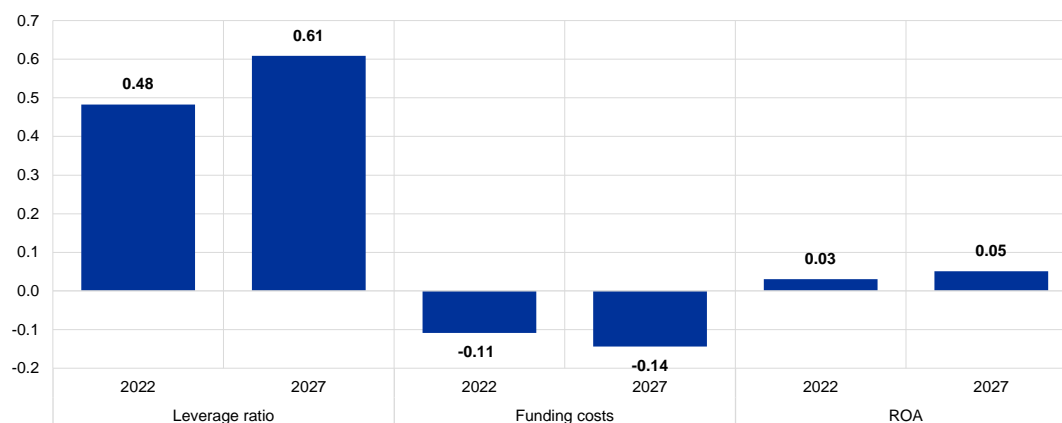
However, the revision of RWAs results in a 0.6 percentage point higher leverage ratio (Chart B). The Basel III finalisation increases risk weightings, including those of generally lower risk-weighted portfolios (like the financial sector or exposures backed by real estate). A broad-based increase in risk weightings limits banks' ability to reduce the overall capital charges by re-optimising their portfolio composition.

Higher bank capitalisation in relation to nominal exposures comes hand in hand with improved banks' funding positions. In the medium term, a broad-based increase in capital risk

charges would reduce wholesale funding costs, and additionally have a positive effect on the loan-to-deposit ratio, limiting the demand for wholesale funding. Both mechanisms lead to a reduction in banks' overall funding costs.

On the downside, at least in the short term, an increase in RWAs would result in stronger bank deleveraging compared to a proportional increase in regulatory capital ratios. Accordingly, following an increase in RWA the output growth is also moderately lower than in the situation of a similar revision of regulatory capital ratios.

5　The resilience-building benefits of Basel III finalisation

One of the expectations of higher bank capitalisation is that the banking system will be more resilient to adverse shocks. It should sustain financial intermediation even in negative circumstances. The benefits of the new capital regulation should be judged both against the most likely outcomes based on a stable growth rate for the economy, and those for adverse events, including deep recessions or banking crises.

This section illustrates the resilience-building capacity of the Basel III finalisation package by looking at the shifts in the lower percentiles of the GDP growth distribution. It reports the corresponding changes as measured by GaR and the EGS. The larger the upward shift in any of these measures, the shallower the reduction in GDP growth in adverse economic conditions and the greater the potential benefits of the reforms.

An additional element introduced in the section is a study of recession or crisis events. Focusing on such events provides an alternative illustration of the positive impact that the Basel III regulation would have. Systemic events, such as recession episodes, are selected from the distribution of simulated economic outcomes under the existing regime. These events must be mapped against similar periods and shock sequences in the distribution of economic outcomes under the Basel III finalisation. The ability of the new regime to limit the severity of such crises can then be derived as the difference between the depth and timing of recessionary episodes under both regulatory setups.

Finally, the section concludes by showing the outcome of the exercise following the logic of the LEI approach and recognising the "flow" rather than "stock" nature of GDP. The LEI approach suggests that to balance the costs and benefits a regulatory package, GDP losses should be calculated by summing up the value of foregone GDP, rather than taking the percentage deviations of GDP from its baseline level at any point in time. This perspective can also be applied in our Growth-at-Risk analysis and expanded to the full distribution of plausible scenarios.

5.1　Growth-at-risk

The Basel III finalisation package affects not only the mean but also the tails of the distribution of euro area output growth. From 2022, a gradual upward shift can be seen in the lower percentiles of the annual GDP growth that strengthen at the end of 10-year horizon in 2027. Chart 11 contextualises this shift by comparing the GDP growth distributions with and without the Basel III finalisation 10 years after the package is introduced, i.e. in 2027. The means of the two distributions are similar, even if the mode of the distribution with the Basel III finalisation moves slightly to the

right as compared to the mode of no-Basel III distribution (by less than 0.05 percentage points). The introduction of the Basel III finalisation reduces the variance of the GDP growth – the variance coefficient goes down by 4%. Two further properties of the Basel III distribution are synthetically captured in a shift of its lower percentile. First, the mass of probability in the left tail of the distribution decreases, marking a fall in the probability of observing GDP growth rates below the mean. Second, the heaviness of the tails of the distribution decreases, signifying a reduction in the probability of extreme growth outcomes.

Chart 11

The distribution of the annual euro area growth rate with and without the Basel III finalisation at the end of 2027

From 2022 onwards the Basel III finalisation reduces the probability of extremely low output growth

(number of simulations)
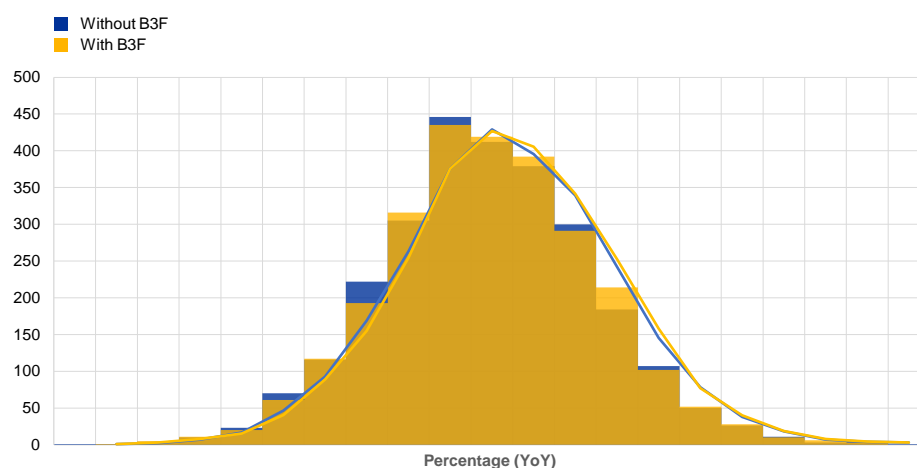
Notes: Bars correspond with original empirical density function of GDP growth estimates. For Basel III finalisation (B3F) distribution: the simulations assume gradual introduction of the output floor. The lines represent the Kernel estimates and the continuous approximation to the discrete distribution.

The permanent gain in GaR amounts to 0.1 percentage points higher annual growth rate of the euro area GDP in adverse circumstances. The first bar to the left in Chart 12 shows the upward shift in the 10th percentile of the Basel III GDP growth distribution as compared to the no-Basel III GDP growth distribution read out from Chart 11. An alternative way of presenting the euro area GaR gain from the Basel III finalisation is to look at the shifts in GaR for individual euro area countries. The change in country-level GaR weighted by the nominal GDP of individual euro area countries appears even larger and amounts to 0.15 percentage points[12], as shown in the second bar in Chart 12. At the same time, there is high heterogeneity in country results, with the lowest and largest gains in small periphery countries, such as Cyprus and Malta (lowest), and the Baltics and Luxembourg (highest). The two bars to the right in Chart 12 report the difference between the EGS of the distributions with and without the Basel III finalisation as alternative metrics

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[12] Weighted country-level GaR corresponds closer to LEI studies when the probability of a crisis is assessed on a country level. Country-level assessment of benefits (even if weighted proportionally to the size of the economy) would provide higher estimates than those run at Euro Area level (as in this paper).

summarising the information about changes in the tails of the GDP distribution. Along with the latter metrics, the mean expected annual growth rate below the 10th percentile of the annual growth rate is expected to increase by 0.11 percentage points at euro area level, and by 0.18 percentage points on average at country-level. These numbers should be considered against the expected mean steady-state annual growth rate for the euro area economy of slightly below 2%.

Chart 12

Gains in GaR and expected growth shortfall (EGS) tied to the Basel III finalisation

Basel III finalisation permanently reduces the severity of negative economic growth outcomes
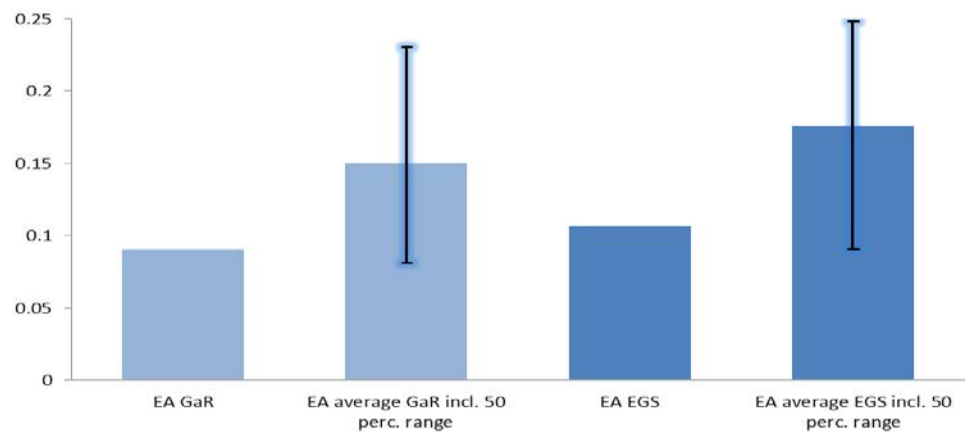
Notes: y-axis – percentage points of the annual GDP growth rate. EA GaR – the value of the 10th percentile of the annual EA-wide GDP growth rate distribution, EA average GaR – the weighted average (GDP weights) of the 10th percentiles of country-level annual GDP growth rate distributions for the euro are countries, EA EGS – the value of the expected growth shortfall at the 10th percentile of the annual EA-wide GDP growth rate distribution, EA average GaR – the weighted average of the expected growth shortfall at the 10th percentile of country-level annual GDP growth rate distributions. 50 percentage ranges are based on country-level results.

5.2 Looking at crisis events

Looking at the results from yet a different angle, the Basel III reforms would reduce GDP losses in the euro area by close to 0.2 percentage points following a deep recession or a crisis event. To arrive at a full distribution of possible GDP outcomes, the model was used to generate multiple alternative paths for the evolution of the economy. Looking at these paths one at a time, episodes of lower, or even negative GDP growth, can be selected. Chart 13 depicts the median of such episodes, identified as a fall in euro area-wide GDP which occurs in two consecutive quarters and jointly amounts to at least 1% of GDP. GDP is plotted in levels and normalised to the level of GDP in the last quarter before the median recession. In the absence of the Basel III finalisation, GDP would fall 1.5% below its initial level in the first year of a median euro area recession, as shown by the blue line in Chart 13. Euro area GDP would rebound thereafter to return to its pre-crisis level two and a half years after the onset of the median recession. The yellow line marks the more positive outcome with the Basel III finalisation in place. Recession episodes would become shallower, and rebounds ensue faster.

