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How high should risk weights be on Norwegian residential mortgages?

Henrik Andersen¹, 31 May 2013

The authorities and market participants have questioned whether banks in Norway hold sufficient equity capital for their residential mortgages. Banks calculate how much equity capital they must hold by weighting their assets by the applicable risk weights. The largest banks use internal models to estimate risk weights for their assets (the internal ratings-based approach, or IRB).² Following the introduction of new capital standards in 2007, residential mortgage risk weights have fallen by up to 80 percent for the IRB banks in Norway. At end-2012, the average residential mortgage risk weight of IRB banks in Norway was 11.2 percent, less than a third of the minimum requirement applicable to the smaller banks that use the standardised approach. This analysis uses historical default and loss data, stress tests and other points of reference to calculate what the average risk weight should be for Norwegian residential mortgages. The calculations show that the risk weights of IRB banks in Norway should be raised from current levels. The calculations, which apply data back to the banking crisis in the early 1990s, indicate that banks' risk weights for residential mortgages should be around 20 to 30 percent.

1. Introduction

In connection with the introduction of new capital standards in 2007 (Basel II), banks were given the option of using internal models to calculate risk weights. In Norway, average residential mortgage risk weights for banks using the internal ratings-based approach (IRB banks) have fallen by up to 80 percent since the introduction of Basel II. In isolation, the decline in risk weights reduces banks' risk-weighted assets, giving banks higher reported capital adequacy.³ For the time being, transitional arrangements from the old capital adequacy framework (the Basel I floor) limit the effect of low risk weights for most IRB banks.⁴ Under

¹ I am grateful to Sigbjørn Atle Berg and Sindre Weme for a number of useful input comments. I am also grateful to Knut Kolvig, Arild Lund, Olav Mundal, Kjell Bjørn Nordal, Ingvild Svendsen and Lars-Tore Turtveit for useful input.

² DNB, Nordea Bank Norge, SpareBank 1 SR-Bank, Sparebanken Vest, SpareBank 1 SMN, SpareBank 1 Nord-Norge, SpareBanken Hedmark and Bank 1 Oslo Akershus.

³ Banks' capital requirements are calculated as a percentage of their risk-weighted assets. Risk-weighted assets are calculated by multiplying banks' exposure at default for various assets by the applicable risk weights. As from 1 July 2016, a systemically important bank's Common Equity Tier 1 (CET1) capital must equal at least 12 percent of these risk-weighted assets. CET1 capital is the bank's equity capital less intangible assets such as goodwill and deferred tax.

⁴ Under the transitional arrangements as they currently stand, the level of risk-weighted assets calculated in accordance with Basel III may not be lower than 80 percent of what would have been the level under Basel I.

Basel II, smaller Norwegian banks (banks using the standardised approach) were able to reduce their risk weights on residential mortgages by approximately 30 percent.⁵

Banks calculate capital requirements using risk weights intended to reflect the risk of unexpected losses.⁶ Expected losses should be reflected in lending margins and covered by current earnings. Risk weights calculated using the IRB approach are normally assumed to reflect actual risk better than the risk weights applied by banks using the standardised approach.

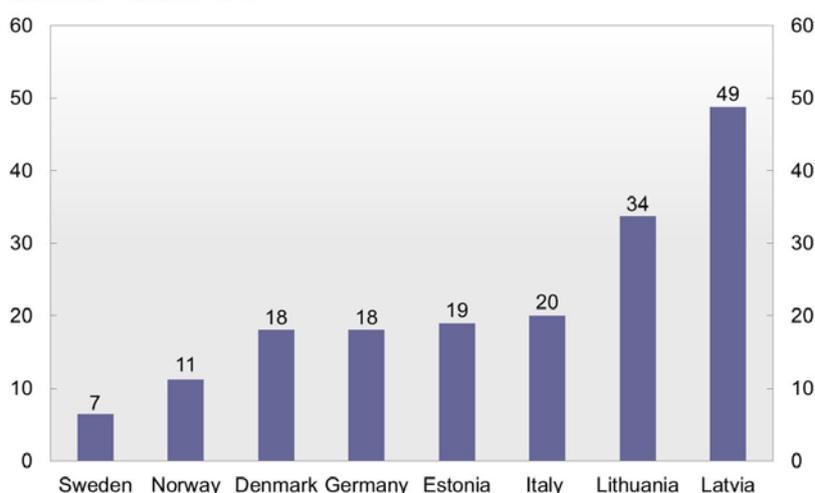
The assumptions underlying the calculated risk weights often vary across countries. An important source of differences among internal models may be that the time series used to calculate risk vary in length. Some countries permit the use of substantially shorter time series than set out in the requirement that an ideal time series should cover an entire business cycle. The reason may be that longer time series are unavailable or deemed insufficiently representative of the current risk picture. Risk weights will be substantially lower if time series do not contain data from downturns.

There is wide cross-border variation in the risk weights applied by IRB banks to calculate capital requirements for residential mortgages (see Chart 1). The largest banks in Latvia must have on average seven times as much equity capital for each krone in residential mortgage loans as the largest Swedish banks. This may reflect real differences in risk between Latvian and Swedish residential mortgage loans. The reason may also be that banks' risk models produce different risk weights for comparable assets.

⁵ Banks using the standardised approach may apply a risk weight of 35 percent to residential mortgages with a loan-to-value ratio below 80 percent if the requirements are met for classifying the exposure as retail (see definition in Section 2). Residential mortgages with a loan-to-value ratio above 80 percent shall have a risk weight of 75 percent. If the requirements for retail are not met, banks must use a risk weight of 100 percent. Under Basel I, the risk weight for residential mortgages with a loan-to-value ratio below (above) 80 percent was 50 (100) percent for all banks.

⁶ Risk weight functions under the IRB approach produce capital requirements for unexpected losses (see Paragraph 212 in Basel Committee (2006b)). Expected losses are treated separately in the calculation of capital (numerator) (see Paragraph 43 in Basel Committee (2006b)).

Chart 1 Average IRB bank residential mortgage risk weights in selected countries. Percent. 2011¹⁾



1) 2012 for Norway

Sources: Institutions' Pillar 3 reports, central banks and FSAs in the countries selected

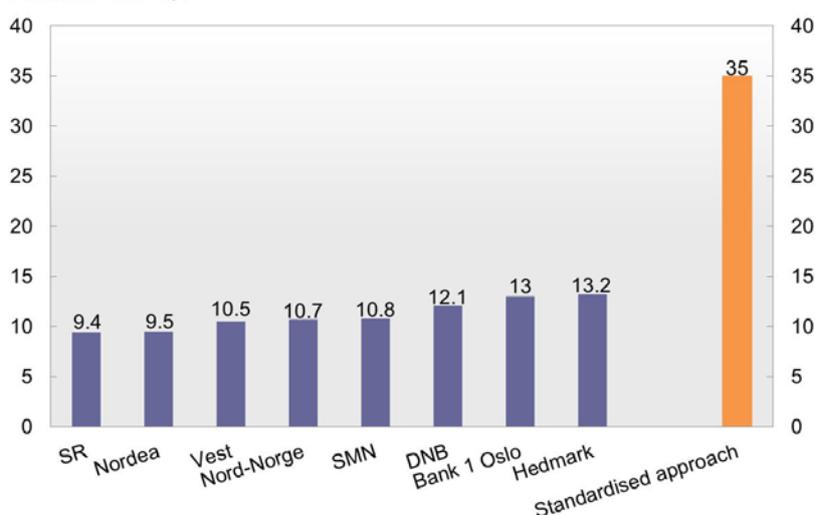
Chart 2 shows that there is relatively little variation in residential mortgage risk weights across IRB banks in Norway, partly because five⁷ of the IRB banks use the same internal models. In addition, Finanstilsynet (Financial Supervisory Authority of Norway) applies the same standards to all IRB models in Norway. However, IRB banks' residential mortgage risk weights are considerably lower than those the smaller, standardised-approach banks must apply.⁸ At end-2012, the IRB banks had an average residential mortgage risk weight of 11.2 percent, less than a third of the minimum requirement for banks using the standardised approach. Nevertheless, the risk weights cannot be assessed without taking into consideration the transitional arrangements (the Basel I floor). Banks that at the margin are bound by the floor apply in reality a risk weight of 40 percent for new residential mortgages.⁹ The largest banks must therefore hold more equity capital for their residential mortgages than indicated by their internal models.

