OpenRisk White Paper

Risk Capital for Non-Performing Loans

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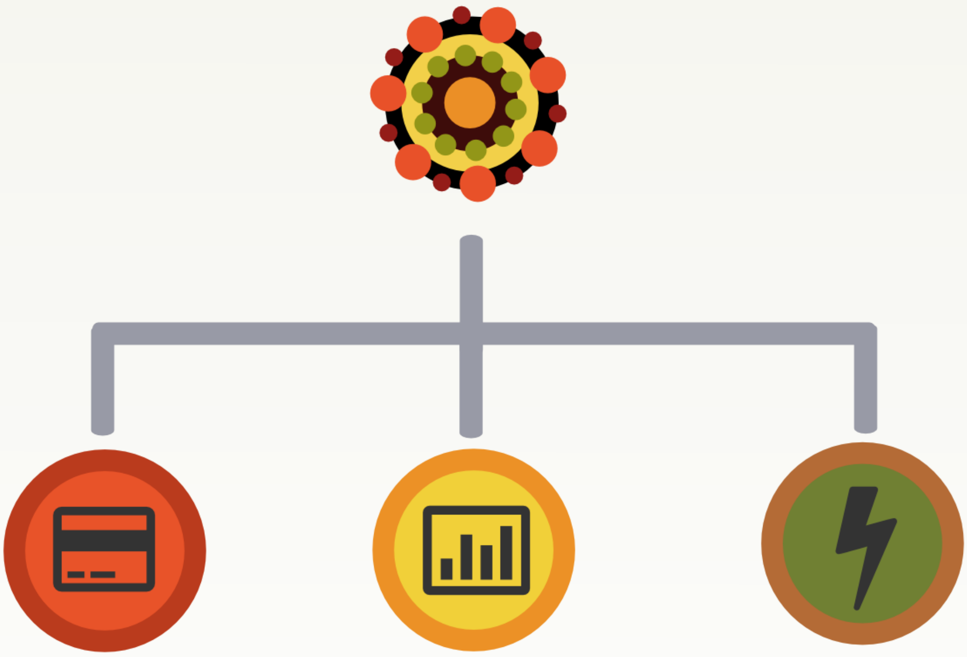

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SUMMARY

We develop a conceptual framework for risk capital calculation for portfolios of non-performing loans. In general banking practice, loans that pass a threshold of delinquency are declared non-performing and are provisioned. Yet there is a residual risk that the provisioning is not sufficient. This risk must be covered by capital buffers. The literature for risk capital requirements for NPL portfolios is very limited, which implies that Stress Testing and Internal Capital Adequacy Assessment (ICAAP) requirements for non-performing loans are harder to meet. Our framework builds on tools used in portfolio credit risk modeling and provides a structured approach to address the risk profile that is specific to non-performing loans.

The white paper has three main sections:

- A *Review* section discussing the motivation, concepts and previous research on non-performing loan portfolio risk analysis,
- A *Non-Technical discussion* of the proposed methodology
- The *Technical Documentation* section documenting more precisely the proposed approach to non-performing loan risk analysis

Further Resources

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Review of the NPL Risk Framework Landscape

Motivation

It is an empirical fact that the large majority of borrowers repay their loans. This does not happen automatically, but follows from implicit and explicit risk management practices: Both the borrowing and lending parties to the loan contract have an interest in the normal repayment of the loan. Yet invariably a fraction of the overall population will prove to be either unable or unwilling to make full repayment, leading to "impaired" loans, also called non-performing loans (NPL). Such NPL portfolios accumulate in particular after significant recessions [1].

Different jurisdictions approach the issue of NPL in distinctly different ways from a business, accounting and regulatory perspective. Practices around non-performing loans range from sale and immediate "write-off" to a "hold-to-resolution" approach[2]. The latter can lead to significant pools of NPL accumulating in bank balance sheets. Once large NPL have accumulated they pose unique risk management challenges. Chief among them is the residual risk for further losses in the NPL pool that have not been anticipated.