Chart 13

Comparing the median recession event with and without the Basel III finalisation

Basel III finalisation leads to shorter and shallower economic recissions

(normalised index)
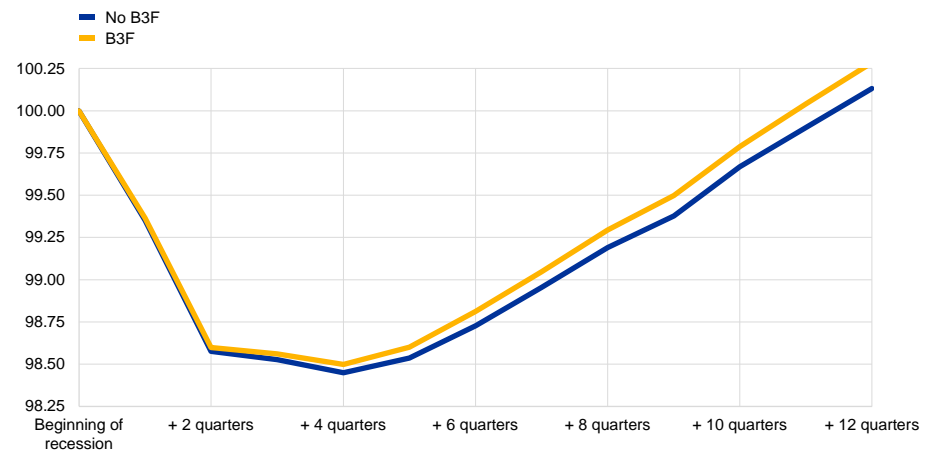
5.3 Net benefit estimate

The Basel III finalisation affects not only the growth rate but consequently also the level of long-term GDP in the tails of its distribution. When comparing the effects of regulatory reforms that accrue at different points in time, future GDP needs to be expressed in the same units, thus usually stated at its present value. Chart 14 shows the distribution of the euro area GDP level discounted by its steady-state growth rate and assuming a zero time-preference rate. The mean path of the GDP level with the introduction of the Basel III finalisation (marked by the thick solid red line) remains below the line under an assumption of no phase-in of the reform (solid blue line) for the first few years after 2018, but in the longer term both lines tend to converge. At the same time, the positive difference between GaR (10th percentile) under the new regulatory regime and the old one gradually increases over time.

Chart 14

The distribution of the discounted value of euro area GDP with and without the
Basel III finalisation over time

The resilience benefits cumulate over time
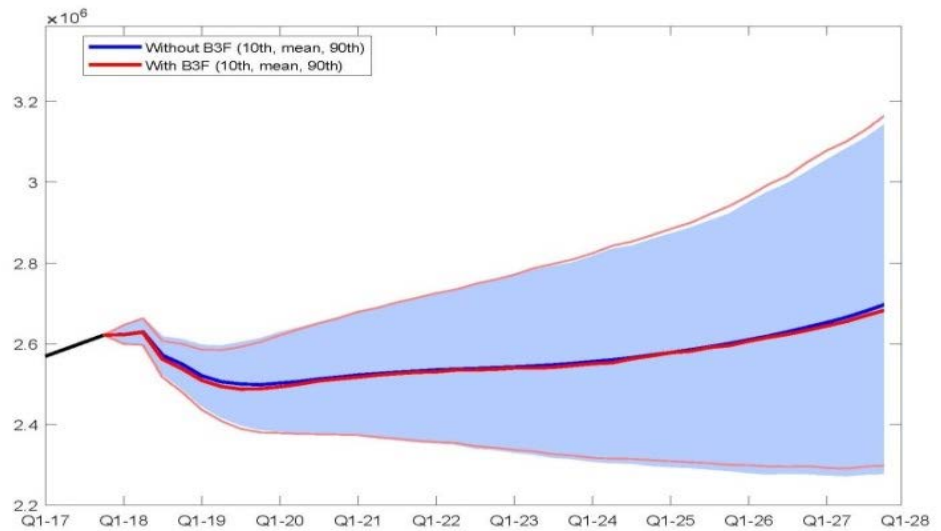
**The cumulated difference between GDP with and without the Basel III
finalisation provides an alternative measure of the net economic benefit to be
gained from the reform at any point in time.** The overall product of the economy
over the timeframe can be measured by summing up mean quarterly GDP from the
end 2017 until the reference period. This calculation can be performed for each
simulated path, and later compared for the simulations with and without the Basel III
finalisation. The difference between the latter becomes a measure of the foregone
(or additional) product, which will exhibit longer memory than the deviation between
the levels of growth rates of GDP with and without the reform. Chart 15 shows the
distribution of the difference between the cumulated GDP with the Basel III
finalisation and without the Basel III finalisation, discounted as in Chart 14 and
expressed as a percentage of 2017 GDP.

Chart 15

The distribution of the compounded value of the euro area GDP with and without the Basel III finalisation over time

The net benefit of the reform is higher for the gradual versus immediate phase-in of the output floor
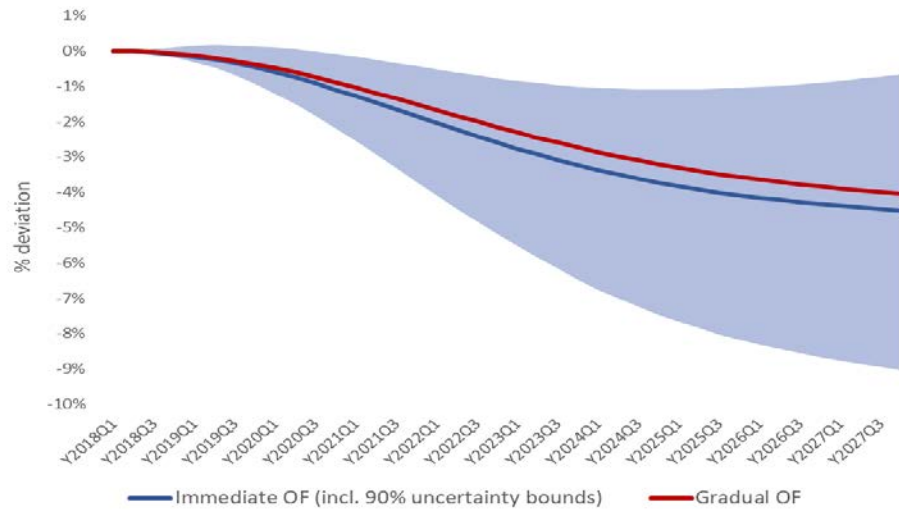
The balance of costs and benefits from the Basel III finalisation measured in terms of foregone output remains negative in the longer term. This result corresponds closely to the inherent properties of the measure, long-memory and higher effective weighting attributed to short-term versus longer-term developments. These shortcomings of the measure notwithstanding, the measure substantiates the benefits from the gradual versus immediate phase-in of the substantial capital requirements package.

6 Selected results

## 6.1 How do banks close the capital gap in the transition phase?

Retained earnings are twice as important for restoring CET1 capital ratios as a reduction in risk weighted amounts, i.e. deleveraging. To see how banks rebuild their CET1 capital ratio, the evolution of the latter is decomposed into the contribution of retained earnings and of the reduction in risk weighted amounts. Had retained earnings and risk exposure amounts remained unaffected by the introduction of the Basel III finalisation, the resulting CET1 ratio would have been 2.5 percentage points lower than otherwise predicted for 2027. Out of this 2.5 percentage points gap, 1.6 percentage points can be attributed to higher retained earnings and 0.9 percentage points to changes in assets (Chart 16). The contribution of both – retained earnings and asset adjustment – increases over time, with a more pronounced increase in the contribution of retained earnings.

Chart 16

Adjustment through retained earnings and through adjusting RWA

On aggregate, banks mainly restore their CET1 ratio by retaining more profits
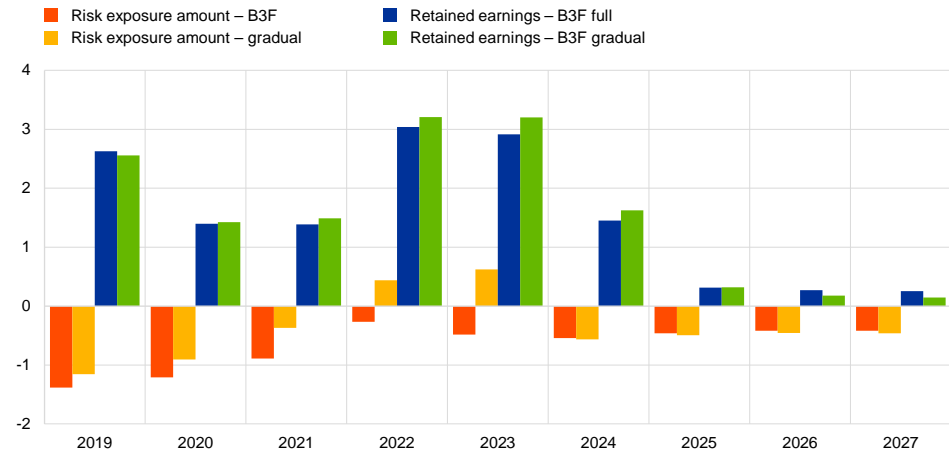
(CET1 ratio in percentages)
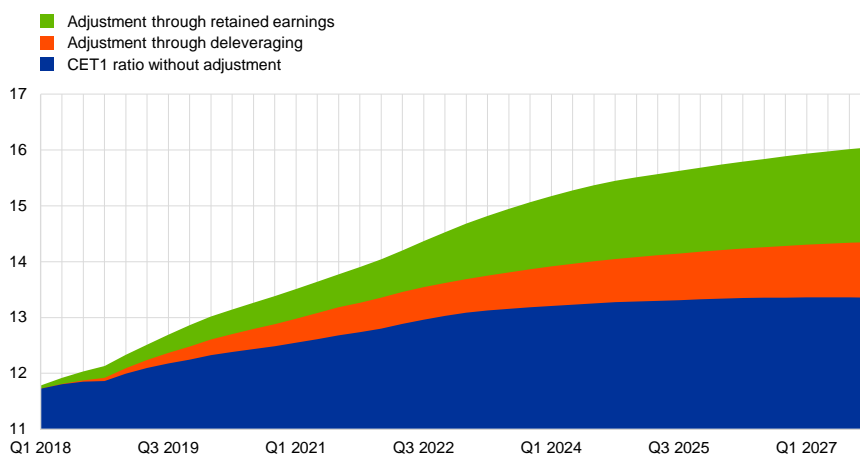
The bulk of adjustment through earnings retention would take place in the first six years following the reform, and through deleveraging in the three years after the reform. The growth rate of retained earnings would be higher by around 2 percentage points at euro area level for six years following the introduction of the Basel III reform (Chart 17). The growth rate of risk weighted assets amounts would in turn be lower by 1 percentage point for the first three years following the introduction of the reform package. The latter effect becomes weaker with the gradual phase-in of the output floor.

