STAFF MEMO

Effects of the IRB approach on bank lending to Norwegian enterprises

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This paper analyses how the introduction of the IRB approach may have affected banks' lending to enterprises, lending margins and portfolio quality in Norway. Our results show that the IRB banks' lending margins decreased compared with the standardised approach banks following the introduction of the IRB approach. Growth in lending to the corporate market was also higher for the IRB banks than for the standardised approach banks during the first years after the introduction. However, this may be the result of factors other than the IRB approach. Our analyses do not indicate that the IRB approach has led to finer granularity in the pricing of corporate loans. We find some support for the hypothesis that the IRB approach may have improved the quality of banks' portfolios.

Key words: regulation, banks, IRB, enterprises, credit

1. Introduction

Banks play a key role in the economy, offering services that are crucial to economic growth, such as providing credit to enterprises and private individuals.[2] Access to such services is often impaired during banking crises. The macroeconomic costs of banking crises are therefore high.

Holding more equity capital improves banks' resilience to losses and reduces the risk of crises. The authorities have therefore imposed requirements with regard to the amount of equity a bank must use to finance lending. Equity requirements vary with credit risk. Since equity financing in isolation is more costly than other financing, such capital requirements can affect banks' risk management, lending growth and lending rates.

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[2] Banks provide credit, accept deposits, execute payments and provide risk management services.

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In practice, banks must satisfy *capital adequacy* requirements, ie the minimum capital banks must hold relative to risk-weighted assets. Risk-weighted assets are calculated by risk-weighting loans and other exposures. Each risk weight is set to reflect the risk of unexpected losses. Banks with more risky assets are therefore subject to higher capital requirements. In the 1990s and the beginning of the 2000s, banks used fixed, standardised risk weights (Basel I). With the introduction of the Basel II capital framework in 2007, several of the largest banks in Norway were permitted to use internal models to calculate risk weights (the IRB approach[3]). The alternative is to apply more general, standardised risk weights set by the authorities (the standardised approach).[4]
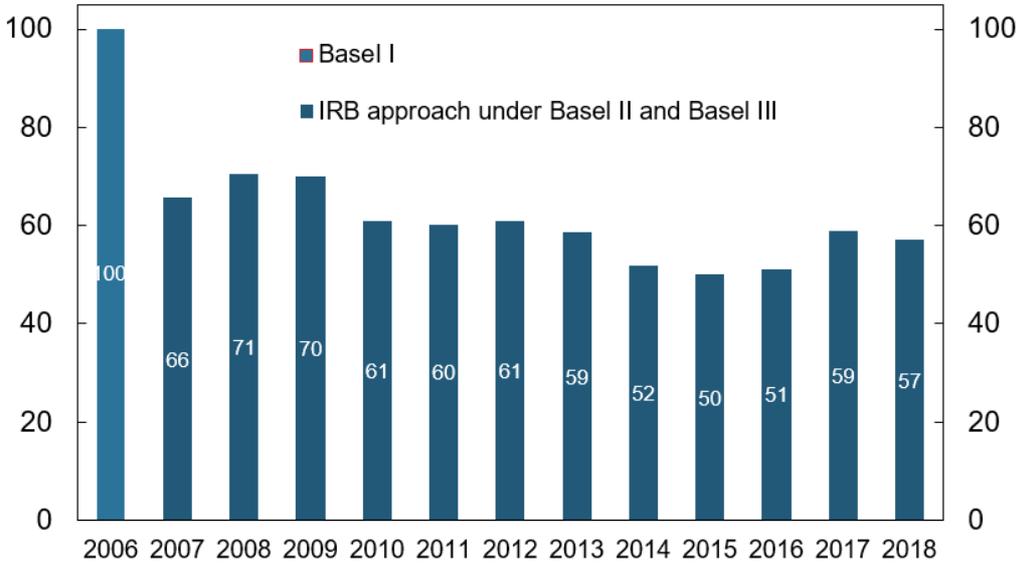
One of the aims of the IRB approach was to improve risk management and capital allocation efficiency. Banks applying the IRB approach (IRB banks) use enterprise- and bank-specific data to a greater extent than standardised approach banks. This can improve banks' ability to assess which borrowers to extend credit to and at which interest rate, so that expected losses are covered by a bank's operating income. If this is the case, the IRB approach can reduce the risk of solvency problems in IRB banks. The IRB approach can also improve capital allocation efficiency in the economy. If bank credit is supplied to a greater extent to enterprises with good debt-servicing capacity, a larger share of capital can be invested in profitable projects.

The IRB approach has contributed to reducing Norwegian IRB banks' capital requirements. Charts 1 and 2 show that the IRB banks' risk weights for corporate loans and residential mortgages have fallen sharply since 2006. The IRB banks' average risk weight for corporate exposures has declined by almost half since 2006, and residential mortgage risk weights have fallen even more.

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[3] Internal Ratings-Based (IRB) Approach.
[4] Banks applying the standardised approach can nevertheless use internal risk models for loan pricing.

Chart 1 Average risk weight for corporate exposures under Basel I and the IRB approach. Weighted average of Norwegian IRB banks.[1] Percent. 2006 – 2018

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1) Disregarding the transitional rule for the transition from Basel I.

Sources: Banking groups' Pillar 3 reports

Chart 2 Average residential mortgage risk weight under Basel I and the IRB approach. Weighted average of Norwegian IRB banks.[1] Percent. 2006 – 2018
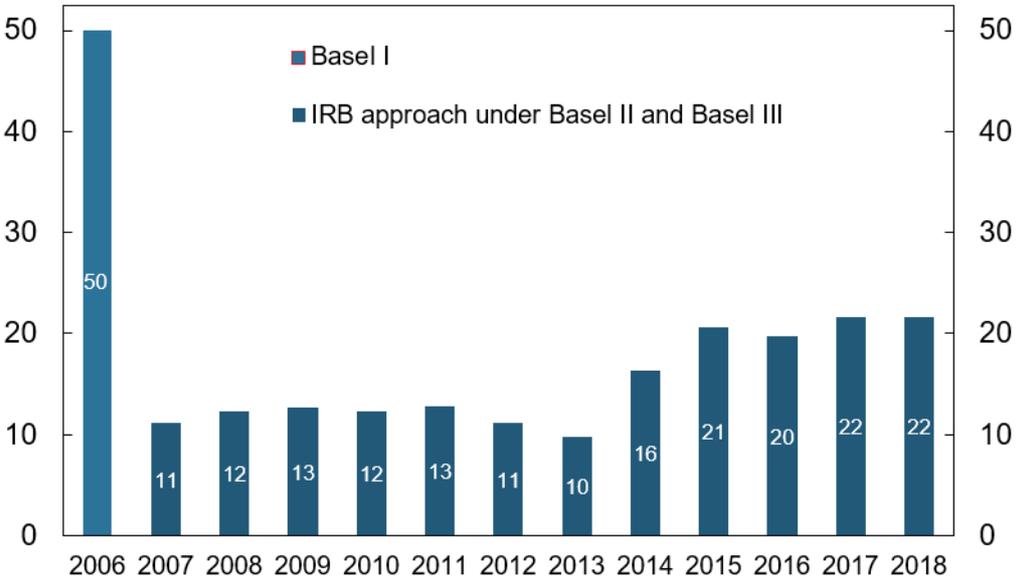
1) Disregarding the transitional rule for the transition from Basel I.

