

THE FINAL BASEL III STANDARD AND THE DANISH MORTGAGE SECTOR

Impact on Danish mortgage banks and customers

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AUTHORS

Helge Sigurd Næss-Schmidt
Jonas Bjarke Jensen
Astrid Leth Nielsen
Sebastian William Kleberg

PREFACE

The Final Basel III Standard from December 2017 sets out revised international standards for banking regulation. The package is now about to be implemented in the EU. The European Commission has recently published a proposal, outlining how this reform could be implemented in the EU.

The suggested proposed implementation contains some deviations from a previous impact assessment by the European Banking Authority (EBA). Considering this and our previous research, Finance Denmark has asked Copenhagen Economics to analyse the impact of the EU Commission's proposal for the Danish mortgage portfolio and the real economy. Furthermore, we were asked to analyse the impact of other scenarios for implementation, based on the current debate around the EU implementation.

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EXECUTIVE SUMMARY

The European Commission has recently published a proposal on how to implement the Final Basel III Standard in a European context. The Final Basel III Standard introduces the concept of an output floor, which has an impact on the minimum level of capital that banks are required to hold for each type of asset. The motivation behind the output floor is to create a backstop for excessively low modelled capital requirements compared to a realistic assessment of risks, and to enhance comparability between banks.

Should the Final Basel III Standard be implemented according to the EU Commission's proposal, the output floor will be binding for Danish mortgage banks and lead to significantly higher capital requirements and thereby higher cost of capital. However, the EU Commission is suggesting temporary exemptions, giving relief to low-risk portfolios such as mortgages. Making such exemptions permanent or implementing the output floor via the parallel stack approach could mitigate the increase in capital requirements caused by the Final Basel III Standard and maintain the underlying risk sensitivity.

Capital requirements are pushed above underlying risks with a negative impact on the real economy

Implementing the output floor according to the EU Commission's proposal will de facto entail a significant increase in capital requirements for low-risk assets. Further, banks bound by the output floor will lose the risk sensitivity of their capital requirements, as underlying risks of assets are no longer reflected. On average in the EU, the Commission assesses that capital requirements would increase by 6%-8%. However, Danish mortgage portfolios would be affected to a much larger degree, with an increase in capital requirements of 36% on average. Note, that the estimated impact is the effect of the reform on mortgage portfolios when it is fully implemented and viewed in isolation i.e., disregarding temporary exemptions proposed by the Commission and interplay effects from the impact on group level.¹

This is primarily attributed to the low-risk nature of the Danish mortgage portfolio; looking across portfolios, the increase in capital requirements is around average for households and commercial mortgages, whereas private rental property will experience a lower increase.

Higher capital requirements will increase borrowing costs for mortgage customers

¹ The estimated increase in capital requirements is based on data from the mortgage banks at end 2020 and without taking into account supervisory initiatives during 2021 which may affect the capital requirement for credit risk and thereby the impact of Final Basel III.

In time, we expect that the increase in capital requirements for low-risk assets will translate into higher borrowing costs for end-customers as capital is a more expensive source of funding (compared to debt). In total, we estimate that annual borrowing costs for Danish mortgage customers will increase by some DKK 3.5 bn (around EUR 0.5 bn) if the EU Commission's proposal for implementation is followed.

Exactly how this will translate into higher costs for different customers depends on the pricing strategy within different mortgage banks as well as the local competitive situation.

In our price model estimation, we find that loans secured by commercial real estate will have the largest increase in borrowing costs.² Concretely, we find the increase in borrowing costs for commercial property mortgages to be around 0.23 percentage points, and agricultural mortgages to increase with 0.22 percentage points.

For loans to owner occupied houses, we find an average increase in borrowing costs of around 0.12 percentage points. For a typical Danish homeowner, this corresponds to an increased cost of DKK 1,800 (EUR 240) per year, with a loan-to-value ratio of 60%. For new homeowners with an LTV of 80%, we find that capital costs for the banks increase by DKK 4,400 – to which extent this is passed on the customer depends on the pricing strategy of the individual banks.

Increased borrowing costs will reduce investments and GDP

We expect that the increased borrowing costs will lead to fewer investments, which eventually will impact productivity and GDP. Using a model framework similar to what was used as the analytical foundation behind the original Basel III package, we assess that the Danish GDP will permanently be reduced by around 0.25% (when only considering the mortgage portfolio). This corresponds to around DKK 6 bn (EUR 0.8 bn). In other words, every year, the Danish GDP will be DKK 6 bn lower than it would have otherwise been.

At the same time, we find little benefit in the higher capital requirements in the EU Commission's suggested approach for the Danish economy as a whole. The already implemented post-crisis banking reform has increased capitalisation of the Danish banking sector – including the mortgage sector – to a point where additional increases have a very limited ability to reduce the risk of a new financial crisis.

Making the suggested exemptions for mortgages permanent or implementing the output floor via the parallel stacks approach could maintain the risk sensitivity of capital requirements

There are other ways of implementing the Final Basel III package, which could mitigate the increase in capital requirements.

The European Commission has suggested temporary exemptions for, e.g., loans secured by residential real estate, allowing banks to apply significantly lower risk weights in the calculation of the output floor. Making this exemption permanent could neutralise the effect from the output floor, resulting in much smaller increases in capital requirements for countries with low-risk portfolios like Denmark, thereby leading to a more uniform impact across Europe. With this approach the IRB

² This is based on assumptions about a full pass-through of increase in costs to consumers (implying the increase in cost of capital for banks is equal to the increase in costs of borrowing for customers). See Appendix A for a detailed explanation.

capital requirement would more likely become binding in Denmark, including the adjustments and new elements in the Final Basel III package.³

In addition, the alternative options neutralising the large capital requirement increase, is more consistent with economic considerations as well as the original spirit behind the Final Basel III Standard, as it would:

- to a larger extent maintain the link between capital requirements and underlying risks for assets
- lead to a smaller impact on capital requirements for mortgages, with resulting smaller impact on borrowing costs
- be closer to the impact on a global level, such as in the Americas where capital requirements are expected to increase by around 1%-2%

This underlines that imposing fixed global international standards on banks with highly different structures and underlying risks can reduce economic welfare. Hence, Denmark and in particular the mortgage portfolio as well as the EU would be best served with an implementation that reflects this variation, hereby adhering to the original aim of the Basel proposals.

³ With reference to ECB's and supervisory authorities' ongoing monitoring of internal models it is expected to increase capital requirements.

CHAPTER 1

THE IMPACT ON THE DANISH MORTGAGE PORTFOLIO

In December 2017, the Basel Committee agreed on a new regulatory framework to address identified shortcomings of the original Basel III agreement denoted the 'Final Basel III Standard'. In October 2021, the EU Commission came forward with a proposal on how to implement the Final Basel III Standard in the EU.

This chapter provides an overview of how the Final Basel III Standard will impact capital requirements of the Danish mortgage portfolio.⁴ In chapter 3, we present a few alternative options for implementation, which could change the impact on the Danish mortgage portfolio significantly. Section 1.1 gives a short introduction to the original Basel III framework that was agreed upon in 2010 and the finalisation of the Basel III standard that was agreed upon in 2017. Section 1.2 provides an overview of the impact of the Final Basel III Standard on the Danish mortgage portfolio and describes in more detail one of the central aspects of the reform, the output floor. Section 1.3 concludes this chapter with a brief comparison of the European and the US mortgage markets.

1.1 THE FINAL BASEL III STANDARD

The third instalment of the Basel agreements, the original Basel III standard, significantly increased capital requirements. It was developed in response to the 2008 financial crisis with the objective of increasing the resilience of the financial sector by increasing bank capital requirements⁵ (i.e., the amount of equity banks must hold).

The original Basel III measures significantly reduced the risk of a financial crisis arising from insufficient capitalisation of the banking sector; average capitalisation in the EU increased from around 8% in 2007 to close to 15% in 2019, see Figure 1.⁶ By 2019, the average capitalisation had reached around 18% for Danish banks. For Danish mortgage banks, the average capitalisation is currently above 22%.

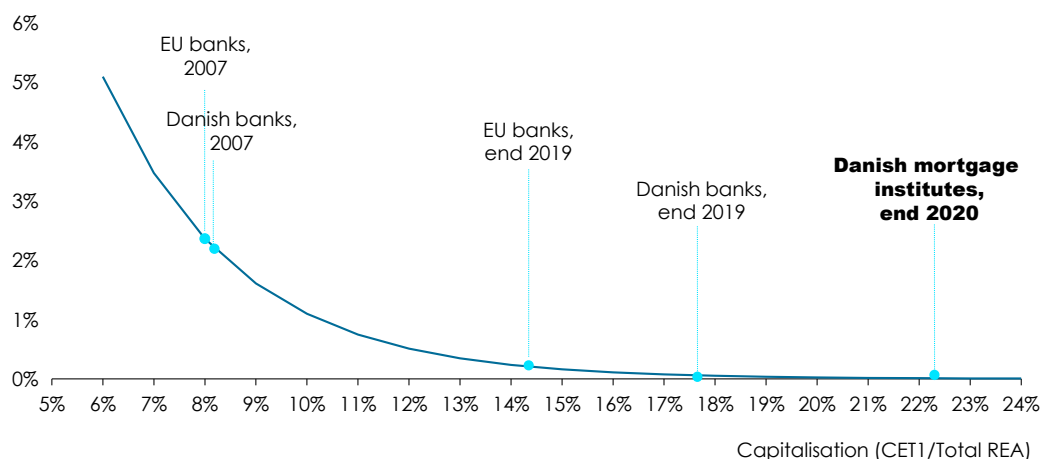
⁴ We include the following six Danish mortgage banks, thereby covering the entire market: DLR Kredit, Jyske Realkredit, Nordea Kredit, Nykredit Realkredit, Realkredit Denmark, Totalkredit.

⁵ A capital requirement is the amount of equity that a bank is required to hold, based on the riskiness of its assets. This requirement is put in place to reduce/avoid systemic risk in the event of a crisis.

⁶ Throughout the report we will consider capitalisation and capital requirements in terms of CET1, implying that we will not take other additional capital requirements (additional tier 1, tier 2, etc.) into account. This is to simplify the calculations. Only taking CET1 into account implies that the capital requirements considered are lower, but on the other hand have a higher cost of capital.

Figure 1
Risk of a crisis in the EU given pre- and post-financial crisis capitalisation

Risk of a crisis in a given year



Note: The figure shows the relationship between the level of capitalisation of banks (horizontal axis) and the probability of a financial crisis, in any given year. The higher the level of capital held by banks, the lower the probability of a financial crisis. The level of capitalisation is expressed as CET1 in % of un-floored Risk Exposure Amount (REA).

Source: BIS (2010), page 15 and own calculations; ECB (2007) and Danmarks Nationalbank (2008) for pre-crisis capital ratios.

