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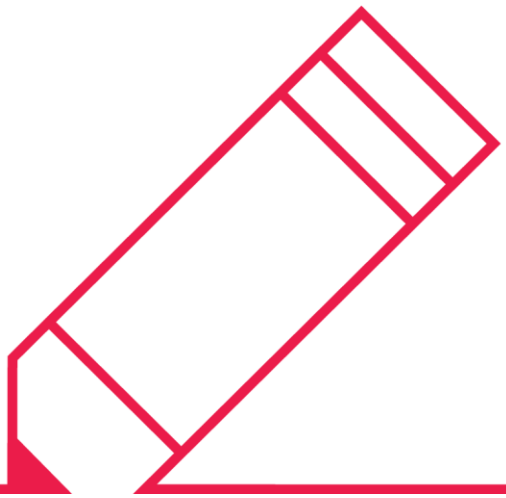
RISK CONTROL

Report

Ratings and Capital Constraints on IBRD and IDA



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Executive Summary

This report analyses the ratings and capital adequacy of the two sovereign lending organisations within the World Bank Group, the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA). Specifically, we quantify the headroom available to these organisations to expand development lending. The analyses are performed using public data obtained from their financial statements and the annual rating assessments of the three global rating agencies, Standard & Poor's, Moody's, and Fitch.

IBRD and IDA face several constraints in managing their balance sheets. These include:

1. The ratings they receive from the rating agencies, more specifically that no downgrade occur in the organisation's AAA rating.
2. The constraint of internal MDB Capital Adequacy Frameworks which generally require that Capital Resources exceed Capital Required (so the Capital Adequacy Ratio equal to the ratio of Capital Resources to Capital Required exceed unity plus perhaps a buffer).

If the organisations choose to transfer risk, they also face:

3. The constraints provided by the pricing that the market requires to supply insurance.
4. If tranched risk transfer is employed, the approach the rating agencies take to evaluating portions of the risk.

Finally, each of the organisations faces one additional constraint:

5. IBRD is constrained by the Statutory Lending Limit (SLL) included in its articles of agreement. (IDA has no corresponding SLL.)
6. IDA is constrained by the need to sustain its business model as a concessional lender. An institution that lends $100 at a zero-interest rate and is not obliged to pay a dividend, (so long as it covers its costs through fees), can sustainably relend the money when it is repaid, again for a zero-interest rate. In this case, for the institution is to operate sustainably, its lending volume is effectively constrained by the size of its equity. We term this constraint the Sustainable Concessional Lending Limit (SCLL).

These constraints are opaque for all but a few specialists within the institutions themselves. This study aims to clarify the nature of the constraints and to examine the room available to the two organisations to increase lending before one or other constraint binds.

To achieve this, we, first, replicate the rating analysis that the two institutions receive from the three global rating agencies. We compute the quantitative elements in the agency scorecards and analyse how judgmental components are likely to respond to changes in the scale of lending.

Second, using public data on the institutions' sovereign lending portfolios, we calculate the credit risk capital that the institutions may conservatively choose to hold. While credit risk capital is only part of the total Economic Capital (EC) (the latter should also cover market, operational and other risks), for sovereign focussed MDBs, credit risk capital is likely to be between 80 and 90% of total EC. Hence, our calculations will provide a reasonably accurate view of the institutions' Capital Adequacy Ratios (i.e., capital available divided by capital required).

Third, we calculate the amounts of fully concessional and fully non-concessional loans that are equivalent to a dollar of blended lending for IDA. We argue that the non-concessional lending is unconstrained since the institution's available capital is sufficient to borrow extensively in capital markets. The sum of IDA's fully concessional lending and the concessional component of its blended loans is less than its capital which creates room to lend more either through more concessional or more blended loans.

