DISCUSSION PAPER SERIES

No. 9494

THE MANIPULATION OF BASEL RISK-WEIGHTS

Mike Mariathasan and Ouarda Merrouche

FINANCIAL ECONOMICS

Centre for Economic Policy Research

www.cepr.org

Available online at: **www.cepr.org/pubs/dps/DP9494.asp**

ISSN 0265-8003

THE MANIPULATION OF BASEL RISK-WEIGHTS

Mike Mariathasan, University of Oxford
Ouarda Merrouche, The Graduate Institute, Geneva, and CEPR

Discussion Paper No. 9494
May 2013

Centre for Economic Policy Research
77 Bastwick Street, London EC1V 3PZ, UK
Tel: (44 20) 7183 8801, Fax: (44 20) 7183 8820
Email: cepr@cepr.org, Website: www.cepr.org

CEPR Discussion Paper No. 9494

May 2013

ABSTRACT

The Manipulation of Basel Risk-Weights*

In this paper, we examine the relationship between banks' approval for the internal ratings-based (IRB) approaches of Basel II and the ratio of risk-weighted over total assets. Analysing a panel of 115 banks from 21 OECD countries that were eventually approved for applying the IRB to their credit portfolio, we find that risk-weight density is lower once regulatory approval is granted. The effect persists when we control for different loan categories, and we provide evidence showing that it cannot be explained by flawed modelling, or improved risk-measurement alone. Consistent with theories of risk-weight manipulation, we find the decline in risk-weights to be particularly prevalent among weakly capitalised banks, when the legal framework for supervision is weak, and in countries where supervisors are overseeing many IRB banks. We conclude that part of the decline in reported riskiness under the IRB results from banks' strategic risk-modelling.

JEL Classification: G20, G21 and G28
Keywords: Basel II, capital regulation and internal ratings-based approach

Mike Mariathasan
University of Oxford
Department of Economics
Manor Road Building
Manor Road
OX1 3UQ

Email:
mike.mariathasan@economics.ox.ac.uk

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=171527

Ouarda Merrouche
The Graduate Institute of International and Development Studies
Rue de Lausanne 132
P.O. Box 136
Geneva 21
SWITZERLAND

Email: ouarda.merrouche@eui.eu

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=157536

*We are grateful for feedback and helpful comments from Christoph Basten, Christoph Bertsch, Elena Carletti, Ralph De Haas, Thomas Gehrig, Tullio Jappelli, Nicos Koussis, Christian Laux, Gyöngyi Lóránth, Steven Ongena, Marco Pagano, Pascal Paul, Tim Schmidt-Eisenlohr, Joel Shapiro, Philip Strahan, Johannes Stroebel, Anjan Thakor, an anonymous referee and seminar participants at the Central Bank of Cyprus, University of Oxford, Skema Business School Sophia Antipolis, EBRD London, CSEF Naples, Saïd Business School, Banque de France, University of Vienna, the Graduate Institute Geneva, and the Marie Curie ITN Conference on Financial Risk Management & Risk Reporting in Konstanz. An earlier version of this paper was circulated under the title “The Manipulation of Basel Risk Weights. Evidence from 2007-10.” and published as University of Oxford Working Paper Nr. 621.

Submitted 13 May 2013

1 Introduction

We analyse a cross-sectional panel of 115 banks from 21 OECD countries to better understand the relationship between the regulatory move from Basel I to Basel II and changes in the ratio of risk-weighted over total assets.[1] Using annual balance sheet information from Bankscope for the period 2004 to 2010, we examine the role of the internal ratings-based approach (IRB), in particular, and investigate whether its impact can be explained by fundamental changes in banks' portfolios, or whether it is driven by differences in credit risk-modelling instead. We also test whether there is empirical support for the view that banks use changes in credit risk-modelling strategically, to improve their capital adequacy ratio (CAR; the ratio of regulatory capital over risk-weighted assets).[2] We find that reported riskiness declines upon IRB approval, and that the effect is particularly prevalent among weakly capitalised banks. The latter result, in particular, is consistent with theoretical work suggesting that the IRB introduces an opportunity for banks to under-report the riskiness of their portfolio, and that low levels of capital strengthen the incentives to exploit this opportunity (because they increase banks' put option value of limited liability ex ante, while simultaneously decreasing the regulatory ability to sanction ex post; Blum, 2008). We derive additional support for the hypothesis of a systematic bias in IRB risk-weights from observing that the decline in risk-weights is muted when supervisory scrutiny is high, and from showing that reported riskiness increased prior to bank failure, only if banks had not adopted the IRB; if they had adopted the IRB, we find no increase, and if banks were also weakly capitalised,

[1] Throughout the paper we will refer to the ratio of risk-weighted over total assets, either as reported riskiness (because banks effectively self-report risk-weights under the IRB), as risk-weight density (as in Le Lesle and Avramova, 2012), or as average risk-weights.

[2] The Economist (2012), among many others, provides narrative evidence of strategic risk-modelling, and refers to the capital adequacy ratio (CAR) under the IRB as *Do-It-Yourself (DIY) capital*.

reported riskiness actually declined prior to failure. In addition, our evidence shows that the quality of internal models is not systematically lower among weakly capitalised banks, and that weakly capitalised banks increase dividend payments relatively more upon IRB approval. These supplementary findings suggest that the internal models of weakly capitalised banks are not accidently biased, and that more fragile banks behave less prudently in general.

Bank capital has long been at the center of microprudential bank regulation and constitutes the core of the global regulatory standards commonly known as the Basel standards. It owes its prominence to a consensus among researchers and policymakers that higher levels of bank capital are associated with improved bank stability, but also to the duality of the purpose it serves: *ex post*, equity acts as a buffer against adverse conditions, protecting banks from defaulting on their payment obligations, while *ex ante* it serves to discipline shareholders and managers by having them participate in the banks' losses (Perotti et al., 2011). Despite this general consensus, however, much disagreement about the details of efficient regulation persists in practice. Opinions differ, in particular, with respect to the correct level of required capital and the valuation of banks' portfolios. While too little capital may lead to excessive risk-taking and instability, requiring banks to hold too much capital may induce them to curtail lending and to impose costs on the real economy.[3] That the multiplicity of opinions about efficient capital regulation is shared even by the Basel Committee on Banking Supervision (BCBS), is reflected in the evolution of its global standards: when the

[3]The view that high capital levels are costly is not undisputed: Admati et al. (2011) and Admati and Hellwig (2013), for example, have argued that higher equity levels would not impair banks' activities because they would also reduce borrowing costs. In the presence of deposit insurance and taxation-related advantages for debt over equity, however, the monitoring incentives for depositors and the effect of equity on borrowing costs remain unclear. We interpret banks' lobbying for lower capital requirements as evidence in support of an existing cost advantage of debt over equity, and conduct our analysis under the premise that banks, on average, prefer high leverage ratios.

first Basel accords (Basel I) were adopted in 1988, it defined five risk-weight categories for the banks' assets and required a CAR of 8% in order for a bank to be classified as "sufficiently capitalised."[4] Under the second Basel accords (Basel II, published in 2004), instead, the BCBS extended the number of risk-weight categories, and, more importantly, changed the rules for assigning them to different assets. What mattered for calculating risk-weights was no longer only the counterparty, but either the asset's external credit rating (under the standardised approach, SA), or the banks' internal risk models (under the Foundational Internal Ratings-Based approach, F-IRB, or the Advanced Internal Ratings-Based approach, A-IRB). An important reason for moving from Basel I to Basel II was to reduce margins for regulatory arbitrage and to improve efficiency by linking capital charges more directly to banks' risk-taking. Regulators also invoked the hope that the process leading up to Basel II would improve banks' credit risk-modelling and the communication between banks and the supervisory agencies (see Tarullo, 2008). In practice, however, Basel II raised the level of complexity[5] and implemented a hybrid regime in which banks are permitted to calculate parameters such as a loan's probability of default (PD), its exposure at default (EAD), or its loss given default (LGD) with internal models, while the actual capital charges are calculated by using these values as inputs into a (potentially different) model decided by the BCBS. The new regulatory framework also failed to account for correlations

[4]The "Basel accords" are an international set of rules for banking regulation, proposed by the supranational BCBS at the Bank of International Settlements (BIS) in Basel. The four initial risk weight categories were 0% (e.g. for cash), 20% (e.g. for assets involving banks located in OECD countries), 50% (e.g. for loans secured by mortgages secured by residential property) and 100% (e.g. for personal consumer loans). In addition, there was also an option for a charge of 10% that the national supervisor could assign to claims on domestic public sector entities. The percentages correspond to the weights that the corresponding assets were assigned in the calculation of the banks' RWAs, implying that higher risk-weights (i.e. riskier assets) correspond to higher capital requirements. The 8% requirement refers to the CAR that was required from banks. For more detail, see the homepage of the BCBS: http://www.bis.org/bcbs/index.htm.

[5]Haldane (2011) speaks of about 200,000 effective risk categories under the Basel II regime.

(e.g. between mortgage assets and derivatives) and relied on short time series; it neglected endogeneities, and lead some commentators to conclude that risk calibrations under the Basel II regime caused excessive indebtedness and maturity transformation, in particular among those banks that are operating under the IRB (Hellwig, 2010). These shortcomings "were beginning to become apparent to the members of the BCBS well before the start of the global financial crisis" (Larson, 2011, p. 23), but it was, of course, the crisis itself that eventually provided incontestable evidence of their inefficacy. Since then, the task for regulators and researchers alike has been to analyse precisely why and how capital regulation failed, and to devise new rules for the global financial system. Whilst the former have effectively opted for augmenting the existing framework with "more of the same - and better" (Haldane, 2011, p. 2) under the Basel III accords (released in September 2010), the latter have only just begun to study the role of bank capital and risk-weights in the run-up to and during the events of 2007-10. In this paper, we contribute to these efforts by bringing new evidence to bear and by highlighting some of the obfuscating forces that were introduced via the IRB.