Regulatory Risk Framework

The current Basel prescriptions for risk capital against NPL depend on which of the regulatory options has been adopted[1]:

- For banks using standardized methods, the capital charge for NPLs amounts to 12 percent of risk weighted assets but only applies to NPLs that are inadequately provisioned or not collateralized.
- Under the internal ratings-based models, the capital charges on NPLs depend on a more risk based approach:
  - For banks under the Basel II IRB Advanced (IRBA) approach, the capital cost for NPLs is twofold: (i) a capital deduction for the provision shortfall between Basel II expected losses and IFRS accounting provisions. This capital deduction is known as the IRB shortfall, and (ii) a capital charge for gross NPLs (i.e., even if adequately provisioned), based on banks internal models.
  - In contrast, banks under the IRB foundation (IRBF) approach are only required to deduct the IRB shortfall.

Accounting Treatment

The accounting treatment of NPL's is very diverse and there are no global standards. A key characteristic that complicates the accounting treatment is that loan assets migrating into NPL pools are typically under *accrual accounting*. For consistency, post-delinquency, there is use of special constructs such as "Interest in suspense" accounts, which keep track of scheduled interest income charged against the client but which is not included in the Profit and Loss account. In any case the implementation of IFRS 9 will have significant impact in the accounting practice of NPL's.

Economic Capital Risk Framework

There is remarkably limited literature on Economic Capital approaches to NPL portfolios. While some LGD modeling literature is relevant [3] in this respect, the only extant publication that is explicitly focused on NPL risks appears to be [4]. These authors present two models for forecasting the non-performing portfolios loss and derive a probability distribution. In the first model, the loss for each loan is a Gaussian random variable, and the risk determinants are the portfolio concentration, as well as systematic and idiosyncratic risk. The second model is a mixture mode that allows for diversification with a performing portfolio.

Future NPL capital requirements under stress

In this white paper we discuss a general framework for assessing *present* capital requirements for NPL pools. Similar to other emerging approaches to stress testing, a separate requirement is to ensure *future* capital requirements can be met under adverse stress scenarios. Ideally this is done consistently by applying the current required capital methodology, but in a forward fashion, and taking into account both depleting capital buffers and the minimum desired target credit profile of the firm [5]

Non-Technical Description

This white paper explores design aspects of a suitable NPL risk quantification framework. At this level of abstraction assets linking to consumer and corporate clients (and corresponding non-performing loans) can be treated similarly. While individual attributes, relevant risk factors and regulatory and accounting treatment do vary (and need to be taken into account in concrete implementations of the framework), from a fundamental risk modeling perspective these are secondary differences.

The impaired loan life cycle

We review first - in a stylized fashion - the life cycle of a non-performing loan.

- The transition of a loan from the ”good” or performing book to the ”bad” or non-performing book starts when the asset is transferred to a specialized resolution unit when certain criteria are met (e.g a threshold period of delinquency).
- Clients with non-performing loans may subsequently be treated individually or collectively depending on factors such as the size of the exposure, the capabilities of the firm etc.
- Once in the non-performing portfolio, a provision is raised against outstanding loans, after a review period. The amount of impairment loss at any assessment point is measured as the difference between the outstanding loan balance and the present value of estimated future cash flows.
- Estimated future cash flows include amounts expected from the client (both principal and interest) and/or from the realization of related collateral (security). The value of cash flows associated with the realization of related collateral is the expected cash amount based on current markets. The timing of cash receipts reflects a best estimate at the time of the assessment.
- Cash or other assets received from a client while in workout are applied to reduce the net customer balance.
- The provision amount is recognized in the profit and loss account. The carrying amount of the financial asset is reduced by the amount of the provision. For collateralised assets, the estimated cash flows used to calculate any impairment reflect the cash flows that might result from foreclosure.
- All cases under resolution are monitored on an ongoing basis to assess whether there is a requirement for provision updates. If the impaired asset becomes performing after certain period, it is returned to the good book.

