

Basel Committee on Banking Supervision

CRE

Calculation of RWA for credit
risk

CRE31

IRB approach: risk weight
functions

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framework.



BANK FOR INTERNATIONAL SETTLEMENTS

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Introduction

31.1 This chapter presents the calculation of risk weighted assets under the internal ratings-based (IRB) approach for: (i) corporate, sovereign and bank exposures; (ii) retail exposures; and (iii) equity exposures. Risk weighted assets (RWA) are designed to address unexpected losses (UL) from exposures. The method of calculating expected losses (EL), and for determining the difference between that measure and provisions, is described [CRE35](#).

Explanation of the risk-weight functions

31.2 Regarding the risk-weight functions for deriving risk weighted assets set out in this chapter:

- (1) Probability of default (PD) and loss-given-default (LGD) are measured as decimals
- (2) Exposure at default (EAD) is measured as currency (eg euros), except where explicitly noted otherwise
- (3) \ln denotes the natural logarithm
- (4) $N(x)$ denotes the cumulative distribution function for a standard normal random variable (ie the probability that a normal random variable with mean zero and variance of one is less than or equal to x). The normal cumulative distribution function is, for example, available in Excel as the function NORMSDIST.
- (5) $G(z)$ denotes the inverse cumulative distribution function for a standard normal random variable (ie the value of x such that $N(x) = z$). The inverse of the normal cumulative distribution function is, for example, available in Excel as the function NORMSINV.

Risk-weighted assets for corporate, sovereign and bank exposures

Risk-weight functions for corporate, sovereign and bank exposures

31.3 The derivation of RWA is dependent on estimates of the PD, LGD, EAD and, in some cases, effective maturity (M), for a given exposure.

31.4 For exposures not in default, the formula for calculating RWA is as follows (illustrative risk weights are shown in [CRE99](#)):

$$\text{Correlation} = R = 0.12 \cdot \frac{(1 - e^{-50 \cdot PD})}{(1 - e^{-50})} + 0.24 \cdot \left(1 - \frac{(1 - e^{-50 \cdot PD})}{(1 - e^{-50})} \right)$$

$$\text{Maturity adjustment} = b = \left[0.11852 - 0.05478 \cdot \ln(PD) \right]^2$$

$$\text{Capital requirement} = K = \left[\text{LGD} \cdot N \left[\frac{G(PD)}{\sqrt{(1-R)}} + \sqrt{\frac{R}{1-R}} \cdot G(0.999) \right] - PD \cdot \text{LGD} \right] \cdot \frac{(1 + (M - 2.5) \cdot b)}{(1 - 1.5 \cdot b)}$$

$$\text{RWA} = K \cdot 12.5 \cdot \text{EAD}$$

- 31.5** If the calculation in [CRE31.4](#) above results in a negative capital charge for any individual sovereign exposure, banks should apply a zero capital charge for that exposure.
- 31.6** Regarding the formula set out in [CRE31.4](#) above, M is the effective maturity, calculated according to [CRE32.39](#) to [CRE32.49](#), and the following terms are used to refer to specific parts of the capital requirements formula:

$$\text{Full maturity adjustment} = \frac{(1 + (M - 2.5) \cdot b)}{(1 - 1.5 \cdot b)}$$

$$\text{Explicit maturity adjustment} = (1 + (M - 2.5) \cdot b)$$

- 31.7** The capital requirement (K) for a defaulted exposure is equal to the greater of zero and the difference between its LGD (described in [CRE36.85](#)) and the bank's best estimate of expected loss (described in [CRE36.88](#)). The risk-weighted asset amount for the defaulted exposure is the product of K, 12.5, and the EAD.
- 31.8** A multiplier of 1.25 is applied to the correlation parameter of all exposures to financial institutions meeting the following criteria:
- (1) Regulated financial institutions whose total assets are greater than or equal to US \$100 billion. The most recent audited financial statement of the parent company and consolidated subsidiaries must be used in order to determine asset size. For the purpose of this paragraph, a regulated financial institution is defined as a parent and its subsidiaries where any substantial legal entity in the consolidated group is supervised by a regulator that imposes prudential requirements consistent with international norms. These include, but are not limited to, prudentially regulated Insurance Companies, Broker /Dealers, Banks, Thrifts and Futures Commission Merchants.