The European Commission has recently put forward a proposal for the implementation of the Final Basel III framework in a European context. One of the key measures is a so-called output floor, providing a minimum level of capital that a bank must hold (based on the banks' exposures), thus working as a back-stop for excessive low estimated risk. It is based on the internationally agreed⁷ final Basel III standard which sets out new standards for bank regulation. Note that currently, another backstop for excessively low estimated risk is in place; the leverage ratio, requiring banks to hold a minimum of capital related to their total assets.

Policy makers' key concern has been that the variation in the risk estimated by the internal models (and by that, variation in capital requirements) is not linked to corresponding variations in the underlying risks. In particular, policy makers are concerned that modelled risks are underestimating actual risks. This would mean that banks might underestimate potential losses and therefore would not have enough capital to keep the financial system stable in a crisis. The output floor is (among other measures) meant to address this.⁸ We will discuss this in section 1.2.2.

The proposal for implementation by the EU Commission will now be subject to negotiation with, e.g., the European Parliament, see Figure 2 for an overview of the timeline.

⁷ A revised regulatory framework to finalise the post-crisis reforms denoted the 'Final Basel III Standard' was agreed upon by the Basel Committee in December 2017. This was an addition to the original Basel III framework and centers around a revision of the technical calculation of the risk exposure amount for banks.

⁸ See CE 2020 and Appendix A at the end of this study for more details.

Figure 2
Timeline of Final Basel III Standard: agreement and implementation



Note: The start of the implementation depends on the duration of the negotiations with the European Parliament and the European Council.

Source: Illustration by Copenhagen Economics, based on publicly available information.

1.2 IMPACT ON THE DANISH MORTGAGE PORTFOLIO

In the newest impact assessment following the EU Commission's proposal for implementation, the increase in capital requirements is assessed to be 6-8% for the European banking sector *on average*. It should be noted that the European Commission mentions that this is an approximate estimate, as not all elements in the final proposal have been subject to a thorough impact assessment.

However, the average impact is not reflecting the impact on individual portfolios. Risks of underlying assets vary significantly across countries and portfolios, and the impact can therefore be expected to differ significantly. A good example is the Danish mortgage portfolio, which is characterised by relatively high-quality collateral and low historical losses, meaning relatively low implied capital requirements.⁹

Concretely, based on data by end 2020 from Danish mortgage banks, we find that the Commission's proposal (without taking into account the proposed temporary exemption for loans secured by residential real estate) would lead to a potential increase in capital requirements for the mortgage portfolio by 36%, see Figure 3.¹⁰

The estimate (as well as the other estimates in this chapter) are based upon a data gathering exercise from Danish mortgage banks.¹¹ However, please note that it was carried out before the content of the final proposal from the EU Commission was fully known. This means that there could be

⁹ The proposal from the EU Commission includes CVA exemptions, the 'extra' SME discount known from CRR2 and a special treatment of operational risk.⁹ Further, national authorities can allow financial institutions to maintain the Pillar II requirement in absolute values instead of percentage, thereby mitigating some of the impact of the Final Basel III package. We base our main scenario on this.

¹⁰ This is slightly higher than the increase for the entire banking sector, on 29%, although it follows the so-called EU-specific approach (a different package than the current proposal for implementation), see CE (2020).

¹¹ The data gathering exercise was carried out by Finance Denmark where the six mortgage banks in Denmark were asked to assess the increase in REA for their different portfolios due to the Final Basel III package. Thus, the reported numbers here are closely linked to the assessments carried out by the mortgage banks themselves.

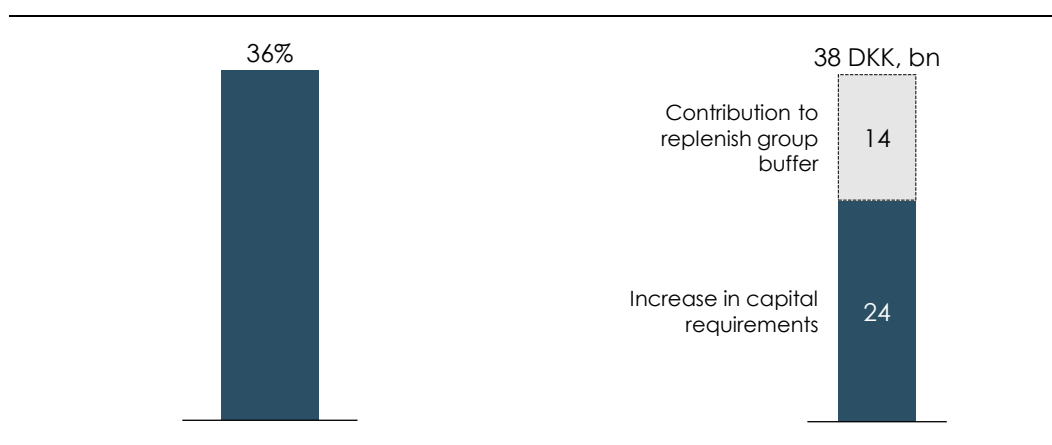
some deviations between the assumptions behind the figures presented and the final outcome of the proposal. Also, note that the estimation is based on our expectation that all Danish mortgage portfolios pass the hard test and thereby are eligible for the loan-splitting approach.¹²

Furthermore, we have in this exercise estimated the impact on the Danish mortgage portfolios, viewed in isolation, thus disregarding interplay effects with the impact on group level. In the actual implementation, the output floor will, in the Commission's proposal, only apply at the consolidated level in banking groups.

Figure 3 Increase in capital requirements following the Final Basel III Standard

Increase in capital requirements
Per cent of original CET1 requirements

Additional capital needed
DKK, bn



Note: We define the lower bound of our estimate to be the increase required when only looking at capital requirements (DKK 24 bn). In our upper estimate, we assume that the market buffer hold at group level would have to be fully replenished (DKK 38 bn).

Source: Copenhagen Economics, based on data-gathering exercise from the six Danish mortgage banks performed by Finance Denmark.

We assess that an increase of 36% in capital requirements for the mortgage portfolio corresponds to banks having to raise additional CET1 capital of DKK 24-38 bn, depending on the extent to which group capital buffers on top of requirements are fully replenished.¹³ Danish banks might not fully replenish their current CET1 ratio. For example, banks might already have started to increase capitalisation in preparation for the reform, implying market expectations of a buffer on top of capital requirements could still be satisfied without a full replenishment of the current buffer. This also implies that the impact of DKK 24-38 bn is estimated with a baseline of the package not being implemented at all (i.e., that banks have not started thinking about it today). Thus, it is not an estimate of how much *more* capital banks will need to raise compared to the situation today.

¹² If this is not the case, the increase in capital requirements could be higher. Further, we assume all portfolios for Danish mortgage banks to be eligible for loan-splitting on the standardised approach. This implies that we assume Danish mortgage banks portfolio of Income Producing Real Estate (IPRE) to pass the hard test. The loan-splitting approach implies that one (relatively lower) risk weight is applied to the part of the loan with an LTV ratio below 55%, whereas the standard counterparty risk weight is applied to the part of the loan with an LTV ratio over 55%.

¹³ The impact is also including the effects of countercyclical buffers, which currently are set to zero – but are expected to normalise as the economy recovers from the Covid-19 crisis.

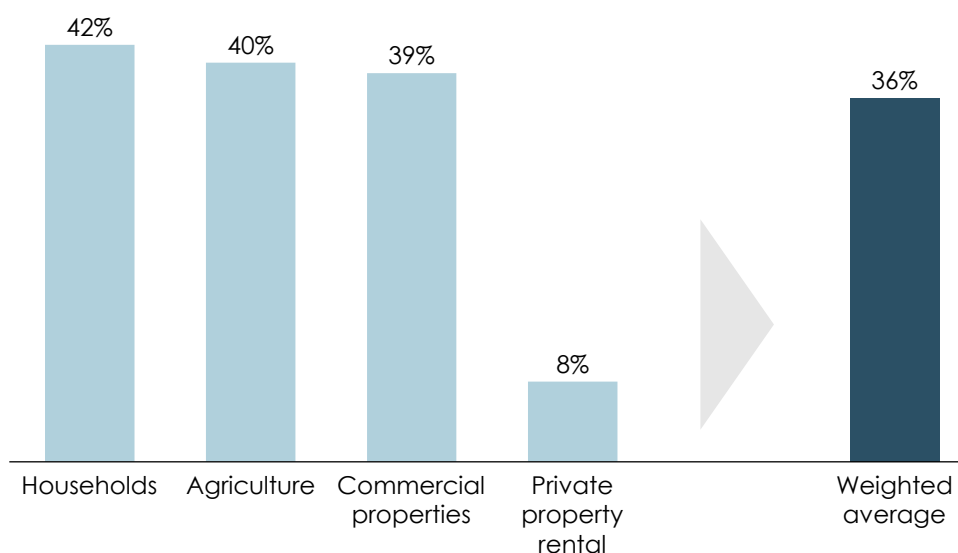
1.2.1 Impact on portfolio level

The impact of the Final Basel III package varies significantly across portfolios. To illustrate this, we divide the impact for the Danish mortgage portfolio into four categories: households (i.e., owner-occupied dwellings), agricultural properties, commercial properties and private rental property. We find the impact for households, agricultural properties and commercial properties to be around the average impact, spanning from an increase in capital requirements of 39-42%. Only for private rental property do we find a lower and more limited impact on capital requirements, with an increase of 8%.

Figure 4

Increase in capital requirements (MRC) based on asset class/portfolio

Per cent of original CET1 requirements



Note: 'Commercial properties' includes properties for offices and business, manufacturing and manual business and social and cultural purposes as well as education.

Source: Copenhagen Economics, based on data-gathering exercise from the six Danish mortgage banks performed by Finance Denmark.

1.2.2 The output floor

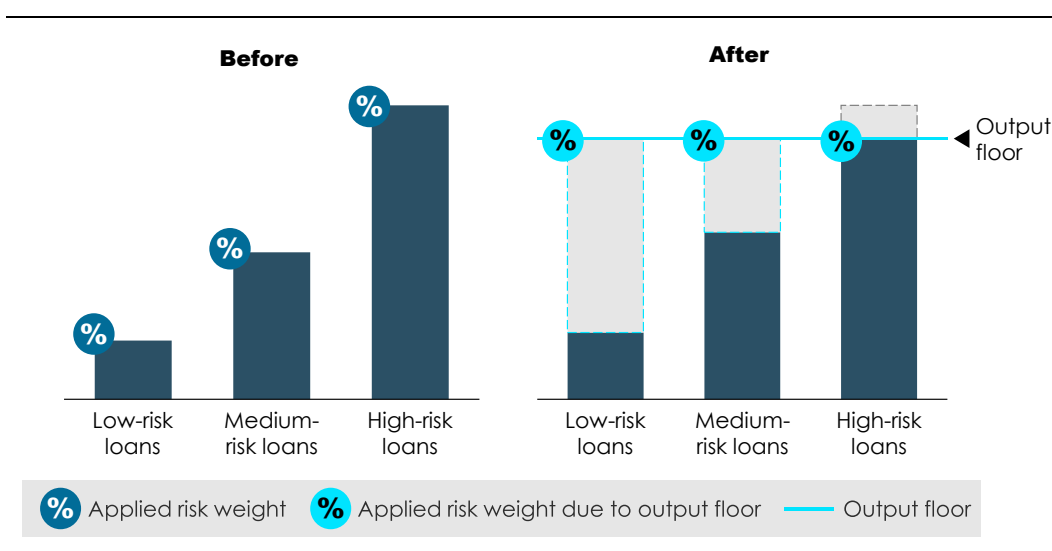
The significant increase in capital requirements for the Danish mortgage portfolio can to a large degree be narrowed down to a single element in the new package, namely the output floor. With the objective of reducing variability in banks' risk-weighted assets, it effectively establishes a lower bound of required capital for each type of asset.