- If the amount of a past impairment loss decreases and the decrease can be related objectively to an event occurring after the impairment was recognized, then an impairment *reversal* through the PnL is possible.

- Impaired loans are written off, i.e. the impairment provision set off against the loan's carrying value when there is no longer any realistic prospect of recovery of all or part of the loan. The time limit for write off varies and can extend over many years.

Design requirements for a risk based approach

Risk capital should cover the risk that current provisions against an NPL pool may be materially lower than the ultimately realized write-offs. When we look to compute risk capital for a portfolio currently in workout, this population will contain assets at various stages of the work-out process and with different provisions assigned (seasoning cohorts).

We lay down the general characteristics required from a NPL risk capital model:

- Should be empirical (based on historical realizations) and validate-able against future performance
- Should capture all identified material risk factors (both static and dynamic)
- Should be applicable, if necessary, at individual loan level (not only at portfolio level)
- Should be taking the specificities of the provisioning process into account, in particular that provisions exhibit a *term structure*, that is a profile that depends on the time to resolution
- Should have outcomes compatible with natural constraints (e.g. cap the possible range of loss to the total exposure)
- Should be broadly aligned with methodologies used for performing loan portfolios. Ideally the NPL risk framework can be joined-up with performing book frameworks to offer also *integrated* risk metrics (e.g. total risk profile)

We expect at the outset that the distribution of unexpectedly large *write-off realizations* versus the current provisions has following possible risk drivers:

1. *Static attributes* of the case being worked out. These will be characteristics of the loan product and/or the client that are known ex-ante.[1]

2. *Dynamic (systemic, or portfolio) drivers* that depend on external (economic) factors that affect *all* assets. Such external factors could be regional or country GDP or asset markets performance. A good overview of such drivers relevant for NPL is given in [6].

3. *Idiosyncratic elements* associated with individual exposures. Those reflect uncertainties and new information that is specific to a given asset. Such elements will in general be important if there are *large concentrations* in the NPL pool.

[1] These maybe already reflected in e.g. the LGD model used for the performing book. A non-exhaustive list of possible static segmentation dimensions can be: the business line, industrial sector, region or country, size (for companies), loan seniority, available security (collateral), degree of coverage etc.

4. The accuracy of the provisioning (in terms of anticipating the eventual write-off level), may also be linked to internal factors.

The behavior of write-offs can be modeled entirely independently of details of the provisioning process. This is closely related the standard LGD modeling for the performing book[2].

The requirements and risk factors identified in the previous section translate into model design as follows:

- Static attributes determine the number of distinct models and the characteristics used in each.
- Idiosyncratic and dynamic risk factors shape the factor structure(s) employed
- The probabilistic distribution should respect the natural bounds: The following stylized facts apply to the write-off distribution[3]:
  - The write-off can in the worst case be equal to the outstanding balance (for assets with definite exposure-at-default)
  - There can be zero write-off if the asset returns to performing
- There is an increased requirement to capture factors affecting the timing and amount of write-offs

An important observation regarding LGD modeling is that it provides a framework for *ex-ante* risk analysis and it applies to populations that have just entered the NPL portfolio. In this sense simply applying an LGD model to an NPL pool may be missing significant information. We are interested in the properties of the final write-off versus the history of initial and subsequent provision values. We have the following stylized facts:

- The time of resolution is important and may have significant risk information. It is not necessarily the physical date of resolution but the workout duration that is of primary importance. This duration depends on a number of internal and external factors but in any case the decision to close a case or not at any given moment is with the *creditor* (NPL portfolio owner).
- Internal factors might include: reluctance to recognize loss, e.g., due to impact on PnL and capital position, inefficient workout and operational risks, or exercising an option to wait for more liquid markets and asset valuations.
- External factors may be legal process uncertainties, illiquid markets etc.
- A provision, at any given time during the resolution process, is meant to be the best and unbiased estimate of the ultimate write-off given the information available at that time