2 Related literature

A number of recent reports and academic papers suggests that the risk-sensitivity of Basel II risk-weights is limited. First, BCBS (2009) reports that some banks may succeed in appearing strongly capitalised according to their regulatory capital, while *de facto* holding only low levels of high quality capital (e.g. of tangible common equity). BCBS (2013), instead, finds that heterogeneity across banks' modelling choices is an important determinant of risk-weights for market risk. Similarly, the Financial Services Authority (2010) finds a wide range of implied capital requirements when it

asks different banks to assess a common portfolio based on their internal models. In addition to variations across banks, Samuels et al. (2012) report within bank variations of up to 20% (year on year) for risk-weighted assets (RWAs) of the same credit risk bucket. Finally, EBA (2013) analyzes a cross sectional sample of large banks and finds that risk-weights are driven by both, fundamental and non-fundamental factors. We confirm these results in our panel and provide evidence suggesting that strategic risk-modelling (as discussed, for example, in The Economist, 2012) could be one of the non-fundamental components. Le Lesle and Avramova (2012) provide further evidence of heterogeneity with respect to the calculation of risk-weights, both across and within regulatory regimes. They discuss the possible driving forces behind this variation - the banks' business models, the quality of their portfolios but also institutional, accounting and regulatory parameters - and document decreasing risk-weights over time; specifically among European banks who were allowed more flexibility than most of the banks under US regulation. While they repeatedly refer to the possibility that "[b]anks may 'game' the system by underestimating risks to optimize their capital beyond what prudence requires" (p. 7) their small sample size (55 banks) does not allow them to investigate the issue further. Using a larger sample and focusing on the effect of IRB approval, we are able to provide evidence showing that banks did indeed make strategic use of methodological changes. Providing additional support for the hypothesis of limited risk-sensitivity of risk-weights, Vallascas and Hagendorff (2013) test whether market measures of portfolio risk can explain movements in RWAs and conclude that this is not the case; their point estimate of the overall effect of IRB adoption, instead, is very similar to our findings.

More generally, our work is also related to the literature showing that banks exploit regulatory ambiguities. Acharya et al. (2012), for instance, find evidence that guaran-

tees were structured so as to reduce regulatory capital requirements. Like us, they find these tendencies to be stronger for banks with lower levels of capital. Black and Strahan (2002) also provide evidence consistent with our results, when they identify more risky investment behaviour among more weakly capitalised banks. On the other hand, Huizinga and Laeven (2012) offer insights into the (ab)use of discretionary accounting practices when they show that banks tend to overvalue real estate-related assets such as mortgage-backed securities. Their results differ from ours in that they suggest that even unweighted leverage ratios may offer "a distorted view of the financial health of the banks" (Huizinga and Laeven (2012), p. 614).

Finally, there are also a couple of theoretical papers that can assist our empirical efforts: Calem and Rob (1999) explain the emergence of a U-shaped relationship between capital and risk-taking as the consequence of a trade-off between the option value of deposit insurance, and the expected return on risky investment. Similarly to Furlong and Keeley (1989), or Keeley and Furlong (1990), they show that weakly capitalised banks have strong incentives to invest in risky assets. Because riskier assets imply higher capital charges, one may suspect that these banks also have stronger incentives to use internal models strategically. Blum (2008), on the other hand, proposes a simple model of banks' incentives under the IRB, and addresses the issue of manipulation explicitly. We use his model to structure our analysis, and are able to verify its empirical predictions. We confirm, more specifically, that more supervisory scrutiny reduces risk-weight manipulation and that reported portfolio risk is lower, when banks are weakly capitalised.

3 Setup

3.1 Sample

We analyse a sample of 115 banks from 21 OECD countries, which were approved for adopting the F-IRB or the A-IRB approach during 2007-10 (see Figure 1). We collected IRB approval dates from the banks' annual and Pillar 3 reports, or directly from the supervisory agencies, and combined the information with annual and consolidated balance sheet data from Bureau van Dijk's Bankscope database. Most banks in our sample were approved for using the IRB approach for credit risk (not for market or operational risk), and their loan portfolios account for 77% of the balance sheet on average. We consider balance sheet information for the years 2004 to 2010, but because banks do not report all relevant variables during every single year, our effective sample size ranges from 148 to 597 observations.

3.2 Model

Throughout the paper, we estimate fixed effects models and report standard errors clustered at the country level. The model selection relies on Monte Carlo studies, identifying it as the recommended option for small cross-sectional samples with a short time dimension (Petersen, 2009; Clark and Linzer, 2013), but our results are robust to estimating random effects models, and to not clustering the standard errors.

In the benchmark case, the dependent variable is the ratio of risk-weighted over total assets, $\left(\frac{RWA}{TA}\right)_{i,t}$. As control variables, $X_{i,t}$, we typically include bank and year fixed effects, as well as the natural logarithm of the banks' balance sheet, as a measure of bank size, and GDP growth to account for changing economic conditions in the banks' home countries. Other control variables that we include in different combinations

capture additional bank and country characteristics (see Table 1 for summary statistics and Table 2 for correlations); we discuss these variables along with the corresponding regressions in the subsequent sections. The main explanatory variable in the benchmark setup is the IRB approval dummy, $1_{i,t}^{IRB}$; it is equal to one from the year of a banks' IRB approval onwards, and zero otherwise.

Denoting the error term by $u_{i,t}$, our benchmark model is then given by equation (1).

$$\left(\frac{RWA}{TA}\right)_{i,t} = \alpha + \beta \cdot 1_{i,t}^{IRB} + \zeta' X_{i,t} + u_{i,t} \tag{1}$$

To understand how different bank and country characteristics affect the role of IRB adoption, we also include interaction variables, $I_{i,t}$, capturing, for example, the level of banks' capitalisation, measures of a country's supervisory strength, or characteristics of the IRB approval. In these cases, the model becomes:

$$\left(\frac{RWA}{TA}\right)_{i,t} = \alpha + \beta \cdot 1_{i,t}^{IRB} + \gamma' I_{i,t} + \delta' \left(1_{i,t}^{IRB} \cdot I_{i,t}\right) + \zeta' X_{i,t} + u_{i,t} \tag{2}$$

In cases where the interaction variable is not time-varying, the fixed effects pick up the independent effect on the dependent variable, so that we have $\gamma = 0$ in equation (2). In addition, we also estimate our models with variations of the dependent variable. This is done not only for robustness, but also to analyse how indicators of the banks' actual behaviour compare to their reported risk-taking under the IRB. Variations of the left hand side variables include, for example, a measure of what the European Banking Authority (EBA) calls the global charge,[6] the ratios of impaired loans over total assets (to asses the quality of banks' credit risk models), dividends over total assets, and the

[6]The ratio of risk-weighted assets plus expected losses over total assets. The reason for considering the global charge, is that internal models are also used to calculate banks' expected losses. As we do not observe expected losses explicitly, however, we use loan loss provisions as an approximate measure.

growth rate of gross loans. Furthermore, we also consider the effect of IRB adoption on actual capitalisation, to test whether internal models command lower levels of equity, as well as the reported riskiness of banks that failed during 2007-10, to contrast reported with ex post risk.

As an additional robustness check, we also estimate our model at the country level, defining the dependent variable as the average difference in the ratio of risk-weighted over total assets, between banks that adopted one of the two IRB approaches after 2007 and banks that remained under the SA (Delta; see Figure 2). The IRB adoption variable, in this setup, is a dummy variable equal to one from the year the law set as deadline for the first approval of the IRB approach. Instead of bank fixed effects, we include country fixed effects. The advantage of this alternative specification is that it allows us to better control for country specific factors that may affect banks' risk-taking behaviour (e.g. institutions).

4 IRB approval and reported riskiness

4.1 Benchmark

Table 3 provides the results of our benchmark specification. In columns (1), and (3) to (5), the dependent variable is the ratio of risk-weighted over total assets. In column (2), instead, it is equal to our measure of the global charge. In columns (6) and (7), we move to the aforementioned country-level specification, using Delta as the dependent variable.

Column (1) corresponds to the model in equation (1). We control for gross loans, to capture changes in the asset structure, and for bank size, as a central bank characteris-

tic.[7] We also control for GDP growth and for year fixed effects, to capture movements in risk-weights over the business cycle. The estimates show that banks' reported riskiness decreases by 0.029 upon adoption of the IRB. For the average bank in our sample, this is equivalent to an increase in the CAR of 64 basis points.[8] Considering that much of the regulatory debate around Basel III concerned changing the capital requirement by about two percentage points, this is economically sizeable. The significant negative effect, as well as the size of the coefficient is robust to looking at the global charge (column 2), and to controlling for the cost of debt (i.e. the opportunity cost of equity) and the government's ability to bail banks out (the ratio of public debt over GDP, column 3).[9] Additional confidence in our setup, can also be derived from the observation that the size of the coefficient on IRB adoption is of the same magnitude as the effect reported in Vallascas and Hagendorff (2013).

In column (4), we interact IRB adoption with a dummy variable that is equal to one for every bank that was approved for the A-IRB. While the F-IRB provides banks with the option to calculate the PD for a given loan, using their internal credit risk models, the A-IRB extends this option to the calculation of maturities, the LGD, and the EAD.[10] If the use of internal models allows banks to under-report the riskiness of

[7] Gross loans are a fairly rough measure of changes in the asset structure. We will thus also control for changes in the structure of the loan portfolio later on. Since this implies a significantly reduced sample size, however, we chose to only control for gross loans in the benchmark setup.

[8] The capital adequacy ratio is defined as the ratio of capital over risk-weighted assets. IRB adoption changes reported riskiness from a sample average of 0.515 (see Table 1) to 0.486; multiplied by the average balance sheet size of our sample (US$ $4.52 \cdot 10^8$), this corresponds to a change in risk-weighted assets from US$ 232.780.000 to US$ 219.536.400. With average regulatory capital equal to US$ $2.46 \cdot 10^7$, we therefore arrive at a change in the CAR from 10.57% (without IRB approval) to 11.21% (with IRB approval).

[9] In Mariathasan and Merrouche (2012), we show that the level of public debt over GDP is an important determinant of banks' bailout probabilities. We have also included banks' non-interest income and measures of bank profitability in unreported regressions and found the effect to be robust.