⁷ IRB banks that are a part of the SpareBank 1 alliance, i.e. SpareBank 1 SR-Bank, SpareBank 1 SMN, SpareBank 1 Nord-Norge, SpareBanken Hedmark and Bank 1 Oslo Akershus, use the same IRB models.

⁸ The IRB approach is used to calculate risk weights for approximately 70 percent of Norwegian residential mortgages.

⁹ 80 percent of the risk weight under Basel I, which is 50 percent.

Chart 2 Average residential mortgage risk weights for banks in Norway.
Percent. 2012 Q4



Sources: Institutions' Pillar 3 reports

Some factors suggest that the difference in residential mortgage risk weights between IRB banks and banks using the standardised approach should be narrower and that there should be less cross-border variation in risk weights on residential mortgages. Residential mortgages are, to a considerable extent, a standardised product. All banks in Norway face more or less the same housing market and must follow the same guidelines for prudent lending drawn up by Finanstilsynet. The other Nordic and Baltic countries have introduced or are about to introduce lending guidelines similar to those in Norway.¹⁰

The decline in residential mortgage risk weights since 2007 and the considerable differences in risk weights both within a country and across borders have raised doubts among national authorities and market participants as to whether these risk weights reflect the actual risk of residential mortgage lending. Reports by the European Banking Authority and the Basel Committee show that the internal models of a sample of large banks produce very different risk weights for the same exposure (see European Banking Authority (2013) and Basel Committee (2013)). Finansinspektionen, the Swedish financial supervisory authority, has introduced a 15 percent floor on residential mortgage risk weights (see Finansinspektionen (2013)). The Swedish authorities doubt that the very low model-generated risk weights reflect the risk banks assume when issuing residential mortgages in Sweden. The aim of the floor on residential mortgage risk weights in Sweden is to mitigate this model-based risk. The floor has been set on the basis of calculations that are based in turn on losses on Swedish residential mortgages during the banking crisis of the early 1990s, the assumptions in Sveriges Riksbank's stress test and data banks use in their own stress tests.

¹⁰ Estonia and Iceland have, for the time being, not included quantitative standards in their guidelines. The other Nordic and Baltic countries have introduced guidelines containing quantitative standards for loan-to-value ratios. Loan-to-value standards range from 85 percent (Norway and Sweden), 90 percent (Finland and Latvia) and up to 95 percent (in Lithuania, the requirement varies between 85 and 95 percent). In Denmark, mortgage lenders account for most of the residential mortgages in the country. Mortgage lenders may only issue loans with a loan-to-value ratio below 80 percent.

In Norway, the Ministry of Finance circulated for comment a memo on IRB banks' risk weights for residential mortgages in March 2013 (see Regjeringen (2013)). The Ministry stressed that it was important that any new system for calculating capital requirements did not reduce risk-weighted assets compared with current standards including the Basel I floor, i.e. the average risk weight for residential mortgages should be at least 20 to 25 percent.

The aim of this memo is to calculate what the average risk weight should be for Norwegian residential mortgages on the basis of the risk each bank assumes when issuing such mortgages. The memo contains an assessment that applies the same criteria used by Finansinspektionen in Sweden to set its 15 percent floor. Risk weights for residential mortgages are calculated on the basis of:

1. Historical loss and default data for Norway
2. Stress tests
3. Other benchmarks

Section 2 addresses those sections of the capital framework that are relevant to the analysis in this memo. Section 3 is an account of my calculations based on historical loss and default data, and Section 4 presents calculations of residential mortgage risk weights on the basis of two different stress tests. The memo concludes by comparing the calculated residential mortgage risk weights presented in Sections 3 and 4 with other benchmarks.

2. Capital framework

The capital framework gives banks the option of using three different approaches for calculating capital requirements for credit risk: the standardised approach, the foundation IRB approach and the advanced IRB approach. Capital requirements are to be calculated by weighting banks' exposures by the applicable risk weights. Risk weights may be calculated at portfolio level for retail loans, i.e. residential mortgages and other loans to private individuals, and loans to small and medium-sized enterprises. For other exposures, risk weights are to be calculated separately for each exposure within the various segments.

IRB banks must use a specific formula (the Basel formula) to calculate risk weights (see Appendix 1). This formula is a function of the one-year probability of default (PD), loss given default (LGD), exposure at default (EAD), maturity (M) and correlation between exposures and a factor for systemic risk (R). For retail exposures, no adjustment is made for maturity. Risk weights increase linearly with increases in LGD, but for increases in PD, the relationship is concave.

IRB banks must use the advanced IRB approach to calculate risk weights for residential mortgages.¹¹ Banks using the advanced IRB approach must calculate their own estimates of PD and LGD. These estimates are to be based on historical experience. The capital framework

¹¹ The capital framework does not distinguish between the foundation and advanced IRB approaches for retail exposures.

does not specify whether the most recent observations should be weighted more heavily than observations further back in time. The historical observation period used to estimate PD must be at least five years. For retail loans, PD may never be set below 0.03 percent, and estimates for LGD and EAD should be calculated for an observation period of at least five years that contains at least one downturn. In Norway, banks are required to use data that include the banking crisis in the early 1990s in their risk calculations.¹² LGD may not be lower than 10 percent or the long-term default-weighted average.¹³

3. Historical loss and default data

In this section, the Basel formula is used to calculate residential mortgage risk weights on the basis of:

- Estimates of PD for residential mortgages based on historical data
- Estimates of LGD for residential mortgages based on historical data

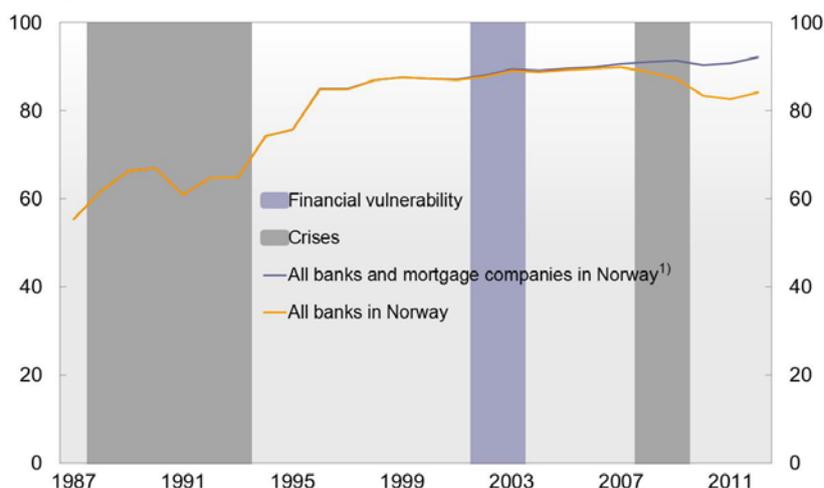
Risk weights for residential mortgages depend on the characteristics of the Basel formula and on the estimated risk parameters (PD and LGD) used in the formula. I use my own estimates of PD and LGD together with the Basel formula to calculate risk weights for Norwegian residential mortgages. I utilise the same assumptions regarding maturity (M) and correlation (R) as in the Capital Requirements Regulation. Different assumptions regarding M and R may also be of considerable importance for the calculated risk weights, but this is beyond the scope of this memo, which only assesses what residential mortgage risk weights should be under current capital rules.