- (2) Unregulated financial institutions, regardless of size. Unregulated financial institutions are, for the purposes of this paragraph, legal entities whose main business includes: the management of financial assets, lending, factoring, leasing, provision of credit enhancements, securitisation, investments, financial custody, central counterparty services, proprietary trading and other financial services activities identified by supervisors.

$$\text{Correlation} = R_{FI} = 1.25 \cdot \left[0.12 \cdot \frac{(1 - e^{-50 \cdot PD})}{(1 - e^{-50})} + 0.24 \cdot \left(1 - \frac{(1 - e^{-50 \cdot PD})}{(1 - e^{-50})} \right) \right]$$

Firm-size adjustment for small or medium-sized entities (SMEs)

31.9 Under the IRB approach for corporate credits, banks will be permitted to separately distinguish exposures to SME borrowers (defined as corporate exposures where the reported sales for the consolidated group of which the firm is a part is less than €50 million) from those to large firms. A firm-size adjustment (ie $0.04 \times (1 - (S - 5) / 45)$) is made to the corporate risk weight formula for exposures to SME borrowers. S is expressed as total annual sales in millions of euros with values of S falling in the range of equal to or less than €50 million or greater than or equal to €5 million. Reported sales of less than €5 million will be treated as if they were equivalent to €5 million for the purposes of the firm-size adjustment for SME borrowers.

$$\text{Correlation} = R = 0.12 \cdot \frac{(1 - e^{-50 \cdot PD})}{(1 - e^{-50})} + 0.24 \cdot \left(1 - \frac{(1 - e^{-50 \cdot PD})}{(1 - e^{-50})} \right) - 0.04 \cdot \left(1 - \frac{(S - 5)}{45} \right)$$

31.10 Subject to national discretion, supervisors may allow banks, as a failsafe, to substitute total assets of the consolidated group for total sales in calculating the SME threshold and the firm-size adjustment. However, total assets should be used only when total sales are not a meaningful indicator of firm size.

Risk weights for specialised lending

31.11 Regarding project finance, object finance, commodities finance and income producing real estate sub-asset classes of specialised lending (SL):

- (1) Banks that meet the requirements for the estimation of PD will be able to use the foundation approach for the corporate asset class to derive risk weights for SL sub-classes. As specified in [CRE33.2](#), banks that do not meet the requirements for the estimation of PD will be required to use the supervisory slotting approach.
- (2) Banks that meet the requirements for the estimation of PD, LGD and EAD (where relevant) will be able to use the advanced approach for the corporate asset class to derive risk weights for SL sub-classes.

31.12 Regarding the high volatility commercial real estate (HVCRE) sub-asset class of SL, banks that meet the requirements for the estimation of PD and whose supervisor has chosen to implement a foundation or advanced approach to HVCRE exposures will use the same formula for the derivation of risk weights that is used for other SL exposures, except that they will apply the following asset correlation formula:

$$\text{Correlation} = R = 0.12 \cdot \frac{(1 - e^{-50 \cdot PD})}{(1 - e^{-50})} + 0.30 \cdot \left(1 - \frac{(1 - e^{-50 \cdot PD})}{(1 - e^{-50})} \right)$$

31.13 Banks that do not meet the requirements for estimation of LGD and EAD for HVCRE exposures must use the supervisory parameters for LGD and EAD for corporate exposures, or use the supervisory slotting approach.

Calculation of risk-weighted assets for exposures subject to the double default framework

31.14 For hedged exposures to be treated within the scope of the double default framework, capital requirements may be calculated according to [CRE31.15](#) to [CRE31.17](#).

31.15 The capital requirement for a hedged exposure subject to the double default treatment (K_{DD}) is calculated by multiplying K_0 as defined below by a multiplier depending on the PD of the protection provider (PD_g):

$$K_{DD} = K_0 \cdot (0.15 + 160 \cdot PD_g)$$

31.16

Regarding the formula in [CRE31.15](#) above, K_o is calculated in the same way as a capital requirement for an unhedged corporate exposure (as defined in [CRE31.3](#) to [CRE31.10](#)), but using different parameters for LGD and the maturity adjustment as follows, where:

- (1) PD_o and PD_g are the probabilities of default of the obligor and guarantor, respectively, both subject to the PD floor set out in [CRE32.3](#).
- (2) The correlation ρ_{os} is calculated according to the formula for correlation (R) in [CRE31.4](#), [CRE31.8](#) or [CRE31.9](#), as applicable, with PD being equal to PD_o .
- (3) LGD_g is the LGD of a comparable direct exposure to the guarantor (ie consistent with [CRE32.20](#)), the LGD associated with an unhedged facility to the guarantor or the unhedged facility to the obligor, depending upon whether in the event both the guarantor and the obligor default during the life of the hedged transaction available evidence and the structure of the guarantee indicate that the amount recovered would depend on the financial condition of the guarantor or obligor, respectively; in estimating either of these LGDs, a bank may recognise collateral posted exclusively against the exposure or credit protection, respectively, in a manner consistent with [CRE32.22](#), [CRE31.11](#), and [CRE36.85](#) to [CRE36.90](#), as applicable. There may be no consideration of double recovery in the LGD estimate.
- (4) The maturity adjustment coefficient b is calculated according to the formula for maturity adjustment (b) in [CRE31.4](#), with PD being the minimum of PD_o and PD_g .
- (5) M is the effective maturity of the credit protection, which may under no circumstances be below the one-year floor if the double default framework is to be applied.

$$K_o = LGD_g \cdot \left[N \left(\frac{G(PD_o) + \sqrt{\rho_{os}} \cdot G(0.999)}{\sqrt{1 - \rho_{os}}} \right) - PD_o \right] \cdot \frac{1 + (M - 2.5) \cdot b}{1 - 1.5 \cdot b}$$

31.17 The risk-weighted asset amount is calculated in the same way as for unhedged exposures, ie:

$$RWA_{DD} = K_{DD} \cdot EAD_g$$

Risk-weighted assets for retail exposures

31.18 There are three separate risk-weight functions for retail exposures, as defined in [CRE31.19](#) to [CRE31.24](#). Risk weights for retail exposures are based on separate assessments of PD and LGD as inputs to the risk-weight functions. None of the three retail risk-weight functions contain the full maturity adjustment component that is present in the risk-weight function for exposures to banks and corporates. Illustrative risk weights are shown in [CRE99](#).

Retail residential mortgage exposures

31.19 For exposures defined in [CRE30.19](#) that are not in default and are secured or partly secured¹ by residential mortgages, risk weights will be assigned based on the following formula:

$$\text{Correlation} = R = 0.15$$

$$\text{Capital requirement} = K = \left[\text{LGD} \cdot N \left[\frac{G(PD)}{\sqrt{(1-R)}} + \sqrt{\frac{R}{1-R}} \cdot G(0.999) \right] - PD \cdot \text{LGD} \right]$$

$$\text{RWA} = K \cdot 12.5 \cdot \text{EAD}$$

Footnotes

¹ This means that risk weights for residential mortgages also apply to the unsecured portion of such residential mortgages.

31.20 The capital requirement (K) for a defaulted exposure is equal to the greater of zero and the difference between its LGD (described in [CRE36.85](#)) and the bank's best estimate of expected loss (described in [CRE36.88](#)). The risk-weighted asset amount for the defaulted exposure is the product of K, 12.5 and the EAD.

Qualifying revolving retail exposures

31.21 For qualifying revolving retail exposures as defined in [CRE30.23](#) that are not in default, risk weights are defined based on the following formula:

$$\text{Correlation} = R = 0.04$$

$$\text{Capital requirement} = K = \left[\text{LGD} \cdot N \left[\frac{G(PD)}{\sqrt{(1-R)}} + \sqrt{\frac{R}{1-R}} \cdot G(0.999) \right] - PD \cdot \text{LGD} \right]$$

$$\text{RWA} = K \cdot 12.5 \cdot \text{EAD}$$

31.22 The capital requirement (K) for a defaulted exposure is equal to the greater of zero and the difference between its LGD (described in [CRE36.85](#)) and the bank's best estimate of expected loss (described in [CRE36.88](#)). The risk-weighted asset amount for the defaulted exposure is the product of K, 12.5, and the EAD.