Source: Banking groups' Pillar 3 reports

The IRB approach may also have contributed to higher lending growth and lower lending margins, ie a lower spread between the lending rate

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and the three-month money market rate (NIBOR). Lending rates on loans to enterprises are often contractually set at a fixed margin above the money market rate, particularly for loans to large enterprises.[5] The lending margin should cover banks' expected credit losses as well as operating expenses and financing costs related to credit. Equity financing is in isolation more costly than other forms of financing. Since IRB banks' capital requirements have decreased more than those of standardised approach banks, the introduction of Basel II may have reduced IRB banks' funding costs compared with standardised approach banks and thereby laid the basis for lower lending margins and higher lending growth.[6]

The IRB approach may also have led to finer granularity in the pricing of corporate exposures and thereby a wider dispersion of lending margins across borrowers. Exposures with low credit risk are assigned lower risk weights under the IRB approach than under the standardised approach. In addition, risk weights for high-risk exposures can be higher under the IRB approach. If the IRB approach produce a wider dispersion of risk weights for corporate exposures, it is reasonable to assume that the IRB approach could also lead to a wider dispersion of lending margins.

In this paper, we analyse the consequences of the IRB approach for Norwegian banks and their corporate customers in Norway. We use bank-specific data and credit data to analyse two questions:

1. Have developments in lending and lending margins been significantly different for IRB banks compared with standardised approach banks?

2. Have developments in portfolio quality been significantly different for IRB banks compared with standardised approach banks?

To answer the first question, we study lending volumes, average lending margins and the dispersion of lending margins across loans. To answer the second question, we analyse credit losses and a range of bank customer characteristics.

A problematic aspect of this analysis is that lending, interest rates and bank portfolio quality are affected by many other factors in addition to

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[5] Bank loans to small enterprises are more often standard variable-rate loans.
[6] Lower equity financing does not necessarily lower the cost of providing credit, however. Investors may consider it risky to invest in banks with low equity capital, for example. In such a situation, a reduction in equity capital could raise the price of wholesale funding and the required return on equity. The overall effect is therefore ambiguous. International studies nonetheless suggest that banks' total funding costs can decrease somewhat when equity ratios fall (see ECB (2011).

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capital requirements. Distinguishing the effects of the IRB approach from the effects of other factors that vary across the two groups of banks can be demanding. Take lending margins, for example. Banks might have reduced their lending margins during the analysis period irrespective of their method of calculating capital ratios. To exclude this possibility, we compare developments in the IRB banks' lending margins with those of the standardised approach banks. If lending margins for the two groups of banks only differ *after* the IRB approach was introduced, we find support for the hypothesis that any change in the IRB banks' lending margins is in fact attributable to the IRB approach.

Second, the fall in the IRB banks' lending margins may be a result of a larger decrease in IRB banks' credit risk compared to that of standardised approach banks around the introduction of the IRB approach. To control for such alternative explanations, we examine enterprises with loans from both the standardised approach banks and the IRB banks. Looking at the interest rate differential between loans to *the same enterprise* before and after the IRB approach ensures that we pick up changes in lending margins that are not the result of differences in customer characteristics.[7]

We cannot control for everything, however. A problem with this method is that we do not control for other factors that only affect IRB banks in the same period, such as the price of IRB banks' wholesale funding, growth ambitions or risk assessments. Another problematic aspect of this analysis is that Basel II also reduced risk weights for standardised approach banks, although not to the same extent as for IRB banks. Overall, these factors may have led to an under- or overestimation of the real effects of the IRB approach.

The findings from our empirical analysis can be summarised in two broad conclusions. First, we find little evidence that the IRB approach affected banks' lending margins. We observe that Norwegian IRB banks' lending margins on corporate loans fell by about 90 basis points compared with the standardised approach banks in the first years after the introduction of the IRB approach. However, the difference decreased again after autumn 2009, making it difficult to conclude that the fall in margins could be attributed to the IRB approach. Nor do we find any sign that the dispersion of corporate interest rates has widened for banks that adopted the IRB approach, despite the fact that the use

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[7] We assume that banks do not change their priority claim over the collateral once the loan has been approved.

of more firm-specific data can improve IRB banks' ability to rate borrowers according to credit risk.

Second, we find some empirical evidence that the IRB approach may have affected banks' portfolio composition. According to our analyses, the concentration of highly liquid customers and customers with small loans has increased for the IRB banks. Measured based on other characteristics such as profitability, equity ratio and credit rating, we find no indication that the IRB approach has changed the composition of banks' portfolios. Nor do we find any indication that the loss ratio has declined more among the IRB banks than among the standardised approach banks.

Our study adds to a small body of literature analysing the consequences of the IRB approach for risk management and lending margins. Behn et al. (2016) find that both losses and default rates are higher for IRB banks than for standardised approach banks, as are lending rates. This may suggest that the IRB banks had more information about their customers and that higher lending rates reflect higher risk. The authors nonetheless conclude that the reform had the opposite of the intended effect as it resulted in lower capital ratios and higher losses for IRB banks. Rajan et al. (2015) find that statistical risk models estimated on historical data do not capture changes in the relationship between customer characteristics and defaults over time. Similarly, Acharya et al. (2014) find that risk weights do not capture changes in real risk, but that other measures of bank solvency, such as leverage ratios, provide a better indication of banks' resilience to financial stress. On the other hand, an analysis conducted by the Basel Committee of more than 100 IRB banks shows that up to three quarters of the variation in risk weights across banks was attributable to differences in underlying risk (see Basel Committee (2013)). This is consistent with the results of the European Banking Authority's (EBA) analyses of over 100 European IRB banks (see EBA (2017) and EBA (2019)), in which the EBA concludes that the variability of IRB banks' capital requirements can largely be explained by measurable characteristics of banks' exposures.

Section 2 of this paper describes those parts of the capital framework that are relevant to our analysis. Section 3 provides an overview of the data sets that we use. Section 4 compares developments in interest rate setting and credit standards for IRB and standardised approach banks, while section 5 compares different indicators of bank portfolio quality. Section 6 concludes.