I use historical data on loss and default in the retail market taken from the banking statistics to calculate PD and LGD for residential mortgages. Lending to the retail market also includes loans other than residential mortgages. In Norway, residential mortgages account for more than 92 percent of total bank and mortgage company lending to the retail market, up from around 55 percent in 1987 (see Chart 3). The remaining retail market loans are primarily credit card debt, car loans and other consumer loans. The credit risk for residential mortgages is normally lower than for other retail market lending. Private individuals who only have loans other than residential mortgages often have weaker debt servicing capacity than residential mortgage customers. Many of those without residential mortgages do not qualify for residential mortgages. In addition, credit card debt and other consumer loans often have little or no collateral. The loss given default (LGD) level will therefore normally be higher on such loans than on low loan-to-value residential mortgages secured on dwellings. Data for the entire retail market will therefore exaggerate the credit risk on residential mortgages somewhat.

¹² The years of the banking crisis should be included in the calculation of the long-term average estimate for PD and the lower floor of the LGD.

¹³ The annual default rate is used to weight the average over the observation period. Thus, years with higher default rates are given a higher weight than years with lower default rates.

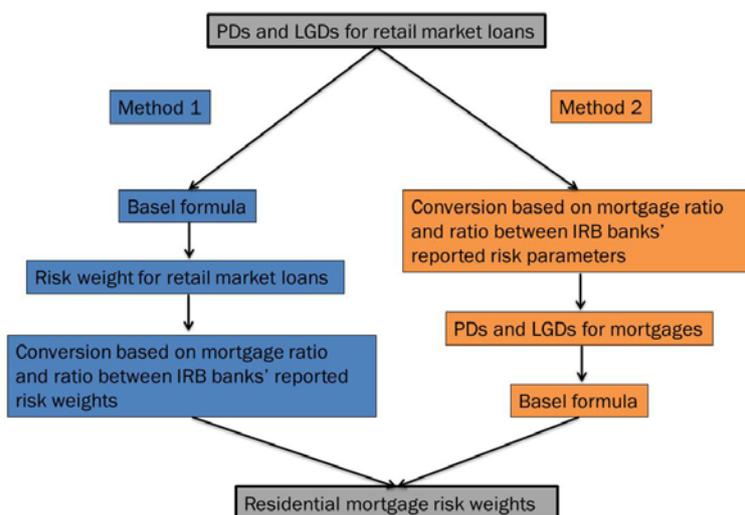
Chart 3 Residential mortgage lending as a share of gross lending to the retail market. Percent. Annual data. 1987–2012



1) Mortgage company lending is not available prior to 1996 Q1
Source: Norges Bank

I use two different methods to correct for the way retail market data exaggerates the credit risk for retail mortgages. Both methods are based on PDs and LGDs on retail market loans (see Chart 4). *Method 1* converts the calculated risk weights for retail market loans to risk weights for residential mortgages. *Method 2* converts PDs and LGDs for retail market loans to PDs and LGDs for residential mortgages so that application of the Basel formula generates risk weights for residential mortgages directly.

Chart 4 Methods for converting risk estimates based on retail market data to residential mortgage risk weights



In *Method 1*, I use the ratio of residential mortgages to total retail market lending by banks and mortgage companies (the residential mortgage ratio), as well as the ratio between IRB banks' reported risk weights, to convert my calculated retail market risk weights to residential mortgage risk weights. According to their Pillar 3 reports, IRB banks' average risk weight for residential mortgages was 11.2 percent at end-2012. The average risk weight for other retail market loans was 28.1 percent. Thus, IRB banks' average residential mortgage risk weight

was about two fifths of the average risk weight for other retail market loans. This is probably an accurate picture of how much lower the credit risk on residential mortgages is than on other retail market loans. I use this ratio to convert calculated risk weights for the retail market to calculated risk weights for the residential mortgage market.¹⁴ I also take account of the increase over time in residential mortgages as a share of bank lending to the retail market by using the average residential mortgage ratio for the period on which the calculations are based.

In *Method 2*, I use the IRB banks' reported risk parameters (PDs and LGDs) and the residential mortgage ratio to convert my calculated risk parameters for the retail market to risk parameters for the residential mortgage market. Then I use the derived PDs and LGDs for residential mortgages to calculate risk weights for residential mortgages using the Basel formula. According to IRB banks' Pillar 3 reports, their average PD for residential mortgages is approximately half of the average PD for other retail market loans. The difference is somewhat greater between IRB banks' LGD for residential mortgages and other retail market loans. I use the ratios between these parameters to convert calculated parameters for the retail market to calculated parameters for the residential mortgage market.¹⁵ I take account of the increase in the residential mortgage ratio over time by using the residential mortgage ratio in year *i* to derive PDs and LGDs in year *i*.

I assume that the quality of banks' and mortgage companies' residential mortgages has remained unchanged over the period for which I have loss and default data. There are some indications that the quality of banks' and mortgage companies' residential mortgages may have changed over the calculation period. Government lending schemes accounted for a far larger share of residential mortgages in the early 1990s than today. The Norwegian State Housing Bank was the principal agency for implementing government housing policy in the 1990s. In 1990, total Housing Bank lending was equal to 55 percent of private banks' total residential mortgage portfolio. According to the annual report for 1990, the Housing Bank's purpose was to ensure the availability of affordable housing throughout Norway and help to reduce the waiting period for approval for mortgages for disadvantaged borrowers in periods of loan queues. This may indicate that the Housing Bank issued more loans to disadvantaged borrowers than private banks, and that the Housing Bank was exposed to higher residential mortgage credit risk than private banks. Thus, historical data on Norwegian private banks' losses may underestimate the risk of residential mortgages. However, the Housing Bank's very favourable borrowing terms also attracted borrowers who were not disadvantaged. Furthermore, most of the Housing Bank's residential mortgages were secured by a first

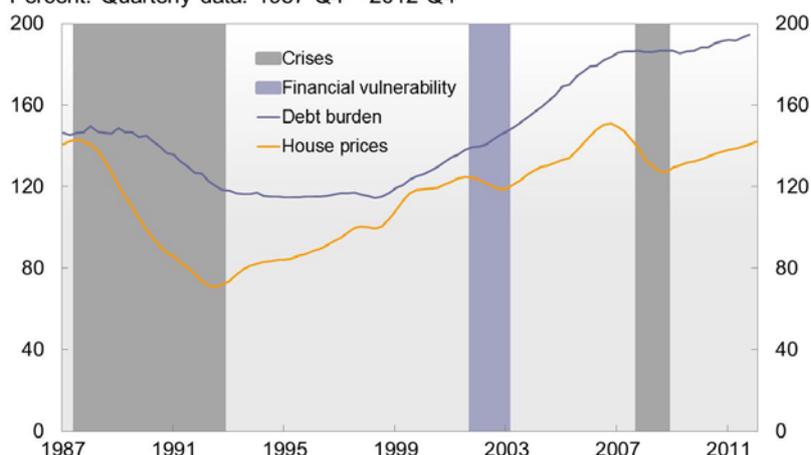
¹⁴ I convert calculated risk weights for the retail market (RW_r) to calculated risk weights for the residential mortgage market (RW_m) on the basis of the average of banks' residential mortgage ratios (X) as well as IRB banks' average risk weight for residential mortgages (Y) and for other loans to the retail market (Z). The calculated risk weight for residential mortgages (RW_m) is given by: $RW_m = RW_r/[X + ((1-X)*Z/Y)]$.

¹⁵ I convert calculated risk parameters for the retail market (RPr_i) to calculated risk parameters for the residential mortgage market (RPr_m_i) on the basis of the residential mortgage ratio in year *i* (X_i) and of IRB banks' average risk parameters for residential mortgages (Y) and for other retail market loans (Z). The calculated risk parameter for residential mortgages in year *i* (RPr_m_i) is given by: $RPr_m_i = RPr_i/[X_i + ((1-X_i)*Z/Y)]$.

priority claim (see Husbanken (1990)), resulting in relatively low losses on the Bank's residential mortgage portfolio.¹⁶ The default rate, however, was fairly high.¹⁷

At the same time, several factors suggest that the credit risk on Norwegian households' residential mortgage debt is higher today than prior to the banking crisis of the 1990s. Household debt continues to rise faster than income, and total household debt is now nearly twice household disposable income (see Chart 5). This is considerably higher than prior to the banking crisis, when household debt amounted to around 1½ times disposable income. Analyses of Norwegian households' tax return data for 2011 show that 12 percent of households had debt of more than five times disposable income. This is higher than before the banking crisis, when less than 8 percent of households were in a comparable situation. At the same time, house prices relative to disposable income are just as high as before the banking crisis (see Chart 5).