The required capitalisation of banks is not only determined by the total amount of exposures but also by the level of risk of these exposures; so-called *risk weights*. For example, holding an EUR 10,000 unsecured corporate loan entails a larger risk than holding an EUR 10,000 government bond. The larger risk is reflected in higher level of capital that banks have to hold against such a loan.

The level of risk of each exposure is identified by its risk weight. Risk weights are estimated by most large banks using internal models.¹⁴ The estimation process and outcome is then reviewed and approved by the competent regulatory authority. The resulting risk weights are used to determine the banks' risk-weighted assets, which determine the overall amount of capital banks must hold.

The output floor proposed in the Final Basel III Standard effectively incorporates a lower bound for the banks' risk-weighted assets in order to provide a back-stop for banks' internally modelled risk weights. In practice, this is equivalent to banks having to apply a minimum risk weight to each category of assets (e.g. rated corporate, SME retail or retail mortgage), instead of applying a risk weight to each asset based on the estimated risk of that asset using internal models, see Figure 5.

Figure 5
Illustration of application of output floor
Estimated level of risk



Note: The figure above illustrates how the output floor would increase risk weights for certain assets. As an example, we show how risk-weights for low- and medium-risk loans will increase, because the risk estimated by banks' models is lower than when the output floor is applied (and binding). The risk weights for the high-risk loans will actually be lower with a binding output floor, because the internal models set a risk weight above the output floor. It should be noted that the output floor is one floor applied on the totality of risk-weighted assets that a bank holds. However, the effect in practice has a different impact on different categories of assets, as illustrated in the figure above. Please note that different risk weights are applied to different categories of borrowers (e.g. unrated corporates, rated corporates, SMEs, etc), so the purpose of the figure is merely to illustrate the effect of the output floor.

Source: Illustration by Copenhagen Economics.

1.2.3 Loss of risk-sensitivity

For low-risk portfolios, such as mortgage loans bounded by the output floor, the risk sensitivity of capital requirements will be significantly reduced, i.e., below the output floor. The same risk level is applied to exposures, independent of their actual risk.

¹⁴ For banks not using internal models, standardised risk weights are prescribed by the Final Basel III Framework.

Thus, the Final Basel III Standard will create a gap between capital requirements and the underlying risks of portfolios of European banks. This is pronounced for Danish banks and mortgage banks with large low-risk portfolios, such as mortgage loans, where there is often a large gap between the risk weight estimated by internal models and the minimum risk weights in the output floor.

This loss of risk sensitivity could distort incentives for financial institutions. When using internally modelled risk weights, there is a clear incentive for banks to reduce the risk within each asset class; if the risk of an asset increases, the capital requirement for that particular asset will also increase, and the bank will be required to hold more (costly) capital. However, with the output floor, increased risk-taking will not lead to higher capital requirements (when below the output floor). Consequently, risk-taking becomes 'cheaper'.

1.3 COMPARISON WITH THE US MARKET

The impact in other regions of the world comes much closer to the objective of the Final Basel III Standard – to not significantly increase capital requirements. For example, in the United States capital requirements are expected to increase by around 1%-2% across the banking sector.¹⁵ The large difference reflects different structures of the banking and mortgage sector, as well as the corporate sector, which makes capital requirements of US banks less susceptible to the output floors.

Regarding the mortgage portfolio, the main difference between the impact in the US and, e.g., the Danish sector includes the following:

- **Mortgage loans are to a larger extent removed from US banks' balance sheets:** The majority of mortgages that US banks issue are sold to Government Sponsored Entities and securitisation is more common in general. Conversely, mortgage loans remain on the balance sheet of European banks until maturity. Because mortgage loans in general have a very low-risk profile – and because the mortgage portfolio is one of the largest bank asset classes in the EU – this significantly reduces the average risk-weights in EU banks, causing output floors to have a higher impact.
- **Dual recourse is not common in the US:** In Europe, the dual recourse to both the borrower and the property is a central element of mortgage lending. This significantly reduces the losses on mortgages compared to the US where non-recourse lending is more common. Again, this leads to lower risk-weights and therefore a larger impact of output floors.
- **US banks have fewer capital buffers in their capital requirements:** This suggests that the impact on capital requirements in absolute terms is lower than in the EU even if the output floor is binding.

¹⁵ See in BIS (2019) '*Basel III monitoring report*'. The country group 'Americas' also contains Canadian, Brazilian and Mexican banks but is dominated by US banks in the sample. The impact in the Americas is therefore indicative of the impact in the US. The results stated here are the numbers for highly capitalised, internationally active banks (Group 1 banks). No US banks are represented in the sample of Group 2 banks.

CHAPTER 2

THE IMPACT ON DANISH MORTGAGE CUSTOMERS AND THE REAL ECONOMY

In this chapter, we analyse how Danish mortgage customers are likely to be affected by the Final Basel III reform, if the proposal laid forward by the EU Commission is implemented, and how this will impact the real economy. Section 2.1 focuses on the impact on mortgage customers. Section 2.2 illustrates the impact on customers in two concrete cases: a new homeowner and a mortgage loan secured by an agricultural property. Finally, Section 2.3 describes what the package will entail for the real economy in Denmark in terms of welfare loss and decline in GDP.

2.1 IMPACT ON MORTGAGE CUSTOMERS

The higher capital requirements, from the proposal by the EU Commission, will translate into higher costs for mortgage banks, which we expect eventually will be passed on to their customers in terms of higher borrowing costs.¹⁶ This is widely accepted in the economic literature, e.g., from Bank of England, IMF and ECB.¹⁷

The dynamics can be explained as follows: higher capital requirements mean that mortgage banks have to hold more equity for each loan they grant. Equity is a significantly more expensive source of funding than debt: it typically has a required return from investors of 10%-15%, whereas debt funding costs are usually around 1%-2%.¹⁸ The main reason is that equity is subordinated to debt in case of default, i.e., holding equity entails higher risk, giving rise to a higher required return.¹⁹ Higher capital requirements therefore mean higher costs for banks, which they will eventually seek to cover.

How the higher capital requirements are passed on to the different customer segments is, however, uncertain. The passing on of costs is the result of banks' internal capital allocation model, price strategy as well as the local competitive situation. In our estimations, we handle this uncertainty by assuming that the price increase for different customers is proportional to the increase in capital requirements.

We find that the estimated average increase in CET1 capital requirements of 36% for the Danish mortgage portfolio leads²⁰ to an average increase in costs of capital of 0.13 percentage points for mortgage banks, which we – as discussed above – expect to be passed on to customers.

¹⁶ We refer to these costs of borrowing from banks collectively as 'borrowing cost' below.

¹⁷ See, for instance, BIS (2010), Miles et al. (2011), The Riksbank (2011), IMF (2016), ECB (2016) and Bank of England (2016). Note that this is a long-term consideration – in the short-to-medium term, pass-on can be influenced by competitive dynamics in the banking market, see discussion in Copenhagen Economics (2020) 'Impact of the Final Basel III Framework in Sweden'.

¹⁸ In this study, we assume an average cost of equity funding after taxes of 10%, corresponding to a before-tax cost of equity of around 13%. This number is based on the European banking study by ZEB (2018), covering the 50 largest European banks. The debt funding rate for the Danish mortgage banks in our sample is around 1% and is calculated on a bank level using data on bank interest expenditure and total financial liabilities from annual reports.

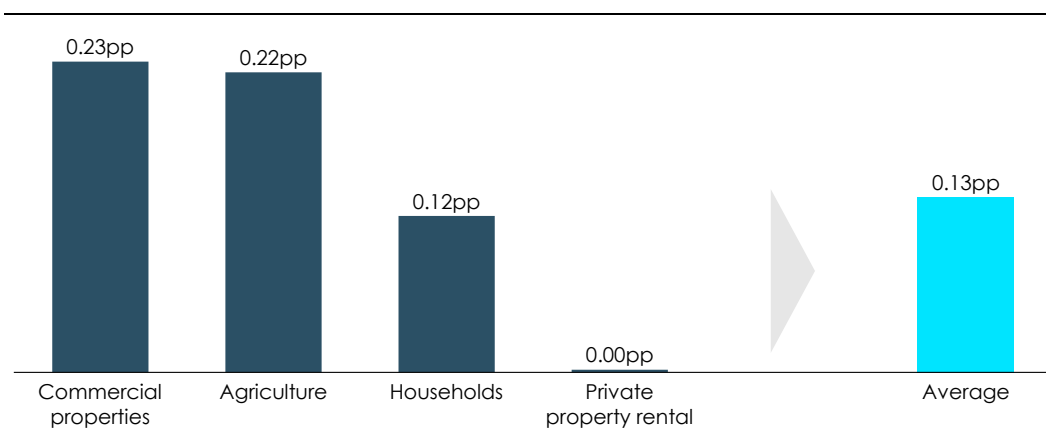
¹⁹ A mitigating effect is that a higher share of equity funding leads to lower required return, both for debt and equity because a higher capitalisation makes a bank less risky. This is known as the Modigliani-Miller effect and the lower required return on equity is included in our results. However, we assume the debt funding rate to be constant. See Copenhagen Economics (2020) 'Impact of the Final Basel III Framework in Sweden' for further discussion.

²⁰ With all portfolios being on the loan-splitting standardised approach.

Looking at the increase in costs on a customer level, we find that mortgage banks' business customers are the most affected. We estimate that on average the package will increase borrowing costs for loans secured by commercial properties with 0.23 percentage points and with 0.22 percentage points for loans secured by agricultural properties, see Figure 6.

For retail mortgage customers (i.e., households), we estimate that on average the Final Basel III package will increase borrowing costs for households by around 0.12 percentage points. For mortgage customers with fixed interest up to five years, this corresponds to an increase in average borrowing costs of some 17%; debt service costs would increase from 0.7%, to close to 0.9%.