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2. The capital framework

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The banks' capital adequacy ratio is calculated as capital as a percentage of risk-weighted assets:

$$Capital\ adequacy\ ratio = \frac{Capital}{Risk-weighted\ assets}$$

The numerator in the capital adequacy equation, ie the bank's capital, can consist of different qualities of capital. Banks are required to meet minimum requirements for Common Equity Tier 1 (CET1) capital, Tier 1 capital and total regulatory capital.[8]

The denominator in the capital adequacy equation, ie risk-weighted assets, is computed by assigning risk weights to a bank's assets (exposures). The higher the risk of loss on an asset, the higher its risk weight should be. Risk weights are intended to reflect the risk of unexpected losses. Expected losses should be reflected in lending margins and are covered by banks' operating income.

Under Basel I, banks used fixed, standardised risk weights to calculate capital requirements.[9] The Basel I framework was subsequently criticised for not taking sufficient account of differences in risk. High-risk banks could in some cases be subject to the same capital requirements as banks with lower risk. Large international banks using internal models for risk management argued that internal models should be used to calculate capital requirements, as internal models provided a more accurate picture of actual risk than the Basel I framework.

Basel I was replaced by the Basel II framework in Norway in 2007. Under Basel II, risk weights were intended to more accurately reflect actual risk, which would contribute to better risk management and more efficient capital allocation. Under the Basel II framework, banks were permitted to use three different approaches for calculating capital requirements for credit risk: the standardised approach, the foundation IRB approach (FIRB) and the advanced IRB approach (AIRB) (see Ministry of Finance (2006)).[10] The IRB approach was calibrated to give banks lower capital requirements than under both the standardised

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[8] CET1 capital is a bank's equity capital net of deductions such as goodwill, deferred tax assets and other intangibles. Tier 1 capital comprises CET 1 capital and additional Tier 1 capital (AT1) such as preferred capital securities and hybrid capital. Regulatory capital is the sum of Tier 1 and Tier 2 capital. Tier 2 capital also includes time-limited subordinated loan capital.
[9] Residential mortgages with loan-to-value ratios below (above) 80 percent were assigned a risk weight of 50 (100) percent, while corporate exposures were assigned a risk weight of 100 percent.
[10] Banks must also calculate capital requirements for market and operational risk. As these requirements account for a small part of banks' capital requirements, this paper focuses on credit risk.

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approach and Basel I, giving banks an incentive to adopt the IRB approach.

Banks must apply to Finanstilsynet (Financial Supervisory Authority of Norway) for approval to use the IRB approach. The five largest Norwegian banks and Nordea Norge adopted the IRB approach in 2007 and have since applied the IRB approach to an increasing portion of their exposures. Since 2007, other Norwegian banks have also become IRB banks (see Table 1).

Table 1 Approvals of Norwegian banks' IRB models.[1] 2007 – 2018

	DNB[2]	Spb. SR-Bank	Spb. 1 SMN	Spb. Vest	Spb. 1 Nord-Norge	Spb. Møre	Spb. 1 Østlandet[3]	BN Bank	Bank 1 Oslo Akershus[3]
2007	IRB mortgages and FIRB corporates	IRB mortgages and FIRB corporates	IRB mortgages and FIRB corporates	IRB mortgages and FIRB corporates	IRB mortgages and FIRB corporates				
2008									IRB mortgages and FIRB corporates
2009	AIRB corporates	IRB mortgages	IRB mortgages	IRB mortgages	IRB mortgages				IRB mortgages
2010	AIRB corporates								
2011									
2012	IRB mortgages and AIRB corporates and inst.						IRB mortgages and FIRB corporates		
2013									
2014						FIRB corporates		AIRB corporates	
2015	AIRB corporates	AIRB corporates	AIRB corporates		AIRB corporates	IRB mortgages	AIRB corporates	IRB mortgages	AIRB corporates
2016									
2017				AIRB corporates					
2018									

1) The overview is based on publicly available information and does not necessarily include all IRB approvals.
2) IRB models for parts of DNB's corporate portfolio have been approved in several rounds.
3) Sparebanken Hedmark prior to the merger with Sparebanken Hedmark and SpareBank 1 Oslo Akershus on 1 April 2017. SpareBank1 Østlandet after the merger.

Sources: Official letters from Finanstilsynet and banks' reports, press releases and stock exchange notifications

The IRB approach has reduced Norwegian IRB banks' capital requirements (Charts 1 and 2). For the smaller banks, which use the standardised approach, the introduction of Basel II has not resulted in

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the same decrease in risk weights. Under the standardised approach, commercial property loans and loans to enterprises without a credit rating are assigned a risk weight of 100 percent, the same as under Basel I. Loans to smaller enterprises classified as *Retail*[11] are assigned a risk weight of 75 percent.

A transitional rule (Basel I floor) was introduced to limit the potential reduction in IRB banks' capital requirements compared with Basel I.[12] Most Norwegian IRB banks have been bound by the Basel I floor since the introduction of the IRB approach. This has reduced the differences in capital requirements in real terms between Norwegian IRB banks and standardised approach banks. The floor was removed from Norwegian capital adequacy rules at the end of 2019. Banks that at the margin were bound by the floor applied in reality risk weights for new exposures of about 80 percent of the risk weights under Basel I, ie risk weights of about 80 percent for new corporate exposures.[13]

3. Data

We use several data sources to assess the effects of the IRB approach. Data from the ORBOF banking statistics[14] are used to analyse developments in banks' lending, lending margins and corporate loan losses. The banking statistics are complemented by risk weight data from banks' Pillar 3 reports.

The Norwegian Tax Administration's credit data contain outstanding debt and interest paid on all loans provided by banks in Norway to Norwegian enterprises. We use these data to estimate how the IRB approach has affected average lending margins and the dispersion of lending margins across corporate borrowers. Lending rates applied to loans are not observed directly in the data set. The average lending rate is therefore calculated by dividing the year's interest payments by the average outstanding loan amount for the current and previous year.[15]

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[11] A corporate exposure can be included in the *Retail* segment if the bank's total exposure to the enterprise is less than EUR 1 million euro and annual turnover for the enterprise is less than EUR 50 million.

[12] In 2007, IRB banks' risk-weighted assets could not be lower than 95 percent of risk-weighted assets under the Basel I rules. In 2008, the Basel I floor was reduced to 90 percent and to 80 percent in 2009.

[13] 80 percent of the Basel I risk weight at 100 percent corresponds to a risk weight of 80 percent. Since banks were not required to calculated capital requirements for operational risk under Basel I, the effective risk weights are in practice somewhat lower than 80 percent of the Basel I weights.

[14] See *Offentlig regnskapsrapportering for banker og finansieringsforetak (ORBOF)* [banks' and financial undertakings' financial reporting to the Norwegian authorities] (Norwegian only): https://www.ssb.no/innrapportering/naeringsliv/orbof.

[15] Getz Wold and Juelsrud (2020) show that this method results in about the same interest rate as is reported in Statistics Norway's official statistics. We minimise measurement errors by excluding observations of interest rates below and above a certain level.