Chart 17

Difference in growth of REA and retained earnings compared to under the current regulation

Deleveraging plays only a secondary role in banks' adjustments

(difference in growth (y-oy) in pp)

- ■ Risk exposure amount – B3F (orange)
- ■ Risk exposure amount – gradual (yellow)
- ■ Retained earnings – B3F full (blue)
- ■ Retained earnings – B3F gradual (green)

The relative effect of profit accumulation versus lending reduction would depend on bank capital targets and the bank-specific intensity of the Basel III changes. The two most important capital targets are: (i) the regulatory requirement, which consists of Pillar 1 requirements, P2R, combined buffer requirement, and P2G; and (ii) the bank's internal capital target, including a management buffer on top of regulatory requirements. Breaching these targets would trigger two adjustment mechanisms. When a bank's capital ratio falls below its internal capital target, the bank starts retaining more profits to restore it. When a bank's capital ratio falls below its regulatory capital target, it additionally shortens its loan supply.
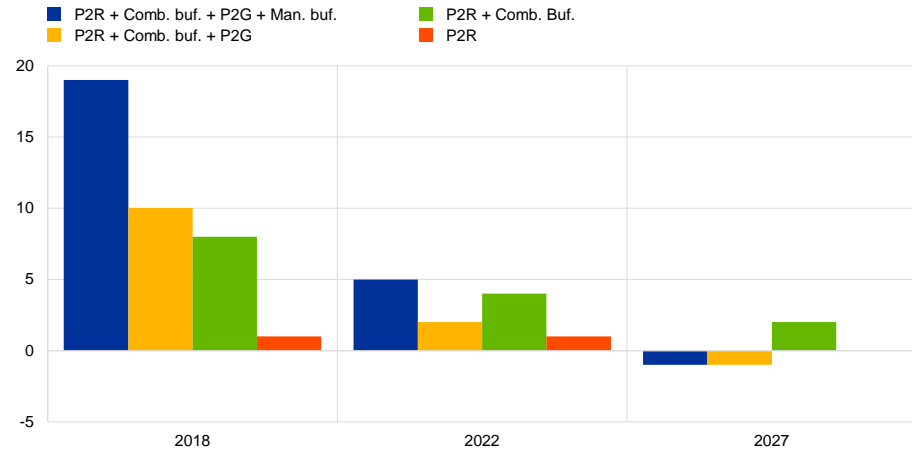
Following an immediate introduction of the Basel III finalisation, 20% of banks would experience a reduction in their actual capital ratios below their internal targets, and over 10% below their regulatory targets. Chart 18 illustrates this initial impact of the reform in more detail. Of those banks that would experience a fall in their actual capital ratio below their regulatory targets, the majority would also become subject to maximum distributable amount restrictions. With gradual implementation of the output floor, fewer (three less) banks fall below the CET1 regulatory threshold and below the MDA threshold (six less). Five years following the reform, banks recover most of their capital buffers, and the effect phases out completely ten years after the reform.

Chart 18

Difference in the number of banks breaching the capital thresholds compared to under the current regulation

In the initial stage, the Basel III finalisation pushes several banks below their capital targets

(difference in number of banks breaching the thresholds)

- ■ (blue) P2R + Comb. buf. + P2G + Man. buf.
- ■ (yellow) P2R + Comb. buf. + P2G
- ■ (green) P2R + Comb. Buf.
- ■ (red) P2R

Notes: The chart shows an increase/decrease in number of banks below capital thresholds when Basel III finalisation is in place. The increase may be higher for less demanding requirements or even negative as it is calculated as a difference relative to the outcome without Basel III finalisation in place. P2R – Pillar I + Pillar II requirements; Comb. buf. – Combined buffer requirements; P2G – Pillar II guidance; Man. buf. – Management buffer.

Interestingly, the impact of the Basel III finalisation would be stronger for banks with higher initial capitalisation. Chart 19 displays the relationship between initial bank capitalisation (measured as CET1 surplus/shortfall versus its regulatory capital target) and the impact of the Basel III finalisation (expressed as a change in CET1 ratio). The association between the two is slightly negative and relates to a larger impact for IRB banks that hold on average slightly higher capital surpluses. This is favourable for the absorption of the Basel III finalisation impact as it would reduce the capital gap which must be closed and make it less common for banks to fall below their regulatory target. Accordingly, to close the capital gap, it would be more likely for banks to retain earnings rather than deleverage. Overall, this association lowers the transitory costs of the Basel III finalisation for the banking system, and later for the real economy.

A higher impact of the Basel III finalisation overlaps with better initial capitalisation
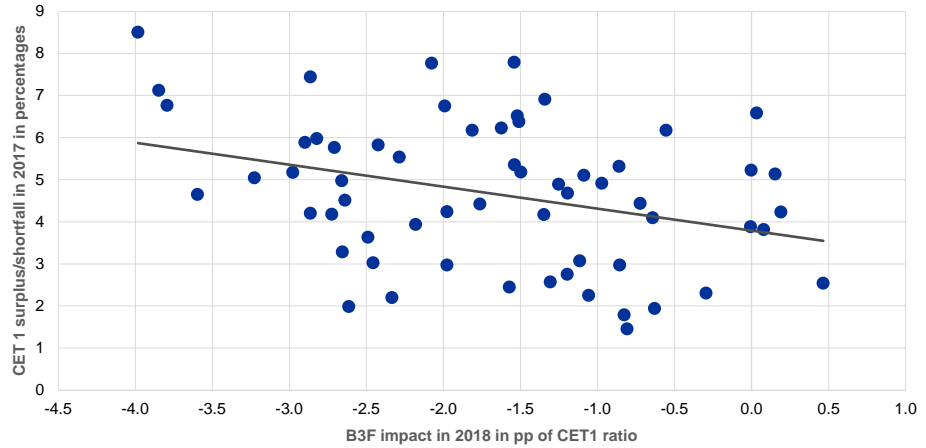

6.2 Bank profitability matters for the economic costs of the reform

Only banks that generate enough profits could cover the capital needs arising from the Basel III finalisation through retention of earnings. Banks whose capitalisation is above the internal target are represented by blue dots in Chart 20. These banks have a high retention rate only at lower levels of profitability. Banks whose capitalisation is below the internal target are represented by red and green dots. They would attempt to restore their capital ratio by retaining a higher share of profits and their retention rate would mostly stand at 100%. As also shown in Chart 20, banks with a capital shortfall with respect to the regulatory target (green dots) frequently experience a loss. If a bank generates a loss, its retention rate is set at 0% to reflect the fact that loss absorption would make no positive contribution to capital in this case.

Chart 20

Share of retained earnings vs return on assets with a Basel III finalisation setup –
bank-year observations

Banks can close the capital gap through retained earnings only if they generate profit
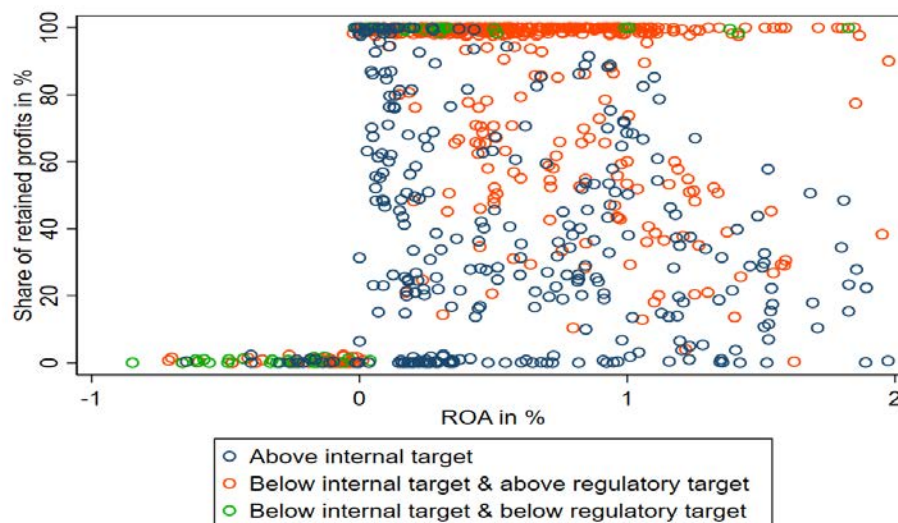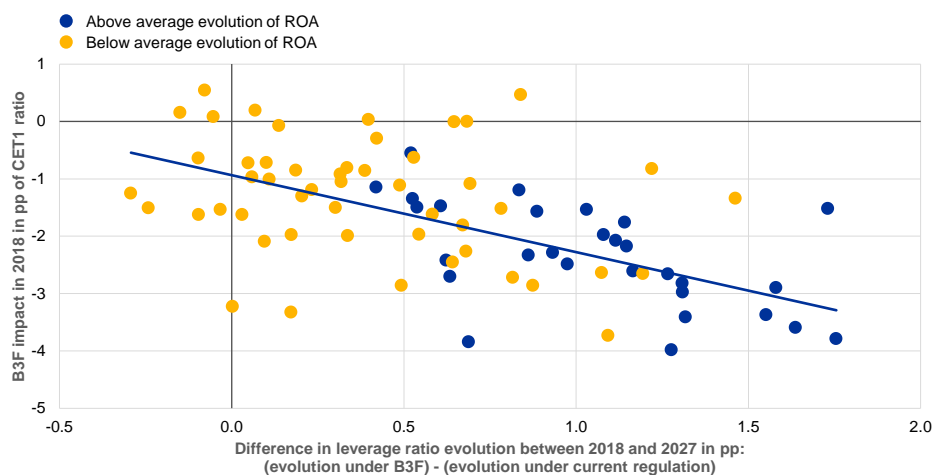

Banks with high income-generating capacity and experiencing a higher individual impact of the Basel III finalisation would accumulate more capital over time. Chart 21 shows that banks with above average future ROA would accumulate, on average, more capital over time and experience a higher increase in the leverage ratios. It also shows that initially, banks with relatively high ROA prospects would also be more substantially impacted by the Basel III finalisation. Banks with the highest capital needs following the introduction of the Basel III reforms would start accumulating more capital, and their capitalisation would improve the fastest. This would trigger a positive feedback loop, with a more pronounced decrease in the cost of external funding of these banks, allowing them to raise funds more cheaply. This in turn would benefit their profitability and support profit retention.