To make the distinction between NPL risk modeling and standard LGD modeling more transparent let us imagine the following hypothetical scenario: Two NPL portfolios contain assets that have been in workout for two years. They are identical in their static attributes. On the basis of historical write-off data they have the same LGD risk profile and the same amount of initial provisioning. Yet for one of them we observe that historical initial provisions were within a narrow range of the eventual write-off, whereas for the other we notice that there is consistently a steep increase after one or two years. Which of the

[2] A key difference being that there might be cases of defaulted assets that return to performing which are never provisioned
[3] While there can be exceptions, they do not concern significant categories or amounts

two pools has higher residual risk? Clearly the second case is more volatile. We can summarizes these differences as follows:

Box 1. Key differences between LGD models and NPL risk models

- There is an increased requirement to capture factors affecting the timing and amount of write-offs because the entire pool is non-performing
- The risk is defined with reference to the current provision rather than with reference to outstanding balance
- The provision history is relevant and may have implications for the residual risk profile

Technical Documentation

Model Setup

Here we lay out a notational and mathematical framework to capture the previous qualitative discussion in more concrete terms.

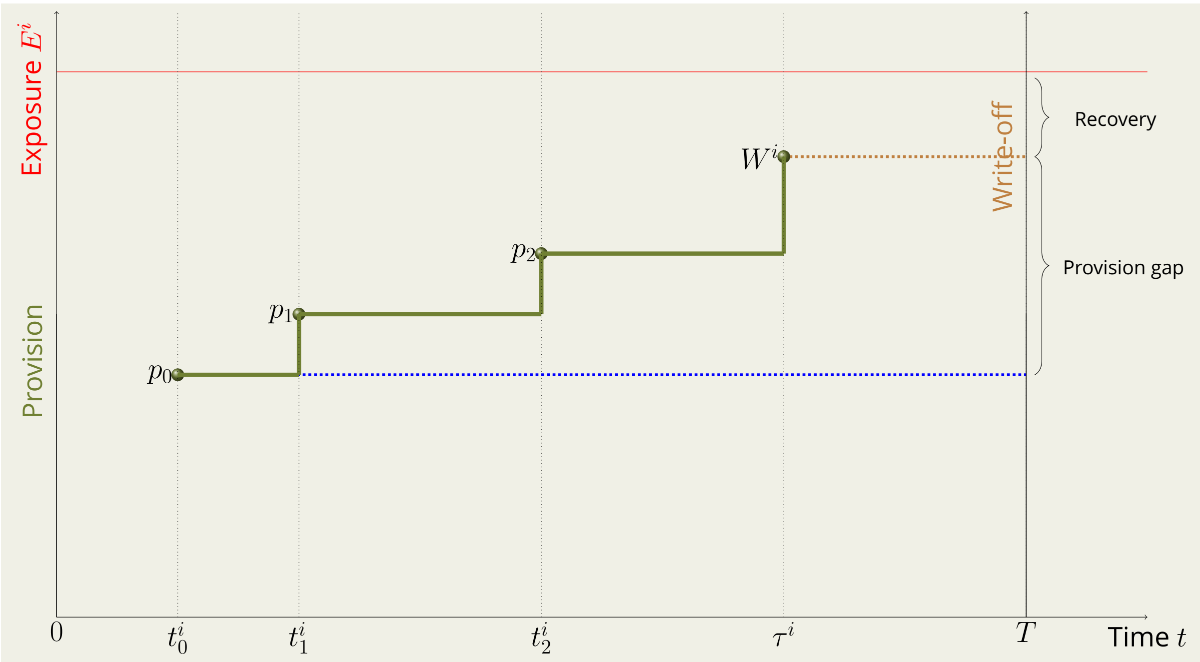

Figure 1: The diagram illustrates...