[10] Depending on the discretion of the national regulator, maturities can in some cases also be calculated under the F-IRB.

their portfolio, one may suspect that under-reporting is stronger when the approval is more permissive, i.e. when banks are approved for the A-IRB. In contrast to this intuition, however, the results in column (4) suggest that approval for the A-IRB does not change the effect on reported riskiness relative to approval for the F-IRB. While this could indicate that the crucial effect derives from the banks' option to calculate the PD, and that other parameters are not as relevant, it should also be noted that only relatively small fractions of the portfolios in our sample are approved for applying the A-IRB. In column (5), we therefore also interact IRB adoption with a dummy variable for low IRB coverage, that is equal to one for every bank that has less than 80% of its portfolio approved for either of the IRB approaches. Intuition suggests that the drop in reported riskiness should be stronger if the IRB is applied to a larger fraction of the portfolio; interacting IRB adoption with the degree of coverage, however, turns out to be insignificant (although the coefficient on IRB adoption is larger than in previous specifications). While this would suggest that the degree of coverage is not of primary relevance, relatively little variation in coverage means that the result should not be overemphasized. Despite these shortcomings, columns (4) and (5) serve as additional robustness checks for the negative relationship between IRB adoption and average risk-weights. Columns (6) and (7), finally, report results for the aforementioned country-level specification. They show that the significantly negative link between IRB adoption and reported riskiness persists, also when we control for country fixed effects.

The result that IRB adoption is associated with lower average risk-weights is not necessarily surprising. Much of the banks' lobbying prior to Basel II was, in fact, aimed at reducing capital charges, and the BCBS itself has proclaimed that lower capital requirements were amongst the goals of the IRB.[11] What remains to be identified,

[11]Note however, that according to some of the first consultative papers preparing the Basel II

however, are the mechanisms by which the IRB enables lower average risk-weights. We distinguish between four alternatives:

1. Portfolio re-allocation. If the IRB assigns low risk-weights to certain groups of assets (e.g. highly rated government bonds), it provides incentives for banks to shift resources from assets with high capital charges to assets that require less equity funding. For a given balance sheet size, such re-allocation would imply lower risk-weighted assets, and thus lower reported riskiness.

2. Improved risk-measurement. Because risk categories under Basel I were coarse, it is conceivable that the corresponding capital charges were too demanding, and that more precise risk-measurement could reduce them. Considering, for example, that consumer loans were previously assigned a risk-weight of 100%, the lower risk-weight density under the IRB may result from the fact that internal models identify some consumer loans as safer than others.

3. Faulty risk-modelling. The crisis of 2007-10 has revealed that many financial models were flawed in their assumptions, particularly regarding risk. If the banks' internal models rely on these flawed assumptions as well, they simply underestimate credit risk systematically. In this case, the assigned capital charges would also be lower than under Basel I.

4. Risk-weight manipulation. The internal models that the banks use are sophisticated and complex, and therefore very difficult to supervise. In addition, there is also often too little data to conduct meaningful tests of the models' assumptions. In particular when they are used to assess novel products. It follows, that much

framework, capital charges would have increased. For more detail on the regulatory process, and the influence of the banking lobby, see Tarullo (2008), or Gehrig (forthcoming).

of the risk-weight calculation is left to the discretion of the banker. Under the assumption that equity is costly, this introduces incentives to use this discretion in the bank's favour, i.e. to choose modelling assumptions strategically and to calculate regulatory capital requirements down. In this case, the observation that reported riskiness declined upon IRB adoption would be the result of the banks' efforts to minimize capital charges for a given credit risk.

Although all of the four channels could potentially account for the observed reduction in reported riskiness, their respective policy implications are very different. The re-allocation of resources towards safer assets and better risk-measurement, for instance, are desirable and worth promoting. Faulty risk-modelling, instead, is undesirable but largely escapes the influence of the policymaker (except, maybe, via public investment in financial research). Risk-weight manipulation, however, is not only undesirable, but also falls within the supervisor's core responsibilities. If regulatory capital charges do indeed depend on banks' profit considerations, this raises important doubts about the ability of the Basel standards to curtail excessive risk-taking, and thus to promote financial stability. Our aim, in the remainder of the paper, is therefore to distinguish between the different channels, and more specifically to determine whether the data supports the manipulation-hypothesis. Because we cannot observe or measure banks' motives directly, our strategy is to rely on indirect inference, and to test the empirical implications of the four different channels. To this end, we will focus on the following predictions:

1. If the decline in risk-weights can be explained by a re-allocation of resources towards safer loans, the effect should disappear when we substitute aggregate lending for disaggregated loan categories in our benchmark model.

2. If capital charges were too high under Basel I, the IRB should allow banks to reduce equity *without becoming significantly more fragile*.

3. If lower reported riskiness results from using internal models that systematically underestimate credit risk, we should observe banks that use these models to underestimate their loan applicants' credit risk more frequently as well. This should result in a higher fraction of impaired loans.

4. If the decline in average risk-weights is the result of strategic modelling, we should expect it to be muted in environments where supervisory scrutiny is high. According to Blum (2008), we should also expect to observe more manipulation when the put option value of limited liability is higher, i.e. when banks are more weakly capitalised.

The evidence we present in the subsequent sections shows that the reduction in average risk-weights is likely to be driven by more than one of these channels; we also show, however, that the only explanation that is consistently supported by the evidence, is the one of intentional misreporting.

4.2 Loan categories and bank capitalisation

In this section, we address the first potential explanation for the decline in average risk-weights: namely, that banks re-allocated their resources towards safer loans. The benchmark results in Table 3 are conditional on controlling for changes in gross loans, i.e. for the flow of resources into and out of the loan portfolio, but they do not account for variation across different loan categories within the portfolio. To capture this variation as well, we substitute gross loans for measures of corporate loans, residential loans, and liquid assets in Table 4. Ideally we would like to control for even more asset and

loan categories, but because only very few banks report disaggregated lending data in Bankscope, including the aforementioned three already reduces our sample to 148 bank-year observations. Column (1) of Table 4 is based on a version of the model in equation (1), where we have added the three available asset categories as additional controls. We find, that the coefficient on IRB adoption becomes statistically insignificant, which would be consistent with the hypothesis that resource re-allocation can explain the decline in reported riskiness. Given that none of the loan categories turns out to be significant either, and keeping the small sample size in mind, however, it seems advisable not to overemphasize this observation. In fact, if we eliminate the time fixed effects from the regression, the coefficient on IRB adoption re-emerges as significant, even if disaggregated loan categories are accounted for (column 2); this is consistent with the explanation that there is too little variation in IRB adoption within the severely reduced sample.

Because it has been suggested that incentives to under-report portfolio risk are particularly strong among weakly capitalised banks, we proceed to test whether the capitalisation of banks affects the coefficient on IRB adoption in columns (3) to (7). In columns (3) to (5) the sample is split using two interaction variables: a dummy variable equal to one if the ratio of Tier 1 capital over total assets is below the sample mean plus one standard deviation (Low capital 75), and a dummy variable that is equal to one if the Tier 1 capital ratio is above that threshold (High capital 75). In columns (6) and (7), instead, we include only the dummy variable for low capitalisation; given that the variable is time-varying, we also add the dummy itself as an additional control. In columns (3) to (5) the coefficient on IRB* Low capital (75) captures the link between IRB approval and reported riskiness for weakly capitalised banks, while the same coefficient captures the effect *relative to better capitalised banks* in columns (6) and (7).

Across the different specifications, we find that strongly and weakly capitalised banks respond differently to being approved for the IRB, and more specifically that weakly capitalised banks report significantly lower riskiness - even controlling for disaggregate loan categories. The result is robust to controlling for the cost of debt and the fiscal position of the government.

Since the observation that weakly capitalised banks reduce their reported riskiness in response to being approved for the IRB (relative to better capitalised banks, or even in absolute terms), is consistent with the available theory on risk-weight manipulation, we explore the robustness of this result further in Table 5. To make use of the larger sample size, we return to the specification without individual loan categories and explore robustness with respect to the level of Tier 1 capital that we require to classify a bank as strongly capitalised (by defining high and low capitalisation relative to the sample mean); we also add a control variable capturing a country specific effect of the financial crisis (Country*Crisis FE). Across specifications, the result that weakly capitalised banks reduce reported riskiness relative to better capitalised banks (and, in fact, in absolute terms) holds. We also interact the capitalisation dummy with the A-IRB and the coverage dummy that we used in our benchmark specification, and find their insignificance confirmed. The only exception is the result in column (8), where it appears to be the case that weakly capitalised banks with a low coverage ratio report higher riskiness than weakly capitalised banks on average; the coefficient is significant at the 10% level and its positive sign is consistent with the intuition that higher coverage should amplify the effect of IRB adoption.

We conclude that the statistically and economically significant negative relationship between IRB approval and reported riskiness persists in the subsample of weakly capitalised banks - just as the theory on risk-weight manipulation would suggest - and that

it is robust to controlling for disaggregate loan categories.

4.3 Ex post riskiness

If the decline in average risk-weights cannot (entirely) be explained by a shift towards safer assets, three alternative explanations remain. In this section, we focus on the possibility that capital charges under Basel I were too high, and that the IRB allowed banks to correct this excessive charge. If this was the case, we should observe two things. Firstly, that those banks that report lower riskiness increase leverage upon being approved for the IRB, and secondly, that reducing capital does not significantly impair bank stability.

To see whether these predictions are consistent with the evidence, we repeat our benchmark regressions in Table 6, using the ratio of common equity over total assets and the ratio of total regulatory capital (Tier 1 and Tier 2) over total assets as dependent variables.[12] The first observation to make, is that for the average bank in our sample, capital levels seem not to have responded to IRB adoption (column 1). If we split the sample according to the banks' capitalisation, however, we find that capital levels have actually increased for well capitalised banks, while they have decreased for weakly capitalised banks. This is consistent with the idea of a more refined risk-assessment under Basel II. For instance, if the internal models determine that credit risk is higher (lower) than implied by Basel I, banks should be expected to increase (decrease) capital accordingly. In particular for those banks that reduced capital, however, it is important to establish whether reported riskiness corresponds to actual risk, or - if not - whether

[12]Since the Low capital dummy variable is defined based on the ratio of Tier 1 capital over total assets, we do not consider this ratio as a dependent variable. The correlation of Low capital with CE is -0.5832, with the ratio of total regulatory capital over total assets it is -0.6232, and with the ratio of Tier 1 capital over total assets it is -0.7428.

the bias is intentional or the result of an honest mistake.

