THE IRB SUPERVISORY FORMULA AND ESTIMATION RISK

The Prudential Regulatory Authority (PRA) has previously expressed concerns regarding potential errors stemming from the internal model estimation process within the context of credit risk, calling for Margin of Conservatism (MoC) to cover for possible underestimation. However, an agreed upon solution shared by banks and regulators/supervisors has not yet been found to date.

> *"An institution shall add to to it's estimates a margin of conervatism that is related to the expected range of estimation errors. Where methods and data are considered to be less satisfactory, the expected range of errors is larger, the margin of conservatism shall be larger."*
>
> *Article 179(1) (f) of EU Regulation 575/2013 (the CRR)*

The paper[1] released by the European Banking Authority (EBA) investigates the effect of the estimation error in the context of Probability of Default (PD) models used by banks that have an internal model approval (i.e. in an Asymptotic Single Risk Factor Model – in short ASRF, the foundation for the derivation of credit risk measures under the Internal Ratings Based (IRB) approach).

The EBA uses Monte Carlo simulations to quantify the bias created by the estimation error and explores an approach to account for this bias. The suggested solution is to use the historical observed probabilities of default to estimate the margin of converstism.

EBA have deemed the proposed approach compliant with the general requirements required by Article 179 Capital Requirements Regulation (CRR), and the more specific requirements listed in the ECB guide to internal models[2].

SUMMARY OF THE METHODOLOGY UNDERLYING THE IRB MODELS

The Basel Committee on Banking Supervision (BCBS) renewed the prudential regulation for banks with the introduction of a risk-based framework (widely known as Basel II), and allowed financial institutions to use their internal models to calculate minimum capital requirements for major risk types.

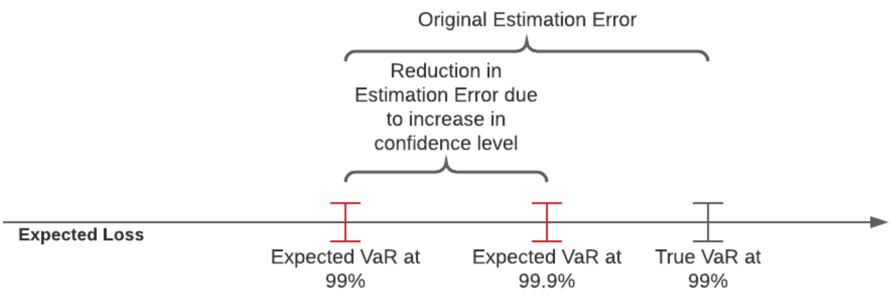
BCBS uses a stochastic credit portfolio model to provide estimates of the loss amount which will be exceeded with a predefined probability. The probability denotes the likelihood that the firm will not be able to meet its credit obligations through its capital. The confidence level denoted as α, which is specified by the regulator, typically 99%, is represented by 1-minus this likelihood. The corresponding loss threshold is referred to as Value-at-Risk (VaR) at the specified confidence level. **This implies that, in theory, the credit losses experienced by the bank should only exceed the VaR once every 1000 years.**

To calculate VaR, it is essential to estimate parameters. However, these estimates are subject to uncertainty commonly referred to as estimation risk.

As prescribed by the BCBS, banks currently use a standard normal distribution curve within acceptable levels of confidence, typically 99%. This also means that the range of acceptable values for VaR is within a wide range and eliminates the outliers in a portfolio. Increasing the confidence levels to 99.9% widens the range further and covers nearly all of the portfolio. The high confidence level is chosen to make estimates more conservative to account for estimation error that may inevitably occur from bank's internal estimates. This is illustrated in Figure 1.

[1] EBA, The Estimation Risk and The IRB Supervisory Formula, 11 January 2021
[2] ECB, ECB guide to internal models, October 2019

Figure 1: EBA's representation comparing the true and estimated VaR.



The CRR states that banks implementing the IRB approach should add further MoC, which should be proportionate to the estimation error.

ASRF MODEL

ASRF Model is a simplified Credit Portfolio risk model that underpins the Basel II capital requirements. In this model, all systematic risks that affect all borrowers to a certain degree, such as industry or regional risks, are modelled with only one systematic risk factor.

Through the ASRF framework, it is possible to estimate both the Expected Loses (EL) and Unexpected Losses (UL) associated with each credit exposure.

The Unexpected Loss can be expressed as a product of the PD and the Loss Given Default (LGD) parameters. The PD represents the expected default rate under the baseline conditions (otherwise known as long-run PD^{LR}), however for UL, the PD is calibrated to the downturn scenario of the single systematic risk factor. The aim of the UL is to transform the long-run average PD to the PD expected under a downturn scenario.