The basics

- A delinquent client (indexed by $i \in [1, N]$) enters the resolution process at time t_0^i corresponding to the time of raising the first *material* provisions.
- For simplicity the associated outstanding exposure E^i is assumed known and fixed (in practice there can be both scheduled and unscheduled changes to the exposure, e.g., partial repayments and exposure changes for derivative contracts).

- The case gets resolved at some later *random* time τ^i. We assume a maximum allowed resolution time of T.
- The variable $T^i = \tau^i - t^i$, is the total workout time for each resolved case.
- An amount W^i written off (not known before τ^i) and the remaining exposure ($r^i = E^i - W^i$) is denoted as recovered. The realized Loss Given Default of a resolved case is $LGD^i = W^i/E^i$ and the realized Recovery Rate is $RR^i = r^i/E^i$.
- The resolution process admits only two possible states at any given time $t > t_0^i$:
  - the case is still "open" and has acquired "seasoning" $s^i(t) = t - t_0^i$;
  - the case has been resolved at some time $\tau^i \leq t$.
- We assume that write-offs are completed in a single final step. In practice write-offs may be a process, with partial write-offs along the way. The timing and magnitude of such partial write-offs might be informative, but for simplicity we ignore this aspect

Provisions as loss expectations

The time τ^i can be seen as the optimal exercise time of a option. The linkage with the classic theory of optimal default[7] is as follows: At the time of default the borrower is exercising the put option inherent in the lending relationship to put their assets with the creditor in exchange for relinquishing the loan obligation. The creditor though, is not obliged to liquidate their position immediately, but retains extensive freedom as to the path of action. Economically the creditor will try to *minimize* the value of that put extended to the borrower, by maximizing the value of the asset and hence the possible recovery. Unlike a classic option exercise problem though, the exercise decision is not driven exclusively by the value of underlying assets. As discussed in the previous section the workout strategy may be influenced by accounting, tax or other firm-wide considerations.

The mathematical expression capturing this expectation is:

$$p_t^i = \min_{\tau^i \in [t,T]} \mathrm{E}[W^i | F_t] \tag{1}$$

which indicates that the provision is an economic value linked to the expected write-off, assuming that write-off will happen at an optimal (for the creditor) time τ^i. For clarity we are ignoring here interest rates.

At any moment we have the following equality (which is the analog of call-put parity)

$$p_t^i + r_t^i = E^i \tag{2}$$

where r_t is the running best estimate for the *expected* recovery value. That expectation is given along similar lines by:

$$r_t^i = \max_{\tau^i \in [t,T]} \mathrm{E}[E^i - W^i | F_t] \tag{3}$$

We can express the write-off as a function of the underlying value of the asset when workout is complete. The relationship is

$$W^i = \max(0, E^i - A_\tau^i) \tag{4}$$

This expression captures the fact that if the final asset value exceeds exposure, there is no write-off. The asset value A^i_t should not interpreted as the observable market valuation of any particular asset. It is the *implied* total value to the creditor that is consistent with the eventual write-off amount.

We can express the provision and recovery expectations in terms of the implied asset value distribution:

$$p_t = \min_{\tau \in [t,T]} \mathrm{E}[\max(0, E^i - A^i_\tau)|F_t] \quad (5)$$

$$r_t = \max_{\tau \in [t,T]} \mathrm{E}[\min(E^i, A^i_\tau)|F_t] \quad (6)$$

Some remarks:

- The initial provision p_{t_0} is a positive number expressing the initial expectation for the write-off, at the time of first material provisioning.
- Any subsequent provision p_t differs from the initial provision as it updates the expectation (best estimate) with information revealed in the meantime. This is effectively a reassessment on the basis of the realized path of the underlying asset A^i_t and the expectations for the future. This updated provision will likely involve better estimates for the resolution time τ^i and the ultimate write-off W^i.