Figure 6
Increase in customers' borrowing costs due to the Final Basel III
Increase in costs of borrowing, percentage points (pp)



Note: For private rental property, the increase in RW is very limited, which translated to a very small increase in borrowing costs, here depicted as zero.

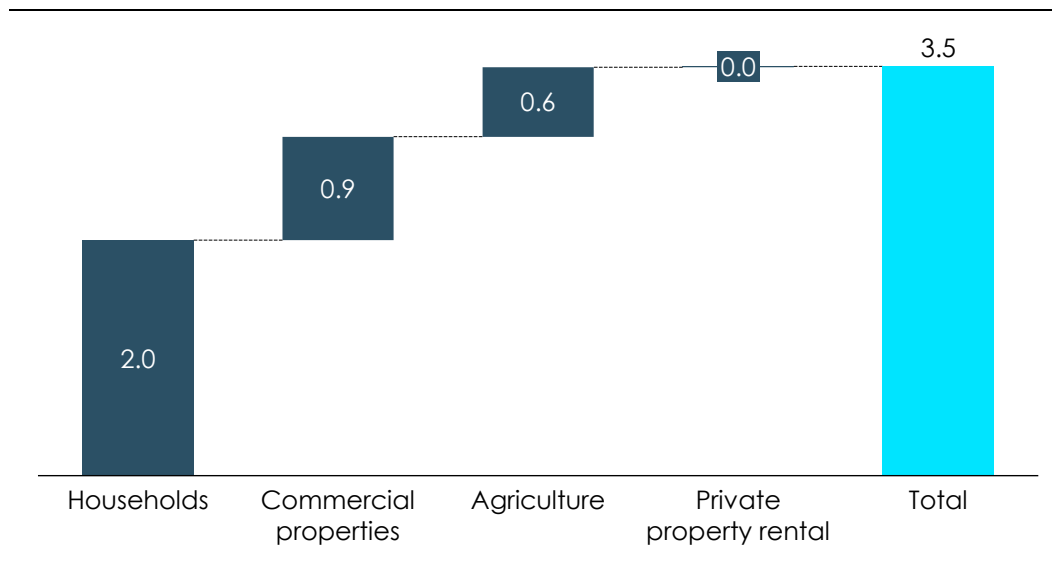
Source: Copenhagen Economics, based on data-gathering exercise from the six Danish mortgage banks performed by Finance Denmark.

Note that the estimated increase in borrowing costs is permanent and will be sustained across business cycles. Thus, the impact is not comparable to ordinary interest rate hikes but should rather be interpreted as a permanent cost wedge in capital allocation between lender and borrower.²¹

Looking at absolute numbers, we estimate the annual increase in borrowing costs for Danish mortgage customers to correspond to some DKK 3.5 bn, see Figure 7. The increase in borrowing costs will be largest for households, with DKK 2 bn. This is despite the fact that households experience a smaller increase in borrowing costs compared to commercial properties, as retail mortgages account for the largest share of total loans.

²¹ We primarily consider long-term effects as The Final Basel III Framework is a permanent regulation, intended to be in effect for many years. In the short-to-medium term, the competitive dynamics on the banking market could affect how banks adjust to the changing costs, and typically imply a lower pass-through of costs.

Figure 7
Total increase in costs for customers of Danish mortgage banks
DKK bn



Source: Copenhagen Economics, based on data-gathering exercise from the six Danish mortgage banks performed by Finance Denmark.

In time, we expect the increase in businesses' (and households') borrowing costs to have real-economy consequences – as described in section 2.3 below – both via reduced investments leading to lower GDP, as well as a welfare loss for households, due to higher debt service costs and thereby less net income available for private consumption.

2.2 CASES OF IMPACT ON DIFFERENT CUSTOMERS

To illustrate the impact of the proposal laid forward by the European Commission, in this section we provide two cases of how borrowing costs will increase for customers.

Our first case focuses on a typical homeowner, where the house is financed with a mortgage (with an average LTV ratio, in our case assumed to be 60%).²² Here we find additional annual debt service costs of around DKK 1,800, see Box 1. If we instead look at a new homeowner with a loan-to-value of 80%, borrowing costs could (depending on mortgage banks pricing strategy) increase with up to DKK 4,400, see Box 1.

²² Around 55-60% for owner-occupied dwellings across the mortgage institutes considered in this report. Note, this is the average weighted LTV ratio, and thereby differs from the median LTV.

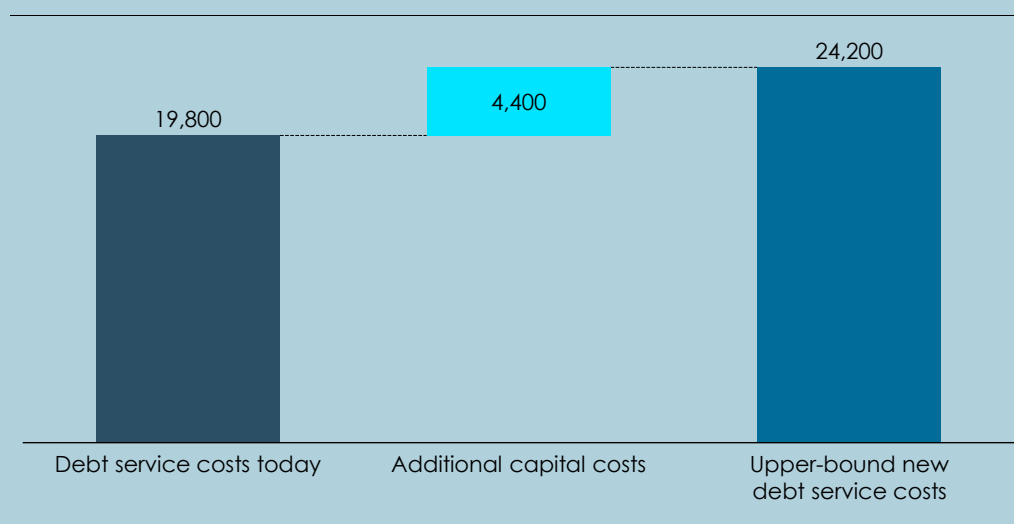
Box 1 Case: Impact on a typical homeowner and a new homeowner

To illustrate the impact of the reform on the mortgage market, we consider a typical Danish homeowner, with an LTV ratio on 60% (around the weighted average). The average sales price for a house in Denmark is around DKK 2.5 million (EUR 336,000), which corresponds to a mortgage loan around DKK 1.5 million (EUR 200,000).²³

With these assumptions and a current average mortgage rate on 0.7%²⁴, we estimate that the increase in borrowing costs of around 0.12 percentage points will increase the annual interest expenditures of the mortgage loan by around DKK 1,800 (EUR 240) before tax. If the homeowner gradually repays the mortgage, the increase in borrowing costs will gradually decline correspondingly.

In addition, we consider a family buying a new home, where they borrow 80% of the house price, corresponding to a mortgage loan around DKK 2.0 million (EUR 266,000). Under the loan-splitting approach, a higher LTV will result in a higher RW for the loan and thereby higher costs of capital for the bank. Concretely, we find the increase in cost of capital to be of around 0.22 pp. Depending on the extent to which the additional costs are passed on to the customer, annual interest expenditures could increase up to DKK 4,400 (EUR 590) before tax. Again, if the homeowner gradually repays the mortgage, the increase in borrowing costs will gradually decline correspondingly.

Figure B.8
Increase in annual capital costs for a new homeowner with LTV of 80%
DKK



Note: Numbers are rounded. For the loan with an LTV of 80% we assume the current interest rate to be around 1%.

Source: Illustration by Copenhagen Economics, based on data from the EBA's transparency exercise, Finance Denmark, Hypostat (2021), Statistics Denmark (sales of real property database) and own calculations.

²³ Statistics Denmark: [Link](#)

²⁴ Hypostat (2021)

Our second case focuses on a farm owning property financed by a mortgage with an average loan-to-value ratio (around 40%).²⁵ Here we find that annual interest expenditures will increase by around DKK 8,900. Looking instead at a farm owning property with an LTV of 60%,²⁶ yearly debt service costs could increase by around DKK 14,500 if costs are passed directly on to the specific customer segment, see Box 2.

²⁵ For the case the LTV is assumed to be 40%. Precise numbers for average weighted LTV ratio for farm owning properties does not appear in annual reports.

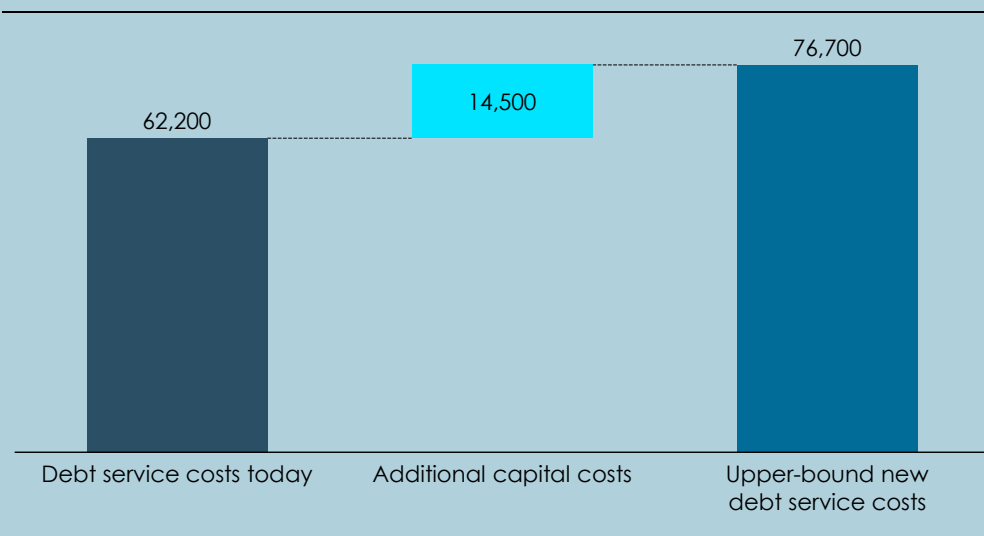
²⁶ Ageras: [Link](#)

Box 2 Case: Impact on an owner of an agricultural property with loan-to-value of 40% and 60% respectively

To illustrate the impact of the reform on the agricultural mortgage market, we consider a farm owning a property with an average LTV ratio around 40%. The sales price for an agricultural property in Denmark (around average size, for properties where business is conducted) is currently at around DKK 10.1 million (EUR 1,35 million) – with an assumed LTV of 40%, this corresponds to a mortgage loan of around DKK 4 million (EUR 540,000). The estimated increase borrowing costs of around 0.22 percentage points implies an increase in annual interest expenditures of around DKK 8,900 (EUR 650) before tax.