Under the ASRF framework the stressed conditional PD could be estimated as a function of the long-run PD. The LGD represents a conservative value that can be expected to be observed in a downturn (DWT) scenario. The banks are required to estimate the PD^{LR} and LGD^{DWT} parameters for each borrower.

As the Regulation is interested in adverse shocks, the stressed PD can be derived from fixing the systematic risk factor to a conservative estimate i.e. conservatimate estimate of the GDP.

ESTIMATION ERROR

The ASRF framework assumes the PD is known; however it is an estimated parameter, which introduces estimation risk.

Given that banks cannot determine a true PD, they rely on observations of defaults to estimate the PD based on the average default rate (DR). The bank evaluates the DR over time t as the number of exposures found in default divided by the number of all exposures in the portfolio at the beginning of the period. Then, by obtaining a time series of default rates it is possible to consider the average of the observed default rates as the estimator of the parameter PD^{LR} (i.e. DR Estimator).

It is assumed that if there is a long enough time series to consider the realisation of all the possible scenarios together with the corresponding default rates, then it would be possible to obtain the actual parameter PD^{LR} as the average of such default rates. In such a case, we can consider the highest default rate as the worst-case default rate (WCDR) that can be observed across all possible scenarios.

Having defined the estimator of the parameter PD^{LR} as the average of observed default rates and taking into account its variance, the impact of the estimator is illustrated in Table 1, which investigates and quantifies the potential impact of the estimation error through EBA's Monte Carlo simulations.

Table 1: Difference between WCDR and the DR Estimator[3]:

Confidence Level α		PD^{LR}			
		0.1%	**1%**	**5%**	**10%**
99%	$WCDR_{99\%}$	1.498%	10.427%	32.887%	49.649%
	DR $Estimator_{99\%}$	1.398%	9.552%	30.948%	47.425%
	$Delta_{99\%}$	**0.100%**	**0.875%**	**1.939%**	**2.224%**
99.5%	$WCDR_{99.5\%}$	2.236%	13.692%	38.985%	56.140%
	DR $Estimator_{99.5\%}$	2.025%	12.390%	36.563%	53.590%
	$Delta_{99.5\%}$	**0.211%**	**1.303%**	**2.422%**	**2.550%**
99.9%	**DR $Estimator_{99.9\%}$**	**4.089%**	**19.969%**	**48.952%**	**65.873%**

Table 1 illustrates that the Value-at-Risk for a PD^{LR} of 0.1% is in a worst case 1.498% (at a 99% confidence level). However, the DR Estimator only results in 1.398% at a 99% confidence level. One solution to obtain a more prudent risk measure is to move to a higher confidence level.

[3] Sourced from the EBA paper, The Estimation Risk and The IRB Supervisory Formula.

CORRECTION OF THE ERROR

The proposed solution in the previous section would not be viable given that banks are unable to modify the confidence level due to regulatory requirements. Therefore, an alternative approach to introduce the MoC is considered.

The approach considered is obtained by substituting the estimator of PD^{LR} with the upper bound of an interval estimator using confidence level $\beta \in (0,1)$.