While it might be tempting at this point to utilize the vast machinery of stochastic processes to specify models for the underlying assets it appears a-priory quite hard to link those to specific asset markets. Instead we suggest in the next section more empirical approaches.

Modeling Considerations

We sketch the main steps involved in modeling risk capital for NPL's. First, some preliminary considerations and requirements:

- Historical provisioning data for worked-out (closed) cases are the objective basis on which to estimate residual risk
- As with LGD modeling, we establish whether there are characteristics that allow the segmentation of the portfolio in homogeneous pools which exhibit similar recovery characteristics
- We construct cohorts of cases having entered resolution at the same time[4]
- The historical dataset must be shown as representative of current open cases. This must be established both on the basis of static attributes and the dynamic behavior of cohorts (trends in workout periods, provision history of open cases etc)

Next, we establish the marginal and joint distributions of the write-off realizations. The core of any modeling approach consists of establishing the distribution of W^i around the provision level and - in more complex models - as a function of static pool and dynamic (time varying) attributes

[4]The defined materiality threshold for the initial provision may have impact in distribution to cohorts

- In the most conservative approach, we work with the pairs of data $W^i, p^i_{t_0}$, namely the write-off versus the *initial* provision estimate. This approach accentuates the possibility that early provisions are aggressively low. Yet if the current NPL pool is seasoned enough to have seen its provisions already stabilize, this approach will likely penalize for that prior history (will create a capital requirement for a shortfall that has already been covered)
- Alternatively we work with the pairs of data W^i, p^i_t, i.e., we assign weight to all observations of provision adjustments. This solves the problem of over-conservatism but is potentially open to gaming (if later provisions are adjusted only slightly). A balanced approach is to "bucket" provision levels into regular intervals (e.g. annual or quarterly)
- Another required choice is the approach to scaling the historical data in order to obtain comparable realizations. This can be done in number of different ways. A natural normalization is provided by the amount of un-provisioned exposure:

$$R^i_t = \frac{W^i - p^i_t}{E^i - p^i_t} \tag{7}$$

The range of R^i_t is in $[-p^i_t/(E^i - p^i_t), 1]$ with the positive range $[0, 1]$ denoting realization of additional (fractional) loss and the negative range $[-p^i_t/(E^i - p^i_t), 0]$ denoting a provision reversal.

NPL Portfolio Risk Capital

We consider an NPL portfolio at time t. Final cumulative write-offs for this portfolio once all cases are resolved at time T would be the sum of individual write-offs

$$W^a = \sum_i^N W^i \tag{8}$$

which are to be compared against total cumulative provisions at time t.

$$p^a_t = \sum_i^N p^i_t \tag{9}$$

Risk capital K at time t is held to protect against the possibility that $W^a > p^a_t$. We assume a hold-to-resolution horizon, as the typical one-year risk horizon makes less sense in a typical NPL context: Each cohort is a static amortizing pool, there is little revenue and ability to raise additional capital while management options are largely confined to the optimal resolution.

Provisions are fungible, i.e. capital is not held against individual assets but against the entire portfolio. We want to ensure that the total risk is controlled so that it does not exceed capital with a likelihood higher than α:

$$P(W^a - p^a_t > K) = \alpha \tag{10}$$

Monte Carlo Simulation

With the exception of very simplified models, the calculation of risk capital for a portfolio of NPL loans is likely to involve Monte Carlo simulation. The main steps involved are as follows:

- Calculate dynamic variable realizations (macro factors, specific risks)

- For all homogeneous pools (of different static characteristics) calculate either individual per asset or collectively:
- Realizations for the resolution time τ^i (in models where it is considered random)
- Realizations for the write-off amount (e.g. $W^i = p^i_t + R^i_t(E^i - p^i_t)$)
- Construct a term structure of write-off distributions for all forward periods (or the final period in a single-step approach)
- Calculate the capital level K that corresponds to the desired confidence level for each one of the periods (or the final period in a single-step approach)

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