In addition, we consider a case where the LTV is 60%, which corresponds to a mortgage loan of around DKK 6 million (EUR 800,000).²⁷ Under the loan-splitting approach, a higher LTV will result in a higher RW for the loan and thereby higher costs of capital for the bank. Concretely, we find the increase in cost of capital to be of around 0.24²⁸ percentage points. Depending on the extent to which the additional costs are passed on to the customer, annual interest expenditures could increase up to DKK 14,500 (EUR 1,900) before tax.

Figure B.9
Increase in annual capital costs for a farm with LTV of 60%
DKK



Note: Numbers are rounded. The mortgage rate for agricultural properties is around 1,0% based on Nykredit, DLR Kredit and Nordea's online loan calculators. We assume this to be the case for both loans.

Source: Illustration by Copenhagen Economics, based on data from the EBA's transparency exercise, Finance Denmark, Hypostat (2021), Statistics Denmark (sales of real property database) and own calculations.

²⁷ Statistics Denmark: [Link](#)

²⁸ Result obtained under the loan-splitting approach when the LTV for the loan is on 60% as in this case.

2.3 IMPACT ON THE REAL ECONOMY

In time, we expect that the increase in capital requirements for the mortgage portfolio and thereby borrowing costs will impact the real economy. In general, the effects are materialised through two channels:

2.3.1 GDP impact

The higher borrowing costs for businesses will curb investment activity, causing a decline in overall productivity that eventually contracts GDP. In a previous report, we found that the increase in the capital need of between DKK 58-90 bn for the entire banking sector would lead to a decline in GDP of up to 1%.²⁹

In this study, we only consider a part of the banking market, i.e., the mortgage portfolio. In general, it is difficult to single out the impact from specific portfolios in these kinds of macroeconomic top-down estimations. Nevertheless, to make a high-level assessment of the GDP impact from the mortgage portfolio, we consider two factors:

- The mortgage portfolio constitutes around 60%-70% of total lending in Denmark.³⁰
- The loan composition is different, with a larger share of household lending in the mortgage portfolio. This is an important aspect, as it is the increased borrowing costs for businesses which causes the decline in investments and thereby GDP.

Taking this into account, we assess that around a quarter of the estimated GDP impact, would stem from the impact on the mortgage portfolio, corresponding to a decline in GDP of roughly 0.25%, or around DKK 6 bn, see Figure 10.³¹ However, as described above, the estimate is subject to significant uncertainty.

2.3.2 Impact on households

Besides the GDP impact, arising from higher lending costs for companies, households will also experience higher borrowing costs. We expect the impact on households to leave no GDP effect, as this will not impact investment activity by companies (which is what results in lower productivity that eventually contracts GDP).³² However, it can still be considered a cost to society from a welfare perspective since increased interest expenditures leave less space for private consumption. We estimate that higher capital requirements will lead to an extra bill to be paid by households of around DKK 2 bn on a yearly basis, see Figure 10.³³

²⁹ Copenhagen Economics (2020).

³⁰ Nationalbanken, table "DNBALA: MFI-sektorens balance, ekskl. Nationalbanken efter aggregerede balanceposter, datatype og rapporterende institut".

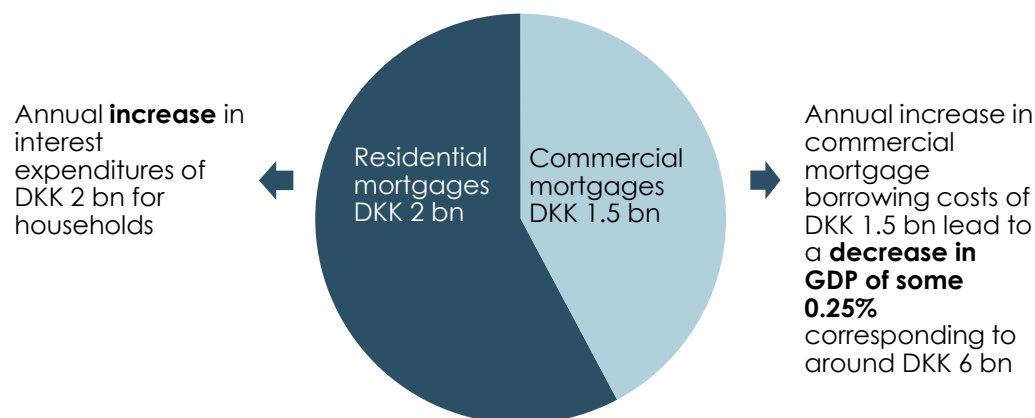
³¹ See appendix B for a detailed explanation of our macroeconomic model.

³² The GDP effect is dependent on companies' investment activity; more investments (e.g. a new factory, more effective machinery or investments into R&D) will increase productivity and eventually GDP. We do not, in line with standard macroeconomic theory, assume this effect to apply to households, as investments by households will not impact productivity.

³³ This is solely driven by extra costs for households in owner-occupied dwellings.

Figure 10
Economic impact from higher capital requirements

Bn DKK



Source: Copenhagen Economics, based on data-gathering exercise from the six Danish mortgage banks performed by Finance Denmark.

2.4 LITTLE NET BENEFIT OF THE BASEL PACKAGE

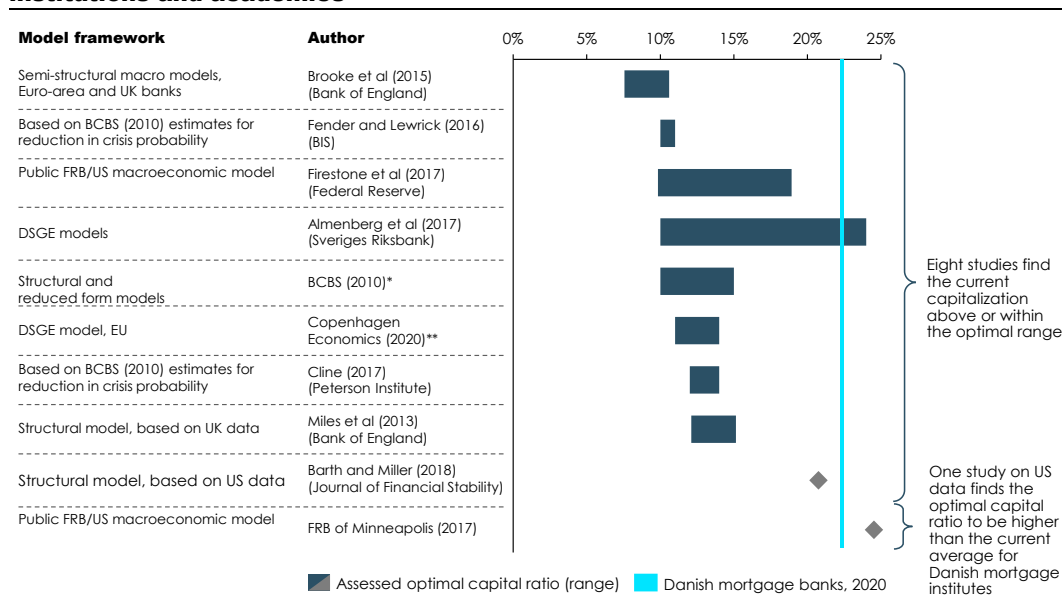
In general, economic research shows that higher capital requirements provide societal benefits in terms of lower risk of a crisis. However, European banks, and in particular Danish banks and mortgage banks, have increased solvency to a point where further general increases in capitalisation bring little benefit in terms of reducing the risk of a crisis. For example, based on the research by the Basel committee in preparation for the original Basel III proposal, we find very limited benefits of higher capital requirements (below 0.05% of GDP for the banking market as a whole and less for the mortgage sector in isolation).³⁴

In general, estimates of optimal level of capitalization entails significant uncertainties and is a heavily discussed topic within economic research. Nevertheless, a recent literature review by the Basel Committee shows that most of the research assesses the current level of capitalisation of the Danish mortgage sector to be above or within the optimal level, except one study based on American data, see Figure 11.³⁵

³⁴ The main analytical work behind the original Basel III package (known as the LEI report): Basel Committee on Banking Supervision (2010): An assessment of the long-term economic impact of stronger capital and liquidity requirements.

³⁵ See for example a recent literature review by the Basel Committee on Banking Supervision (2019): [The costs and benefits of bank capital – a review of the literature](#): Danish banks' capital ratios are currently within or above all of the recent estimates on the optimal level of capital, except for one estimate for the US banking sector. One noteworthy exception is the recent macroeconomic impact assessment conducted by EBA (2019b): [Macroeconomic assessment, credit valuation adjustment and market risk](#). We discuss the implications of the report in CE (2020), p. 39.

Figure 11
Capitalisation of Danish mortgage banks are at or above the optimal range of most institutions and academics



Note: BIS (2019), 'The costs and benefits of bank capital – a review of the literature'.

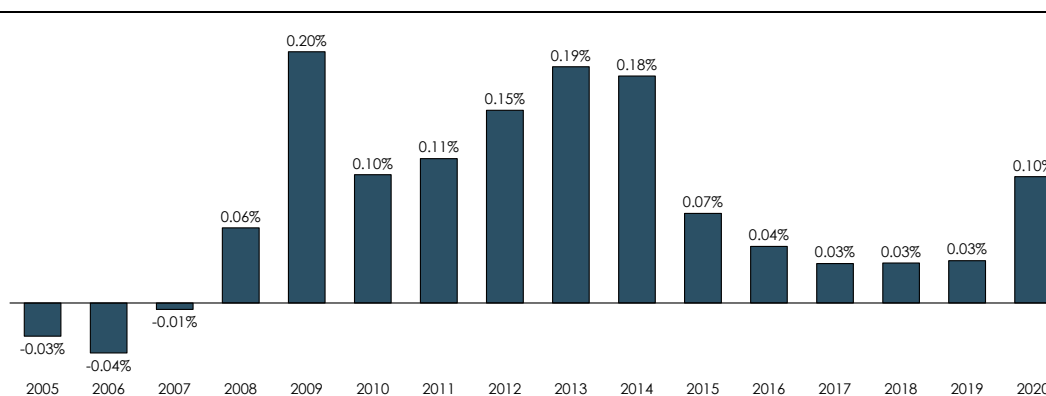
Source: See BIS (2019) for more detailed information on all estimates. Note that the estimates were originally based on capital ratios measured in different units (i.e., some in risk-weighted ratios, others in leverage ratios). We convert ratios from T1/RWA to CET1/RWA using the conversion factor 1.32 based on BCBS (2010), 'An assessment of long-term economic impact of stronger capital and liquidity requirements', table A5.1.* BCBS (2010) estimates are not comparable as this ratio is TCE/RWA Basel II. RWA Basel II differs from the later definition of RWA in final Basel III, which the rest of the estimates is based upon.** CE is not included in BCBS (2019).

More generally, we find that the impact on the Danish mortgage portfolio of an increase of 36% in capital requirements, compared to the average impact throughout Europe of 6-8%, is an example of how the package can lead to suboptimal outcomes for individual portfolios. From an economic point of view, it is difficult to identify arguments of why the Danish mortgage sector should have its capitalisation increased by 36%.