Other retail exposures

31.23 For all other retail exposures that are not in default, risk weights are assigned based on the following function, which allows correlation to vary with PD:

$$\text{Correlation} = R = 0.03 \cdot \frac{(1 - e^{-35 \cdot PD})}{(1 - e^{-35})} + 0.16 \cdot \left(1 - \frac{(1 - e^{-35 \cdot PD})}{(1 - e^{-35})} \right)$$

$$\text{Capital requirement} = K = \left[\text{LGD} \cdot N \left[\frac{G(PD)}{\sqrt{(1-R)}} + \sqrt{\frac{R}{1-R}} \cdot G(0.999) \right] - PD \cdot \text{LGD} \right]$$

$$\text{RWA} = K \cdot 12.5 \cdot \text{EAD}$$

31.24 The capital requirement (K) for a defaulted exposure is equal to the greater of zero and the difference between its LGD (described in [CRE36.85](#)) and the bank's best estimate of expected loss (described in [CRE36.88](#)). The risk-weighted asset amount for the defaulted exposure is the product of K, 12.5, and the EAD.

Risk-weighted assets for equity exposures

31.25 There are two broad methods for calculating risk-weighted assets for equity exposures not held in the trading book:

- (1) The market-based approach, which is further subdivided into:
 - (a) a simple risk weight method; and
 - (b) an internal models method.

(2) The PD/LGD approach.

31.26 RWA for equity exposures in the trading book are subject to the market risk capital rules.

31.27 Supervisors will decide which approach or approaches will be used by banks, and in what circumstances. Certain equity holdings are excluded as defined in [CRE31.43](#) to [CRE31.45](#) and are subject to the capital charges required under the standardised approach.

31.28 Where supervisors permit both methodologies, banks' choices must be made consistently, and in particular not determined by regulatory arbitrage considerations.

31.29 Investments in significant minority- or majority-owned and –controlled commercial entities below the materiality thresholds in [CRE20.33](#) must be risk-weighted using the approaches in this chapter ([CRE31](#)), with the relevant risk weight subject to a floor of 100%. Investments in excess of the materiality thresholds must be risk-weighted at 1250%.

Market-based approach

31.30 Under the market-based approach, institutions are permitted to calculate the minimum capital requirements for their banking book equity holdings using one or both of two separate and distinct methods: a simple risk weight method or an internal models method. The method used should be consistent with the amount and complexity of the institution's equity holdings and commensurate with the overall size and sophistication of the institution. Supervisors may require the use of either method based on the individual circumstances of an institution.

Market-based approach: simple risk weight method

31.31 Under the simple risk weight method, a 300% risk weight is to be applied to equity holdings that are publicly traded and a 400% risk weight is to be applied to all other equity holdings. A publicly traded holding is defined as any equity security traded on a recognised security exchange.

31.32 Short cash positions and derivative instruments held in the banking book are permitted to offset long positions in the same individual stocks provided that these instruments have been explicitly designated as hedges of specific equity holdings and that they have remaining maturities of at least one year. Other short positions are to be treated as if they are long positions with the relevant risk weight applied to the absolute value of each position. In the context of maturity mismatched positions, the methodology is that for corporate exposures.

Market-based approach: internal models method

31.33 IRB banks may use, or may be required by their supervisor to use, internal risk measurement models to calculate the risk-based capital requirement. Under this alternative, banks must hold capital equal to the potential loss on the institution's equity holdings as derived using internal value-at-risk models subject to the 99th percentile, one-tailed confidence interval of the difference between quarterly returns and an appropriate risk-free rate computed over a long-term sample period. The capital charge would be incorporated into an institution's risk-based capital ratio through the calculation of risk-weighted equivalent assets.

31.34 The risk weight used to convert holdings into risk-weighted equivalent assets would be calculated by multiplying the derived capital charge by 12.5 (ie the inverse of the minimum 8% risk-based capital requirement). Capital charges calculated under the internal models method may be no less than the capital charges that would be calculated under the simple risk weight method using a 200% risk weight for publicly traded equity holdings and a 300% risk weight for all other equity holdings. These minimum capital charges would be calculated separately using the methodology of the simple risk weight approach. Further, these minimum risk weights are to apply at the individual exposure level rather than at the portfolio level.

31.35 A bank may be permitted by its supervisor to employ different market-based approaches to different portfolios based on appropriate considerations and where the bank itself uses different approaches internally.

31.36 Banks are permitted to recognise guarantees but not collateral obtained on an equity position wherein the capital requirement is determined through use of the market-based approach.