Developments in the quality of Norwegian banks' portfolios is also analysed by comparing credit data with enterprise data. Data on business enterprises from the Brønnøysund Register contain accounting data for all Norwegian limited companies with bank debt in the period 2003-2016. The data set also contains the enterprises' credit ratings.[16]

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4. Effects of the IRB approach on lending rates and lending

This section analyses how the IRB approach may have changed banks' lending to enterprises and their lending rates. We focus on the five Norwegian banks that adopted the IRB approach in 2007. In addition, we assess five foreign-owned banks that have used the IRB approach for about as long as the five Norwegian IRB banks.[17] The foreign-owned banks probably play a crucial role for competition in the corporate loan market in Norway, partly because they face lower capital requirements than Norwegian banks and hold a substantial share of the market in Norway. Other Norwegian banks that adopted the IRB approach after 2007 are excluded from our empirical analysis.

4.1. Analysis at bank level

Bank lending data show that banks may have adapted to expectations of lower risk weights under Basel II long before its introduction in 2007. Both the IRB banks and the standardised approach banks increased their lending to the corporate market considerably in the period preceding the introduction of Basel II (Chart 3). Lending growth was highest for the foreign-owned IRB banks. High credit demand probably made a strong contribution to the high level of lending growth in the period, but the introduction of Basel II may also have resulted in an increase in the supply of bank credit. The Basel Committee published impact studies in 2003 and 2006 that indicated that the IRB approach could result in considerably lower capital requirements (see Basel Committee (2003) and (2006)).[18] In 2006, corporate lending growth for both the Norwegian and the foreign-owned IRB banks was higher than for the standardised approach banks.

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[16] Provided by Bisnode.
[17] Handelsbanken, Nordea, SEB and Swedbank have used the IRB approach since 2007, while Danske Bank adopted the IRB approach in 2008.
[18] The Basel Committee published its first impact study for Basel II in 2001 (see Basel Committee, 2001). According to this study, the IRB approach would result in higher capital requirements for most banks. The proposed Basel II framework was adjusted following this study.

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Chart 3 Growth in corporate lending by banks and mortgage companies[1]. Four-quarter change. Percent. 2002 Q4 – 2019 Q3
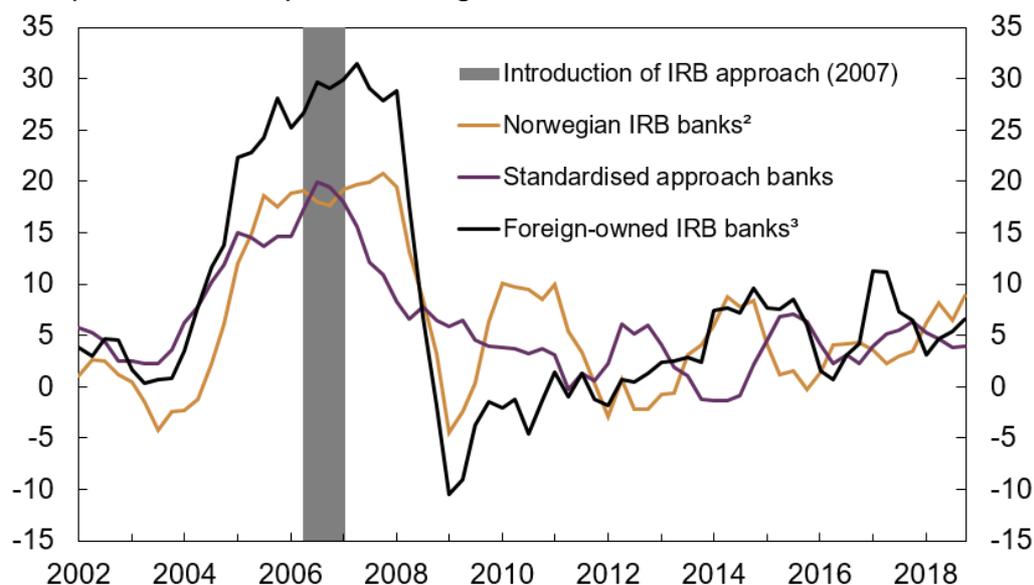
1) Excluding banks established after 2001 Q3.
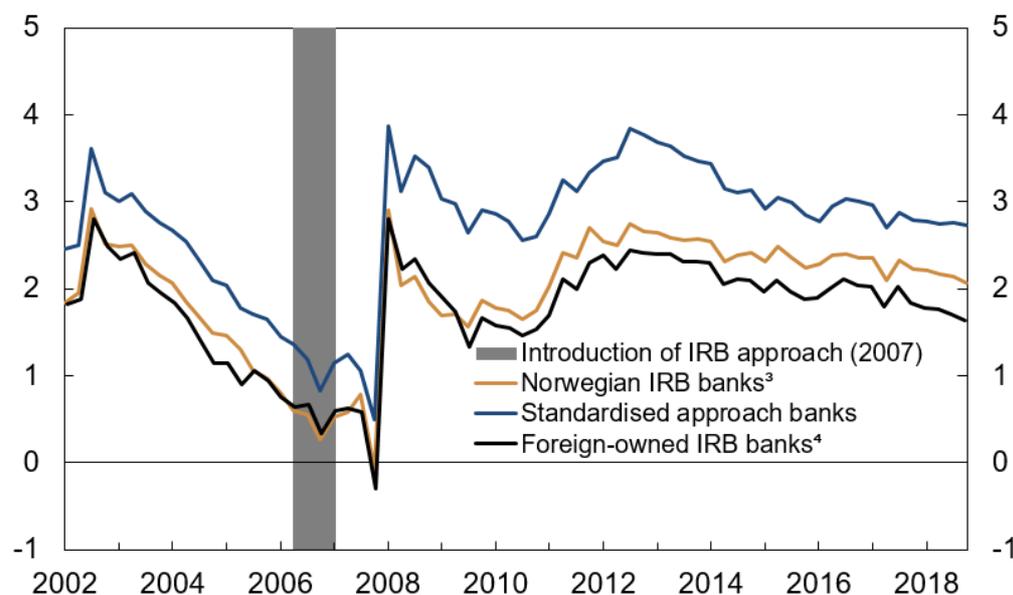2) DNB, SpareBank 1 SR-Bank, SpareBank 1 SMN, Sparebanken Vest and SpareBank 1 Nord-Norge.
3) Danske Bank, Handelsbanken, Nordea, SEB and Swedbank.

Source: Norges Bank

Growth in lending to the corporate market was also higher for the IRB banks, particularly the foreign-owned IRB banks, than for the standardised approach banks in the first years after the introduction of Basel II. However, during the financial crisis of 2008-2009, both the Norwegian and the foreign-owned IRB banks tightened lending to a greater extent than the standardised approach banks. Since then, the IRB banks and the standardised approach banks have grown at about the same pace, with the highest corporate lending growth rate alternating between the two. Overall, it is difficult to draw any conclusion about the effects of the IRB approach from this data source alone.