Chart 21

Basel III finalisation impact vs evolution of leverage ratio

Banks experiencing a stronger impact of the Basel III finalisation also experience more favourable evolution of CET1 ratio in the long term

- Above average evolution of ROA
- Below average evolution of ROA

y-axis: B3F impact in 2018 in pp of CET1 ratio (1, 0, -1, -2, -3, -4, -5)

x-axis: -0.5, 0.0, 0.5, 1.0, 1.5, 2.0

Difference in leverage ratio evolution between 2018 and 2027 in pp:
(evolution under B3F) - (evolution under current regulation)

Banks' income-generating capacity is often correlated with their initial profitability. Chart 22 characterises the banks with average yearly R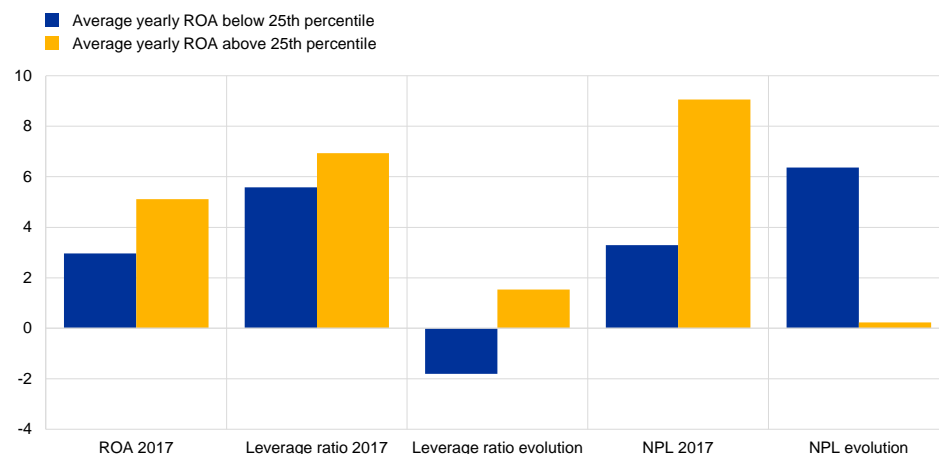OA below or above the 25th percentile. At the starting point, banks at the lower end of the profitability distribution have a ROA that is lower by about a half as compared to other banks. Similarly, their leverage ratio is also lower, and it further deteriorates over the projection horizon. This results in their higher funding costs compared to other banks. Non-performing loans are another good predictor of future ROA. Although less profitable banks start with a lower stock of NPLs on average, their NPL ratios become significantly higher in the projection horizon.

Chart 22

Characteristics of banks with low and high ROA

Low starting ROA, high evolution of NPL and low capitalisation are the best predictors of weak future profitability

(in percentages and in pp)

- Average yearly ROA below 25th percentile
- Average yearly ROA above 25th percentile

y-axis: 10, 8, 6, 4, 2, 0, -2, -4

x-axis categories: ROA 2017, Leverage ratio 2017, Leverage ratio evolution, NPL 2017, NPL evolution

Note: ROA 2017 is multiplied by 10 for clearer representation. Outcomes are (non-weighted) averages for each group.

Banks with a capital shortfall and low profitability are more likely to restore their capital ratio through deleveraging. Chart 23 shows that banks with relatively low profitability – coloured red – are concentrated in the upper left corner of the picture. These banks would mostly rely on a reduction in assets in restoring their capital ratios. Among the remaining banks (coloured blue), banks with the largest initial negative impact would combine profit accumulation with some degree of deleveraging.

Chart 23
Adjustment through retained earnings vs adjustment through deleveraging over 10 years

Banks with a lower profitability more frequently adjust through deleveraging
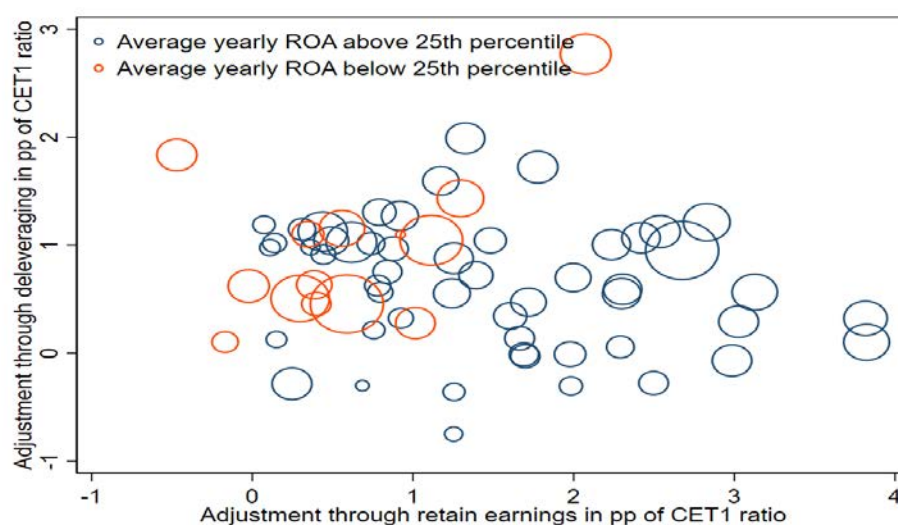
Note: Size of markers denotes the intensity of the Basel II finalisation impact on banks' RWA at the initial stage.

6.3 Evolution of bank solvency and leverage

Banks with large initial capital buffers above the regulatory requirements would be able to absorb the reform impact without major adjustments of their loan supply. Banks whose capitalisation is closer to the regulatory target ahead of the Basel III reform would be more likely to deleverage to restore their capital ratio (Chart 24).

Chart 24

Initial capitalisation vs cumulative loan growth

Banks with higher initial capitalisation have higher loan growth following the Basel III finalisation
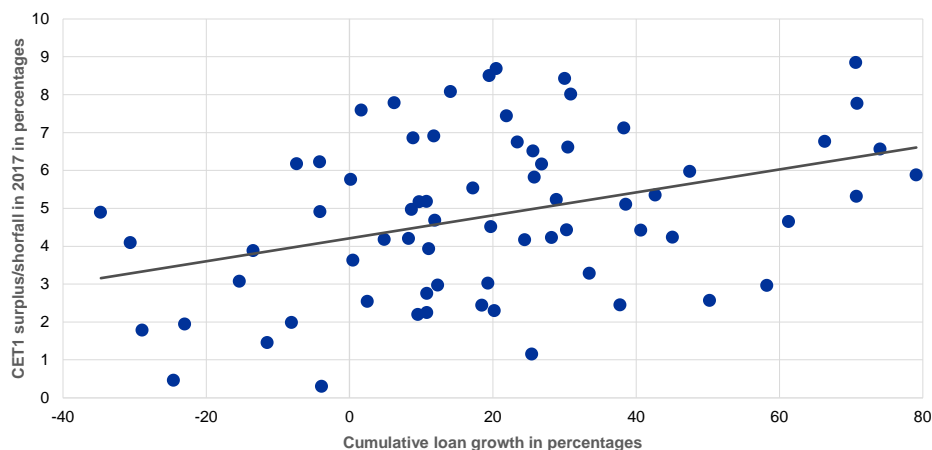

The intensity of bank deleveraging would strongly depend on a bank's CET1 surplus or shortfall, which is the difference between a bank's CET1 ratio and its regulatory target ratio. The lower the surplus, the lower is bank loan supply. This relation is non-linear (Chart 25). Once the CET1 ratio falls below the regulatory requirement and banks experience a capital shortfall, they would start deleveraging more intensively. This would be the main cause for more moderate loan evolution under the Basel III finalisation regulatory regime. Over the longer term, however, the number of banks with a CET1 shortfall would decrease reducing the need for further deleveraging.

Chart 25

Change in bank CET1 surplus/shortfall between 2017 and 2027 vs cumulative loan growth

Lending of banks with CET1 shortfall reacts strongest
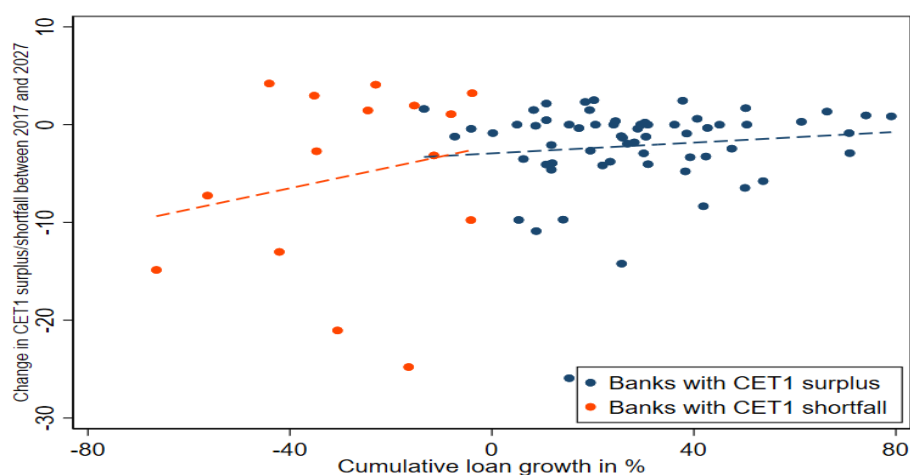
Note: A bank is assigned to CET1 shortfall if its CET1 ratio falls below the regulatory target at any point between 2018 and 2027.

The relationship between the initial bank capitalisation and the initial impact of the Basel III finalisation influenced bank outcomes over the projection horizon. Chart 26 divides banks into four groups depending on their initial level of capitalisation and the severity of the initial Basel III finalisation impact. The four groups are defined by cutting the CET1 surplus/shortfall (including P2R and P2G requirements set in 2017) and the Basel III finalisation impact, measured as a drop in CET1 ratio on introduction, at their medians. For instance, the group denoted as High surplus/shortfall and High Basel III finalisation impact shows the outcomes for banks with above-median CET1 surplus/shortfall and above-median impact of the Basel III finalisation. The figure summarises the behaviour of six variables for each bank group separately. The surplus/shortfall and Basel III finalisation impact are measured as a deviation (in percent) of the mean value of a variable in the group from the population mean. The remaining four variables are measured as the difference in evolution with the Basel III finalisation as compared to the low-income level without that finalisation. For instance, the impact on CET1 ratio is measured as the difference between the evolution of the CET1 ratio under the Basel III finalisation and the evolution under the existing regulatory setup.

Chart 26
Effects on main bank aggregates – split across Basel III finalisation impact and initial CET1 surplus/shortfall

Negative effect of the Basel III finalisation on loans, but positive on leverage ratio and profitability
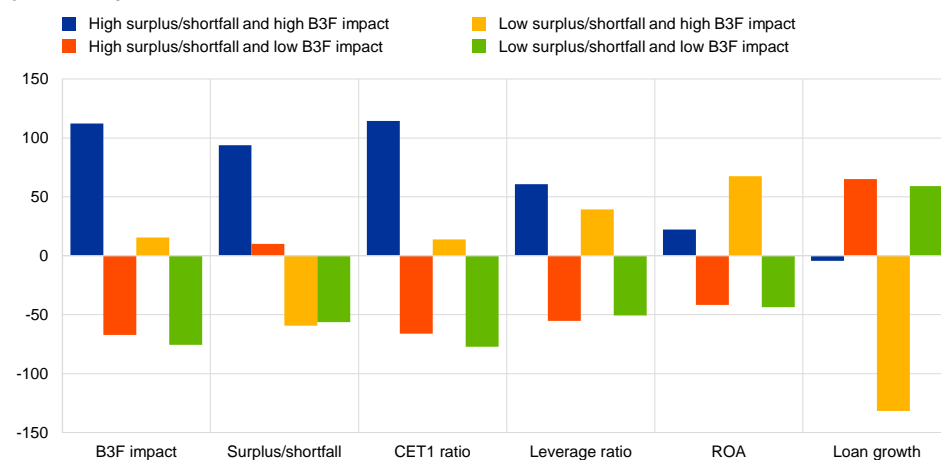
Note: Banks with high (low) surplus/shortfall are those for which the CET1 surplus/shortfall in 2017 is above (below) median. Banks with high (low) Basel III finalisation (B3F) impact are those for which B3F impact on CET1 ratio in 2018q1 is above (below) median.