Fourth, we analyse the scope for the institutions to transfer risk on their sovereign to public donors or to the private market. In our study, we focus on synthetic securitisations in which the institution retains a junior (sized to cover the Expected Loss on the securitised portfolio) and a thick senior tranche. In this context, a key issue is the rating that the rating agencies assign to the retained senior tranche because this affects the efficiency of the risk transfer. In the light of these factors, we compute the additional lending that the institutions could achieve and the different risk transfers.

Our findings for IBRD are as follows.

- For IBRD, the constraints of maintaining a AAA rating and maintaining capital resources greater than required Economic Capital are less constraining that the Statutory Lending Limit (SLL). The SLL binds when the portfolio of DRAs and Treasury assets has expanded by no more than 45%. IBRD has already raised the possibility to its Board of Directors that its SLL be abolished.
- The IBRD could boost its Development Related Asset (DRA) lending and Treasury assets by around 71% before its Moody's rating is downgraded. Fitch would downgrade the IBRD at a similar point if its assets progressively expanded. The Standard & Poor's rating is much less constraining and would only be downgraded after more than a doubling in the volume of assets.
- The constraint that the Capital Adequacy Ratio (CAR) exceed unity is less constraining for IBRD than the 'no rating downgrade' constraint, in that exposure could increase by 147% before the CAR equals unity. Of course, evaluating the CAR depends on how Economic Capital (EC) is calculated. In this study, we have implemented an industry standard Credit Portfolio Model (CPM), calibrated it based on commonly applied techniques and provided sensitivity analysis. We have also assumed that the net contribution of non-DRA-loan-related components of EC amount to no more than 10% of DRA-loan-related EC. This is true of some other sovereign focussed MDBs. Finally, we have added a buffer of 10% to the DRA-credit-related capital estimate generated by the CPM we employ. Again, we have observed other MDBs that work with buffers of the order of 10% in computing their CAR.

Our analysis of IDA results in the following findings.

- We allow for the presence on its balance sheet of highly concessional loans. These are booked at par (justified by the fact that IDA does not pay dividends) but the value of these loans would have to written down if IDA were insolvent. If the value of loans were adjusted, IDA's equity would be correspondingly lower. Even though the rating agencies do not adjust its equity for the subsidy value of its loans, IDA, in its internal capital adequacy assessments chooses to include an adjustment. It applies this to the required capital resources rather than by discounting loan values which appears to be more natural. In the CAR analysis we perform for IDA, we follow the latter approach by calculating and subtracting from assets the value of the subsidy element in IDA's loans.
- We find that the ratings constraint for IDA hardly binds at all. Substantial expansion in DRAs and Treasury assets, of around 200%, would be necessary before any downgrade occurs. Even larger increases in assets would be required before a CAR constraint were breached. The expanded DRAs in question would consist either of non-concessional loans or concessional loans for which IDA finds donor governments willing to cover the subsidy component.
- While IDA could borrow extensively, a conclusion that it can boost its concessional lending extensively would be misplaced. The institution's non-binding rating constraint and very high CAR mean that it has plenty of scope to lend more on a non-concessional basis. But IDA and most of its stakeholders are clear that it should remain a concessional lender. Such a lender faces the additional constraint that managing its balance sheet sustainably permits it only to offer fully concessional, zero-interest-rate loans up to a ceiling of its equity (assuming it can cover its costs from fees). As we show in the study, there remains some unexploited headroom in IDA's lending because only part of its existing loan book is fully concessional while a large fraction is 'blended' (meaning partially concessional but not zero-interest-rate) and a small amount is non-concessional. This lending profile means that some additional lending headroom remains. This we compute to equal 15% or 12% of its total loan book par value depending on whether it chooses to boost concessional or blended lending. (Note that in this analysis, we are not assuming any additional donor willingness to cover the concessional element in IDA lending.)