Our data on interest rates show that the introduction of Basel II may have pulled down the IRB banks' lending margins (see Chart 4). Before the introduction, Norwegian IRB banks' corporate lending margins were on average 0.6 percentage point lower than the equivalent margins for standardised approach banks. After the introduction, this difference gradually increased to 1.5 percentage points in autumn 2009. The difference in lending margins between the foreign-owned IRB banks and the standardised approach banks increased by almost the same extent. This supports the hypothesis that the IRB approach may have resulted in cheaper corporate loans.

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Chart 4 Lending margin[1] on the stock of corporate loans from banks and mortgage companies[2]. Percent. 2002 Q4 – 2019 Q3

1) Spread between lending rate and three-month money market rate.
2) Excluding banks established after 2001 Q3.
3) DNB, SpareBank 1 SR-Bank, SpareBank 1 SMN, Sparebanken Vest and SpareBank 1 Nord-Norge.
4) Danske Bank, Handelsbanken, Nordea, SEB and Swedbank.

Source: Norges Bank

The difference in lending margins between the Norwegian IRB banks and the standardised approach banks gradually reverted after autumn 2009, possibly because of the increase in general capital requirements following the financial crisis.[19] This may have affected the Norwegian IRB banks more than the standardised approach banks as IRB banks had adjusted their capital ratios closer to the requirements (see Getz Wold and Juelsrud (2020)). Another explanation could be that lending margins were affected by factors other than the IRB approach, such as the price of wholesale funding[20]. However, the foreign-owned IRB banks in Norway, which rely heavily on wholesale funding, were able to maintain the difference in margins vis-à-vis the standardised approach banks to a far greater extent than the Norwegian IRB banks. This may be because the Basel I floor was applied in a different way in Norway than in other countries, with the result that the Basel I floor was more

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[19] Until 2012, the minimum CET1 capital requirement in Norway was just over 5 percent. In autumn 2011, the EU decided that the largest banks should have a minimum CET1 capital ratio of 9 percent by summer 2012. Finanstilsynet (Financial Supervisory Authority of Norway) expected Norwegian banks to meet the same requirement. The requirement continued to increase in pace with the phasing in of the new capital framework (CRD IV/CRR) in summer 2013 (see Kragh-Sørensen (2012) and Lund and Nordal (2017) for more detailed descriptions).
[20] Banks that rely exclusively on equity and customer deposits will not be directly affected by changes in the price of wholesale funding. This is the case for a number of the smaller standardised approach banks.

binding for the Norwegian than for the foreign-owned IRB banks.[21]
Since the Basel I floor was more binding in Norway, the Norwegian IRB
banks' adjustment may have been influenced by the Basel I rules to a
greater extent than that of the foreign-owned IRB banks.

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4.2. Analysis at loan level

This section presents an analysis of the effects of the IRB approach on
individual corporate loans. As in 4.1, we explore whether the IRB
approach may have resulted in cheaper loans, but in contrast to 4.1, we
examine developments in lending margins at *loan* level. A fall in the IRB
banks' lending margins relative to those of the standardised approach
banks following the introduction of the IRB approach could indicate that
the IRB approach has contributed to cheaper loans. Similarly, we
assess whether the IRB approach has led to finer granularity in the
pricing of corporate loans.

We estimate the difference in interest rates between the IRB banks and
the standardised approach banks among enterprises that borrow from
both IRB and standardised approach banks. As customer composition
is constant under this method, any changes in interest rates after 2007
can be interpreted as a consequence of the IRB approach. As very few
Norwegian enterprises have loans with both a foreign-owned IRB bank
and a standardised approach bank, the analyses at loan level do not
assess the effects for the foreign-owned IRB banks.

Chart 5 shows the difference in average lending margin between the
IRB banks and the standardised approach banks.[22] Compared with the
standardised approach banks, the average margin on lending to these
enterprises is significantly higher for the IRB banks in 2004. In 2005,
this difference is no longer significantly different from zero, and in 2006,
the lending margin is significantly lower for the IRB banks. The
difference remains negative, but is not significantly different from zero
until 2010. This may indicate that the IRB approach resulted in lower
lending margins, although we do not have a good explanation for the
time lag.[23] The difference is about 90 basis points in 2010. As in Chart

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[21] The Norwegian IRB banks applied the Basel I floor in their calculation of risk-weighted assets, as
recommended by the Basel Committee (the Basel Committee version). The foreign-owned banks applied
the floor as a lower limit on capital, as defined in the EU Directive (the EU version). In contrast to the Basel
Committee version, the EU version of the floor did not have any effect for banks with a capital ratio of more
than 80 percent of the minimum requirement under Basel I (see Borchgrevink, 2012). In isolation, this
contributed to a larger reduction in the capital requirements for the foreign-owned IRB banks than for the
Norwegian IRB banks.
[22] The method is explained in section 1 of the appendix.
[23] The difference in 2006 may reflect banks' expectations of lower capital requirements under the IRB
approach.

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4, the difference in lending margin between the Norwegian IRB banks
and the standardised approach banks decreases again after 2010.