The initial level of capitalisation is of importance since it has the strongest bearing on the impact of the Basel III finalisation on lending. When a high Basel III finalisation impact is associated with a low initial CET1 surplus/shortfall, the resulting loan growth is impaired (yellow bar in Loan growth). In turn, strongly capitalised banks can absorb high Basel III finalisation impact without extensively limiting the loan supply (navy blue bar in Loan growth).

The Basel III finalisation positively affects bank profitability, especially for banks with lower initial capitalisation and high initial impact of the regulation. The Basel III finalisation regime incentivises lower capitalised banks to boost their

capital accumulation, improving their final CET1 and leverage ratios and consequently reducing their funding costs (see also 6.5).

## 6.4 Higher loss-absorbing capacity

By increasing the capitalisation of banks, the Basel III finalisation improves banks' loss-absorbing capacity. The level of provisions in 2027, expressed as a share of CET1 capital, would be about 3 percentage points lower with the Basel III finalisation as compared to the current regulation (see Chart 27). This difference is solely due to the higher amount of capital with the Basel III finalisation. The level of provisions, on the other hand, is comparable under both regimes since the Basel III finalisation does not impact the provisioning rules.

Chart 27

Increased loss absorption in 2027 – absorption of provisions and an overall increase in loss absorption

With the Basel III finalisation, banks can absorb 15% more losses, in percent of CET1 capital

(difference to current regulation in 2027 in pp)

■ Percentage ΔCET1 capital
■ ΔCET1 ratio
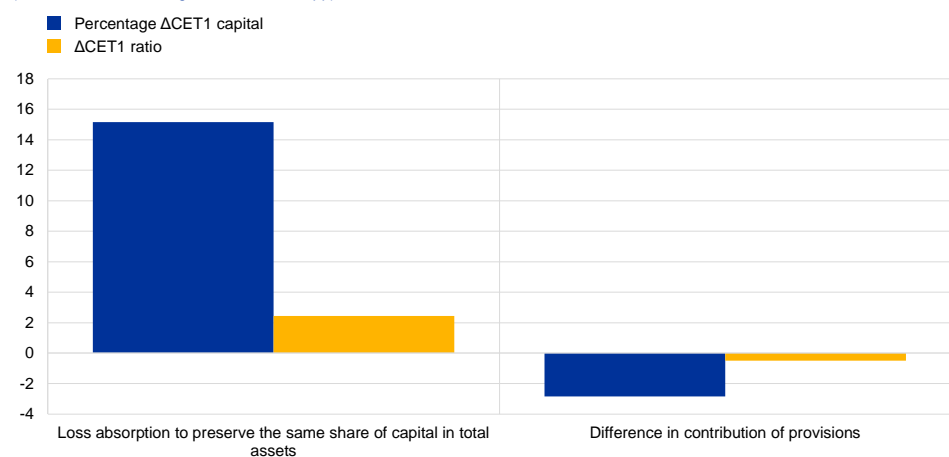
Loss-absorption capacity increases by about 15% with the Basel III finalisation. The system wide CET1 ratio is projected to stand around 16% in 2027 under both the current and the Basel III finalisation frameworks. The capital stock as a percent of total assets is nevertheless much higher under the Basel III finalisation regime. If the same share of CET1 capital in total assets were to be preserved as under the current regulation (5.6% in 2027), banks would be able to absorb losses that were up to EUR 290 billion higher. This represents 15% of CET1 capital in 2027. In other words, all other things being equal, bank CET1 ratio could drop by 2.5 percentage points before the share of capital in total assets reached the outcome under the current regulation. This increased loss-absorption capacity shows a strong positive correlation with the initial Basel III finalisation impact (Chart 28).

Chart 28

Basel III finalisation impact vs increase in loss absorption in 2027

Banks with a stronger Basel III finalisation impact accumulate more capital and have a larger increase in loss absorption capacity
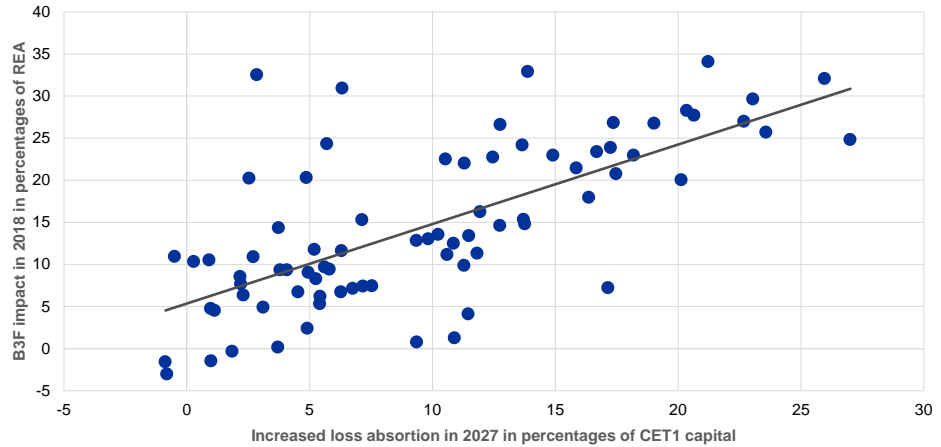
## 6.5 A sustained reduction in funding costs

An increase in bank leverage ratio resulting from the Basel III finalisation would lower bank debt-funding costs and benefit bank profitability. Chart 29 shows a positive correlation between an increase in banks' capitalisation and a longer-term decrease in funding costs under Basel III as compared to no-reform simulations. Bank leverage ratios in 2027 are higher by 110 basis points on average under the Basel III finalisation regime as compared to the leverage ratios in the absence of regulatory changes, while the debt-funding costs are on average reduced by 30 basis points. The decrease in funding costs would be substantial, particularly for those banks that increase their capitalisation most markedly.[13]

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[13] The negative relationship between the funding cost and the leverage ratio results from two model mechanisms discussed in this section. First, higher bank capital compared to the asset size implies lower debt-financing needs. Second, debt-financing costs, and in particular wholesale funding costs, are empirically linked to bank leverage ratios.

Chart 29

Capitalisation and debt funding costs

Increased bank capitalisation reduces debt funding costs over a period of 10 years
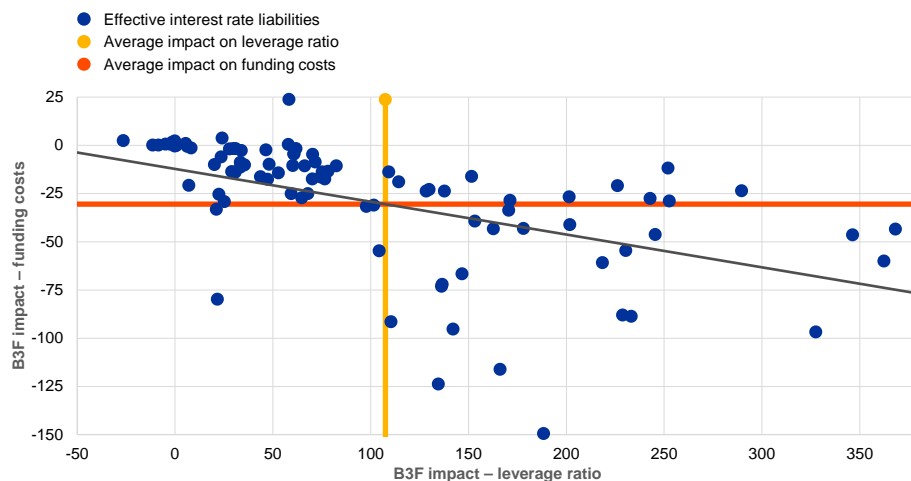

Reduced funding costs would boost bank profitability. Chart 30 explores the link between lower funding costs and increased net return on assets. Banks for which the regulatory changes are more impactful experience the largest profitability gains in the longer term.

Chart 30

Funding costs and profitability

The impact of Basel III on funding costs is directly linked to an increase in profitability in 2027
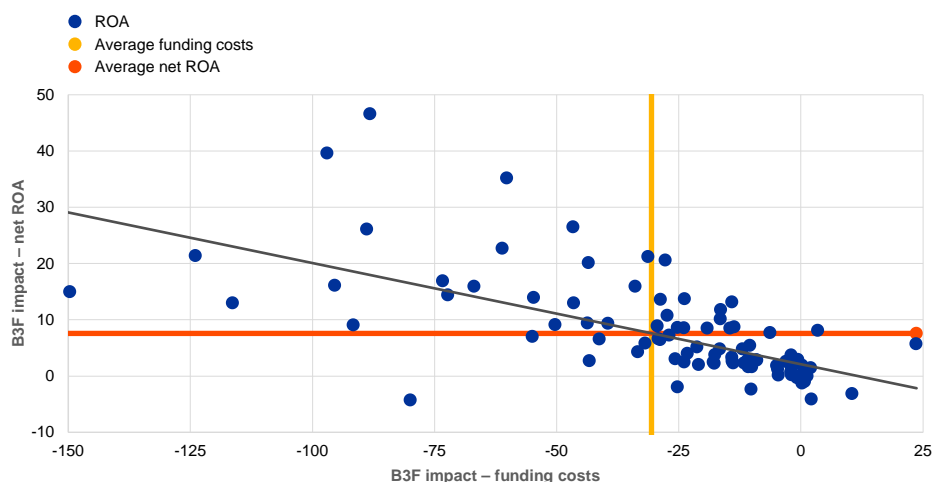

The reduction in debt funding costs relates first and foremost to lower counterparty risk and the cost of wholesale funding. An increase in the leverage ratios reduces counterparty credit risk, which is reflected in lower interest rates faced by banks in wholesale markets. Chart 31 shows that the reduction in wholesale funding costs is positively correlated to the scale of increase in the leverage ratio and is especially marked for banks with low initial capitalisation (blue dots).