We postpone the latter question to the subsequent section and focus the link between actual (ex post) risk and self-reported riskiness under the IRB for now. Motivated by Figure 3, we interact IRB adoption with dummy variables that are equal to one if the bank was resolved during 2007-10, but the resolution had not yet taken place (Pre resolution), or if the bank was resolved during 2007-10, and the resolution had already taken place (Post resolution). Banks are defined as resolved if they were either publicly recapitalised, forced into a merger, nationalised or bankrupt.[13] As before, we also distinguish between strongly and weakly capitalised banks. The corresponding results in Table 7 show, that reported riskiness increases prior to a bank's failure (as one would expect for a bank so fragile that it had to be resolved later on), but also that the effect is muted for resolved banks that had already adopted the IRB, and that it is, in fact, inverted for weakly capitalised banks that had adopted the IRB. In other words, and consistent with Figures 3 and 4, we find that reported riskiness did not increase for banks that were resolved and had adopted the IRB, whereas it actually decreased for weakly capitalised banks that were resolved and had adopted the IRB. This suggests that reported riskiness does not necessarily reflect actual riskiness, and that capital was actually reduced by too much from an ex post perspective. One may therefore conjecture that weaker banks intentionally misreported risk in order to disguise their fragility vis-à-vis its supervisor and other market participants. This conjecture points us to the final two explanations for the decline in average reported riskiness, and to the question of whether the insufficient capitalisation can be attributed to honest modelling mistakes, or to misconduct along the lines suggested in Blum (2008) or The Economist

[13]The resolution variable is based on data we have collected and reported in Mariathasan and Merrouche (2012).

(2012).

4.4 Modelling mistake vs. strategic modelling

Distinguishing between the two remaining explanations for the decline in reported riskiness requires us to determine whether the banks' models were flawed, i.e. unknowingly reliant on wrong assumptions, or whether they were designed deliberately, to reduce capital charges. To separate one explanation from the other, we first account for different measures of supervisory scrutiny: if banks use their options for modelling credit risk opportunistically indeed, we should expect closer supervision to curtail this behaviour, i.e. to imply a more muted response to IRB adoption. If the decline in average risk-weights results from flawed modelling assumptions, instead, it is unlikely that the effect of IRB adoption is affected by the degree of supervision.[14] In a second step, we also provide more general evidence on the behaviour of weakly capitalised banks, and show that their internal models appear to outperform the models of the better capitalised banks.

We use three different measures to account for the degree of supervisory scrutiny: an index for the strength of external audit, the number of supervisors per bank, and the number of IRB banks in the banks' host countries. The first two are variables provided in the World Bank's *Bank Regulation and Supervision Survey*, and we construct two separate variables from our sample to generate the third: the cumulative sum of the number of banks that were approved for the IRB in a given country (Cum. sum of IRB banks; time-varying) and the maximum number of IRB banks in a given country (Nr. of

[14] One could imagine that enhanced supervision improves a bank's internal model, e.g. because it involves additional testing. Since internal models are typically bank specific, however, this would require assuming that the (external) supervisor has skills or information regarding the bank's risk-taking that are superior to the skills and the information available to the bank. In our opinion, this is unlikely to be the case.

IRB banks; constant). The intuition for the latter variables results from conversations with regulators and relies on the assumption that supervisors are challenged more if the banking sector they are regulating is characterised by a larger number of complex institutions (that have more, and more complex external linkages and dependencies). The strength of external audit-index, instead, relies on the answers to the following questions: 1) Is an external audit required?; 2) Are auditors licensed or certified?; 3) Do supervisors receive a copy of the auditor's report?; 4) Can supervisors meet with auditors without prior approval by the bank?; 5) Are auditors legally required to report bank misconduct to supervisors?; 6) Can supervisors take legal action against external auditors?; 7) Are specific requirements for the extent or nature of the audit spelled out? Variation across countries is largest for the last three questions, i.e. precisely for those questions that address the legal responsibility of the external auditor, and the nature of the actual auditing exercise. The corresponding results in Table 8 are based on our benchmark specification; to account for the fact that our sample spans the financial crisis, and to capture the possibility that different countries were affected differently by the global events, we add an interaction variable between a country specific dummy and a variable for the financial crisis that is equal to one from 2008 onwards. All estimates are consistent with the hypothesis that banks under-report credit risk intentionally, and that stronger supervision reduces their incentives, or their ability, to do so: stronger external audit mutes the decline in reported riskiness, and reported riskiness is particularly low if the supervisor is responsible for a large number of IRB banks, independent of the measure we use. In Table 9, we also look at the effect of supervisory scrutiny at the country level, using Delta as the alternative dependent variable, IRB Law as the country-level variable for IRB adoption, and controlling for country fixed effects. The results are identical: the effect on Delta is less pronounced

when external audit is more thorough, whereas it is more pronounced in countries with a larger number of IRB banks.

Alternatively, one can also approach the task of distinguishing between flawed models and intentionally miscalculated risk from a different angle, and test whether those banks that report lower credit risk also make lower quality loans. If this were the case, it would be consistent with the view that these banks rely on models that underestimate credit risk systematically. We test the corresponding hypothesis by examining the effect on impaired loans, in columns (1), (2), and (7) of Table 10. Distinguishing between weakly and strongly capitalised banks, allows us to shows that impaired loans are higher among well-capitalised banks that receive IRB approval, while they do not seem to respond in the case of weakly capitalised banks; if anything, it seems to be the case that impaired loans decrease upon IRB approval in the subsample of weakly capitalised banks (column 7). This suggests that the models of weakly capitalised banks are actually more successful at identifying credit risk than the models of better capitalised banks; this is in contrast to the hypothesis that the decline in reported riskiness is due to modelling mistakes and provides additional evidence in support of the manipulation-hypothesis.

There is, however, also an alternative interpretation of the evidence in Table 10, suggesting that weakly capitalised banks are simply less likely to classify a weakly performing loan as an impaired loan (see Huizinga and Laeven, 2012 for evidence consistent with this interpretation). In this case, our findings would not be conclusive about the quality of the models these banks use; they would, however, be indicative of a more general, behavioural, point: namely that weakly capitalised banks are more likely to behave fraudulently, and thus to engage in regulatory arbitrage. Columns (3) to (6), and (8) of Table 10, where we exchange the dependent variable for the growth rate of

gross loans and the ratio of dividend payments over total assets, explore this hypothesis further. Across models, we find that better capitalised banks behave more prudently after receiving IRB approval (they make fewer new loans and lower dividend payments), while weakly capitalised institutions appear to move in the opposite direction: they reduce their lending by less and they actually increase dividend payments relative to their balance sheet size. To the extent that we can infer behavioural information from these results, they also confirm the hypothesis that weakly capitalised banks would be more likely to engage in regulatory arbitrage.

Given that we do not observe the motivation for banks' choices directly, we rely on indirect inference to distinguish between modelling mistakes and strategic misreporting of credit risk. We find that closer supervision mutes the negative relationship between IRB adoption and reported riskiness, and that banks that report lower risk-weights do not systematically underestimate credit risk. In addition, our results are also consistent with the existing empirical literature in that they identify weakly capitalised banks as more opportunistic. While our evidence does not allow us to eliminate any of the four potential explanations completely, the hypothesis of strategic risk-modelling is the only one that can explain all of our results. We therefore conclude that the evidence supports Blum's hypothesis of risk-weight manipulation under Basel II's IRB, and that the banks' profit maximizing motive is likely to be among the non-fundamental determinants of risk-weights identified in EBA (2013).

4.5 Robustness

Our empirical strategy requires us to comment on a number of potential concerns. The most important one is endogeneity, and more specifically, the question of whether (and

how) it matters that we study only banks that adopt the IRB eventually, as well as the potential simultaneity of the IRB approval variable. Put differently, we need to discuss whether banks that are more likely to be approved for the IRB are also banks for which the IRB is more (or less) likely to have an effect on risk-weight density, and whether the ratio of risk-weighted over total assets could potentially affect IRB approval.

We address the first concern, using the two-step estimation procedure proposed in Heckman (1976); that is, we first estimate a selection model for a sample of banks that also includes non-IRB adopters. This allows us to calculate probabilities of IRB adoption, and thereby the inverse Mills ratio. In a second step, we then re-estimate our previous regressions including the inverse Mills ratio as an additional regressor. The corresponding robustness results for our main findings are presented in columns (1) to (6) of Table 11. Given that the point estimates are now slightly smaller than before, one may suspect that there is some selection bias in our benchmark estimates, but given that the difference in coefficients is not significant, and considering that the Mills ratio is only significant in the regression on common equity, we conclude that our findings are not importantly affected by sample selection bias. In columns (7) and (8) we also address the issue of simultaneity by instrumenting our IRB approval variable by IRB adoption at the country level (IRB Law) and the interaction between IRB Law and a large bank dummy (equal to one if a bank's balance sheet size exceeds US$ 50 billion). The idea is that, while a single bank's risk-weight density may be relevant for its own IRB approval, it is less likely to determine its host country's first IRB approval. The fact that the point estimates are slightly larger than before might suggest that a higher risk-weight density makes IRB approval more likely indeed, and that there is some simultaneity bias in our benchmark estimates; given that the differences between the coefficients are statistically insignificant, however, we can conclude that simultaneity bias is unlikely

to affect our results importantly. In other words, our findings appear to be robust to sample selection and simultaneity bias, both qualitatively and quantitatively.