First of all, the Danish mortgage sector is considered very robust among financial markets participants. Danish covered bonds are top-rated among rating agencies, with AAA ratings on all covered bonds issued by mortgage banks. This credit rating is similar to the one obtained for, e.g., Danish and German government bonds, implying that rating agencies more or less assess the same probability of default on Danish covered bonds as for the Danish government.

Second, looking at credit losses within the sector, it is also difficult to justify a large increase in capital requirements seen from a risk perspective. Losses have historically been low, see Figure 12.

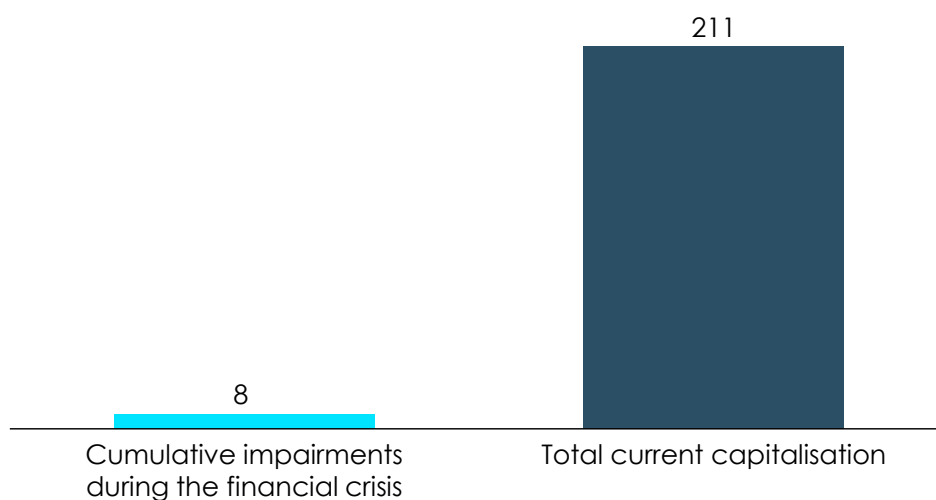
Figure 12
Total impairments of the Danish mortgage sector
Per cent of total lending



Source: Danish Financial Authority (2021), 'Markedsudvikling for realkredit'.

For example, during the financial crisis, cumulative impairments for the mortgage sector were around DKK 8 bn (in 2008-2010).³⁶ This is compared to a capitalisation today of around DKK 211 bn³⁷ (only considering CET1), see Figure 13. Therefore, it is difficult to see a realistic crisis scenario where the current capitalisation of the Danish mortgage banks will be insufficient.

Figure 13
Losses during the financial crisis vs. total capitalisation of Danish mortgage banks
DKK, bn



Source: Danish Financial Authority (2021), 'Markedsudvikling for realkredit' and annual reports for mortgage banks.

³⁶ Danish Financial Supervisory Authority.

³⁷ CET1 held by the mortgage banks included in the study, i.e., part of this CET1 covers capitalisation on group level for other banking business than mortgage lending.

CHAPTER 3

ALTERNATIVE OPTIONS OF IMPLEMENTING THE FINAL BASEL III STANDARD

As discussed in the previous two chapters, the suggested EU implementation of the Final Basel III package, will lead to a large increase in capital requirements for the Danish mortgage portfolio, with a resulting significant increase in borrowing costs for Danish mortgage customers.

However, there are other ways of implementing the Final Basel III package which could mitigate the increase in capital requirements. For example, the European Commission has suggested a temporary exemption for loans secured by residential real estate, allowing banks to apply significantly lower risk weights during a transition period.

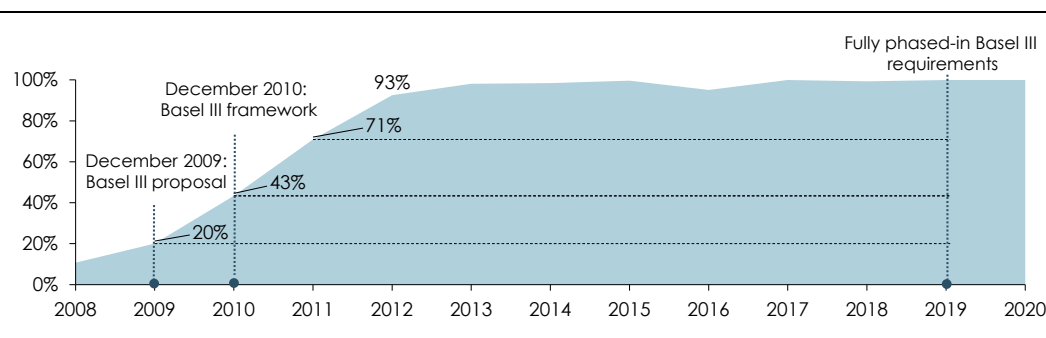
In this chapter, we evaluate different options of implementing the Final Basel III package in a European context. In Section 3.1 we describe the alternative options for implementation and analyse the impact in Denmark of these. We conclude in Section 3.2 by presenting a possible way forward for the implementation of the Final Basel III Standard in the EU.

3.1 ALTERNATIVE IMPLEMENTATIONS

In the proposal for the EU implementation of the Final Basel III, the Commission has introduced temporary exemptions for 'low risk portfolios', e.g., loans secured by residential real estate, as mitigation. Furthermore, the Commission has in the proposal opened a door to making the exemption permanent.

To have any real impact on the capital need of institutions, we would expect that the exemptions would have to be made permanent. Market participants typically expect banks to be fully compliant with new permanent capital requirements shortly after a package is implemented. Furthermore, supervisory authorities could expect banks not to wait with increasing capitalisation until the capital requirements become binding. This was exactly what happened after the implementation of the first Basel III agreement – despite a long implementation period, most banks had adjusted to comply with the package after two years, see Figure 14.

Figure 14
Banking assets compliant with Basel III CET1 capital requirements
 Per cent of total EU bank assets



Note: The minimum CET1 capital requirements under Basel III assumed here are the ones mentioned in the original publication on Basel III from December 2010. This implies a fully phased-in CET1 requirement of 9.5%, assuming a countercyclical capital buffer equal to the maximum value of 2.5%.

Source: S&P Global Market Intelligence database; BCBS (2009) – Strengthening the resilience of the banking sector, BCBS (2010) – Basel III: A global regulatory framework for more resilient banks and banking systems.

Against this background, we analyse the impact on capital requirements from four different alternative ways of implementing the Final Basel III package in a European context:

- 1) The so-called parallel stack approach, which is an alternative way of implementing the output floor, as described in CE (2021): *'The impact of the output floor in the Final Basel III package'*.
- 2) Exemption for residential mortgages is made permanent (with adjustment in the calculation of the output floor on the entire loan amount). We also estimate the impact only with adjustment in the calculation of the output floor on the part of the loan amount with an LTV ratio below 55%.
- 3) Exemption for residential mortgages is extended to commercial mortgages and both are made permanent.

In the following, we go through each option and estimate the extent to which it would mitigate the increase in capital requirements found in chapter 1.

Option 1: Parallel stack approach

EU banks, and thereby Danish mortgage banks, are subject to locally set capital requirements (for example the O-SII and P2R buffer) to guard against different local systemic and institutional specific risks. The interaction between these EU-specific capital requirements and the output floor is one of the reasons why the impact in general is larger in the EU than globally, and for Danish mortgage banks much larger than the European average.

To avoid this, the *parallel stack* approach has been suggested.³⁸ This approach means that banks are subject to two parallel calculations of capital requirements, where the binding capital requirement would be the highest of the two stacks³⁹:

³⁸ For more details on the technical workings see CE (2020).

³⁹ For a more detailed description on the parallel stack approach and different varieties of it, see CE (2020).

- The *floored stack* calculation, where the output floor is only applied to capital requirements that are internationally agreed (and not the EU-specific ones).⁴⁰
- The *non-floored stack* calculation, where EU banks are subject to all capital buffers – including the EU-specific ones – in a calculation without the output floor.

Option 2: Exemption for residential mortgages, adjustment on entire loan amount

The EU Commission's proposal for a temporary exemption for residential mortgages is made permanent.⁴¹ This implies that the loan amount with an LTV ratio below 55% will (under the standardised approach for loan splitting) be assigned a RW of 10%, whereas the loan amounts with an LTV on 55-80% will be assigned a RW of 45%. Loan amounts in the LTV bucket from 80-100% will receive counterparty RW.

Households (i.e., owner-occupied dwellings) and private rental property (i.e., firms renting out buildings for residential use) is in CRR3 categorised as residential mortgages, implying the adjustment in RW's applies for these categories.

We also estimate what the effect would be, with no adjustment for the loan amount with an LTV ratio above 55%, i.e., applying counterparty RW to the loan amount with LTV 55-100%. The European Commission is suggesting starting to phase out the adjustment for loan amounts with an LTV ratio above 55% already in 2030.

Option 3: Exemption for residential mortgages extended to commercial mortgages

The exemption for residential mortgages is extended to cover commercial mortgages in a similar way. This implies a similar adjustment in the RW applied to the share of the loan amount with an LTV ratio below 55%, i.e., a RW of 30% instead of 60%. We define the categories agricultural and commercial properties to be commercial mortgages. In general, commercial mortgages are considered more risky than residential ones, and thus also have a lower allowed LTV (60%, or in special cases up to 70%) for mortgages loans, compared to residential mortgages. We thus assume no adjustment for the loan amount above an LTV ratio of 55%.

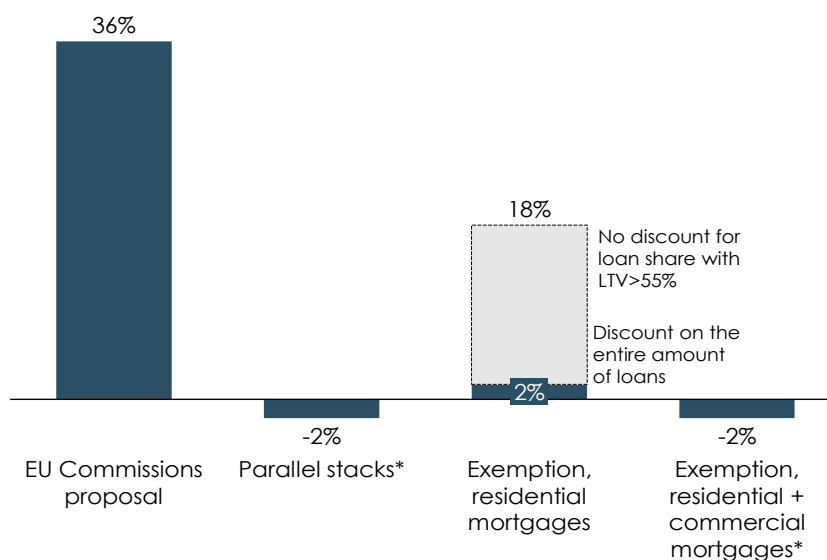
Looking at increases in capital requirements, all alternative options for implementation outlined above will significantly reduce the increase in capital requirements experienced by Danish mortgage banks, cf. Figure 15.