Chart 5 Household debt and house prices relative to disposable income¹⁾. Percent. Quarterly data. 1987 Q4 – 2012 Q4



1) Disposable income corrected for estimated reinvested share dividends for 2000–2005 and redemption/reduction of equity capital for 2006–2012
Sources: Norges Bank, Norwegian Association of Real Estate Agents (NEF), Association of Real Estate Agency Firms (EFF), Finn.no, Pöyry and Statistics Norway

3.1 Probability of default (PD)

I estimate PDs for retail market loans on the basis of the default rate on retail market loans (see Chart 6). Defaulted loans in the banking statistics¹⁸ are classified according to the same

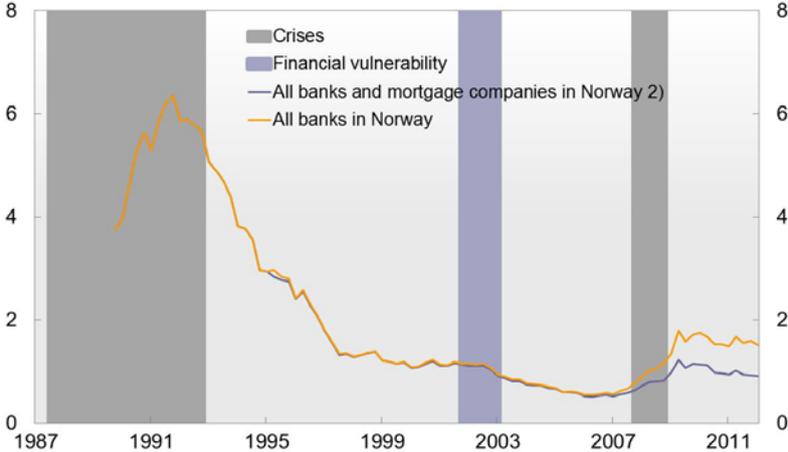
¹⁶ In the period 1991-95, the Housing Bank's annual losses averaged 0.2 percent of its total loan portfolio. By comparison, the average annual loss rate of private banks' retail market loan portfolios over the same period was 0.8 percent.

¹⁷ In the period 1991-95, the Housing Bank's default rate averaged 4.8 percent. By comparison, the average default rate on banks' and mortgage companies' retail market over the same period was 4.4 percent.

¹⁸ In 1991, a regulation entered into force with a separate provision for defaulted loans. Under the regulation, a default event has occurred if a scheduled payment on a loan or overdraft facility had not been made 90 days after the due date. In accordance with the guidelines issued by Kredittilsynet in 1987, banks applied a similar definition of default in the years prior to 1991. In 2009, the limit for the default classification was reduced to 30 days.

criteria that define defaulted loans in the Capital Requirements Regulations.¹⁹ I assume that defaulted residential mortgages are classified as being in default for one year before being removed from the stock of defaulted loans.²⁰ The average default rate over a longer time period will then provide a good indication of the likelihood that a retail market customer will default on his loan in the coming year (PD). The method used to calculate LGDs in Section 3.2 makes the results more robust to erroneous PD estimations.

Chart 6 Default rate on retail market loans. Percent. Quarterly data¹⁾. 1990 Q3 – 2012 Q4



1) Four-month data for the period August 1990 to August 1991
 2) Defaulted loan data for mortgage companies not available prior to 1996 Q1
 Source: Norges Bank

From 2007, the default rate was higher for banks alone than for banks and mortgage companies combined. The reason is that in June 2007, banks were permitted to transfer residential mortgages with a loan-to-value ratio below 75 percent to mortgage companies that issue covered bonds. The default rate on these residential mortgages is lower than the retail market loans remaining on banks’ books. At end-2012, approximately 60 percent of all residential mortgage loans were held by covered bond mortgage companies.

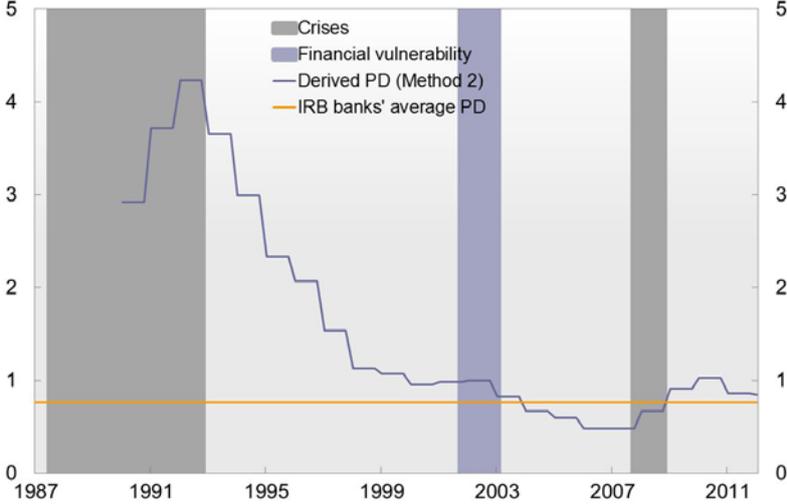
Debt servicing capacity among private individuals who do not hold a residential mortgage is often weaker than among those who do. PDs on residential mortgages are therefore lower than

¹⁹ Under Section 10-1 of the Capital Requirements Regulations (see Ministry of Finance, 2012), a loan exposure shall be regarded as in default if an obligor is more than 90 days past due on a credit obligation, and the amount is material. In addition, a loan exposure shall be regarded as in default if, as a result of a deterioration in the creditworthiness of the counterparty, the financial institution recognises an impairment loss or agrees to changes in lending terms.

²⁰ Empirical evidence on the resolution times for defaulted residential mortgages is weak, but analyses of resolution times for defaulted commercial loans may be used to estimate the resolution time for defaulted residential mortgages. Felsovalyi et al. (1998) find that it takes between 16 and 25 months from the time commercial loans are classified as in default until resolution. Gupton et al. (2000) perform a similar analysis of US banks’ loans to large enterprises and find that loans remain classified as defaulted for between 13 and 20 months. Gupton et al. (2000) also find a shorter resolution time for secured commercial loans (1.3 years) than for unsecured commercial loans (1.7 years). Residential mortgages are secured by collateral that is normally more homogeneous and liquid than collateral securing commercial loans. Moreover, residential mortgages are a more standardised loan product than commercial loans. This suggests a shorter resolution time for residential mortgages than for commercial loans.

PDs on other retail market loans, such as credit card debt, car loans and other consumer loans. As a result, the default rate in the retail market exaggerates PDs for residential mortgages somewhat. Under *Method 2*, PDs for the retail market are converted to PDs for residential mortgages on the basis of the ratio between IRB banks' reported PDs for residential mortgages and PDs for other retail market loans (see Chart 7).

Chart 7 Derived PD for residential mortgages in Norway (Method 2). Average PD for mortgages of IRB banks in Norway. Percent. Annual data. 1990-2012



Sources: Institutions' Pillar 3 reports and Norges Bank

The chart shows that the derived PD for residential mortgages peaked at 4.2 percent in 1992. This is considerably higher than IRB banks' average PD for residential mortgages of 0.8 percent. However, the derived PD for residential mortgages declined after 1992, reaching a bottom at around 0.5 percent in 2007.