Chart 31
Capitalisation and wholesale funding costs

Banks with lower initial capitalisation experience strongest reduction in funding costs
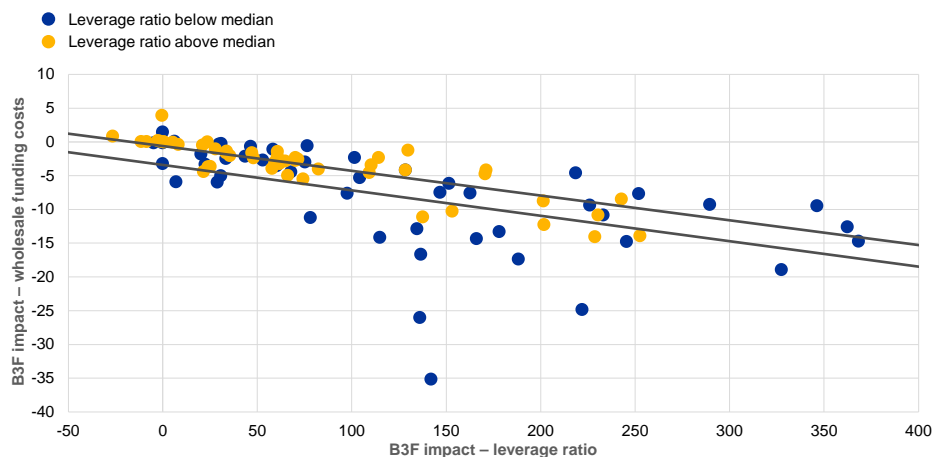
**Improved capitalisation serves to lower wholesale funding costs, especially in adverse economic or market conditions.** In tail conditions, the marginal effect of additional capital on wholesale funding costs is amplified. Chart 32 shows that, in a median scenario, wholesale funding costs drop by 10 basis points following the Basel III finalisation. The gap increases to up to 25 basis points in adverse scenarios. By improving bank capitalisation, the Basel III finalisation helps to create favourable borrowing conditions in stressed markets and makes banks more resilient in times of economic downturn and uncertainty.

Chart 32
The evolution of the impact of the Basel III finalisation across scenarios

Especially in adverse scenarios, increased capitalisation helps to keep funding costs down

(Basel III finalisation impact: wholesale funding costs)
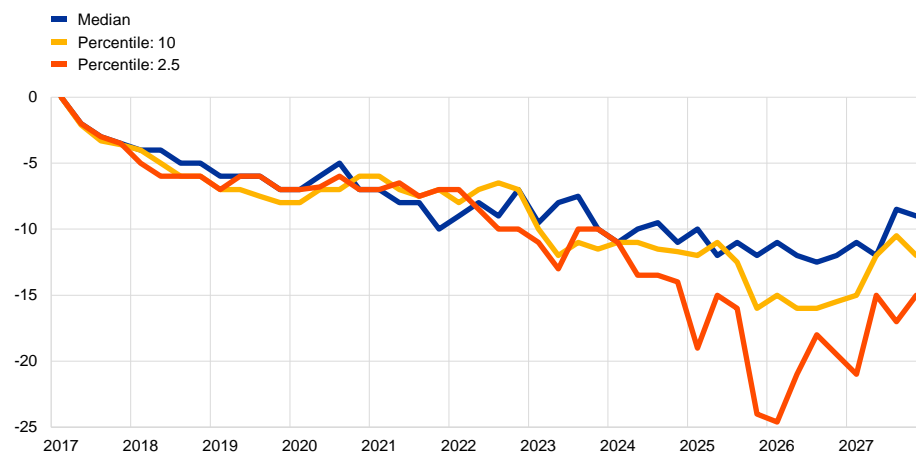
Note: the three percentiles pictured refer to the severity of the underlying macroeconomic scenario (as measured by cumulative impact at year-end 2027) generated by stochastic simulations.

The impact of the regulatory changes on wholesale funding costs is strongest for longer maturity instruments (Chart 33). Sight deposits, at the short end of the

yield curve[14], are affected only marginally, up to 10 basis points in severe macroeconomic conditions. At short maturities, macroeconomic factors are much more important in determining the cost of wholesale funding than microeconomic firm-level variables. As the maturity of instruments increases across liability classes, solid bank fundamentals become increasingly relevant for favourable assessment of their credit risk. Accordingly, the costs of funding through financial term deposits[15] and securities[16] that have a wide range of maturities – typically between 2 and 20 years – are strongest affected by the Basel III finalisation.

At the long end of the yield curve, the impact of the Basel III finalisation is more pronounced than at the short end

Note: The two percentiles in the chart refer to the severity of the underlying macroeconomic scenario (as measured by cumulative impact at year-end 2017) generated by stochastic simulations.
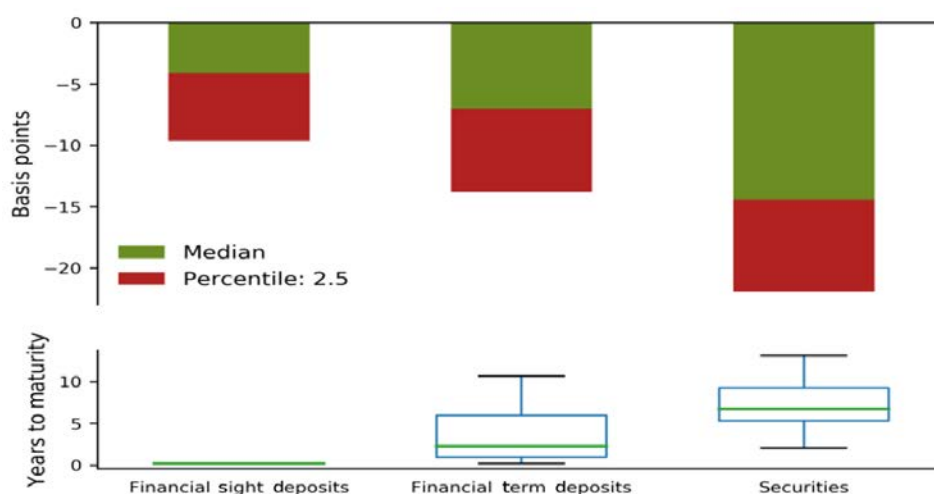
Lastly, adopting the Basel III package would also reduce bank demand for wholesale funding. In the absence of the Basel III finalisation package the loan-to-deposits ratio in the model tends to trend moderately upwards, which is reflected in a gradual increase in wholesale funding volumes, both nominally and as a share of total liabilities (Chart 34). This increase is, however, moderated following the introduction of the Basel III finalisation package reflecting the growing role of own funds on the liability side of bank balance sheets. The favourable funding composition effect adds to the reduction in debt funding costs given that wholesale markets tend to offer the most expensive source of funding (the average costs of wholesale funding in 2027 would amount to around 1.75%, while that of retail funding to below 0.50%).

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[14] Sight deposits consists of deposits and certificates of deposits issued by other financial institutions that can be withdrawn at any time and are generally characterised by lower credit risk.

[15] Financial term deposits include deposits and repurchase agreements with fixed maturities, usually between 6 months to 4 years.

[16] Securities denotes collateralised and uncollateralised securities as well as fixed-income instruments convertible to equity.

Chart 34
Decomposition of liabilities

Both in nominal and relative terms, the importance of wholesale funding for European banks increases
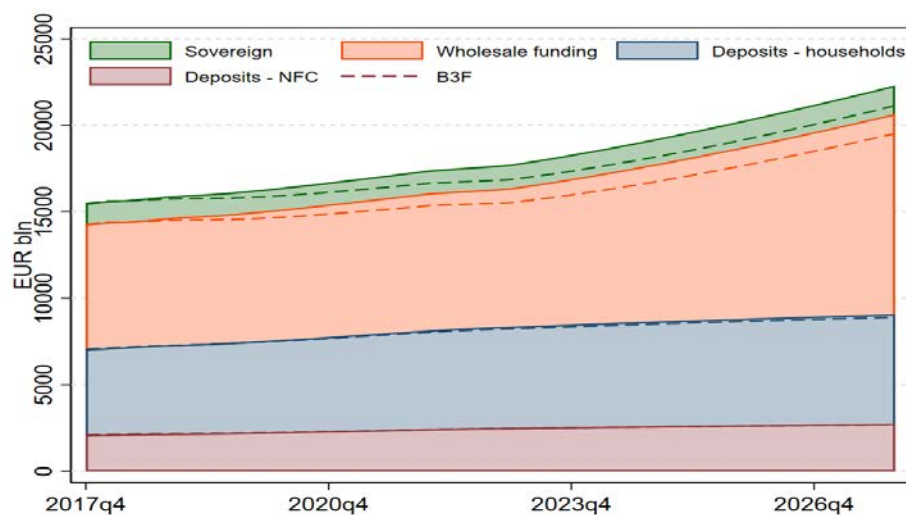

6.6   Selected elements of the Basel III finalisation

This subsection looks at the impact of each of the three state-dependent components of the Basel III finalisation: the impact of the output floor, operational risk changes and the cap on the leverage ratio. The marginal impact of these elements of the package is deduced by comparing the impact of the full package with the impact of the Basel III finalisation but excluding one element at a time. Applying this methodology, Chart 35 shows, for instance, that the output floor and the revised operational risk framework would each contribute about EUR 250 billion to risk exposure amounts in 2027. While the effect of operational risk revision on REA would be immediate, the effect of the output floor would phase in gradually and reach the full amount after 5 years.

Chart 35

The evolution of the risk exposure amount without the output floor and without op. risk revision

The output floor and operational risk revision each contribute about EUR 250 bln to REA
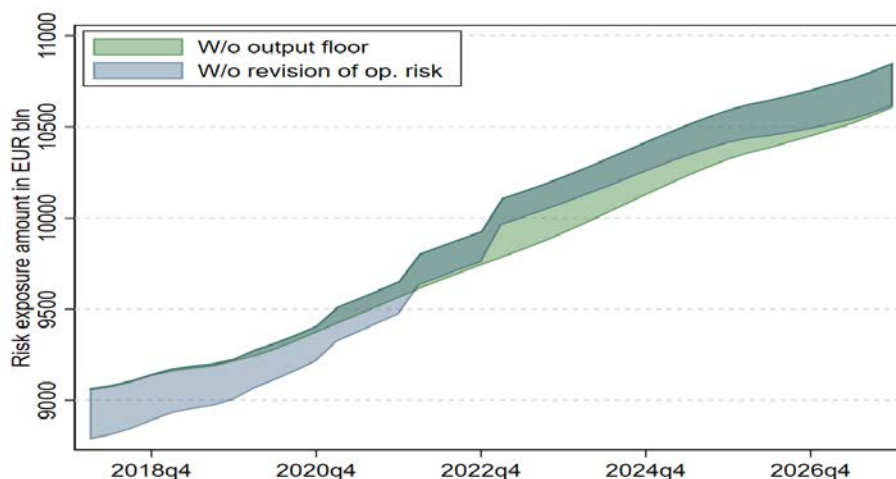
Note: The upper bound shows the evolution of REA with gradual implementation of the Basel III finalisation. The areas span the difference that would arise without output floor or without operational risk revision.

Both the output floor and the revised operational risk framework would have a positive impact on bank leverage ratios and ROA in a longer term. Chart 36 shows the marginal impact of the two components on the set of bank-level variables. The negative impact of the output floor and revised operational risk charges on the CET1 ratio follows directly from a related increase in REA and would gradually diminish over time, while the positive impact on leverage would increase. The higher leverage ratio would positively influence funding costs and profitability. Loan supply is (among other things) a function of the CET1 capital ratio and would be thus, on average, affected moderately negatively by the two elements of the Basel III finalisation.