5 Conclusion

We have shown that, weakly capitalised banks in particular, report lower average risk-weights when they are approved for either of Basel II's IRB approaches. We have also shown that the decline in risk-weights is inconsistent with the banks' ex post riskiness, unlikely to be explained by systematically flawed models of credit risk, and present even when we control for disaggregated loan categories. We have supplemented our findings with results showing that weakly capitalised banks are more likely to engage in regulatory arbitrage, and we have found the decline in reported riskiness to be muted when regulatory supervision is more thorough. Our evidence therefore supports narratives arguing that the IRB enables banks to under-report regulatory risk-weights, and the theory of risk-weight manipulation provided in Blum (2008).

In addition, our analysis also offers several lessons for banking regulators: first, it emphasises the value of simple and transparent rules. While a more complex risk-assignment may be more efficient in theory, practical issues with the implementation must also be taken into consideration. Second, our findings regarding the role of external auditing suggests, that a simple way of improving the traction of the IRB may be to emphasise the legal responsibility of the auditors; if they are legally required to report misconduct to the regulatory agency, for example, this seems to decrease the degree of misreporting significantly. Third, our evidence suggests that, while aiming to correct a valid concern, the IRB's scaling factor in the formula for risk-weights could be improved, for example by making it dependent on the banks' leverage ratios. Finally, our analysis

suggests that the simple leverage constraint, imposed under Basel III, has been a step in the right direction, as it limits the degree of misconduct that banks are able to engage in. We also conclude, however, that more research into the consequences of a systematic bias in Basel risk-weights is advisable, and that the IRB approach may need a more fundamental revision in the future.

References

Acharya, Viral V., Philipp Schnabl, and Gustavo Suarez, "Securitization without risk transfer," *CEPR Discussion Paper*, January 2012, (8769).

Admati, Anat and Martin Hellwig, *The Bankers' New Clothes: What's Wrong With Banking and What to Do about it?*, Princeton University Press, 2013.

_ **, Peter DeMarzo, Martin Hellwig, and Paul Pfleiderer**, "Fallacies, irrelevant facts and myths in the discussion on capital regulation: Why bank equity is not expensive," *Stanford Graduate School of Business Working Paper*, 2011, (2065).

BCBS, "Consultative proposals to strengthen the resilience of the banking sector announced by the Basel Committee," December 2009.

_ , "Regulatory consistency assessment programme (RCAP) - Analysis of risk-weighted assets for market risk," *Bank for International Settlements*, 2013.

Black, Sandra E. and Philip E. Strahan, "Entrepreneurship and Bank Credit Availability," *Journal of Finance*, 2002, *57* (6), 2807–2833.

Blum, Juerg M., "Why Basel II may need a leverage ratio restriction," *Journal of Banking and Finance*, 2008, *32* (8), 1699–1707.

Calem, Paul and Rafael Rob, "The Impact of Capital-Based Regulation on Bank Risk-Taking," *Journal of Financial Intermediation*, 1999, *8* (4), 317–352.

Clark, Tom S. and Drew A. Linzer, "Should I Use Fixed or Random Effects?," *mimeo*, 2013.

EBA, "Interim results of the EBA review of the consistency of risk-weighted assets. Top-down assessment of the banking book," *European Banking Authority*, 2013.

Financial Services Authority, "Results of 2009 Hypothetical Portfolio Exercise for Sovereigns, Banks and Large Corporations," March 2010.

Furlong, Frederick T. and Michael C. Keeley, "Capital regulation and bank risk-taking: A note," *Journal of Banking and Finance*, 1989, *13* (6), 883–891.

Gehrig, Thomas P., "Capital, Trust and Competitiveness in the Banking Sector," *Revue d'Economie Financiere*, forthcoming.

Haldane, Andrew G., "Capital Discipline," January 2011. Speech given at the American Economic Association, Denver.

Heckman, James J., "The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models," *Annals of Economic and Social Measurement*, 1976, *5* (4), 475–492.

Hellwig, Martin, "Capital Regulation after the Crisis: Business as Usual?," *Preprints of the Max Planck Institute for Research on Collective Goods*, 2010, *31.*

Huizinga, Harry and Luc Laeven, "Bank valuation and accounting discretion during a financial crisis," *Journal of FInancial Economics*, 2012, *106* (3), 614–634.

Keeley, Michael C. and Frederick T. Furlong, "A reexamination of mean-variance analysis of bank capital regulation," *Journal of Banking and Finance*, 1990, *14* (1), 69–84.

Larson, Joe, "What Are the Basel Captial Accords?," April 2011.

Le Lesle, Vanessa and Sofiya Avramova, "Revisiting Risk-Weighted Assets. Why Do RWAs Differ Across Countries and What Can Be Done About It?," *IMF Working Paper*, 2012, *90*.

Mariathasan, Mike and Ouarda Merrouche, "Recapitalisation, Credit and Liquidity," *Economic Policy*, 2012, *27* (72), 603–646.

Perotti, Enrico, Lev Ratnovski, and Razvan Vlahu, "Capital Regulation and Tail Risk," *International Journal of Central Banking*, 2011, *7* (4), 123–163.

Petersen, Mitchell A., "Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches," *Review of Financial Studies*, 2009, *22* (1), 435–480.

Samuels, Simon, Mike Harrison, and Nimish Rajkotia, "The Dog that dug. (Yet) more digging into RWAs ...," *Barclays Equity Research*, 2012.

Tarullo, Daniel K., *Banking on Basel. The Future of International Financial Regulation.*, Peterson Institute for International Economics, 2008.

The Economist, "DIY capital. An edifice of modern banking regulation comes under scrutiny.," *The Economist*, December 2012.

Vallascas, Francesco and Jens Hagendorff, "The Risk Sensitivity of Capital Requirements: Evidence from an International Sample of Large Banks," *Review of Finance*, 2013.

Table 1: **Descriptive statistics**

The sample covers annual observations for 115 IRB banks and 21 OECD countries over the period 2004-10. Delta is the average difference in the ratio of risk-weighted over total assets, between banks that adopt the IRB from 2007 and banks that remain under the standard approach (see Figure 2); Cum. sum of IRB banks is the cumulative sum of IRB banks in a given country (time varying), Nr. of IRB banks is the maximum number of IRB banks in a given country (time invariant). The strength of external audit index adds one for an affirmative answer to each of the following questions: 1) Is an external audit required?; 2) Are auditors licensed or certified?; 3) Do supervisors receive a copy of the auditor's report?; 4) Can supervisors meet with auditors without prior approval by the bank?; 5) Are auditors legally required to report bank misconduct to supervisors?; 6) Can supervisors take legal action against external auditors?; 7) Are specific requirements for the extent or nature of the audit spelled out?

	(1)	(2)	(3)	(4)	(5)
	N	Mean	s.d.	Min	Max
Bank level variables					
RWA/TA	597	0.515	0.176	0.024	0.965
(RWA+EL)/TA	597	0.519	0.177	0.025	0.966
Gross loans/TA	597	0.563	0.178	0.020	0.993
Corporate loans/TA	249	0.241	0.147	0.002	0.671
Liquid assets/TA	597	0.191	0.138	0.012	0.649
Residential loans/TA	204	0.229	0.144	0.008	0.602
Ln (TA)	597	18.963	1.573	13.224	21.843
Country level variables					
Delta	118	-0.065	0.168	-0.474	0.338
Cum. sum of IRB banks	603	4.146	4.624	0	15
Nr. of IRB banks	603	7.556	4.304	0	15
Strength of external audit	498	5.845	0.799	5	7
Nr. of supervisors per bank	480	3.230	3.009	0.300	11.500
GDP growth	597	1.068	3.059	-8.354	7.02
Short-term rate	597	2.396	1.846	0.029	6.973
Public debt/GDP	582	0.661	0.496	0.049	1.835

Table 2: **Correlation matrix for selected control variables.**

	(1)	(2)	(3)	(4)	(5)
(1) Strength of external audit	1.000				
(2) Nr. of supervisors per bank	-0.265	1.000			
(3) GDP growth	-0.091	0.002	1.000		
(4) Public debt/GDP	-0.034	-0.239	-0.250	1.000	
(5) Short-term rate	0.036	0.204	0.247	-0.356	1.000

Table 3: **Benchmark**

The sample covers 115 banks from 21 OECD countries over the period 2004-10. All banks adopted the IRB between 2007 and 2010. The dependent variable is the ratio of risk-weighted over total assets, or the global charge (the ratio of risk-weighted assets plus expected losses, proxied by loan loss provisions, over total assets). In columns (6) and (7), the dependent variable is equal to Delta, i.e. the average difference in the ratio of risk-weighted over total assets, between banks that adopt the IRB from 2007 and banks that remain under the standard approach (see Figure 2). In columns (1) to (5), IRB is a dummy variable that is equal to one from the year a bank implements the IRB approach (after receiving approval from the regulator) and zero otherwise; in columns (6) and (7), IRB is the a dummy equal to one from the year the law sets as deadline for the first approval of the IRB approach by the regulator (also IRB Law in Table 9). AIRB is a dummy variable equal to one if the bank was approved for the advanced IRB approach on some or all of its assets (typically only for a small fraction of assets). Low coverage is equal to one if the IRB approach is applied to less than 80% of the assets in the portfolio (the sample average is 77%). Standard errors are clustered at the country level; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	RWA/TA	(RWA+EL)/TA	RWA/TA	RWA/TA	RWA/TA	Delta	Delta
IRB	-0.029**	-0.030**	-0.031**	-0.028**	-0.038**		
	(0.013)	(0.013)	(0.014)	(0.013)	(0.018)		
IRB Law						-0.077**	-0.090**
						(0.035)	(0.039)
AIRB				-0.005			
				(0.016)			
IRB*Low coverage					0.026		
					(0.020)		
Gross loans/TA	0.501***	0.515***	0.490***	0.500***	0.506***		
	(0.118)	(0.125)	(0.118)	(0.119)	(0.120)		
Ln(TA)	-0.056	-0.058*	-0.054	-0.057	-0.060		
	(0.034)	(0.033)	(0.034)	(0.034)	(0.036)		
GDP growth	-0.000	-0.001	0.001	0.000	0.000	-0.002	-0.002
	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Short-term rate			-0.000				0.240
			(0.005)				(0.147)
Public debt/GDP			-0.026				0.010**
			(0.093)				(0.005)
Constant	1.322*	1.348**	1.295*	1.325*	1.379*	-0.021	-0.176**
	(0.659)	(0.644)	(0.639)	(0.665)	(0.693)	(0.021)	(0.082)
Bank FE	✓	✓	✓	✓	✓	-	-
Country FE	-	-	-	-	-	✓	✓
Year FE	✓	✓	✓	✓	✓	-	-
Observations	597	597	582	597	597	118	117
R-squared	0.403	0.381	0.372	0.403	0.410	0.166	0.192