3.2 Loss given default (LGD)

Since loss given default (LGD) data for residential mortgages are unavailable, LGD must be derived on the basis of other data series. The expected loss rate on an exposure can be defined as a the product of PD and LGD:

$$(1) \quad \text{Expected loss rate} = PD * LGD \approx \text{default rate} * LGD$$

It follows from (1) that LGD can be derived by dividing the loss rate by the default rate:

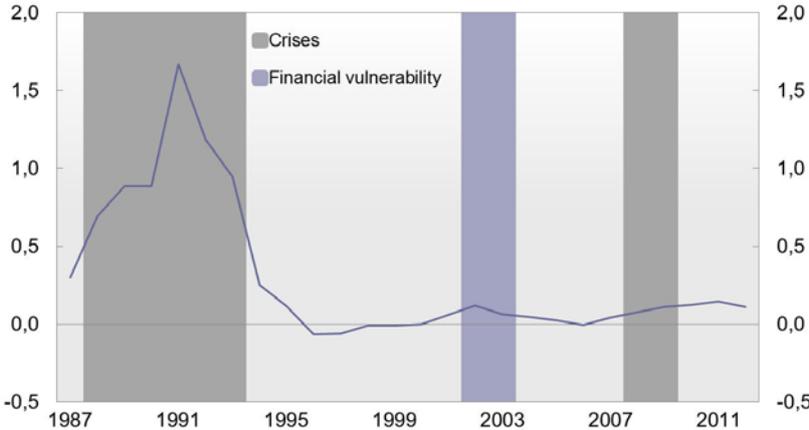
$$(2) \quad \frac{\text{Loss rate}}{\text{Default rate}} = \frac{\text{Default rate} * LGD}{\text{Default rate}} \approx \frac{PD * LGD}{PD} = LGD$$

Data are available on the loss rate, which is equal to the product of PD and LGD. LGD is therefore derived by dividing the loss rate by the estimated PD.

The method used to derive LGD makes the results more robust to erroneous estimations of PD. Since the loss rate is known and LGD is derived on the basis of the loss rate and the estimated PD, an overestimation of PD will lead to an underestimation of LGD and vice versa. For example, reducing the PD by half will double the LGD. At the same time, the Basel formula has been designed so that the risk weight increases linearly with increases in LGD and concavely with increases in PD. These characteristics along with the method for calculating LGD imply that an underestimation of the PD will actually result in a somewhat higher risk weight, and vice versa (see Table 3 in Appendix 2).

Data are available for the Norwegian banks’ loss rate in the retail market for the period 1987-2012 (see Chart 8). The loss rate increased from 0.9 percent in 1990 to 1.7 percent in 1991, then fell back to 1.2 percent in 1992 and 0.9 percent in 1993. One of the main drivers behind the high loss rate in 1990 and 1991 was that the three largest commercial banks were forced to seek capital injections in 1990 (Fokus Bank) and 1991 (Christiania Bank og Kreditkasse and Den norske Bank) (see Berg and Hexeberg (1994)). To assess their capital requirements, the three banks had to conduct a thorough review of their loan portfolios. As a direct result of the review, the three banks recognised substantial losses (see NOU (1992)). In 1991, commercial banks in Norway had an overall loss rate in the retail market of 2.5 percent.

Chart 8 Banks¹⁾ losses²⁾ on retail market loans in percent of gross retail market lending. Percent. Annual data. 1987–2012



1) All banks in Norway from 1997. Prior to 1997, loss rates are calculated for commercial banks and the largest saving banks, excluding branches of foreign banks in Norway
 2) Losses do not include unspecified loss provisions and group writedowns
 Sources: Norges Bank and *Official Norwegian Reports* (NOU) 1992:30

After the banking crisis, the Norwegian banks’ loss rate on retail market loans fell to very low levels. In the period 1995-97, reversals of previously recognised losses resulted in negative loss rates. In 2002, the loss rate rose to just above 0.1 percent, declining again until the financial crisis broke out. In the years 2008-12, the loss rate was approximately 0.1 percent.

Developments in banks’ loan losses in the period 1987-2012 may have been affected by changes in accounting rules. In 1992, new accounting rules were introduced.²¹ However, the

²¹ A new regulation that was issued in 1991, with effect as from the 1992 accounting year, directed banks to distinguish between specific and non-specific loan loss provisions and contained guidelines for how these loan

changes that came with the new accounting rules in 1992 were primarily of a formal and technical nature with limited effect on the size of banks' specific loan loss provisions²² and defaulted loans²³ used in my calculations. New accounting rules were also introduced in 2005²⁴ that may have affected loan loss developments in the years prior to, during and after the financial crisis. The analyses in this memo are based on averages over several years that are less affected by the time when losses had to be recognised. But accounting rules that result in greater fluctuations in recognised loan losses may for brief periods increase banks' need for equity capital. Some of the losses recognised during the banking crisis were subsequently reversed, but most banks had already reached a solvency crisis that forced the authorities to recapitalise them. Therefore, a reasonable prudential requirement will be that a bank's calculated capital requirements should reflect potential loan losses recognised in a banking crisis, and not any reversal of losses that may take place after the crisis has passed.

In Chart 9, I have derived the LGD on retail market loans by dividing the loss rate by the default rate. The calculated LGD on retail market loans is likely to be a satisfactory estimate of the average LGD on Norwegian residential mortgages, but the LGD is normally higher on credit card debt and other consumer loans because such loans have little or no collateral. For that reason, LGD on retail market loans exaggerates LGD on residential mortgages, especially in the early 1990s, when banks' residential mortgage ratios were lower. *Method 2* corrects the calculated LGD for this. Therefore, the calculated LGD on retail market loans is somewhat higher than the derived LGD for residential mortgages under *Method 2*, although the difference has narrowed over time. Following the banking crisis of the early 1990s, the derived LGD on residential mortgages is marginally lower than the estimated LGD on retail market loans. A steadily rising residential mortgage ratio explains the narrowing gap between these two measures.

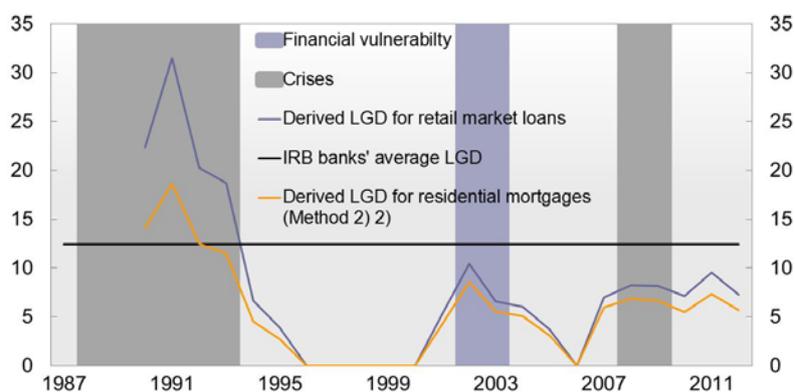
loss provisions were to be calculated. The regulation also allowed banks to make general reserve provisions. These were accounted for as a closing of the books allocation and not as a loss in the income statement. Prior to 1992, banks were allowed to make en bloc provisions that were intended to cover identified, calculated and latent losses. En bloc provisions did not need to be documented and were not deducted from the banks taxable earnings. The right to make en bloc provisions was abolished as from 1992, and from 1992, en bloc funds were reclassified on bank balance sheets as non-specific loss provisions.

²² According to the Smith Commission (Stortinget, 1998), the real changes in banks' loan loss accounting were minor. However, the Commission assumed that the non-specified provisions replaced en bloc provisions. This is probably not correct, because en bloc provisions were primarily made for tax reasons, while there were clearer rules for calculating non-specified provisions. On the other hand, it is likely that the specified loan loss provisions under the 1992 regulations are comparable with loss figures in the years 1987-91.

²³ See footnote 18.

²⁴ A new regulation (No. 1740 of 21 December 2004) based on the principle of fair value accounting was introduced with effect from 2005. Banks are required to write down the book value of individual loans and groups of loans when there is objective evidence of impairment (individual writedowns and group writedowns). The regulation defines what may be regarded as objective evidence. The total amount of impairment shall be recognised as a loss. Impairment losses may be reversed.