*Chart 5. IRB banks'[1] average lending rate less average lending rate of
standardised approach banks for the same enterprise.[2] 2004 – 2013*
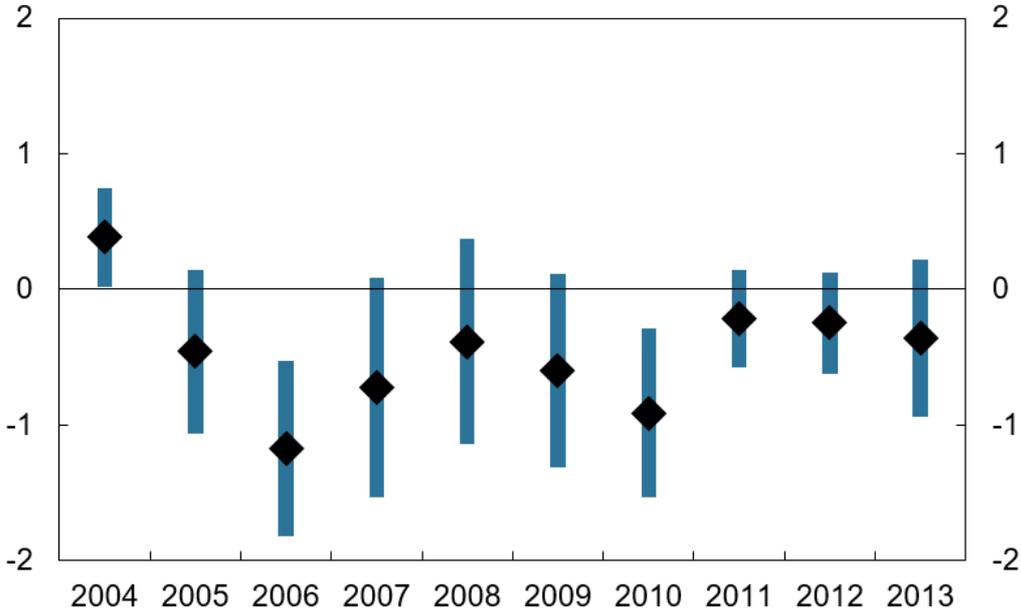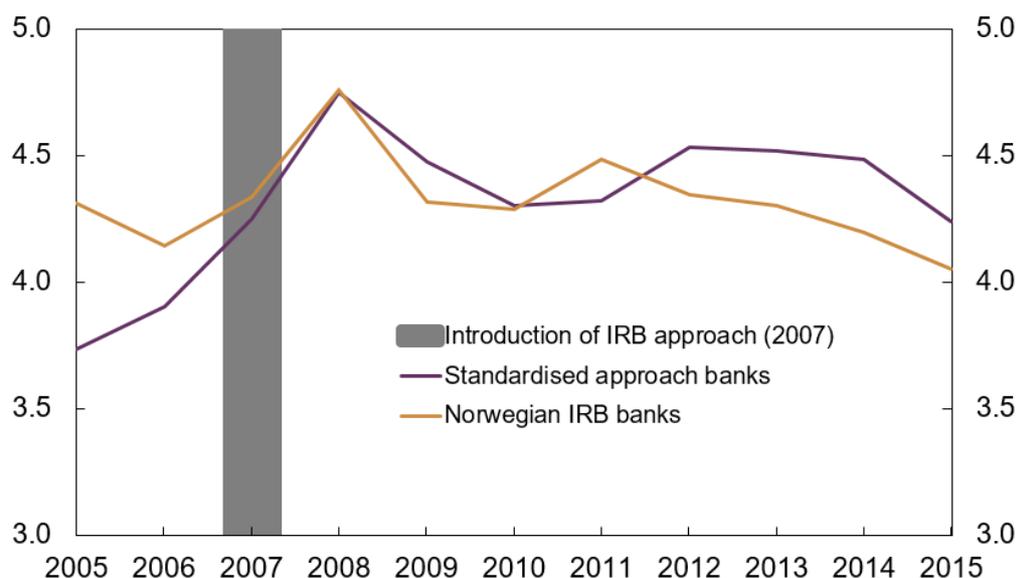

1) DNB, SpareBank 1 SR-Bank, SpareBank 1 SMN, Sparebanken Vest and
SpareBank 1 Nord-Norge.
2) The black diamonds represent the average difference and the bars display the 95
percent confidence interval.

Source: Norges Bank

The IRB approach may also have produced finer granularity in the
pricing of corporate loans and thereby a wider dispersion of lending
margins across borrowers. Chart 6 shows that the dispersion of IRB
banks' rates increased in the period to 2008. However, as standardised
approach banks have shown very similar developments, it is difficult to
conclude that the wider dispersion is attributable to the IRB approach.
Furthermore, we observe that the dispersion decreases after 2008 for
both groups, suggesting that the decrease was driven by factors other
than the IRB approach.

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Chart 6. Dispersion in rates[1] for corporate loans from IRB banks[2] and standardised approach banks. Percent. 2005 – 2015

1) Standard deviation in imputed rates.
2) DNB, SpareBank 1 SR-Bank, SpareBank 1 SMN, Sparebanken Vest and SpareBank 1 Nord-Norge.

Source: Norges Bank

We also conduct a statistical test to provide a better basis for assessing the effects of the IRB approach on the dispersion of rates. First, we calculate the annual standard deviation and the relationship between the 75-25 and the 90-10 percentiles of the distribution in rates for each bank for the period 2003-2016. Then we estimate the difference in the three dispersion measures between the IRB banks and the standardised approach banks pre- and post-2007 (see Table 2).[24] From this analysis, we cannot reject the null hypothesis that the dispersion in the two groups of banks follows the same path. This strengthens the conclusion that the IRB approach has not changed the pricing of credit to enterprises.

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[24] See section 2 of the appendix for an explanation of the method.

Table 2 Difference in dispersion of rates on corporate loans from IRB banks[1] and standardised approach banks pre- and post-2007

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	Standard deviation	75-25 percentiles	90-10 percentiles
Difference between IRB and standardised approach pre- and post-2007	-0.001	-0.21	1.3
Standard error	(0.001)	(0.52)	(11.5)
Explained variance	0.024	0.002	0.011
Observations	1207	1207	1207

1) DNB, SpareBank 1 SR-Bank, SpareBank 1 SMN, Sparebanken Vest and SpareBank 1 Nord-Norge.

Source: Norges Bank

# 5. Effects of the IRB approach on portfolio quality

The analyses in Section 4 show that the IRB banks reduced lending margins and increased lending to the corporate market relative to the standardised approach banks around the time of the introduction of the IRB approach. However, we find no support for the hypothesis that the IRB approach has led to finer granularity in the pricing of corporate loans. The IRB approach may nonetheless have affected the quality of the IRB banks' portfolios. One of the aims of the IRB approach was to contribute to better risk management and capital allocation efficiency. The IRB approach may thus have contributed to changing the composition of the IRB banks' corporate portfolios. For example, the IRB approach may have improved banks' incentives to lend to enterprises with low credit risk as the capital cost of lending to these enterprises is relatively speaking lower.

Chart 7 shows that the corporate loan loss ratio has followed a relatively similar path for the Norwegian IRB banks and the standardised approach banks since 2002. The loss ratio for the foreign-owned IRB banks has varied to a greater extent. On average, the loss ratio for the Norwegian IRB banks has been somewhat lower than for the standardised approach banks, particularly in the years following the introduction of Basel II.

Differences in banks' credit risk are often more pronounced in downturns. Macroeconomic developments in Norway have been solid since the introduction of the IRB approach, with the exception of the financial crisis and the downturn following the oil price fall in 2014. This can make it difficult to use data on banks' loan losses to assess

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changes in portfolio quality. Since 2015, however, loss ratios for Norwegian IRB banks have been higher than for standardised approach banks. This is partly because the Norwegian IRB banks were more exposed to oil-related industries during the oil price decline and incurred larger losses on oil-related loans than the standardised approach banks.