PD/LGD approach

31.37 The minimum requirements and methodology for the PD/LGD approach for equity exposures (including equity of companies that are included in the retail asset class) are the same as those for the IRB foundation approach for corporate exposures subject to the following specifications:²

- (1) The bank's estimate of the PD of a corporate entity in which it holds an equity position must satisfy the same requirements as the bank's estimate of the PD of a corporate entity where the bank holds debt.³ If a bank does not hold debt of the company in whose equity it has invested, and does not have sufficient information on the position of that company to be able to use the applicable definition of default in practice but meets the other standards, a 1.5 scaling factor will be applied to the risk weights derived from the corporate risk-weight function, given the PD set by the bank. If, however, the bank's equity holdings are material and it is permitted to use a PD/LGD approach for regulatory purposes but the bank has not yet met the relevant standards, the simple risk-weight method under the market-based approach will apply.
- (2) An LGD of 90% would be assumed in deriving the risk weight for equity exposures.
- (3) For these purposes, the risk weight is subject to a five-year maturity adjustment whether or not the bank is using the explicit approach to maturity elsewhere in its IRB portfolio.

Footnotes

² *There is no advanced approach for equity exposures, given the 90% LGD assumption.*

³ *In practice, if there is both an equity exposure and an IRB credit exposure to the same counterparty, a default on the credit exposure would thus trigger a simultaneous default for regulatory purposes on the equity exposure.*

31.38 Under the PD/LGD approach, minimum risk weights as set out in [CRE31.39](#) and [CRE31.40](#) apply. When the sum of UL and EL associated with the equity exposure results in less capital than would be required from application of one of the minimum risk weights, the minimum risk weights must be used. In other words, the minimum risk weights must be applied, if the risk weights calculated according to [CRE31.37](#) plus the EL associated with the equity exposure multiplied by 12.5 are smaller than the applicable minimum risk weights.

31.39

A minimum risk weight of 100% applies for the following types of equities for as long as the portfolio is managed in the manner outlined below:

- (1) Public equities where the investment is part of a long-term customer relationship, any capital gains are not expected to be realised in the short term and there is no anticipation of (above trend) capital gains in the long term. It is expected that in almost all cases, the institution will have lending and/or general banking relationships with the portfolio company so that the estimated probability of default is readily available. Given their long-term nature, specification of an appropriate holding period for such investments merits careful consideration. In general, it is expected that the bank will hold the equity over the long term (at least five years).
- (2) Private equities where the returns on the investment are based on regular and periodic cash flows not derived from capital gains and there is no expectation of future (above trend) capital gain or of realising any existing gain.

31.40 For all other equity positions, including net short positions (as defined in [CRE31.32](#)), capital charges calculated under the PD/LGD approach may be no less than the capital charges that would be calculated under a simple risk weight method using a 200% risk weight for publicly traded equity holdings and a 300% risk weight for all other equity holdings.

31.41 The maximum risk weight for the PD/LGD approach for equity exposures is 1250%. This maximum risk weight can be applied, if risk weights calculated according to [CRE31.37](#) plus the EL associated with the equity exposure multiplied by 12.5 exceed the 1250% risk weight.

31.42 Hedging for PD/LGD equity exposures is, as for corporate exposures, subject to an LGD of 90% on the exposure to the provider of the hedge. For these purposes equity positions will be treated as having a five-year maturity.

Exclusions to the market-based and PD/LGD approaches

31.43 Equity holdings in entities whose debt obligations qualify for a zero risk weight under the standardised approach to credit risk can be excluded from the IRB approaches to equity (including those publicly sponsored entities where a zero risk weight can be applied), at the discretion of the national supervisor. If a national supervisor makes such an exclusion this will be available to all banks.

31.44 To promote specified sectors of the economy, supervisors may exclude from the IRB capital charges equity holdings made under legislated programmes that

provide significant subsidies for the investment to the bank and involve some form of government oversight and restrictions on the equity investments. Example of restrictions are limitations on the size and types of businesses in which the bank is investing, allowable amounts of ownership interests, geographical location and other pertinent factors that limit the potential risk of the investment to the bank. Equity holdings made under legislated programmes can only be excluded from the IRB approaches up to an aggregate of 10% of Tier 1 plus Tier 2 capital.

31.45 Supervisors may also exclude the equity exposures of a bank from the IRB treatment based on materiality. The equity exposures of a bank are considered material if their aggregate value, excluding all legislative programmes discussed in [CRE31.44](#), exceeds, on average over the prior year, 10% of bank's Total capital. This materiality threshold is lowered to 5% of a bank's Total capital if the equity portfolio consists of less than 10 individual holdings. National supervisors may use lower materiality thresholds.