Chart 9 Derived LGD for banks¹⁾ retail market loans. Derived LGD for mortgages (Method 2) and IRB banks' average LGD. Percent. Annual data. 1987–2012



1) All banks in Norway from 1997. Prior to 1997, LGDs are calculated for commercial banks and the largest savings banks, excluding branches of foreign banks in Norway
 2) LGD for residential mortgages is derived from the residential mortgage ratio and the ratio between IRB banks' estimated LGD for residential mortgages and LGD for other retail market loans
 Sources: Institutions' Pillar 3 reports and Norges Bank

The derived LGD on residential mortgages peaked at 19 percent in 1991. This is higher than the IRB banks' average LGD for residential mortgages of 12 percent. The sharp fall in house prices that began in 1988 (see Chart 5) can explain the high LGD during the banking crisis. After 1991, the calculated LGD gradually declined. In 2001, the calculated LGD rose, and in 2002, the derived LGD on residential mortgages was nearly 9 percent. The derived LGD on residential mortgages then declined before increasing again to over 7 percent in 2011.

In the period 1996-2000, the derived LGD was 0 percent, on both residential mortgages and retail market loans in general. However, periods when the derived LGD was close to zero should not be given much weight, since they were characterised by substantial reversals of previously recognised losses. Large-scale revaluations pull down the average loan-loss ratio per borrower. In periods characterised by substantial reversals, the derived LGD will therefore not be an accurate measure of the expected future LGD.

3.3 Calculated risk weights

The risk weight for retail market loans is calculated on the basis of the banks' and mortgage companies' default rates (PDs) and on the derived LGDs for banks' retail market loans (*Method 1*). Banks' and mortgage companies' residential mortgage ratios and IRB banks' reported risk weights are then used to convert the calculated risk weight for retail market loans to a risk weight for residential mortgages. The risk weight for residential mortgages is also calculated directly on the basis of the derived risk parameters for residential mortgages (*Method 2*).

Under the capital framework, PDs should preferably be based on data encompassing at least an entire business cycle. The average default rate for the period 1990-2012 will therefore be appropriate as an estimate of PD. According to the capital framework, LGD is to be calculated for an observation period of at least five years that contains at least one downturn. This

suggests that we should include data for the banking crisis (1990-1993) and perhaps also the downturns of 2002-2003 and 2008-2009 in the LGD calculation.

I begin by using the average default rate for the period 1990-2012 as an estimate of the PD and the average LGD for the banking crisis years 1990-1993 as an estimate of the LGD. With these estimates of PD and LGD, *Method 1* produces a residential mortgage risk weight of 34 percent (see Table 1 in Appendix 2). With the same estimation period, *Method 2* yields a derived PD and LGD for residential mortgages of 1.6 percent and 14.2 percent, respectively (see Table 2 in Appendix 2). This results in a risk weight on residential mortgages of 25 percent under *Method 2*. By comparison, IRB banks applied an average PD and LGD on residential mortgages of 0.8 percent and 12.4 percent, respectively, at year-end 2012.²⁵ This resulted in an average risk weight for residential mortgages at IRB banks of 11.2 percent.

The loan-to-value ratios of residential mortgages may have changed over the period for which I have loss and default data. This suggests that estimates of LGD should be based on experience from more than one downturn. Moreover, estimates will be more robust if they are based on longer time series. The calculations show that the average LGD for residential mortgages in the downturn years 1990-1993, 2002-2003 and 2008-2009 is 10.5 percent. If we use this estimate of the LGD and the average default rate for the period 1990-2012 as an estimate of the PD, the residential mortgage risk weight is 19 percent under *Method 2*. With the same estimation periods, *Method 1* yields a residential mortgage risk weight of 25 percent.

4. Stress tests

In this section, the Basel formula is used to calculate residential mortgage risk weights on the basis of:

- Estimates of PD for residential mortgages in two different stress scenarios for the Norwegian economy
- Estimates of LGD for residential mortgages for the banking crisis years 1990-1993

The purpose of Norges Bank's stress tests is to identify vulnerabilities in the banking system as a whole and illustrate how important risk factors may affect banks' capital ratios. These risk factors are based on developments in the current financial system that may be a source of substantial bank losses. Stress tests can thus often shed light on vulnerabilities facing banks in a different manner from historical data.

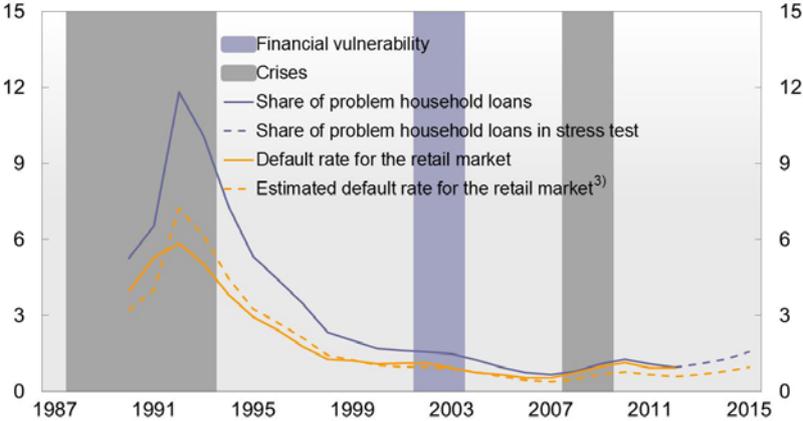
Calculations of banks' risk weights are largely based on historical data. However, historical data will not always reflect the risk in the residential mortgages currently on banks' books. Customer bases may have changed considerably. New borrowers may have a different risk profile, and the credit risk of existing borrowers may have changed markedly. Historically

²⁵ Several IRB banks disclose only unweighted averages for their risk parameters. Unweighted averages are generally higher than weighted averages.

low interest rates over time combined with strong growth in real wages have in recent years resulted in low losses on residential mortgages. It is not given that this trend will continue (see Norwegian Government, 2013). Substantial structural changes in the Norwegian economy have taken place in the past 25 years, some of which can amplify the impact on the banks' solvency in the event of another downturn. Developments in house prices and debt burdens in Norway (see Chart 5) may indicate that households are more vulnerable to higher interest rates, loss of income and a fall in house prices today than before the banking crisis in the early 1990s.

Stress tests can be a useful tool for assessing the risk of residential mortgages that banks currently hold. Stress tests can be used to estimate how vulnerable Norwegian households currently are to a low-probability shock. Norges Bank's stress tests are based on the current household debt burdens and debt-income ratios and estimate the magnitude of losses they could impose on banks in a crisis. In the stress tests, the share of problem household loans is projected on the basis of macroeconomic variables. The share of problem loans includes doubtful and non-performing loans. In the period 1990-2012, the share of problem loans was on average 64 percent higher than the default rate in the retail market (see Chart 10). We use this ratio to convert the share of household problem loans to the default rate for the retail market.²⁶ Historical data for the period between 1990 and 2012 show that this conversion produces relatively accurate results.