Chart 7 Banks'[1] losses[2] on corporate loans as a share of gross loans. Percent. 2002 – 2018
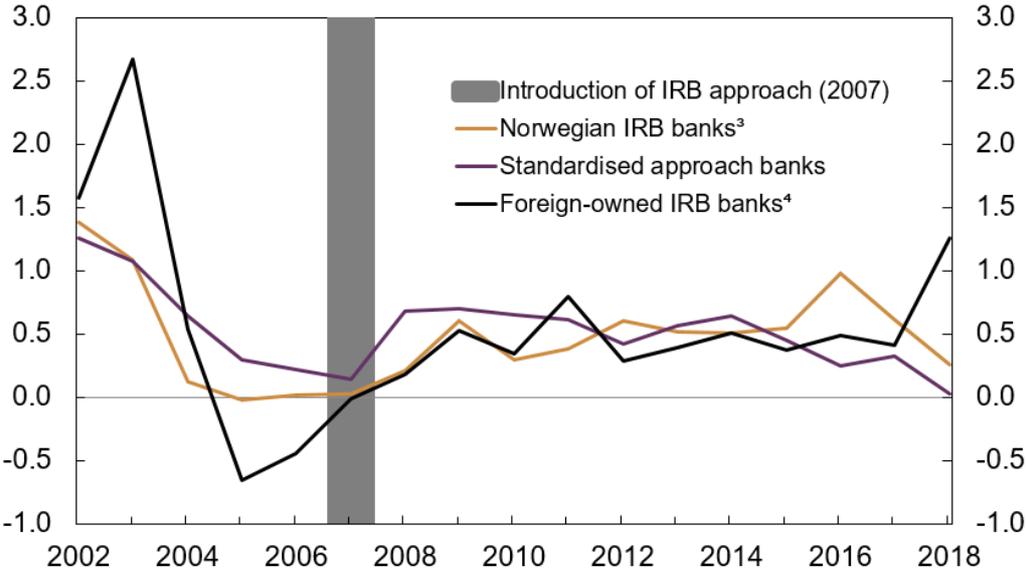
1) Excluding banks established after 2001 Q3.
2) Recognised losses excluding changes in collective impairment losses/unspecified loan loss provisions.
3) DNB, SpareBank 1 SR-Bank, SpareBank 1 SMN, Sparebanken Vest and SpareBank 1 Nord-Norge.
4) Danske Bank, Handelsbanken, Nordea, SEB and Swedbank. A number of foreign-owned banks have not submitted reports for several of the years in this dataset. Nordea has submitted reporting for all the years in the dataset.

Source: Norges Bank

We also assess a number of characteristics of banks' corporate customers in order to shed light on how the IRB approach may have affected banks' portfolio composition. We conduct a statistical analysis to test whether these characteristics changed more for Norwegian IRB banks than for standardised approach banks around the introduction of the IRB approach. We focus on credit risk indicators that are included in Norges Bank's bankruptcy prediction model[25] and the SEBRA model[26]. Table 3 provides a complete overview of these indicators and the

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[25] See Hjelseth and Raknerud (2016) for a more detailed description of Norges Bank' bankruptcy prediction model.
[26] See Bernhardsen and Larsen (2007) for a more detailed description of the SEBRA model.

average for IRB and standardised approach banks before the introduction of the IRB approach.

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Table 3 Characteristics of standardised approach banks' and IRB banks' corporate customers[1] in 2006

Characteristics of customers	Standardised approach	IRB approach	Difference[2]
EBITDA[3] in 1000s of NOK	2050	2541	490***
Share of rating A (Bisnode)	0.309	0.293	-0.015***
Share of rating AA (Bisnode)	0.438	0.463	0.024***
Share of rating AAA (Bisnode)	0.086	0.102	0.016***
Return on total capital in percent	15.7	14.0	-1.6***
Return on equity in percent	20.5	23.3	2.8***
Log(Total assets in 1000 NOK)	8.9	9.1	0.2***
Log(Loan amount in 1000 NOK)	5.8	6.0	0.2***
Net liquid assets as a share of turnover	0.06	3.46	3.4**
Paid-in equity as a share of book equity	1.32	1.37	0,05
Age in years	13.5	14.9	1.4***
EBITDA[3] as share of total debt	0.21	0.20	-0.01***
Trade accounts payable as a share of total assets	0.16	0.16	0.00
Unpaid taxes and dues as a share of total assets	0.029	0.028	-0.001*

1) Enterprises with negative equity or negative total capital were excluded from the comparison.
2) Difference between IRB approach and standardised approach. ***, **, * means that the difference is significant with a p-value respectively of 1, 5 or 10 percent or lower.
3) Earnings before interest, taxes, depreciation and amortisation.

Source: Norges Bank.

There were several significant differences between the IRB banks' average corporate customer and the standardised approach banks' average corporate customer before the IRB approach was introduced. On average, Norwegian IRB banks' customers were more profitable, solid, older and larger than the customers of standardised approach banks. In addition, IRB banks' customers had on average better credit ratings than the customers of standardised approach banks.

To explore whether the IRB approach has changed the quality of banks' portfolios, we assess whether banks' customer characteristics changed around the time of the transition to the IRB approach. Our statistical

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analysis tests whether customer characteristics can explain whether the loan was obtained from a Norwegian IRB bank and whether this is more likely to be the case following the transition to the IRB. If we can reject the null hypothesis that customer statistics are the same before and after the introduction of the IRB approach, this will indicate a change in the portfolio. Section 3 of the appendix describes the method in more detail.

Table 4. Developments in customer characteristics for IRB banks before and after the transition to the IRB approach

Characteristics of customers	Difference between pre- and post-2007[1]	Standard error
EBITDA[3] in 1000s of NOK	0.000	(0.000)
Share of rating A (Bisnode)	0.000	(0.002)
Share of rating AA (Bisnode)	0.001	(0.001)
Share of rating AAA (Bisnode)	0.001	(0.002)
Return on total capital in percent	-0.001	(0.001)
Return on equity in percent	0.000	(0.000)
Log(Total assets in 1000s of NOK)	-0.000	(0.000)
Log(Loan amount in 1000s of NOK)	-0.001*	(0.001)
Net liquid assets as a share of turnover	0.000**	(0.000)
Paid-in equity as a share of book equity	-0.000	(0.000)
Age in years	-0.000	(0.000)
EBITDA[3] as a share of total debt	0.002	(0.004)
Trade accounts payable as a share of total assets	0.000	(0.001)
Unpaid direct and indirect taxes as a share of total assets	0.017	(0.019)

1) ***, **, * means that the difference is significant with a p-value respectively of 1, 5 or 10 percent or lower.

Source: Norges Bank.