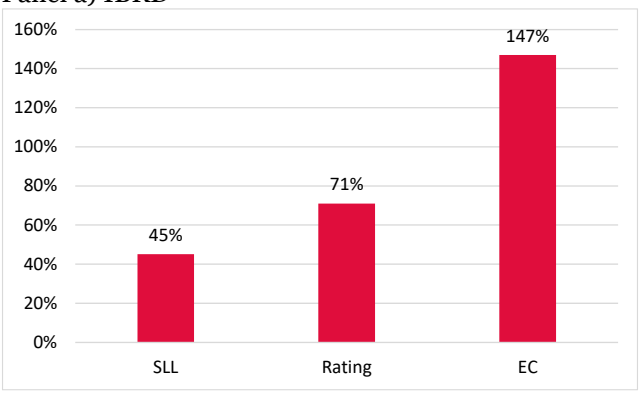
Figure ES1 summarises the constraints on lending implied by the three primary constraints on lending by IBRD and IDA that are investigated in this study. For IBRD, the tightest constraint is the Statutory Lending Limit (SLL) which binds after net loans and guarantees have expanded by 45%. The rating constraint binds for IBRD when lending and guarantees have increased by 71%. This binds when the Moody's rating is downgraded from Aaa. The Fitch rating is downgrade shortly thereafter whereas there is plenty of room for IBRD to expand lending before the Standard & Poor's rating is downgraded. The Economic Capital (EC) constraint (i.e., that the Capital Adequacy Ratio (CAR) (allowing for a buffer of 10% exceeds unity) is only breached after a substantial increase in exposure (and, hence, lending) of 147%.

The precise values of these calculations are, of course, subject to assumptions. The rating calculations presume some deterioration in the qualitative questions that the rating agencies include in their rating evaluations. For Moody's in particular, the judgmental elements are reduced to precise questions that place the MDB in one or

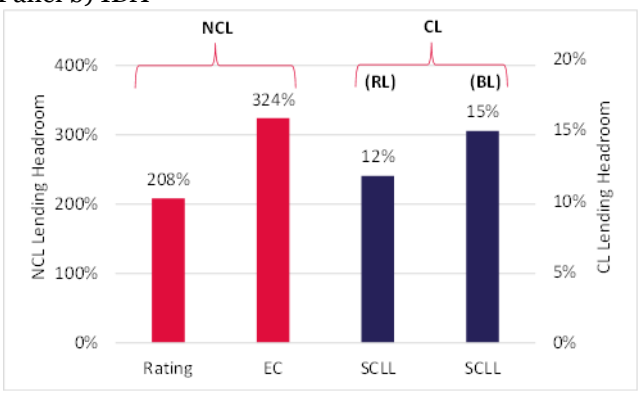
other of several discrete categories. Determining the expansion in lending but they might shift to more negative categories that triggers a deterioration in these judgmental scorings in turn requires that we make a judgment or assumption. Similarly, in the EC constraint calculations, many aspects of the Credit Portfolio Model (CPM) employed in the calculations might be questioned. We have tried several reasonable sensitivity analyses and adopted reasonable assumptions with some conservative elements.

Figure ES1: Summary of Lending Headroom

Panel a) IBRD



Panel b) IDA



Note: The red bars illustrate, for IBRD and IDA, the headroom for additional non-concessional lending in percent of current net lending and guarantees implied by the three sources of constraint, namely Statutory Lending Limit (indicated by 'SLL'), the requirement that the AAA-ratings of all three global rating agencies be maintained (labelled 'Rating') and that the Capital Adequacy Ratio (equal to capital resources (paid in equity and reserves) divided by capital required (Economic Capital plus a 10% buffer)) exceeds unity. IDA has no SLL constraint. In computing CARs for IDA, we have followed a conservative approach, comparable to IDA's internal risk management methodology, of adjusting capital resources downwards to allow for the value of the subsidy element in IDA's loans. More information about the computations may be found in the sister technical paper, Risk Control (2023). The dark blue bars show headroom as a percentage of IDA total lending (relative to the SCLL) if it expands its lending using particular, subsidised loan instruments (CLs or BLs). SCLL denotes Sustainable Concessional Lending Limit, NCL denotes Non-Concessional Loan, CL denotes Concessional Loan, RL denotes Regular Loan and BL denotes Blended Loan. Note that because of the differences in the way these constraints are applied, the rating headroom (71% for IBRD) is expressed in terms of outstanding loans whereas the EC headroom (147% for IBRD) is expressed in terms of outstanding loans plus 50% of undisbursed commitments.