Chart 10 Banks¹⁾ share of household problem loans and the default rate for the retail market. Percent. Annual data. 1990–2015²⁾



1) All banks and mortgage companies in Norway
 2) Projections for the period 2012–2015
 3) Estimated on the basis of the ratio between the share of household problem loans and the default rate in the retail market for the period 1990–2012
 Source: Norges Bank

Our analysis is based on the stress test presented in *Financial Stability 2/12* (see Norges Bank (2012)). The scenario for this stress test includes a sharp fall in activity among Norway's trading partners, very low oil prices and a high level of turbulence in money and bond markets

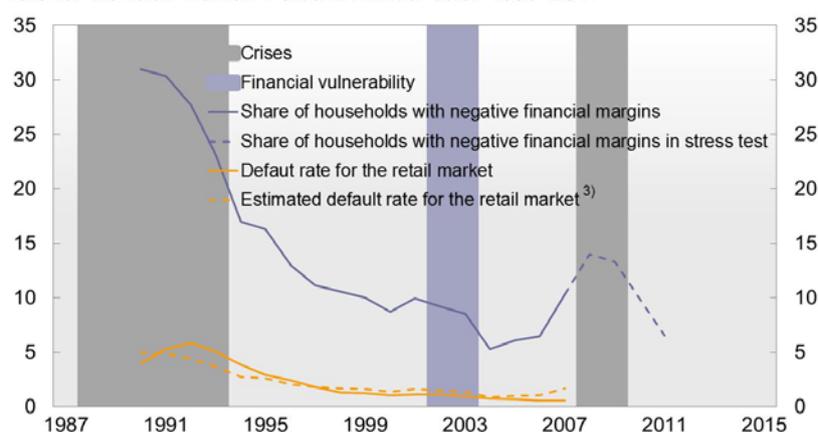
²⁶ The retail market default rate is estimated by dividing the share of household problem loans for each year by 1.64. I assume that the ratio residential mortgages to household loans moved in line with the ratio residential mortgages to the retail market loans. For that reason, differences in the ratio of residential mortgages to total retail market lending are not corrected for in this calculation.

with increased risk premiums in interest rates. Norwegian household expectations deteriorate and house prices fall by over 20 percent between 2013 and 2015. The corporate sector is widely affected, and mainland GDP falls by $\frac{3}{4}$ percent in 2013 and by 1 percent in both 2014 and 2015. If we base our calculations on the average derived PD for the retail market in the stress test and the derived LGD during the banking crisis years 1990-93, the result is a residential mortgage risk weight of 19 percent under *Method 1* and 15 percent under *Method 2* (see Table 1 in Appendix 2). This is at the lower end of the risk weights that result from applying historical default and loss data in Section 3.

Even if the financial position of households overall may appear solid, there may be groups of households that are vulnerable to a fall in house prices, higher interest rates and a loss of income. Norges Bank previously conducted stress tests of individual Norwegian households on the basis of tax return data. One of the main outputs from these stress tests of households is the share of households with negative financial margins, i.e. households not in a position to make interest payments, pay tax and meet living expenses according to the National Institute for Consumer Research (SIFO) standard budget. The advantage of such stress tests is that they use information about the distribution of debt, wealth and income across households. This kind of information on the financial position of individual households is not necessarily captured in macroeconomic relationships. Projections of the share of households with negative financial margins can be used to estimate PDs on residential mortgages.

In the stress test presented in *Financial Stability 2/08* (see Norges Bank, 2008), it was assumed that the turbulence in autumn 2008 would intensify and persist. First, it was assumed that higher risk premiums would lead to continued high lending rates. Second, it was assumed that banks would sharply tighten lending. Third, it was assumed that household expectations regarding future developments would weaken. In this stress scenario, real house prices fall by around 50 percent between 2007 and 2011. Higher unemployment and higher lending rates lead to an increase in the share of households with negative financial margins in 2008 (see Chart 11).

Chart 11 Share of households with negative financial margins. Banks¹⁾ default rate for the retail market. Percent. Annual data. 1990–2011²⁾



1) All banks and mortgage companies in Norway

2) Projections for the period 2008–2011

3) Estimated on the basis of share of households with negative margins and the default rate for the retail market for the period 1990–2007

Source: Norges Bank

In the period 1990–2007, the share of households with negative financial margins was just over six times the default rate in the retail market. This ratio is used to calculate the default rate in the retail market in the stress test in *Financial Stability 2/08*.²⁷ Historical data for the period between 1990 and 2007 show that this conversion is relatively accurate.

Applying the average PD in the stress test and the derived LGD during the banking crisis years 1990–93 results in a residential mortgage risk weight of 33 percent under *Method 1* and 25 percent under *Method 2*. This is about the same as the risk weights obtained in Section 3 by applying data back to the banking crisis in the early 1990s. However, households' vulnerability has increased since 2008 (see Chart 5). The calculated risk weight will therefore be somewhat higher in a similar stress test that assumes current house prices and household debt burdens.

5. Other benchmarks

In this section, the Basel formula is used to calculate residential mortgage risk weights on the basis of:

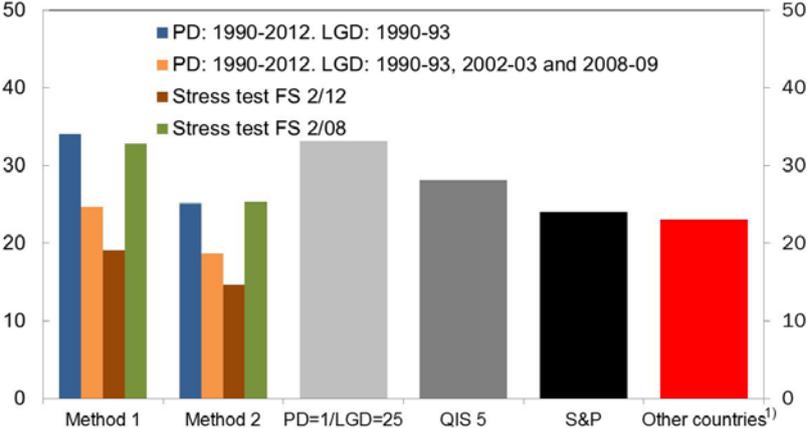
- The average PD and LGD for residential mortgages that Basel II banks in EEA countries reported before Basel II was introduced
- Technical assumptions of lower limits of average PD and LGD for residential mortgages applied by Finanstilsynet in its consultation response to the Ministry of Finance (see Finanstilsynet, 2013b)

In addition, the calculated risk weights are compared with residential mortgage risk weights in other countries and risk weights used by Standard & Poor's to rate Norwegian banks.

²⁷ The default rate in the retail market is estimated by dividing the share of households with negative margins in each year by 6.3.

On 14 December 2012, the Ministry of Finance requested Finanstilsynet to prepare a draft consultation response and draft regulation containing rules that increase risk weights for residential mortgages under the IRB approach, including a proposal for a minimum risk weight for residential mortgages of 35 percent. In the light of a separate review of IRB banks' models for residential mortgages in 2012, Finanstilsynet is seeking in any case to tighten IRB models (see Finanstilsynet, 2013a). Finanstilsynet points out that both higher debt burdens in Norwegian households and experience from other countries may indicate that IRB banks must take into account steeper declines in house prices and higher default rates in their calculations (see Finanstilsynet, 2013b). In its consultation response to the Ministry of Finance, Finanstilsynet applies technical assumptions of lower limits of average volume-weighted PD and LGD of 1 percent and 25 percent, respectively, in the residential mortgage portfolio. If we use a PD of 1 percent and a LGD of 25 percent, the residential mortgage risk weight will be 33 percent (see Chart 12). This is about the same as the calculated residential mortgage risk weights in Sections 3 and 4.

Chart 12 Average mortgage risk weights from various methods and assumptions and average weights in selected countries. Percent



1) Equally weighted risk weights for mortgages in Belgium, Denmark, Estonia, Finland, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Netherlands, Slovakia and Sweden in 2011
Sources: Basel Committee (2006), Norges Bank, Standard & Poor's (2009), central banks and FSAs in the countries selected

The Bank for International Settlements (BIS) conducted several quantitative impact studies of Basel II before the rules were introduced. IRB banks in a number of countries reported the risk parameters they expected to use. Banks probably had an incentive to report relatively conservative risk parameters to the BIS. Reporting risk parameters that were too low could have resulted in a stricter set of rules.