Table 4: **Loan categories**

The sample covers 115 banks from 21 OECD countries over the period 2004-10. All banks adopted the IRB between 2007 and 2010. The dependent variable is the ratio of risk-weighted over total assets, or the global charge (the ratio of risk-weighted assets plus expected losses, proxied by loan loss provisions, over total assets). IRB is a dummy variable that is equal to one from the year a bank implements the IRB approach (after receiving approval from the regulator) and zero otherwise. High capital (75) is a dummy variable equal to one if the ratio of Tier 1 capital to total assets of a bank is above the sample mean plus one standard deviation, Low capital (75) is a dummy variable equal to one if the Tier 1 leverage ratio of Tier 1 capital to total assets of a bank is below the sample mean plus one standard deviation. Standard errors are clustered at the country level; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	RWA/TA	RWA/TA	RWA/TA	RWA/TA	(RWA+EL)/TA	RWA/TA	RWA/TA
IRB	0.004	-0.048**				0.030	0.045**
	(0.024)	(0.020)				(0.019)	(0.019)
Low capital (75)						-0.029**	-0.020
						(0.011)	(0.012)
IRB*High capital (75)			0.043*	0.056**	0.058***		
			(0.021)	(0.019)	(0.019)		
IRB*Low capital (75)			-0.036	-0.024	-0.027	-0.057**	-0.065**
			(0.037)	(0.034)	(0.034)	(0.023)	(0.024)
Corporate loans/TA	-0.046	0.047	-0.005	0.045	-0.021	-0.071	-0.006
	(0.196)	(0.276)	(0.112)	(0.087)	(0.097)	(0.130)	(0.106)
Liquid assets/TA	-0.283	-0.144	-0.208	-0.210	-0.215	-0.235	-0.227
	(0.220)	(0.226)	(0.150)	(0.144)	(0.143)	(0.143)	(0.143)
Residential loans/TA	0.022	0.095	0.101	0.121	0.120	0.091	0.112
	(0.173)	(0.163)	(0.176)	(0.183)	(0.184)	(0.181)	(0.185)
Ln(TA)	-0.000	-0.011	-0.002	-0.005	-0.009	0.003	-0.001
	(0.042)	(0.033)	(0.034)	(0.029)	(0.030)	(0.032)	(0.029)
GDP growth	-0.000	0.001	-0.003	-0.005*	-0.006*	-0.004	-0.006*
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)
Short-term rate				-0.019*	-0.020*		-0.016*
				(0.009)	(0.010)		(0.009)
Public debt/GDP				-0.060	-0.042		-0.051
				(0.044)	(0.049)		(0.047)
Constant	0.609	0.759	0.633	0.730	0.816	0.566	0.669
	(0.803)	(0.641)	(0.639)	(0.552)	(0.559)	(0.605)	(0.531)
Bank FE	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	-	✓	✓	✓	✓	✓
Observations	148	148	148	148	148	148	148
R-squared	0.388	0.187	0.476	0.510	0.480	0.493	0.517

Table 5: **Bank capitalisation**

The sample covers 115 banks from 21 OECD countries over the period 2004-10. All banks adopted the IRB between 2007 and 2010. The dependent variable is the ratio of risk-weighted over total assets, or the global charge (the ratio of risk-weighted assets plus expected losses, proxied by loan loss provisions, over total assets). IRB is a dummy variable that is equal to one from the year a bank implements the IRB approach (after receiving approval from the regulator) and zero otherwise. High capital (75) is a dummy variable equal to one if the ratio of Tier 1 capital to total assets of a bank is above the sample mean plus one standard deviation, Low capital (75) is a dummy variable equal to one if the Tier 1 leverage ratio of Tier 1 capital to total assets of a bank is below the sample mean plus one standard deviation. High capital (50) is a dummy variable equal to one if the ratio of Tier 1 capital to total assets of a bank is above the sample mean, Low capital (50) is a dummy variable equal to one if the Tier 1 leverage ratio of Tier 1 capital to total assets of a bank is below the sample mean. AIRB is a dummy variable equal to one if the bank was approved for the advanced IRB approach on some or all of its assets (typically only for a small fraction of assets). Low coverage is equal to one if the IRB approach is applied to less than 80% of the assets in the portfolio (the sample average is 77%). Crisis is a dummy variable that takes value one from 2008 onwards. Standard errors are clustered at the country level; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1) RWA/TA	(2) RWA/TA	(3) RWA/TA	(4) (RWA+EL)/TA	(5) (RWA+EL)/TA	(6) RWA/TA	(7) RWA/TA	(8) RWA/TA
IRB*High capital (75)	0.004	-0.002	-0.001	0.006	0.000		0.021	-0.006
	(0.022)	(0.030)	(0.031)	(0.022)	(0.031)		(0.029)	(0.027)
IRB*Low capital (75)	-0.042***	-0.032*	-0.033*	-0.045***	-0.034*		-0.046***	-0.053***
	(0.012)	(0.018)	(0.018)	(0.012)	(0.018)		(0.010)	(0.015)
IRB*High capital (50)						-0.029		
						(0.017)		
IRB*Low capital (50)						-0.029**		
						(0.011)		
AIRB*High capital (75)							-0.035	
							(0.038)	
AIRB*Low capital (75)							0.011	
							(0.011)	
IRB*High capital (75)*Low coverage								0.035
								(0.029)
IRB*Low capital (75)*Low coverage								0.029*
								(0.016)
Gross loans/TA	0.505***	0.494***	0.491***	0.515***	0.509***	0.501***	0.497***	0.511***
	(0.104)	(0.112)	(0.115)	(0.111)	(0.120)	(0.118)	(0.104)	(0.106)
Ln(TA)	-0.063*	-0.060	-0.060	-0.064*	-0.062	-0.056	-0.064*	-0.067*
	(0.033)	(0.039)	(0.040)	(0.032)	(0.039)	(0.033)	(0.033)	(0.035)
GDP growth	0.001	0.002	0.003	0.001	0.003	-0.000	0.000	0.001
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Short-term rate			0.003	-0.001	0.003			
			(0.005)	(0.005)	(0.005)			
Public debt/GDP			0.014	-0.034	0.041			
			(0.062)	(0.094)	(0.076)			
Constant	1.441**	1.383*	1.372*	1.475**	1.381*	1.321*	1.466**	1.512**
	(0.641)	(0.761)	(0.764)	(0.590)	(0.749)	(0.646)	(0.637)	(0.668)
Bank FE	✓	✓	✓	✓	✓	✓	✓	✓
Country*Crisis FE	-	✓	✓	-	✓	-	-	-
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Observations	597	597	582	582	582	597	597	597
R-squared	0.433	0.514	0.486	0.384	0.473	0.403	0.441	0.443

Table 6: **Effect on capital**

The sample covers 115 banks from 21 OECD countries over the period 2004-10. All banks adopted the IRB between 2007 and 2010. The dependent variable is the ratio of common equity over total assets, or the ratio of total regulatory capital (Tier 1 plus Tier 2) over total assets. IRB is a dummy variable that is equal to one from the year a bank implements the IRB approach (after receiving approval from the regulator) and zero otherwise. High capital (75) is a dummy variable equal to one if the ratio of Tier 1 capital to total assets of a bank is above the sample mean plus one standard deviation, Low capital (75) is a dummy variable equal to one if the Tier 1 leverage ratio of Tier 1 capital to total assets of a bank is below the sample mean plus one standard deviation. High capital (50) is a dummy variable equal to one if the ratio of Tier 1 capital to total assets of a bank is above the sample mean, Low capital (50) is a dummy variable equal to one if the Tier 1 leverage ratio of Tier 1 capital to total assets of a bank is below the sample mean. Standard errors are clustered at the country level; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1) CE/TA	(2) CE/TA	(3) CE/TA	(4) CE/TA	(5) CE/TA	(6) (T1+T2)/TA	(7) (T1+T2)/TA
IRB	-0.001						
	(0.001)						
IRB*High capital (75)		0.006***	0.006***			0.005**	0.003
		(0.001)	(0.002)			(0.002)	(0.003)
IRB*Low capital (75)		-0.004**	-0.002**			-0.005**	-0.004**
		(0.001)	(0.001)			(0.002)	(0.002)
IRB*High capital (50)				0.002*	0.003***		
				(0.001)	(0.001)		
IRB*Low capital (50)				-0.004***	-0.003*		
				(0.001)	(0.001)		
Ln(TA)	-0.013***	-0.014***	-0.012***	-0.014***	-0.013***	-0.019***	-0.018***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)
GDP growth	0.001**	0.001***	0.000*	0.001**	0.000	0.001***	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.277***	0.304***	0.275***	0.296***	0.282***	0.412***	0.392***
	(0.072)	(0.066)	(0.061)	(0.061)	(0.050)	(0.088)	(0.075)
Bank FE	✓	✓	✓	✓	✓	✓	✓
Country*Crisis FE	-	-	✓	-	✓	-	✓
Year FE	✓	✓	✓	✓	✓	✓	✓
Observations	597	597	597	597	597	597	597
R-squared	0.273	0.369	0.443	0.326	0.426	0.276	0.442