Chart 36

Difference in results without the output floor and without operational risk revision

Without the output floor and op. risk revision, the CET1 ratio (leverage ratio) would be higher (lower)

(difference in pp)

■ Without output floor
■ Without revision of operational risk
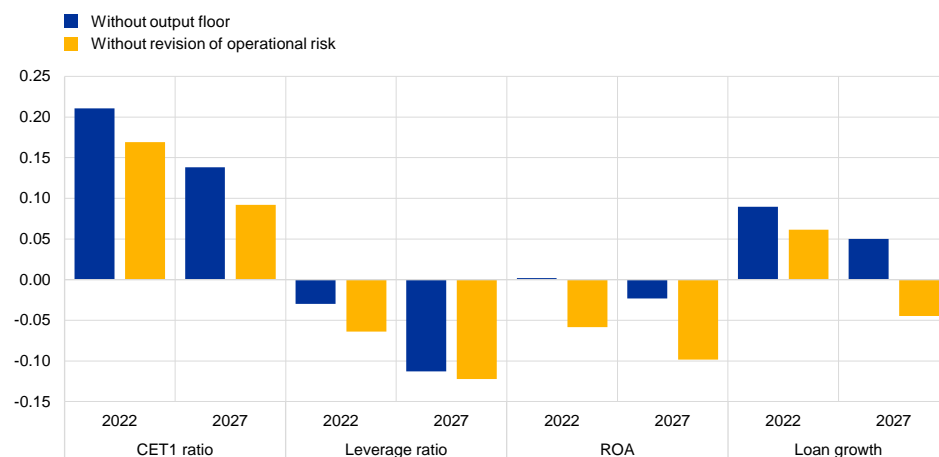
Note: Difference in ROA is multiplied by 10 for clearer representation.

The marginal impact of the cap on bank leverage ratios would be negligible.
Following the introduction of the Basel III finalisation package the number of banks that would breach the CET1 ratio requirements remains higher than the number of banks that would hit the regulatory leverage threshold. The number of banks that approached a CET1 limit decreases over time due to bank endogenous adjustment aiming to restore the CET1 ratio. In contrast, the number of banks below leverage ratio requirements is on a slightly increasing path, resulting in nine banks staying below the threshold at the end of the projection period.

Chart 37

Number of banks hitting the CET1 and leverage ratio requirements

Banks breach CET1 requirements more often, especially at the initial stage of the Basel III finalisation
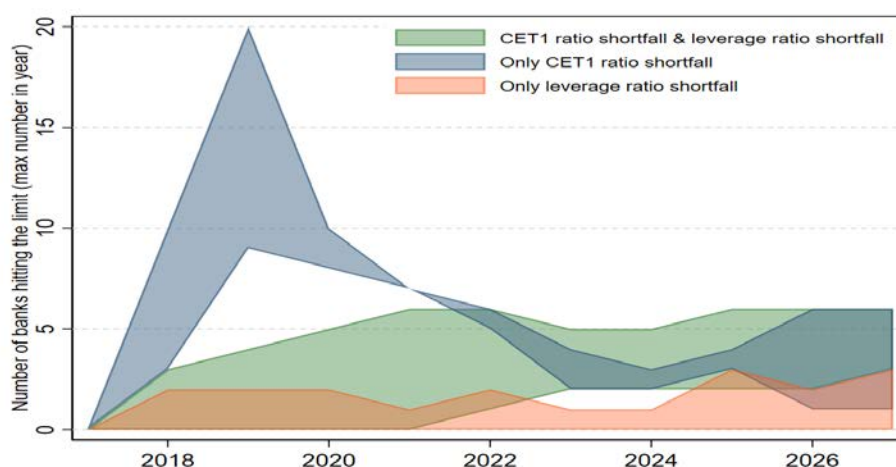
Note: The areas show the range of number of banks below regulatory thresholds. Upper limit of each range is the outcome with the Basel III finalisation, whereas lower limit is with current regulation.

Chart 38

Leverage ratio in 2027

The Basel III finalisation increases leverage ratio requirements for G-SIBs

(leverage ratio in percentages)

- ■ Leverage ratio requirement
- ■ Leverage ratio
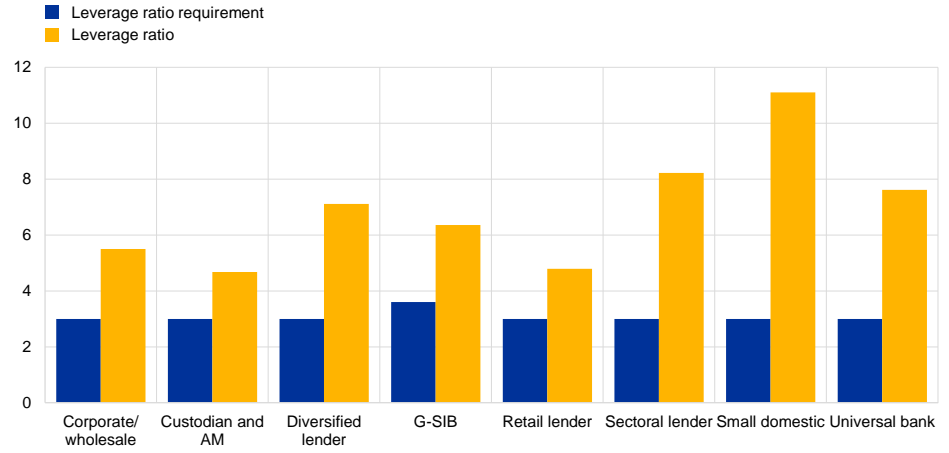
7   Conclusions and policy implications

This paper provides an assessment of the impact of the Basel III finalisation on euro area economies by applying a GaR perspective and a large-scale semi-structural model. Combining a model with a detailed representation of individual banks with an inspection of multiple economic scenarios provides a comprehensive picture of the transmission channels and of the costs and benefits of the Basel III finalisation.

The approach followed in this paper illustrates the merits of looking at policies supporting financial stability through the prism of GaR. Policy design and communication should exploit the advantages of the GaR approach that focuses on the tails of the distributions of the key macro-financial variables and those of semi-structural modelling with its ability to provide forecasts conditional on different regulatory setups. The approach has broad potential applications, can handle the impact assessment of multiple regulatory reforms, and can capture their individual effects as well as their interactions.

The analysis shows that the finalisation of Basel III reforms will bring about a net benefit in the medium to long term. The costs resulting from the new capital framework would amount to a reduction of around 0.2 percentage points in the average annual euro area GDP growth in the first four years after implementation, if the reform package will be introduced in normal times rather than in a recessionary environment. This effect turns positive in the subsequent years and amounts to zero at the end of the ten-year transition period considered. The short-term costs are slightly higher under the more conservative assumption of banks applying an immediate frontloading of the revised output floor.

The benefits of the Basel III finalisation link to the enhanced resilience of the banking sector. In the long term, adverse GDP growth outcomes falling into the 10th percentile of the historical GDP growth density are around 0.1 percentage points higher, reflecting a combination of both a lower likelihood of very deep recessions occurring and milder recession outcomes. Recessions become shorter and shallower, resulting in GDP losses being around 0.2 percentage points lower four years after their beginning. Over a longer horizon, these benefits will continue to accumulate. The net benefits from the reforms at the end of the 10-year horizon remain higher for the gradual, as compared with the immediate phase-in of the output floor, pointing to medium-term gains from gradual phase-in of the capital reforms.

The analysis shows that there are two main channels through which the Basel III finalisation boosts the resilience of the banking sector. First, higher capital stock held against the same amount of nominal assets translates in a higher loss-absorbing capacity. Better capitalised banks that experience losses due, for example, to a deterioration of their asset quality are in a better position to absorb those losses without a significant reduction in their capital ratios. Second, improved bank capitalisation lowers bank funding costs. This effect initially aids especially

lower capitalised banks, or banks more reliant on wholesale funding. The effect is also more pronounced for all banks in bad times as compared to good times. Lower funding costs trigger a positive feedback loop between bank profitability, the ability of banks to speedily restore their capital buffers, and (again) funding costs.

Finalisation of the Basel III reform is expected to have a strong positive effect on the leverage ratios of banks. Broad-based increases in capital charges (risk weights) on bank assets held in both banking and trading books limit the scope for circumvention of the regulation by reshuffling bank portfolios to achieve lower risk-weighted exposures. Accordingly, the leverage ratio of the euro area banking sector is expected to increase by over 1 percentage point in the decade following the introduction of the reforms. A similar effect would be unlikely to emerge in the long term had the reforms targeted an increase in regulatory capital ratios.

The assumptions underlying the cost estimates are conservative and likely to overstate the reduction in lending. First, it is assumed that banks do not anticipate changes in regulation. In reality, banks have several years to adjust to the new standards, which will moderate the contraction in lending. Second, banks are assumed to have no access to capital markets and do not raise capital by issuing new shares. Third, the model incorporates the dynamics of the largest euro area banks only. Since the largest banks are expected to be the most impacted by the Basel III finalisation, this assumption overstates the cost estimates for economy-wide lending. Finally, capital requirements and buffers set by regulators are assumed to remain unchanged, while some national authorities already announced that certain capital requirements will be imposed following finalisation of the Basel III reforms.

There are a few more sources of model uncertainty worth mentioning, although their impact on the outcome is less predictable. The analysis does not fully reflect the possibility of substitution of bank loans by lending by other financial entities given that non-bank intermediation is not included in the model. Such substitution might be encouraged by imposing additional capital charges on banks and moderate the effect of the Basel III reform on overall lending to the real economy. Bank behavioural functions, estimated based on specific data samples, are subject to the usual statistical uncertainties, and the responses of the larger banks in the model may differ wildly from those of smaller banks. Finally, the analysis counterfactually assumes that the introduction of the Basel III finalisation had taken place at the beginning of 2018 and assumes the structure of bank balance sheets as at the end of 2017. The estimates cannot anticipate the changes in the banking sector that will have taken place by 2023, the current timing of the introduction of the reform. In the period to 2023, the banking sector, the economy at large and shocks' propagation channels may well change, particularly in the light of the COVID-19 crisis.

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Appendix: Model description

This appendix summarises the extensions of the Banking Sector Euro Area Stress Test Model (BEAST) not yet present in the model version of Budnik et al. (2020). It discusses new or modified behavioural equations and sets out the assumptions made in modelling bank parameters most affected by the Basel III finalisation such as e.g. credit risk weights. Lastly, it discusses in detail the calibration of selected Basel III finalisation impacts based on the QIS data.

A.1 Bank-level behavioural equations

A.1.1 Distribution of dividends

The model assumes that banks will, if possible, retain the exact amount of profits required to meet regulatory requirements and the internal management buffer. All excess profit is then distributed to shareholders. The maximum distributable amount (MDA) is calculated based on the profit after tax before distribution of dividends, and the bank's capital position relative to the regulatory buffers. The model determines how the MDA is allocated as follows. First, it is assumed that outstanding variable remuneration and pension benefits are paid out.[17] What remains of the MDA after this item (and tax) is then used to pay dividends to Additional Tier 1 (AT1) capital, that is to say dividends to preferred stock and other hybrid instruments.[18] The remainder can then be either distributed to CET1 capital or be retained.