Our statistical analysis gives no clear indication that the IRB approach has changed the quality of Norwegian IRB banks' portfolios (see Table 4). For most of the characteristics of the IRB banks' customers, the analysis does not indicate a significant change after the transition to the IRB approach. There are, however, two exceptions. First, there is an

increase in the concentration of liquid[27] corporate customers of IRB banks. This may reflect that IRB models put emphasis on enterprises' liquidity and thus that to loans to liquid enterprises are assigned lower risk weights under the IRB approach. Second, there is some indication that the concentration of IRB bank customers with small loans has increased after the introduction of the IRB approach. This may reflect the lower risk weights assigned under the IRB approach to small loans classified as *Retail exposures*.[28] Overall, our results are consistent with the hypothesis that the IRB approach has improved the quality of Norwegian IRB banks' portfolios. Our estimates are nevertheless uncertain, and there is no uniform qualitative picture across a broad set of customer characteristics.[29]

Overall, we have not found that the IRB approach has had strong, persistent effects on Norwegian banks. One reason why we do not find stronger effects on lending and lending rates may be the rise in general capital requirements following the financial crisis. This may have affected Norwegian IRB banks more than standardised approach banks, as the IRB banks had adjusted their capital levels closer to the requirements. Another potential explanation could be that Basel II gave IRB banks a larger reduction in capital requirements for residential mortgages than for corporate loans, which may have made it more profitable to take market shares in the retail market rather than the corporate market. Compared with the standardised approach banks, however, the IRB banks have grown more and reduced lending margins more in the corporate market than in the retail market. Another reason why we do not find stronger effects on lending, lending rates and portfolio quality may be that the Basel I floor has been binding for most Norwegian IRB banks since the introduction of the IRB approach in 2007. Banks that were bound by the floor at the margin applied in reality risk weights for new loans of about 80 percent of the risk weights under Basel I. Most IRB banks therefore applied risk weights prescribed by the Basel I rules, ie risk weights that were both higher and showed less variability than those calculated by IRB models. This may have resulted in an adjustment by Norwegian IRB banks that conformed, fully or partly, with the Basel I rules. The floor was removed from the Norwegian rules at the end of 2019.[30] If the floor limited the effects of

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[27] High share of net liquid assets relative to turnover.
[28] Calculations of risk weights for the *Retail* are not adjusted for maturity. In addition, the risk of losses associated with these exposures is correlated to a lesser extent with systemic risk than larger corporate exposures. This is partly the reason why risk weights for *Retail* exposures are generally lower than for loans to larger enterprises.
[29] Since we analyse a relatively large number of outcomes, we cannot exclude the possibility that the significant differences are arbitrary.
[30] A new floor is to be phased in 2022. This floor will be less binding and more risk-sensitive than the Basel I floor.

the IRB approach in the period 2007-2019, the removal of the floor may contribute to higher lending growth and lower lending margins for Norwegian IRB banks ahead.[31] However, we cannot exclude the possibility that developments in bank lending, lending margins and portfolio quality have been strongly affected by factors other than capital requirements, such as the price of wholesale funding, operating costs, banks' risk assessments and competition in the banking sector.

6. Conclusion

This paper has presented an analysis of how the transition to the IRB approach may have affected banks' lending standards, rate setting and portfolio quality in Norway. We compare lending, lending margins and bank portfolio quality for IRB banks with the corresponding variables for standardised approach banks before and after the introduction of the IRB approach in 2007. We control for differences in customer characteristics by examining enterprises that borrow from both standardised approach banks and IRB banks.

Our results suggest that both the Norwegian and the foreign-owned IRB banks reduced lending margins and recorded higher growth in lending to the corporate market relative to the standardised approach banks immediately following the introduction of the IRB approach. It is, however, unclear whether this can be attributed to the IRB approach or other bank-related factors. We find no support for the hypothesis that the IRB approach has resulted in finer granularity in the pricing of corporate loans and thereby a wider dispersion of lending margins across customers. We find some support for the hypothesis that the IRB approach may have increased the quality of Norwegian IRB banks' portfolios, but this picture shows some variation across a broad set of customer characteristics.

Overall, we do not find strong, persistent effects from the IRB approach on Norwegian banks. Foreign-owned IRB banks in Norway have for example succeeded in maintaining the difference in margins vis-à-vis standardised approach banks to a far greater extent than Norwegian IRB banks. One possible reason could be that the Basel I floor has been binding for most Norwegian IRB banks since the IRB approach was introduced in 2007. This may have led to an adjustment by

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[31] More stringent capital requirements for foreign-owned banks may induce these banks to tighten lending in Norway. The systemic risk buffer rate for Norwegian loans will be raised from 3.0 percent to 4.5 percent from end-2020. At the same time, the Ministry of Finance will introduce a temporary minimum requirement for an average risk weight for Norwegian commercial property loans of 35 percent. The Ministry of Finance expects to request the European Systemic Risk Board (ESRB) to issue a recommendation to other countries' authorities to recognise the Norwegian requirements so that they can also be applied to foreign banks' exposures in Norway.

Norwegian IRB banks that conformed, fully or partly, with the old Basel I rules. The floor was removed from the Norwegian rules at the end of 2019. If the floor limited the effects of the IRB approach in the period 2007-2019, the removal of the floor may contribute to higher lending growth and lower lending margins for Norwegian IRB banks ahead.

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Appendix

1. Differences in lending rates

To explore whether the IRB approach has led to lower lending rates, we estimate the model:

$$Rate_{b,f,t} = \alpha_b + \alpha_{f,t} + \sum_{\tau=t} \delta_\tau + \sum_{\tau=t} \beta_\tau(\delta_\tau \cdot IRB_b) + \epsilon_{b,f,t},$$

where $Rate_{b,f,t}$ is the imputed rate on all loans from bank b to firm f in the year t. IRB is a dummy taking the value 1 if the bank becomes an IRB bank in the course of the analysis period and zero otherwise. α_b is a bank fixed effect that captures variability in rates across banks owing to factors that are constant over time. $\alpha_{f,t}$ is a constant firm-year fixedeffect that is intended to capture variability in rates that are explained by time-varying firm-specific shocks, such as an increase in credit demand. δ_τ captures time fixed effects, ie rate variability that is the same across all loans. The sequence of estimated β_τ thereby capture the difference in interest rate for a firm that borrows from both an IRB bank and a standardised approach bank at time τ. $\epsilon_{b,f,t}$ are standard errors and are clustered at bank level.

2. Differences in dispersion of rates

To explore whether the IRB approach has led to a wider dispersion of banks' lending rates, we estimate the model:

$$v_{b,t} = \alpha + \beta_1 IRB_b + \beta_2 Post_t + \beta_3 Post_t \cdot IRB_b + \epsilon_{b,t}$$

, where $v_{b,t}$ is a measure of the dispersion of bank b's lending rates at time t, IRB is an indicator of whether bank b is an IRB bank and $Post_t$ is a dummy that takes the value 1 as from 2007, and zero otherwise. $\epsilon_{b,t}$ are standard errors and are clustered at bank level.

3. Differences in customer characteristics

To explore whether the IRB approach has led to customer selection, we estimate the model:

$$IRB_{l(b,f),t} = \alpha_b + \alpha_f + \beta_1 X_{f,t} + \beta_2 Post_t + \beta_3 X_{f,t} \cdot Post_t + \epsilon_{b,f,t}$$

, where $IRB_{l(b,f),t}$ is an indicator of whether loan l between firm f and bank b is an IRB loan (a loan obtained from an IRB bank), α_b is a bank fixed effect and α_f is a firm fixed effect. $X_{f,t}$ is firm characteristics and $Post_t$ is a dummy that takes the value 1 as from 2007 and zero otherwise. β_1 captures whether firm characteristics are significantly different for IRB loans, and β_3 captures whether this has changed since the transition to the IRB approach.