Table 7: **Resolved banks**

The sample covers 115 banks from 21 OECD countries over the period 2004-10. All banks adopted the IRB between 2007 and 2010. The dependent variable is the ratio of risk-weighted over total assets, or the global charge (the ratio of risk-weighted assets plus expected losses, proxied by loan loss provisions, over total assets). IRB is a dummy variable that is equal to one from the year a bank implements the IRB approach (after receiving approval from the regulator) and zero otherwise. High capital (75) is a dummy variable equal to one if the ratio of Tier 1 capital to total assets of a bank is above the sample mean plus one standard deviation, Low capital (75) is a dummy variable equal to one if the Tier 1 leverage ratio of Tier 1 capital to total assets of a bank is below the sample mean plus one standard deviation. Post resolution is a dummy variable that is equal to one after a bank was either recapitalised, forced into a merger, nationalised or bankrupt and zero otherwise; Pre resolution is a dummy variable that is equal to one prior to resolution. Crisis is a dummy variable that takes value one from 2008 onwards. Standard errors are clustered at the country level; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1) RWA/TA	(2) RWA/TA	(3) RWA/TA	(4) (RWA+EL)/TA	(5) (RWA+EL)/TA	(6) (RWA+EL)/TA
IRB	-0.044	-0.050		-0.045	-0.049	
	(0.049)	(0.041)		(0.050)	(0.041)	
Pre resolution	0.157**	0.159***	0.187***	0.189***	0.181***	0.220***
	(0.055)	(0.039)	(0.053)	(0.056)	(0.041)	(0.053)
Post resolution	0.073	0.009	0.066	0.074	0.009	0.067
	(0.049)	(0.030)	(0.049)	(0.048)	(0.030)	(0.049)
IRB*Pre resolution	-0.105	-0.149**		-0.134	-0.172***	
	(0.092)	(0.050)		(0.094)	(0.051)	
IRB*Post resolution	-0.039	0.002		-0.039	0.002	
	(0.056)	(0.032)		(0.056)	(0.032)	
IRB*High capital (75)			0.075			0.077
			(0.058)			(0.058)
IRB*Low capital (75)			-0.059			-0.061
			(0.050)			(0.050)
IRB*High capital (75)*Pre resolution			-0.055			-0.085
			(0.058)			(0.059)
IRB*High capital (75)*Post resolution			-0.004			-0.005
			(0.070)			(0.071)
IRB*Low capital (75)*Pre resolution			-0.222***			-0.254***
			(0.053)			(0.053)
IRB*Low capital (75)*Post resolution			-0.063			-0.063
			(0.069)			(0.069)
Gross loans/TA	0.455***	0.437***	0.463***	0.462***	0.448***	0.470***
	(0.072)	(0.119)	(0.063)	(0.073)	(0.121)	(0.064)
Ln(TA)	-0.013	-0.001	-0.006	-0.013	-0.001	-0.006
	(0.011)	(0.013)	(0.011)	(0.011)	(0.013)	(0.011)
GDP growth	-0.002	0.003	-0.000	-0.003	0.002	-0.001
	(0.009)	(0.003)	(0.008)	(0.009)	(0.003)	(0.008)
Short-term rate	-0.018	-0.001	-0.018	-0.019	-0.002	-0.019
	(0.020)	(0.005)	(0.019)	(0.020)	(0.005)	(0.018)
Public debt/GDP	-0.035	0.048	-0.038	-0.037	0.072	-0.041
	(0.059)	(0.096)	(0.051)	(0.059)	(0.109)	(0.051)
Constant	0.636***	0.338	0.506**	0.632**	0.318	0.498**
	(0.209)	(0.275)	(0.211)	(0.210)	(0.282)	(0.213)
Bank FE	✓	✓	✓	✓	✓	✓
Country*Crisis FE	-	✓	-	-	✓	-
Year FE	✓	✓	✓	✓	✓	✓
Observations	458	458	458	458	458	458
R-squared	0.360	0.674	0.473	0.356	0.673	0.472

Table 8: **Supervisory scrutiny I**

The sample covers 115 banks from 21 OECD countries over the period 2004-10. All banks adopted the IRB between 2007 and 2010. The dependent variable is the ratio of risk-weighted over total assets, or the global charge (the ratio of risk-weighted assets plus expected losses, proxied by loan loss provisions, over total assets). IRB is a dummy variable that is equal to one from the year a bank implements the IRB approach (after receiving approval from the regulator) and zero otherwise. The strength of external audit index adds one for an affirmative answer to each of the following questions: 1) Is an external audit required?; 2) Are auditors licensed or certified?; 3) Do supervisors receive a copy of the auditor's report?; 4) Can supervisors meet with auditors without prior approval by the bank?; 5) Are auditors legally required to report bank misconduct to supervisors?; 6) Can supervisors take legal action against external auditors?; 7) Are specific requirements for the extent or nature of the audit spelled out? Cum. sum of IRB banks is the cumulative sum of IRB banks in a given country (time varying), Nr. of IRB banks is the maximum number of IRB banks in a given country (time invariant). Crisis is a dummy variable that takes value one from 2008 onwards. Standard errors are clustered at the country level; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1) RWA/TA	(2) RWA/TA	(3) RWA/TA	(4) RWA/TA	(5) (RWA+EL)/TA
IRB	-0.215***	-0.218***	0.063***	0.037**	-0.217***
	(0.066)	(0.071)	(0.017)	(0.013)	(0.066)
IRB*Strength of external audit	0.033***	0.034***			0.033***
	(0.011)	(0.011)			(0.011)
IRB*Nr. of supervisors/bank		-0.000	-0.001	-0.002	
		(0.004)	(0.003)	(0.004)	
Cum. sum of IRB banks				0.001	
				(0.003)	
IRB*Cum. sum of IRB banks				-0.008**	
				(0.003)	
IRB*Nr. of IRB banks			-0.009***		
			(0.003)		
Gross loans/TA	0.418***	0.388***	0.478***	0.478***	0.423***
	(0.112)	(0.114)	(0.130)	(0.131)	(0.110)
Ln(TA)	-0.063	-0.098**	-0.094**	-0.097**	-0.064
	(0.046)	(0.044)	(0.041)	(0.041)	(0.045)
GDP growth	0.004	0.003	0.002	0.002	0.003
	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)
Short-term rate	0.003	0.007**	0.003	0.005	0.003
	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)
Public debt/GDP	0.070	0.081	0.044	0.025	0.077
	(0.062)	(0.067)	(0.056)	(0.056)	(0.062)
Constant	1.433	2.118**	2.012**	2.088**	1.450
	(0.874)	(0.808)	(0.767)	(0.791)	(0.852)
Bank FE	✓	✓	✓	✓	✓
Country*Crisis FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
Observations	483	443	465	465	483
R-squared	0.522	0.532	0.545	0.537	0.510

Table 9: **Supervisory scrutiny II**

The sample covers 115 banks from 21 OECD countries over the period 2004-10. All banks adopted the IRB between 2007 and 2010. The dependent variable is Delta, i.e. the average difference in the ratio of risk-weighted over total assets, between banks that adopt the IRB from 2007 and banks that remain under the standard approach (see Figure 2). IRB Law is a dummy variable equal to one from the year the law sets as deadline for the first approval of the IRB approach by the regulator. The strength of external audit index adds one for an affirmative answer to each of the following questions: 1) Is an external audit required?; 2) Are auditors licensed or certified?; 3) Do supervisors receive a copy of the auditor's report?; 4) Can supervisors meet with auditors without prior approval by the bank?; 5) Are auditors legally required to report bank misconduct to supervisors?; 6) Can supervisors take legal action against external auditors?; 7) Are specific requirements for the extent or nature of the audit spelled out? Cum. sum of IRB banks is the cumulative sum of IRB banks in a given country (time varying), Nr. of IRB banks is the maximum number of IRB banks in a given country (time invariant). Standard errors are clustered at the country level; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1) Delta	(2) Delta	(3) Delta	(4) Delta	(5) Delta	(6) Delta	(7) Delta
IRB Law	-0.476*	-0.712**	-0.834***	-0.839***	-0.557*	0.023	0.021
	(0.229)	(0.246)	(0.212)	(0.251)	(0.273)	(0.086)	(0.083)
IRB Law*Strength of external audit	0.060*	0.089**	0.098***	0.096***	0.071*		
	(0.033)	(0.035)	(0.030)	(0.031)	(0.037)		
IRB*Nr. of supervisors/bank		0.009	0.014*	0.012	0.008	0.004	0.004
		(0.009)	(0.008)	(0.010)	(0.010)	(0.008)	(0.008)
Cum. sum of IRB banks							-0.011*
							(0.006)
IRB Law*Cum. sum of IRB banks							-0.005
							(0.006)
IRB Law*Nr. of IRB banks						-0.016	
						(0.011)	
GDP growth	-0.005*	-0.005*	-0.003	-0.004	-0.004	-0.003	-0.003
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
Public debt/GDP	0.342	0.352	-0.044	0.127			
	(0.199)	(0.204)	(0.136)	(0.226)			
Short-term rate	0.018**	0.016**		0.004	0.008	0.015	0.015
	(0.007)	(0.007)		(0.011)	(0.013)	(0.012)	(0.012)
IRB Law*Public debt/GDP			0.115**	0.098			
			(0.049)	(0.059)			
IRB Law*Short-term rate				0.008	-0.003	-0.010	-0.013
				(0.014)	(0.014)	(0.012)	(0.011)
Constant	-0.242*	-0.256*	0.009	-0.097	-0.035	-0.064	-0.058
	(0.115)	(0.121)	(0.065)	(0.130)	(0.061)	(0.051)	(0.049)
Country FE	✓	✓	✓	✓	✓	✓	✓
Observations	94	82	82	82	83	88	88
R-squared	0.299	0.419	0.431	0.452	0.359	0.368	0.385