⁴⁰ For Danish mortgage banks this concretely implies that the O-SII buffer and the P2R buffer is not included.

⁴¹ In this case, the hard test requires banks to (on institution level), during the last six years on average, not have had losses exceeding 0.25% on the part of the exposures with an LTV below 55%.

Figure 15
Impact of alternative implementation schemes for Final Basel III (under an all-else equal consideration)

Per cent of original CET1 capital requirements



Note: In the case where an exemption for commercial mortgages would be less preferential than residential mortgages (e.g., a RW of 45% instead of 30% applied to the part of the loan amounts with an LTV below 55%), we find that capital requirements will increase with around 0.3%, i.e., an almost neutral impact. *The decrease is under an all-else equal consideration and not an expression of a real discount in the capital requirements.

Source: Copenhagen Economics, based on data-gathering exercise from the six Danish mortgage banks performed by Finance Denmark.

For the parallel stack approach and the option with exemptions for both residential and commercial mortgages, we find that the output floor will *not* be binding, implying that mortgage banks would continue to be allowed to use the IRB method to model RWs, thereby maintaining the risk sensitivity.

Under the IRB method, we find that capital requirements would, under an all-else-equal consideration, decrease. This decrease is not an expression of a real discount in capital requirements. The current capital requirement may for instance include specific requirements for the individual mortgage banks set by the Danish FSA, e.g. requirements related to parameters in the institutions' internal models. Whether similar requirements will be set under the new IRB method have not been taken into account here. Further, with reference to the targeted review of the internal models (TRIM) conducted by ECB with capital requirements rising on average around 12%, increasing requirements of the same magnitude could be expected for Danish banks.

In both cases, we find that it is very marginal whether the output floor is binding or not, implying that some mortgage banks would likely be bounded (our estimation is made on an aggregated level for the entire sector based on the mortgage portfolio). Note that the effects of the output floor are very binary; when it is not binding, risk sensitivity is kept. When the output floor on the other hand is binding (even just exactly binding), and institutions thereby are required to use the standardised approach, this changes the RWs applied to different assets significantly and thereby also the cost of capital and how this is allocated.

Making the exemption for residential mortgages permanent (with an adjustment on the entire loan amount), we find a limited impact on capital requirements, i.e., an increase of around 2%. However, if the adjustment is only applied to the loan amount with an LTV ratio below 55%, the impact will be significantly larger, with an increase in capital requirements of around 18%. Thus, making the exemption for the loan amount with an LTV ratio above 55% permanent has a large impact and significantly mitigates the increase in capital requirements. The reason is the relatively large decrease in RW from 75% to 45%, applied to a significant share of total lending.

3.2 A WAY FORWARD

This paper has highlighted the different paths that the implementation of the Final Basel III can take. Both from an economic as well as a financial stability perspective, we find that the alternative options for implementation suggested in this chapter would be best suited for the Danish economy, due to two main reasons:

- It will lead to a much smaller impact on capital requirements, with a resulting smaller impact on cost of capital and therefore fewer real economy costs.
- It will to a larger extent maintain the link between capital requirements and underlying risks for assets, letting the output floor work as a backstop for excessively low modelled risks.

In addition, the options will bring the impact on the Danish mortgage sector closer to the impact at a global level and thus more in line with the original spirit of the Final Basel III Standard to not significantly increase capital requirements.

Finally, we suggest continuing the ongoing work to increase transparency, comparability and precision of internal models of financial institutions. This is, for example, the focus of the ECB's targeted review of internal models (TRIM) as well as the ongoing monitoring by the national competent authorities (NCAs) and the European Banking Authority within its mandate to provide guidelines for and assessments of internal models. Ultimately, financial institutions that have (1) solid, verifiable models identifying their risks and (2) can document their solidity, even in very adverse economic conditions, should be able to use these models in determining their capital adequacy.

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APPENDIX A

DATA FOUNDATION AND THE BANKING BALANCE SHEET MODEL

The appendix describes both the data-gathering exercise and modelling framework we use to estimate the impact of The Basel III Standard on different customers as well as the impact on demand, investment and GDP estimated with our macroeconomic model.

DATA AND SAMPLE

Our estimations throughout the report are based on a data exercise carried out by Finance Denmark, and as such it differs from previously conducted studies by Copenhagen Economics within this area, which have been primarily based on data from the EBA transparency exercise.

Below follows a description of the data exercise in more detail:

- Covers the entire Danish mortgage market, i.e., six mortgage banks operating in Denmark; DLR Kredit, Jyske Realkredit, Nordea Kredit, Nykredit Realkredit, Realkredit Danmark and Totalkredit.
- Danish mortgage banks were asked to report, by themselves, the impact of the Final Basel III in terms of increase in REA on mortgage portfolios. Thus, what Copenhagen Economics has received is average RW today and the (by the mortgage banks) estimated increases in REA due to the reform. Here, it is assumed that all portfolios will be on the loan-splitting approach and keep the CRR2 SME discount.
- All data reported is from end 2020, i.e., the calculations and thereby the impact found in this study is based on mortgage portfolios as they were end of 2020. When the composition of mortgage exposures changes and taking into account supervisory initiatives during 2021 affecting the capital requirement for credit risk, the impact of the EU Commission's proposal for implementation of the Final Basel III will change.
- All calculations from here are performed by Copenhagen Economics, implying that we adjust for a P2R buffer kept constant in absolute values and calculate an increase in risk weights and thereby finally increases in capital requirements.

The baseline capital requirements, from which we calculate the increase due to the Basel package, are institute-specific and based on publicly available data from annual reports and risk management reports. We include the following capital buffers:

- Pillar 1
- Pillar 2 (i.e., the P2R buffer)
- SIFI buffer
- Capital conservation buffer
- Contracyclical buffer – note that we include this even though it is currently (due to the Covid-19 crisis) set to zero, as the Minister of Business and Industry has announced the buffer will be reintroduced in December 2021.

IMPACT OF A CHANGE IN CAPITAL REQUIREMENTS ON INTEREST RATES

The impact on the portfolio borrowing costs is a consequence of the change in the bank-funding structure after the implementation of the Final Basel III Standard. Due to the increase in the capital

need following the banking package, banks will need to finance a larger share of their credit portfolio with equity, which is more expensive than debt. We assume that banks keep the same CET1 ratio as before the implementation of the Final Basel III Standard. This means that banks are not able to use any buffer they might hold on top of the capital requirements to compensate for the increased capital requirements due to the Basel III revisions.

In general, the impact on funding costs for a portfolio is calculated as:

$$\text{Increase in risk weight} \cdot \text{capital ratio} \cdot (\text{equity cost rate} - \text{debt cost rate})$$

We make the simplifying assumption that the percentage point increase in funding costs will lead to an equivalent percentage point increase in borrowing costs, i.e., that banks fully pass on higher costs to their customers. In the calculations, we assume a required return on equity of 13% (10% after taxes), which is in line with an estimate in a recent study conducted by the EBF, covering the 50 largest banks in Europe.⁴² In comparison, the assumed cost of equity in BIS (2010) is higher than what we assume, namely at 14.8%.

The debt-funding cost rate is estimated for each bank using data on bank interest expenses and financial liabilities from EBA's transparency exercise.

In our estimation, we also account for so-called 'Modigliani-Miller' effects (MM effects). We assume that when the capital ratio increases by 1 percentage point, the cost of equity decreases by around 0.15 percentage points. We assume no change in debt funding cost. The impact on borrowing costs from an increase in capital is thus mitigated by MM effects. For a discussion on MM effects, see Appendix B and Copenhagen Economics (2016a): *'Cumulative impact on financial regulation in Sweden'*.

Finally, we distribute the impact on operational risk REA across credit portfolios according to the share of the respective credit portfolio REA in total banks' credit risk REA.

⁴² See ZEB (2018).

APPENDIX B

ESTIMATION OF THE MACROECONOMIC EFFECTS OF THE FINAL BASEL III FRAMEWORK**MACROECONOMIC COSTS**

To estimate the macroeconomic costs, i.e., the impact on GDP and investments, we use a model developed by Meh and Moran (2010). It is a so-called Dynamic Stochastic General Equilibrium (DSGE) model, which is a structural macroeconomic model. The model has a well-specified financial sector, which enables us to analyse the effects of higher banking costs.

There are several reasons why Meh and Moran (2010) is our preferred macro model:

1. The micro-foundation enables a modelling of banks' response to changing financial regulations. This includes adjustments, both on the asset and liability side, as well as the effects on lending rates.
2. The general equilibrium effects of the model allow for continuous feedback between the real economy and the financial sector. When higher capital requirements are introduced, this increases lending costs, which reduce investments and hereby compress GDP. This, in turn, decreases asset values, making lending even more costly, which reduces investments and thereby GDP further. This cycle continues until the economy has reached a new equilibrium. This is the so-called financial accelerator mechanism.
3. Finally, the paper by Meh and Moran (2010) is respected in academic literature, with numerous citations. The framework constitutes the theoretical foundation of applied models in many economic institutions. For instance, the Swedish Riksbank has used the framework to estimate the effects of Basel III in a paper from 2011. The method is thus a proven way to analyse the relationship between the real economy and changes in the capitalisation of banks.

The model can be calibrated to fit national economies, as described in the appendix of Copenhagen Economics (2016a): *'Cumulative impact of financial regulation in Sweden'*.

How our macroeconomic model works

In the model, there is a moral hazard issue between the households that hold deposits in the banks and the owners of the banks, called 'bankers'. The households cannot monitor whether the bank is monitoring their loans. If the bank does not monitor their loan, there is a risk that borrowers will choose a bad investment project which has a higher risk of default. Monitoring implies a cost to the bankers. Therefore, the households demand that the bankers hold equity to ensure that they have an incentive to monitor their loans – that they have 'skin in the game'.

If the monitoring costs increase, the incentive for the bankers not to monitor households' loans increases (since it is costly) – therefore, the capital requirements from the households increase to ensure that the bankers have enough 'skin in the game' to monitor the loans. As a result, the capital requirement in the model can be increased through increasing the monitoring costs.

Capital requirements and cost of capital

Fundamentally, a bank has two sources of finance, namely equity and debt. Of these, equity has the highest required return. If capital requirements increase, banks are forced to hold more of the expensive equity, and their funding costs increase. The increase in funding costs is mitigated by – viewed in isolation – a decline in the required return on both equity and debt, since more equity implies a lower risk of bank failure.