As a cross-check, I use the average PD and LGD that Basel II banks reported in the BIS fifth quantitative impact study (QIS5) (see Basel Committee (2006a)).²⁸ Basel II banks in EEA countries reported an average PD and LGD for residential mortgages of 1.5 and 16.1 percent,

²⁸ I use reported averages for banks in Group 1 as defined by the Committee of European Banking Supervisors (CEBS). These are banks that are located in EEA countries, have more than EUR 3bn in Tier1 capital and are diversified and internationally active.

respectively. Applying these risk parameters produces a residential mortgage risk weight of 28 percent (see Chart 12). The risk parameters reported in QIS5 are probably consistent with the credit risk of the Norwegian banking sector's exposures. In Norway, household debt burdens and house prices are higher than in most other European countries. In isolation, this pushes up the risk banks assume on residential mortgages, compared with other countries. A very well developed social safety net and strong public finances push the risk in the opposite direction.

It is also useful to compare calculated risk weights with the market's risk assessments. Standard & Poor's has developed its own risk-adjusted measure of banks' capital adequacy, the Standard & Poor's risk adjusted capital (RAC) ratio (see Standard & Poor's, 2009). The objective of the RAC ratio is to better enable the credit rating agency to analyse and compare banks' solvency. Standard & Poor's divides the world's banking system into ten different economic risk groups, where Group 1 has the lowest risk, and Group 10 the highest.²⁹ Norway belongs to Group 2. Standard & Poor's gives high-quality residential mortgages in Group 2 countries a risk weight of 24 percent.³⁰ By comparison, high-quality residential mortgages are given a risk weight of 19 percent in Group 1 countries and 30 percent in Group 3 countries. This corresponds with the average residential mortgage risk weight in a sample of other countries (see Chart 12).

These benchmarks result in residential mortgage risk weights of between 23 and 33 percent. This is approximately the same level as the calculated residential mortgage risk weights in Sections 3 and 4.

6. Conclusion

Following the introduction of Basel II in 2007, residential mortgage risk weights have fallen by up to 80 percent for the largest banks in Norway. At end-2012, IRB banks in Norway had an average residential mortgage risk weight of 11.2 percent, less than a third of the minimum requirement for the smaller banks that use the standardised approach. This has led authorities and market participants to question whether IRB banks in Norway hold sufficient equity capital for their residential mortgages. In addition, there is wide cross-border variation in residential mortgage risk weights.

I use historical default and loss data, stress tests and other benchmarks to calculate what the average risk weight should be for Norwegian residential mortgages. These calculations indicate that IRB banks' residential mortgage risk weights should be raised from current levels. According to the calculations, risk weights for Norwegian residential mortgages should be somewhere between 20 and 30 percent, on average. This is consistent with other benchmarks and residential mortgage risk weights based on default rates from two different stress tests.

²⁹ See Table 12 in Standard & Poor's (2009).

³⁰ See Table 15 in Standard & Poor's (2009).

The calculated risk weights pertain to an average residential mortgage in Norway. The residential mortgage risk weight for customers with good debt servicing capacity and low debt-to-value ratios should be lower than the calculations in this memo show. Similarly, the residential mortgage risk weight for borrowers with weak debt servicing capacity and high debt-to-value ratios should be higher.

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Appendix 1

The formula for calculating risk-weighted assets (RWA)³¹ for the retail market is

$$RWA = 12.5 * 1.06 * EAD \left[LGD * N \left(\frac{G(PD) + \sqrt{R} * G(0.999)}{\sqrt{1-R}} \right) - (PD * LGD) \right]$$

where N is the cumulative standard normal distribution and G its inverse. The formula is calibrated to a solvency margin of 99.9 percent, that is, the estimated probability that a bank's regulatory capital will not cover its losses the following year is less than 0.1%. The formula contains a multiplier set at 1.06 on the basis of BIS quantitative impact studies of Basel II. For the retail market, the correlation (R) is set at 0.15. This includes only the correlation between each exposure and a factor for systemic risk. The correlation between the various exposures is ignored. The formula thus assumes that all idiosyncratic risk may be diversified away.

Since $RWA = \sum_{i=1}^n EAD_i \cdot Risk\ weight_i$ and $R = 0.15$, the formula for calculating the risk weight for *residential mortgage_i* can be shortened to:

$$\begin{aligned} RW\ residential\ mortgage_i \\ = 13.25 * LGD_i * N \left(\frac{G(PD_i) + \sqrt{0.15} * G(0.999)}{\sqrt{0.85}} \right) - (PD_i * LGD_i) \end{aligned}$$

³¹ For a detailed description of the formula, see Basel Committee (2005).

Appendix 2

Table 1 Risk weights for residential mortgages calculated using different methods and assumptions

Probability of default (PD)	Loss given default (LGD)	Method 1 1)	Method 2 2)
Average 1990-2012	Average 1990-93	34%	25%
Average 1990-2012	Average 1990-93, 2002-03 and 2008-09	25%	19%
Stress test FS 2/12, average 2012-15	Average 1990-93	19%	15%
Stress test FS 2/08, average 2008-11	Average 1990-93	33%	25%
IRB banks'3) average4)	IRB banks'3) average4)	14%	
Floor proposed by Finanstilsynet	Floor proposed by Finanstilsynet	33%	
Standard & Poor's (economic risk category 2)	Standard & Poor's (economic risk category 2)	24%	
QIS 5	QIS 5	28%	

1) Residential mortgage risk weights are derived from the calculated retail market risk weight, residential mortgages' share of total retail market lending in Norway and IRB banks' average risk weight for residential mortgages (11.2 percent) and for retail market loans (28.1 percent). If PD and LGD are estimated over different time periods, an equally weighted average of residential mortgage ratios for the two periods are used.

2) Residential mortgage risk weights are calculated using derived PD and LGD for residential mortgages. PD and LGD are derived from estimated PD and LGD on retail market loans, the residential mortgage ratio and the difference between IRB banks' average PD and LGD for retail market loans.

3) DNB Bank Group, Nordea Bank Norge, SpareBank 1 SR-Bank, Sparebanken Vest, SpareBank 1 SMN, SpareBank 1 Nord-Norge, SpareBanken Hedmark and Bank 1 Oslo Akershus.

4) Several IRB banks disclose only unweighted averages for their risk parameters. Unweighted averages are generally higher than weighted averages. Therefore, use of unweighted averages of PD and LGD generates a higher average residential mortgage risk weight than what banks report. In addition, the concavity of the Basel formula may cause average risk weights calculated using average PDs to deviate from average risk weights calculated using PDs and risk weights for individual loans.

Table 2 Risk parameters used in various calculations

Calculation	Probability of default (PD)	Loss given default (LGD)
Average 1990-2012 (Method 2)	1.6 %	
Average 1990-93, 2002-03 and 2008-09 (Method 2)	2.2 %	10.5 %
Average 1990-93 (Method 2)	3.6 %	14.2 %
Stress test <i>Financial Stability</i> 2/12 (Method 2)	0.7 %	
Stress test <i>Financial Stability</i> 2/08 (Method 2)	1.6 %	
IRB banks'1) average2)	0.8 %	12.4 %
Floor proposed by Finanstilsynet	1.0 %	25.0 %
QIS 5	1.5 %	16.1 %

1) DNB Bank Group, Nordea Bank Norge, SpareBank 1 SR-Bank, Sparebanken Vest, SpareBank 1 SMN, SpareBank 1 Nord-Norge, SpareBanken Hedmark and Bank 1 Oslo Akershus

2) Several IRB banks disclose only unweighted averages for their risk parameters. Unweighted averages are generally higher than weighted averages. Therefore, average PD and LGD in the table are somewhat higher than the weighted averages of the IRB banks as a group.

Table 3 Risk weights calculated under various assumptions concerning PD

	Probability of default (PD)	Loss given default (LGD)	Method 1	Method 2	Average
50% reduction of PD	Average 1990-2012	Average 1990-93	44%	32%	33%
	Average 1990-2012	Average 1990-93, 2002-03 and 2008-09	32%	24%	
PD assumed in Table 1	Average 1990-2012	Average 1990-93	34%	25%	26%
	Average 1990-2012	Average 1990-93, 2002-03 and 2008-09	25%	19%	
Doubling of PD	Average 1990-2012	Average 1990-93	25%	19%	19%
	Average 1990-2012	Average 1990-93, 2002-03 and 2008-09	19%	14%	