Table 10: **Suplementary regressions**

The sample covers 115 banks from 21 OECD countries over the period 2004-10. All banks adopted the IRB between 2007 and 2010. The dependent variables are the ratio of impaired loans over total assets (columns 1, 2, and 7), the growth of gross loans (columns 3 and 4), and the ratio of dividend payments over total assets (columns 5, 6, and 8). IRB is a dummy variable that is equal to one from the year a bank implements the IRB approach (after receiving approval from the regulator) and zero otherwise. High capital (75) is a dummy variable equal to one if the ratio of Tier 1 capital to total assets of a bank is above the sample mean plus one standard deviation, Low capital (75) is a dummy variable equal to one if the Tier 1 leverage ratio of Tier 1 capital to total assets of a bank is below the sample mean plus one standard deviation. Crisis is a dummy variable that takes value one from 2008 onwards. Standard errors are clustered at the country level; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Impaired loans/TA	Impaired loans/TA	Growth of gross loans	Growth of gross loans	DIV/TA	DIV/TA	Impaired loans/TA	DIV/TA
IRB							0.834***	-0.003***
							(0.284)	(0.001)
Low capital (75)							0.102	-0.001*
							(0.275)	(0.001)
IRB*High capital (75)	1.036***	0.785**	-9.572***	-6.520**	-0.002**	-0.002**		
	(0.308)	(0.318)	(3.252)	(3.101)	(0.001)	(0.001)		
IRB*Low capital (75)	0.070	0.055	-5.482*	-6.015	-0.000	-0.001	-0.797*	0.002**
	(0.483)	(0.362)	(2.893)	(3.593)	(0.000)	(0.000)	(0.424)	(0.001)
Ln(TA)	-0.462	-0.586	18.070	22.304	-0.002	-0.001	-0.620	-0.000
	(1.182)	(1.023)	(13.024)	(13.637)	(0.001)	(0.001)	(1.058)	(0.001)
GDP growth	-0.350**	-0.106	1.374**	0.395	0.000	-0.000	-0.105	-0.000
	(0.124)	(0.084)	(0.541)	(0.748)	(0.000)	(0.000)	(0.084)	(0.000)
Constant	13.127	14.499	-326.113	-402.085	0.034	0.014	15.056	0.008
	(22.107)	(18.930)	(240.740)	(252.882)	(0.026)	(0.012)	(19.509)	(0.015)
Bank FE	✓	✓	✓	✓	✓	✓	✓	✓
Country*Crisis FE	-	✓	-	✓	-	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Observations	551	551	597	597	467	467	551	467
R-squared	0.386	0.533	0.217	0.263	0.150	0.329	0.533	0.341

Table 11: **Robustness checks**

The sample covers 115 banks from 21 OECD countries over the period 2004-10. All banks adopted the IRB between 2007 and 2010. In columns (1) to (6), we use a two-stage estimation procedure proposed by Heckman (1976). We report only the results from the second stage, but Mills ratio is the inverse Mills ratio from estimating a selection model in the first stage (using a richer sample, with banks that did not adopt the IRB until 2010). In columns (7) and (8), we instrumental variables. The dependent variable is the ratio of risk-weighted over total assets, the ratio of common equity over total assets, or the ratio of impaired loans over total assets. In columns (1) to (6), IRB is a dummy variable that is equal to one from the year a bank implements the IRB approach (after receiving approval from the regulator) and zero otherwise. In columns (7) and (8), it is instrumented as follows. Column (7): IRB instrumented with IRB Law and IRB Law*Large; Column (8): IRB*High capital (75) and IRB*Low capital (75) instrumented with IRB Law, IRB Law*Large and IRB Law*Large*High capital (75). High capital (75) is a dummy variable equal to one if the ratio of Tier 1 capital to total assets of a bank is above the sample mean plus one standard deviation, Low capital (75) is a dummy variable equal to one if the Tier 1 leverage ratio of Tier 1 capital to total assets of a bank is below the sample mean plus one standard deviation. Crisis is a dummy variable that takes value one from 2008 onwards. Standard errors are clustered at the country level; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	RWA/TA	RWA/TA	RWA/TA	RWA/TA	CE/TA	Impaired loans/TA	RWA/TA	RWA/TA
Mills ratio	0.012	-0.000	-0.038	0.047	0.007*	0.729		
	(0.022)	(0.018)	(0.029)	(0.030)	(0.004)	(0.887)		
IRB	-0.028*		-0.226***				-0.070**	
	(0.015)		(0.053)				(0.031)	
IRB*Strength of external audit			0.034***					
			(0.009)					
IRB*High capital (75)		0.004		0.056***	0.007***	1.110***		-0.037
		(0.022)		(0.018)	(0.001)	(0.362)		(0.031)
IRB*Low capital (75)		-0.042***		-0.024	-0.003***	0.185		-0.074**
		(0.013)		(0.035)	(0.001)	(0.509)		(0.030)
Gross loans/TA	0.502***	0.505***	0.424***				0.493***	0.498***
	(0.116)	(0.104)	(0.110)				(0.054)	(0.053)
Corporate loans/TA				0.004				
				(0.097)				
Residential loans/TA				0.092				
				(0.176)				
Liquid assets/TA				-0.230				
				(0.146)				
Ln(TA)	-0.053	-0.063*	-0.075	0.008	-0.012***	-0.266	-0.063***	-0.067***
	(0.036)	(0.035)	(0.047)	(0.038)	(0.004)	(1.306)	(0.019)	(0.018)
GDP growth	0.000	0.001	0.002	-0.001	0.001***	-0.323**	0.001	0.001
	(0.002)	(0.001)	(0.002)	(0.002)	(0.000)	(0.122)	(0.002)	(0.002)
Short-term rate			0.001					
			(0.005)					
Public debt/GDP			0.055					
			(0.065)					
Constant	1.245*	1.444**	1.718*	0.392	0.260***	8.498	1.437***	1.515***
	(0.698)	(0.683)	(0.883)	(0.743)	(0.080)	(25.068)	(0.350)	(0.343)
Bank FE	✓	✓	✓	✓	✓	✓	✓	✓
Country*Crisis FE	-	✓	-	-	-	-	-	-
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Observations	597	597	483	148	597	551	597	597
R-squared	0.403	0.433	0.525	0.488	0.379	0.388	-	-

Figure 1: **IRB adoption**

Number of new sample banks, adopting one of the two IRB approaches over time.

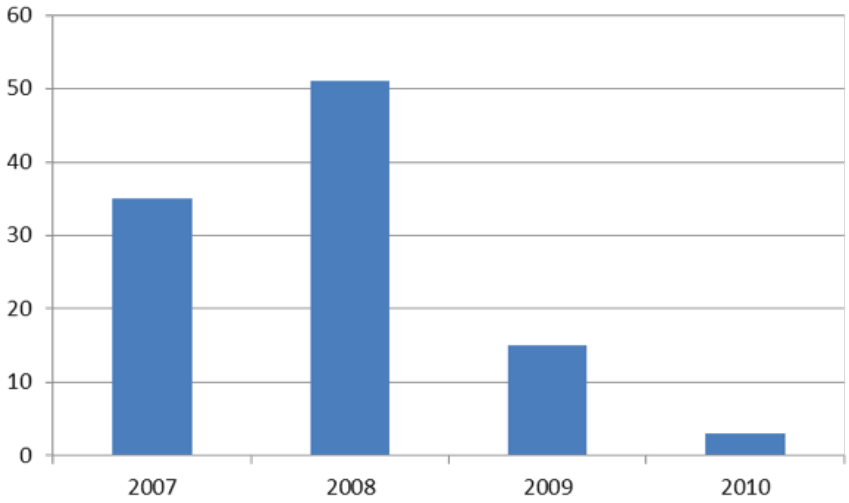

Figure 2: **Delta**

On the vertical axis we have the average difference in the ratio of risk-weighted over total assets, between banks that adopt the IRB from 2007 and banks that remain under the standard approach. The sample covers 21 OECD countries.

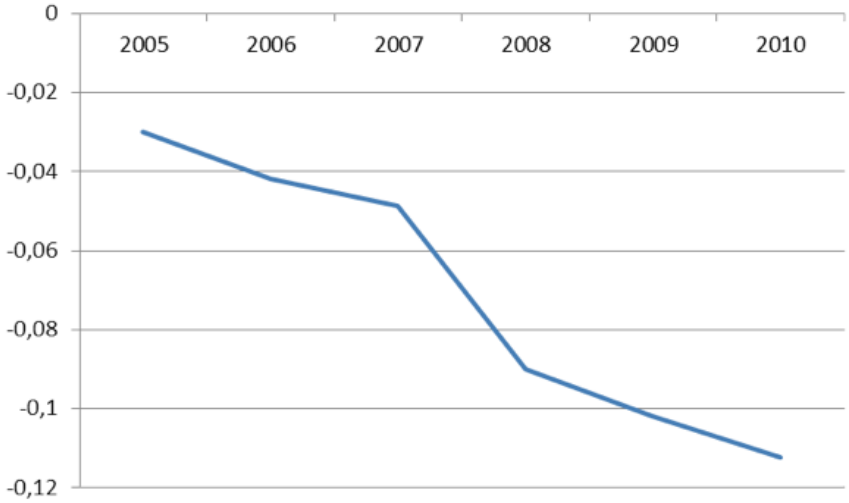

Figure 3: **Resolved**

Reported riskiness around IRB adoption date. Resolved banks were recapitalised, forced into a merger, nationalised or bankrupt during 2007-2010. Source: Bloomberg.

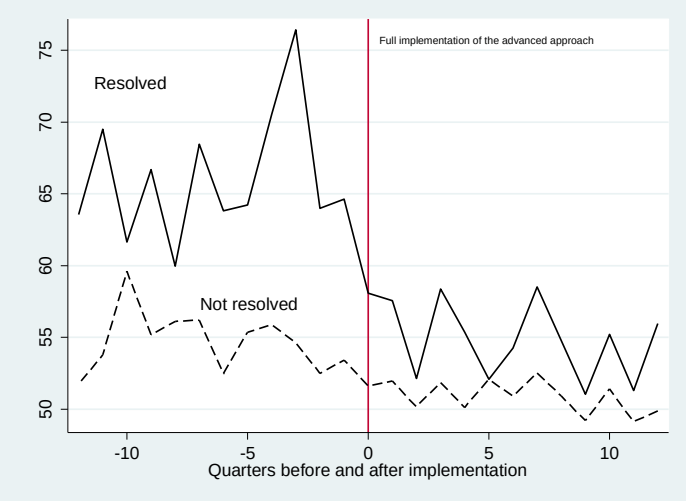

Figure 4: **Quarters to failure**

Ratios of Tier 1 capital over total assets (Tier 1 LR), and over risk-weighted assets (Tier 1 RWR). Resolved banks were recapitalised, forced into a merger, nationalised or bankrupt during 2007-2010. Source: Bloomberg.