Panel b) in Figure ES1 shows the scope for IDA to expand lending. The red bars show the headroom to increase lending implied by the rating and EC constraints. These suggest the scope to expand IDA's balance sheet is very great. The figures are only relevant, however, if the expansion were to involve non-concessional lending. The analysis demonstrates that IDA has a sufficiently large capital cushion that it could readily borrow more in the bond market and lend it out so long as the cost of borrowing could be remunerated (i.e., the lending be non-concessional). Borrowers would still benefit from such loans in that the costs would be low compared to those of borrowing in the market themselves, but they would have to pay a risk-free interest rate plus a credit spread to cover Expected and Unexpected Losses.

IDA and its stakeholders, however, are clear that the institution will remain primarily a concessional lender (even though its is moving towards a 'hybrid' approach that includes some blended loans and even a small amount of non-concessional lending). Unless IDA can find additional donors, willing to bear the cost of the subsidy element in additional concessional lending, it will remain constrained by what we refer to above as the Sustainable Concessional Lending Limit (SCLL), i.e., the constraint that fully concessional (zero-interest-rate) lending plus the fraction of blended loans that amounts to fully concessional loans be less than the organisation's equity capital. On this basis, we are still able to identify some headroom in IDA's current lending. This appears as the blue bars in Figure ES1 which show that IDA could boost its blended or concessional loans by an amount equal to 15% or 12%, respectively, of IDA's total loan par value.

We assess the potential for IBRD and IDA to engage in risk transfer outside the World Bank Group, buying credit protection from external entities that might consist of donor governments, private sector entities or some combination of the two. We compute the reduction in economic capital (EC) for IBRD and IDA when they securitise their respective portfolios A and B. We find that securitisation reduces the EC substantially if the securitised portfolio is riskier. for IBRD the reduction in EC is 12% for portfolio A and 18% for portfolio B. For IDA, the reduction in EC turns out to be 12% for both portfolio A and B (see Table 7.4).

These findings imply that risk transfer offers an effective safety valve in relaxing some of the lending constraints that IBRD and IDA may face. But there are some significant obstacles here. For IBRD, the tightest constraint is the SLL. If the SLL were relaxed (as has been proposed by IBRD), the first constraint to bind would be that associated with a downgrade in the Moody's rating. But, when lending expands, the Moody's rating is affected by a deterioration in both the leverage ratio and the contractual support ratio. This would not be much improved by a securitisation that left IBRD with a thick retained senior tranche.

1. Introduction

Multilateral Development Banks (MDBs) play a key role in financing economic growth in Emerging Market and Developing Economies (EMDEs). An International Monetary Fund study published in 2019 (see IMF (2019)) calculated that an additional US$2.6 trillion of spending per annum until 2030 was required if Emerging Market Economies (EMEs) and Low-Income Countries (LICs) were to meet the requirements of the Sustainable Development Goals (SDGs) in five key areas (education, health, roads, electricity, and water and sanitation).

The current climate emergency further boosts the investment needs of EMDES. An Independent High-Level Expert Group on Climate Finance (LSE (2022)) found that EMDEs other than China must spend US$2.4 trillion per year by 2030 to achieve the climate goals agreed upon in Paris Agreement across all dimensions.