In fact, taking a very simplistic view on finance – disregarding taxes, asymmetric information and regulation – if the capital requirements increase, the required return on debt and equity is reduced exactly so much that the overall funding costs of banks are unchanged. This is the so-called Modigliani-Miller irrelevance theorem. However, when tested empirically, this simplistic perception does not hold true, *cf. Box B.1 below*.

Box B.1 Why the Modigliani-Miller theorem does not hold true

1. **Tax shield**
In contrast to equity, debt payments are tax exempt, and shifting to more equity will increase funding costs. Put simply, a bank needs to provide a larger return on investment simply to pay more in corporate taxes.
2. **Explicit guarantees**
Through the deposit guarantee, the risk to private depositors is guaranteed, i.e., the required return on this part of the debt will not react to the funding structure.
3. **Implicit guarantees**
When banks are too big to fail, the government implicitly takes on a part of the default risk, especially for 'unsecured' debt and equity holders. However, we think this plays a minor role now because banks are fairly well-capitalised.
4. **Creditors value bank debt highly**
Liquidity production is a major element of banks' business models. Creditors tend to value bank debt highly due to its high liquidity, which implies that debt is a relatively cheap source of funding for banks. When banks are forced to replace debt with equity, this is undermined.

Thus, when capital requirements increase, the required return on debt and equity might decline, but overall funding costs will increase. The extent to which funding costs increase depends on factors such as the initial capitalisation level of the bank and the economic activity:

- *With low levels of equity*, an increase in equity will represent a significant reduction in the risk of bank failure. This will imply a significant reduction in the required return on equity and debt, which will curb the increase in the overall funding cost.
- *With high levels of equity*, the reduction in the risk of failure is already quite small and the required return will not decline very much. Equity finance will nevertheless still be more expensive than debt finance due to aforementioned reasons, and the overall funding cost will increase.

The required return also depends on the level of activity in the economy:

- *In normal times*, the required return is hardly affected by higher capitalisation, as investor sensitivity to default risk is low. Acquiring new equity or readjusting the portfolio is more costly than taking on debt, leading to an increase in overall funding cost.

- *In crisis times*, a reduction in default risk can have a large impact on funding costs. Investors will, to a larger extent, discipline banks, as they are less prone to take on risks. Consequently, higher capital requirements will be somewhat offset by the decline in overall funding costs.

In general, the results in the literature are very fragmented and dependent on the data sample used. A study including banks in a 'normal situation' provides results different to one including thinly capitalised banks during the financial crisis. When including the latter, the stressed banks might have a strong influence on the overall results.

A main conclusion from the literature is that higher capitalisation has a distinct, non-linear impact on overall funding costs; above a certain threshold, investors will not consider a bank less risky if it increases the level of equity so overall funding costs will rise.⁴³

Adjustment of macro-model impact

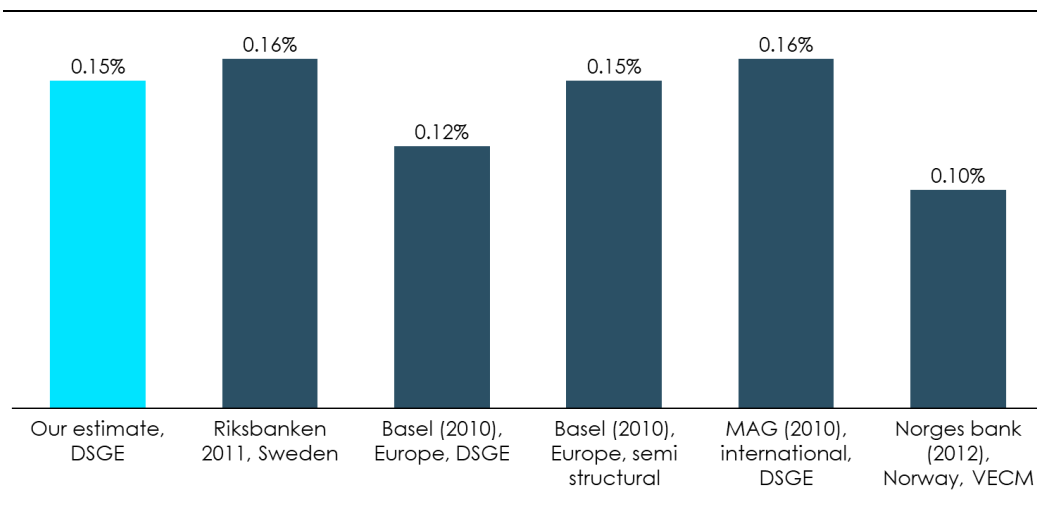
Our model impact on GDP from higher capital requirements might be rather high. Firstly, it does not include any Modigliani-Miller effects, and secondly, and perhaps more importantly, there are no alternative funding sources that companies can switch to when banking financing becomes more costly. As discussed, this is particularly important for large corporates that can more easily switch to bond financing.

To incorporate this, we adjusted our macro-model estimate of 20% downward, giving rise to an estimate of a 0.15% decline in GDP for an increase in CET1 ratio requirement of 1 percentage point.

⁴³ See the appendix of Copenhagen Economics (2016): '*Cumulative impact of financial regulation in Sweden*', for a more thorough discussion of the topic.

Figure B.1**Our estimate compared to those of other institutions**

Decline in long-run GDP due to 1 percentage point increase in CET1 ratio requirements



Source: Copenhagen Economics.

MACROECONOMIC BENEFITS

The macroeconomic benefit arises from reducing the risk of a crisis due to too low capital ratios.

To estimate the benefits, we need an estimate of 1) the impact of higher capital requirements on the risk of a crisis and 2) the macroeconomic costs of a crisis if it were to occur. The macroeconomic benefits can then be estimated as:

$$\text{GDP benefit} = \text{'Reduction in risk of crisis'} \cdot \text{'GDP cost of a crisis'}$$

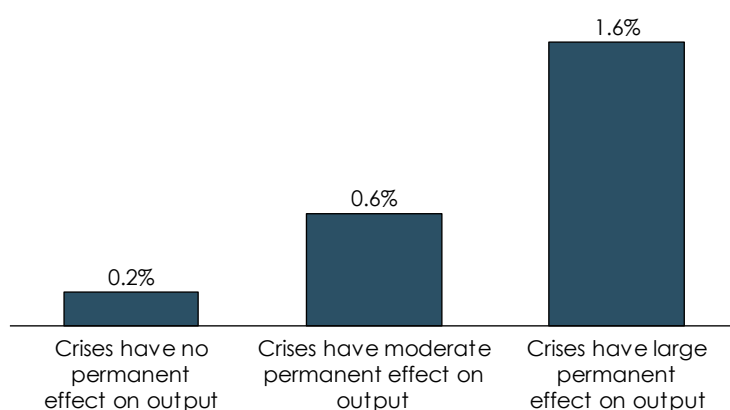
1) Cost of a crisis

The estimated benefits of reducing the risk of a crisis naturally depend on the assumed social and economic costs of a financial crisis. Although it is clear that the costs are immense, they are difficult to estimate and depend on several assumptions.

The estimated benefits of reducing the risk of a financial crisis depend largely on the assumptions made about the long-term effects on productivity. Standard macroeconomic theory suggests that shocks to the economy only have temporary effects and that the economy will eventually recover to its structural long-term level (i.e., that there is a 'steady-state' path unaffected by financial crises).

Basel (2010) summarises the results from several papers. They find that the benefit of reducing the risk of a crisis by one percentage point corresponds to a permanent increase in GDP of around 0.19% to 1.58%, depending on the assumptions, cf. Figure B.2 below:

Figure B.2
Benefit of reducing the risk of a financial crisis by one percentage point
% of GDP



Source: Basel (2010).

In our estimations documented in chapter 3, we have assumed that financial crises have moderate permanent effects on the output (estimate of 0.6%). This entails that after a crisis, GDP will at some point pick up the pre-crisis growth rate *but at a lower level*. The permanent loss in output stems partly from a lower level of business innovation during the crisis, due to an elevated number of bankruptcies and a deteriorated credit transmission impairing investment infrastructure.⁴⁴

2) Risk of a crisis

Our results, described in section 3.2, is based on work from BIS (2010). BIS estimates the relationship between the probability of a banking crisis and the sector-wide average capital ratio. They find a clear non-linear relationship, with benefits converging towards zero. Given the capitalisation of the current EU banking sector, they find that an additional percentage point increase in the capital ratio decreases the risk of a crisis by 0.08 percentage points.

The estimations are based on six different statistical models, which, overall, reduce the risk of outlier results. Nevertheless, it should be mentioned that all six models are (at least to some extent) based on historical correlations under Basel I and II rules. This increases the uncertainty when the estimated relationships are used to assess capital adequacy under Basel III (which is higher and thus out of sample).

⁴⁴ See OECD (2012): Innovation in the crisis and beyond.

APPENDIX C

**EMPERICAL STUDIES ON VARIABILITY OF
INTERNAL MODELS**

Generally, empirical research on internal models – by BIS, EBA and IMF – finds some variability in prediction by internal models – however, this variability is not biased towards lower capital requirements.

For example, a paper by BIS from 2013⁴⁵ finds that:

- For wholesale exposures, unwarranted variation can explain around 15-20% of variations in capital ratios. This means that the remaining 80-85% are explained by fundamentals.
- The variation due to model variability goes in both directions, i.e., is not biased towards lower capital requirements.

A more recent study by the EBA⁴⁶, analysing mortgage, SME and corporate portfolios – the so-called high-default portfolios – largely confirms this:

- 82% of the variability can be explained by observable factors, such as default status, country of the counterparty and portfolio mix etc. The remaining 18% is either due to variability in credit risk within each portfolio or variability in the internal models.
- Model variability is not biased towards lower capital requirements. In fact: *“estimated values for PDs and LGDs are, in general, higher than the observed default rates and loss rates, which suggests that banks are, on average, conservative”*.
- Expressing capital ratios based on observed default rates (rather than PD estimates) would only have a minor impact, i.e., the internal model-based capital adequacy ratios seem in line with observed default rates.

A paper by BIS⁴⁷ from 2016 also finds that model variation does not lead to capital ratios being biased:

- Estimates of PDs for retail and SME exposures are closely aligned with actual outcomes and tend to be higher than the actual long-term default rates for about two thirds of banks in the sample.
- Average LGD and EAD estimates are generally higher than the average actual loss rate and defaulted exposure outcomes.

Finally, a paper from IMF from 2017⁴⁸ finds *“that it is possible to harmonise risk weights without significant impact on bank capital”, “is also in line with the ECB’s most recent TRIM program”*.

⁴⁵ BCBS (2013): *Analysis of risk-weighted assets for credit risk in the banking book*.

⁴⁶ EBA (2017): *Results from the 2016 High Default Portfolios (HDP) Exercise*.

⁴⁷ BCBS (2016): *Analysis of risk-weighted assets for credit risk in the banking book*.

⁴⁸ IMF (2017): *Heterogeneity of Bank Risk Weights in the EU*.