The management buffers of banks are identified based on Supervisory Banking (SUBA) data. The sample comprises quarterly data of about 89 banks for the years 2014 to 2018. All banks in the sample that pay out positive dividends amounting to less than their profit after tax are assumed to be "unrestricted" with respect to their dividend payout. It is further assumed that their actual CET1 ratios after retained earnings are close to their internal capital target. Where the CET1 ratio exceeds the sum of Pillar 1 requirements buffers, and P2G, the surplus capital is taken to be an observed management buffer.

The management buffer for non-custodian and non-state-owned banks is then estimated within a two-limit Tobit regression. The lower truncation bound of the Tobit model reflects the additional assumption that any observed capital excess below 1% is too thin to constitute a management buffer sheltering the bank from

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[17] Because the amounts paid out under this cost category are tax-deductible, giving variable remuneration and pension benefits the highest preference is, at the same time, a sensible and simplifying assumption.

[18] It would seem sensible to assume that preferred stock would be paid out in full before any dividends are paid on common stock. The model makes no allowance for the ability of banks to defer payments on AT1 capital to future time periods.

unexpected events. The upper truncation bound reflects the assumption that it is unlikely that banks hold an internal buffer of more than 10%. Such truncation is not very significant empirically – only 2% and 6% of the observations exceed the limits below and above, respectively.

The management buffer will depend on evolving banks' characteristics. The explanatory variables include the structure of liabilities (a larger share of government and retail funding means lower management buffers, a larger share of wholesale funding leads to larger management buffers), the revenue structure (a larger contribution from relatively less variable net fee and commission income (NFCI) is linked to lower management buffers), non-performing exposures (NPEs) (a greater proportion of NPEs will lead to larger internal buffers) and the firm size (the larger a bank's balance sheet, the lower the management buffer). Overall, the estimation employs balance sheet equity, profit and loss statements, and statements of changes in equity (financial reporting – FINREP 1.03, 2 and 46 respectively), data on capital adequacy and solvency (common reporting – COREP 3 and 6), and the composition of liabilities from 2018 Stress Test Data.

A.1.2 Wholesale funding costs

In the model, the wholesale yield curve consists of a risk-free yield curve and a risk margin. For empirical identification purposes changes in yield spread are assumed to be entirely driven by changes in firm risk. The estimation explores the no-arbitrage condition between the yield spread of bonds issued by a firm and that firm's CDSs (Duffie (1999), Hull et al. (2004)).[19]

Changes in CDS risk margins are estimated using the daily CDS spreads of 32-euro area banks published by the Capital Markets Authority (CMA) separately for each maturity. The sample covers the period from 2014 to 2017. The strongest predictors of risk are bank capitalisation (as measured by the leverage ratio), return on assets, and among macroeconomic variables, GDP and country-level stock price indices. The effect of capitalisation on funding costs displays diminishing returns – at low levels of capitalisation, funding costs react strongly to changes in capitalisation. The changes in bank-level and macro-level variables not only shift the yield curve up or down, but also influence its slope.

The risk margins are added to the simulated realisations of the three-month Euro Interbank Offered Rate (3M EURIBOR) to generate bank-specific yield curves. Thereby, 3M EURBOR is assumed to correspond to the risk- free rate for all

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[19] Using CDS spreads to model changes in funding costs has a whole host of advantages as opposed to using bond yields directly. CDS are traded at variable maturities on OTC markets by third parties. As such, we can deduce a theoretical yield for all maturities along the yield curve independently of bonds issued by a firm. CDS markets tend to be much more liquid – data thus tends to be available in greater abundance, and be of higher quality, especially with respect to firms who are currently unable or unwilling to issue securities on wholesale markets. It is possible to infer these "shadow rates" using CDS spreads for a multitude of banks. CDS spreads, being traded by third parties, are not beset by endogeneity issues that would confound the estimation of funding costs using observed bond yields directly. Other confounding factors inherent to bonds, such as coupon effects or residual maturity effects, are also avoided (see Annaert et al. (2012) for a comprehensive review).

durations. Newly issued securities are assigned that interest rate, given their maturity-at-issuance.

Three sectors of wholesale liabilities are modelled separately. Interest rates for (i) financial sight deposits which include overnight deposits are driven by changes in the yield curve at the lowest maturity. Interest rates for (ii) financial term deposits which contain deposits, certificates of deposits, and repurchase agreements with fixed maturity, usually between 6 months to 4 years, are driven by the low-to-middle section of the yield curve. Interest rates for (iii) securities which include collateralised and uncollateralised securities and fixed-income instruments convertible to equity, are driven by the middle-to-long end of the yield curve. The latter products can have a wide range of maturities, typically between 2 and 20 years in our sample.

Banks' choices of maturity at issuance, given a specific yield curve, are endogenous. For financial term deposits and securities maturities-at-issuance are estimated for 290 bond issuances by the same 31 banks, given the changes in the shape of their predicted yield curves. For financial sight deposits, maturity-at-issuance is assumed to be constant.

A.2   Bank sensitivities to external environment

A.2.1   Transition rates

The model incorporates the entire International Financial Reporting Standard 9 (IFRS9) transition probability matrix. The transition probability matrix is estimated on a sectoral level using the information from the 2018 stress test exercise but allowing for non-zero cure rates from the non-performing stage (S3) to the performing stages (S2, S1). All elements of the matrix are estimated jointly in a seemingly unrelated regressions (SUR) and depend on macroeconomic variables.

A.2.2   IRB risk weightings

Internal ratings-based (IRB) risk weightings are determined as a function of the regulatory parameters dictated by the regulation. These include regulatory PD, LGD, expected loss (EL), and expected loss best estimate (ELBE). All these parameters are modelled at bank-country-sector level using the data from 2018 stress test exercise. Separate model specifications are estimated for the following sectors: non-financial corporates, consumer credit, loans for house purchases, sovereign exposures and exposures to financial institutions.

A.2.3   Standardised risk weights

Standardised risk weightings can be split into two groups. In the first group are risk weights on exposures to economic sectors for which either regulation dictates a

constant risk weighting, or the data shows their limited sensitivity to changing macroeconomic conditions. This includes consumer credit and sovereign exposures. For these two sectors the risk weighting is kept fixed over time. For the second group, non-financial corporates (small and medium-sized enterprises (SMEs) and non-SMEs treated separately) and financial institutions, the risk weightings are modelled using 2018 stress test data as a function of macroeconomic variables and bank-sector-country-specific risk parameters, such as the transition rates. Risk weightings for loans for house purchases depend on the underlying loan to value (LTV). This relationship is derived from COREP and QIS data.

A.3   The real economy and banking sector feedback loop

The feedback loop is introduced by linking bank loans and interest rates on new loans to their macroeconomic counterparts in a country-level Vector Autoregression (VAR) in the macro block. The reactions of individual banks are aggregated at the country level and mapped into proportional changes in macro-level lending and interest rate variables. This feedback loop mechanism was fundamentally revised as compared to its application in the 2018 macroprudential stress test exercise (Budnik et al., 2019) and involves linear and non-linear responses in terms of both credit demand and supply to economic developments or changes in regulatory requirements.

A.4   Assumptions for stochastic simulations

Stochastic simulations involve multiple drawing from the joint distribution of macroeconomic shocks. The macro block involves 11 endogenous variables per economy and 11 structural shocks, including aggregate demand, aggregate supply, or house price shocks. They are jointly normally distributed, with the variance-covariance matrix being estimated in parallel to country VAR parameters. Each scenario involves the paths of such shocks for the full assessment horizon. Accordingly, each scenario can be interpreted as consistent with the historical distribution of structural macroeconomic shocks. The simulations do not involve parameter uncertainty or uncertainty related to the estimates of bank-level behavioural equations.

A.5 Implementation of the Basel III finalisation in the model

A.5.1 Data

The calibration of selected impacts of the final Basel III relied on the Basel monitoring data for quarter 2 2018. The data were collected for 75 institutions by the Basel Committee on Banking Supervision (BCBS) in collaboration with the national competent authorities (NCAs) and the European Banking Authority (EBA). Since the reforms are not yet translated into national regulation, banks are not always able to provide data in all areas. Furthermore, banks sometimes do not report at the highest level of consolidation, or they include only a subset of portfolios due to technical limitations.

A.5.2 Credit risk

The Basel III finalisation package significantly revised the calculation of risk-weighted assets for credit-risk exposures. Common to standardised approach and internal rating-based approach (IRB) is a renewed and more detailed sectoral classification. This is captured in the model either by directly subdividing the modelled portfolios into the new classes where this is possible (like, for instance, separate treatment of SMEs) or through a series of parameters calculated from the QIS dataset.

A major change that applies to the standardised approach, in addition to the new sectoral classification, is the increased risk sensitivity. Since there are no historical data available that would make it possible to model these renewed dynamics, they were captured using scalar parameters calculated from QIS data, i.e. by how much the risk weighting would be different under the renewed approach. For exposures secured by real estate, the proposed loan-splitting approach is implemented directly in the model and the risk weighting endogenously depends on property prices.

The main IRB novelties are the constraints on the use of IRB approaches, revised input floors and revised haircuts for LGD calculation. The input floors concern probabilities of default (PDs) and losses-given-default (LGDs), while the revised haircuts apply to LGDs under the foundation internal ratings-based (F-IRB) approach. These changes are directly accounted for in the model by reclassification of exposures between different regulatory approaches (e.g. from advanced IRB approach to standardised approach), adding input floors based on the regulation, or – as is the case for LGD changes – calibrated based on information from the QIS and COREP.

A.5.3 Operational risk

The new standardised operational risk framework consists of the business indicator (BI) and the internal loss multiplier (ILM). The BI is the aggregate of the following income indicators: interest income, interest expense, interest earning assets, dividend income, other operating income, other operating expenses, fee income, fee expense, net profit and loss (P&L) trading book, and net P&L banking book. The model incorporates these indicators and the BI is derived endogenously. The ILM is computed based on a loss component and the Bank Identifier Code (BIC), and the national discretion of setting it to 1 is not activated. Operational risk losses for the last three years are reported in the 2018 stress test templates. The average of the three-year losses approximates to the average of the losses over the 10 years foreseen in the reforms.

A.5.4 Market risk

The structure of the revised market-risk framework is very different from the current framework. As a result, it is not possible to reliably approximate the revised RWA market risk based on the existing variables of the model. The key items of the revised standardised framework are the sensitivities for different risk types (general interest rate credit spread, equity, commodity and foreign exchange) and residual risk for the prepayment residual-risk add-on and default risk. For the internal model part, the items are the capital charge related to expected shortfall, the non-modellable risk factors and the default risk.

To overcome this limitation, the ratio of the subitems of the revised market-risk framework as compared to the current RWA market-risk framework is assumed to be constant over time. Thus, any market risk item at any point in time is approximated by multiplying banks' current RWA market risk by the bank-specific ratio retrieved from the Basel monitoring data collection template.

A.5.5 Output floor

The output floor limits the use of internal models by flooring total RWAs at 72.5% of the amount had they had been calculated without using internal model-based approaches. To estimate the fully non-modelled RWAs for the floor, credit risk portfolios currently under IRB approaches are additionally and endogenously evaluated as if under the standardised approach. For market-risk charges, a proportionality approach like the one developed to map the existing into the revised framework is applied, with the scaling factors again sourced from the Basel monitoring data collection template.

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