The report of the Panel on Capital Adequacy Frameworks published in June 2022 (see CAF Panel (2022)) proposes steps that MDBs might take that would permit a significant expansion in their lending. MDBs are considering the feasibility of the Panel's proposals. At the same time, MDB shareholders, primarily sovereign governments of both donor and borrower Member Countries (MCs), are examining what they could do, either through direct support to MDB lending or indirectly through their governance of MDBs, to advance the CAF Panel's agenda.

This study aims to contribute to the debate initiated by the CAF Panel report by examining in detail the capital adequacy of two major MDBs, namely the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA). The two institutions represent the sovereign lending focussed members of the World Bank Group. Collectively, they contribute a major fraction of total development lending by MDBs. Through their influential position among MDBs, they can also influence the actions of other institutions.

The analyses we perform are based on public data. Understanding the finances of an MDB from the outside has its challenges. For MDBs, there is no equivalent to the Pillar 3 reports issued by large commercial banks. Individual MDBs provide risk management sections in their financial statements but details are limited. An important public source of information is ratings agency reports on MDBs. But agency evaluations contain judgmental elements and are not fully transparent.

Despite these obstacles, some major MDBs are reasonably straightforward to analyse from the outside since their exposures primarily consist of sovereign loans, information on which is published in their annual reports. The IBRD and IDA correspond to this pattern. Like many MDBs, the two institutions have very low appetite for market or operational risk and hold high quality and short-dated Treasury assets. Hence, most of their risk and, therefore, Economic Capital reflects their sovereign lending.

To shed light on the ratings and capital adequacy of IBRD and IDA and, therefore, to infer the scope they have for additional lending, we perform three exercises.

1. We investigate the rating agency assessments of IBRD and IDA through a careful analysis of the methodologies employed by the three global agencies, Standard & Poor's, Moody's and Fitch. We calculate the point at which the ratings assigned by the agencies change if the IBRD and IDA progressively scale up their Development Related Assets (DRAs) and Other Assets (primarily Treasury assets) without a change in their equity resources. This analysis draws on a precise replication of the decision-trees employed by the rating agencies.

   The agencies apply methodologies that are to varying degrees precise and publicly disclosed. All three agencies rely on a combination of quantified indicators and qualitative judgments. In the case of Moody's, the judgments are formulated as questions that appear in the methodology documents. For others, most notably Fitch, the judgmental elements are less precisely expressed in the published methodologies, so we have endeavoured to express them as questions.

   The analysis shows how different elements of the scorecards (or 'decision trees') lead to a change in rating as the lending and Treasury assets expand proportionally. In the exercise, we allow for deterioration in the answers to the qualitative questions as the balance sheet grows.

2. The second exercise we perform is to implement a set of industry standard Economic Capital (EC) calculations using a ratings-based Credit Portfolio Model (CPM). Much the largest part of the risk faced by MDBs is attributable to credit risk. For a representative MDB other than IBRD and IDA, we believe that the contribution of other risks in Economic Capital calculations is around 10%. Hence, computing the credit risk EC for an MDB tells one a lot about total EC. The model we implement is a ratings-based CPM resembling those employed by (almost all) large commercial banks for Pillar 2 capital calculations and identical in most respects to what we have observed in use in several large MDBs. The model builds on the so-called 'Ordered Probit' methodology popularised by JP Morgan and commonly labelled the Creditmetrics approach.

   We implement several different calibrations to investigate the model's sensitivity and the robustness of the conclusions. A key aspect of the calibration is the degree to which sovereign loan Probabilities of Default (PDs) and Loss Given Default (LGD) rates are assumed to reflect Preferred Creditor Treatment (PCT). MDBs benefit from PCT to the extent that they are treated as senior by distressed sovereigns that default on other debt claims. Since sovereigns operate outside any formal, legal insolvency framework, they can choose to default on one creditor's claims but not another's. One may observe from historical experience that MDBs enjoy significant de facto seniority even though this is not written into debt contracts. We show, though our calculations, that the magnitude of PCT effects substantially influences any evaluation of the capital adequacy of the IBRD and IDA.