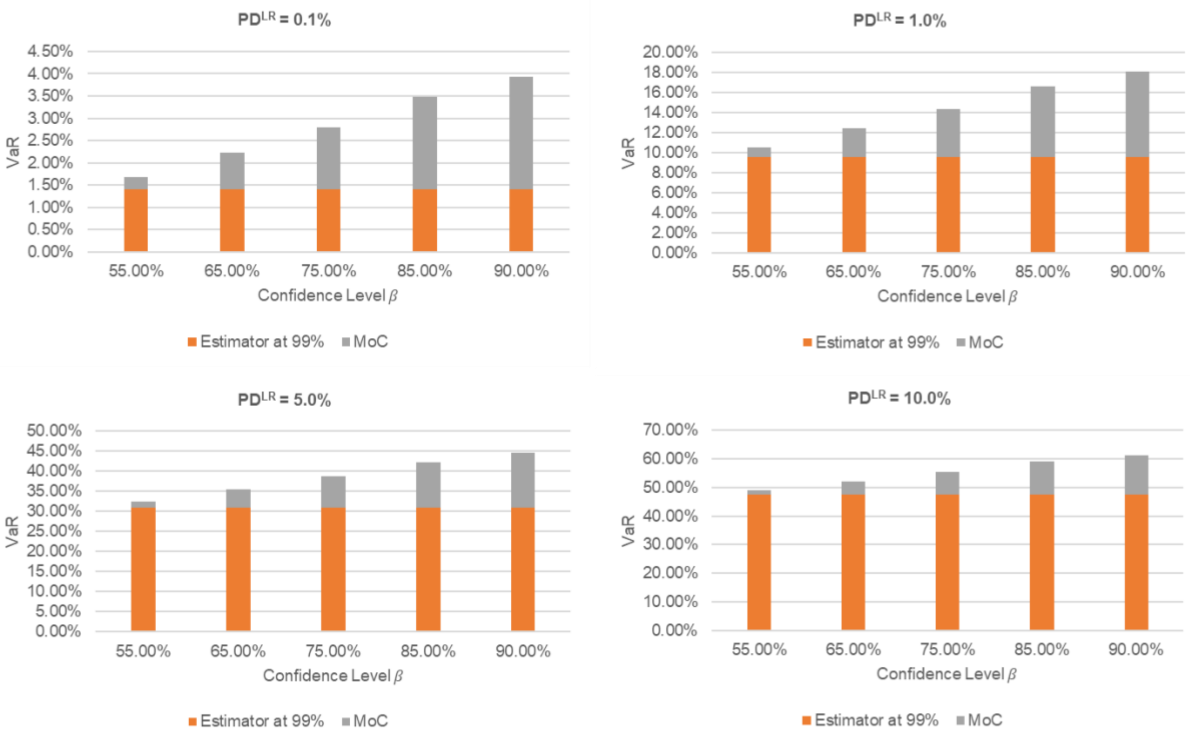
In this methodology, the quantile of the distribution is applied to the estimator of the PD^{LR}, unlike previously, where quantile is applied to the overall distribution defined within the ASRF framework.

The methodology described previously is interpreted as a risk measure, i.e. VaR at a given confidence level α, however to correct for the estimation error, the upper bound of an interval estimator for a given confidence level β is used instead of the expected PD^{LR}. In order to define a new estimator for VaR, the average of the observed default rates should be replaced with the upper bound of the interval estimator.

Note that with this approach, a degree of freedom is introduced, which is the confidence level β. Therefore, to ensure an appropriate correction of the estimation error and required conservatism of the resultant VaR estimates, careful consideration should be given when defining the confidence level β.

Figure 2 illustrates the varying levels of Margin of Conservatism that can be applied based on the varying confidence levels β and the input parameters used in Table 1.

Figure 2: Margin of Conservatism



In order to define the appropriate level of MoC to apply, the expected estimation error needs to be calculated in a similar fashion to the analysis performed by the EBA in the previous section. This enables the appropriate confidence level β to be applied to calculate the upper bound of the interval estimator in order to define the new estimator for VaR.

The appropriate confidence level is set at the discretion of the institution, based on their own input parameters.

HOW CAN REPLY ASSIST?

Avantage Reply, part of the Reply Group, specialises in Financial Services consulting with a focus on Risk Transformations, Treasury and Capital, Quantitative Modelling and Regulatory Advisory. With offices across Europe, we count some of the world's most significant financial groups among our clients, including in Investment, Retail and Commercial Banking, Custodian Banking, Insurance and Investment Management.

Since our inception in 2004, Avantage Reply has been committed to providing insightful and practical advice to our clients. We work across all levels of our client organisations, from Board Members, C-Suite and Heads of Functions to technical specialists, to define and deliver change.

Our solutions are aimed at helping you manage your risk, regulatory and data challenges effectively while ensuring your strategic and cost objectives are met. Our core proposition spans 4 broad areas:

- Risk, Finance & Compliance
- Quantitative Risk Management
- Data Management and Implementations
- Regulatory Engagements

CONTACTS

Vishwas Khanna, Partner

Vishwas specialises in prudential regulation, risk transformations, programme leadership and new bank authorisations. He is a trusted advisor to the C-Suite and senior management at banks and offers objective, independent advice to his clients to influence strategic decision-making.
vi.khanna@reply.com

Hadrien Van Der Vaeran, Senior Manager

Hadrien is a senior risk management practitioner specialising in prudential regulation, regulatory reporting, quantitative risk modelling and data and systems implementations. He has experience of delivering complex risk programmes across UK and Europe.
h.vandervaeren@reply.com

Nick Strazdin, Manager

Nick is a manager with a strong background in financial industry and significant experience of working within different areas of risk management. His expertise include risk methodologies, quantitative risk modelling and model validation, scenario analysis and stress testing, capital requirements estimation and capital management.
n.strazdin@reply.com

Hussain Jamali, Senior Consultant

Hussain is a Senior Consultant specialising in retail credit risk modelling and regulations. He has experience of delivering challenging models for challenger and Tier 1 banks.
h.jamali@reply.com

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