   An additional consideration for EC analysis of IDA is the fact that the institution engages in heavily concessional lending. While its loans are booked at par in its balance sheet, their value is in most cases much lower because they bear interest rates much below market rates (and even below the rates that would be fairly priced, allowing for the de facto seniority or Preferred Creditor Treatment (PCT) that IDA enjoys). Lower loan values might then imply reduced equity. IDA's accounts do not include a loan value adjustment because the loans are assumed to be financed with equity and IDA is not expected to pay dividends on its equity.

   While the rating agencies do not adjust IDA's equity for the lower value of its loan book, IDA itself in its internal risk management chooses to add loan value adjustment to its EC to obtain when it labels its Total Required Resources. This then is compared to its Total Available Resources, i.e., its equity. In our CAR analysis, we perform a detailed calculation of the value of IDA's loan subsidies. Finding this a more natural approach, we then adjust down equity resources rather than adjusting up required capital.

3. The third exercise we calculate the amounts of fully concessional and fully non-concessional loans that are equivalent to a dollar of blended lending. IDA currently lends an amount approximately equal to its capital, but this lending includes (i) non-concessional loans, (ii) so-called blended loans and (iii) fully concessional (zero-interest-rate) loans. Blended loans have relatively low but still non-zero interest rates.

   We argue that the non-concessional lending is unconstrained since the institution's available capital is sufficient to borrow extensively in capital markets. The sum of IDA's fully concessional lending and the concessional component of its blended loans is less than its capital which creates room to lend more either through more concessional or more blended loans.

4. The fourth exercise we perform is to consider the feasibility of risk transfer for IBRD and IDA. Specifically, we consider synthetic securitisations of sub-portfolios of these institutions' sovereign loan books. Key aspects are the prices that the market might set to provide insurance and the ratings that the rating agencies would assign to tranches that the two institutions might retain. The ratings of retained senior tranches matter because they feed back into the agencies' ratings of the MDBs themselves and, hence, influence the capital efficiency of risk transfer as far as the institutions are concerned.

   On the first topic, we employ a pricing approach based on a simple analytical model and calibrated to pool expected losses adjusted for market risk premiums using sovereign bond market data. On the second topic, we assume that the retained senior tranches are rated using a methodology that Standard & Poor's developed at the request of the African Development Bank (AfDB) for application to the retained senior tranche in the landmark 2019 Room2Run transaction.[1]

[1] For a description of this transaction, see Risk Control (2019).

From the four analyses just described (of ratings, capital adequacy and risk transfer), we shed light on the headroom available to the IBRD and IDA to expand their lending. In managing their balance sheets, the two institutions face the following constraints:

1. Agency ratings of the MDBs themselves
2. Internal Capital Adequacy Frameworks
3. Rating agency treatment of risk transfers
4. Market pricing of risk transfers
5. For IBRD, there is a fifth constraint, namely the gearing constraint included in its statutes.
6. For IDA, there is an additional constraint, namely the Sustainable Concessional Lending Limit (SCLL).

Through our analyses, we show how and when these constraints would bind if lending were to expand.

The document is organised as follows. Section 2 provides profiles of the two institutions from a financial and risk point of view. This provides important context for what follows. Specifically, we describe the two institutions' balance sheets and the key risk indicators on which the institutions themselves focus. Section 3 examines the ratings the two institutions receive from the three major rating agencies and investigates how these ratings would be affected by an expansion in lending, accompanied by a proportionate increase in non-loan assets (thereby maintaining liquidity). Section 4 describes a series of capital adequacy calculations for the two institutions based on public data on their sovereign loan books. Section 5 explains the constraint on IDA lending attributable to its use of concessional loans. Section 6 investigates the scope for risk transfer off the balance sheets of the two institutions involving synthetic securitisation of the institutions' sovereign loans. Section 7 brings together the different analyses of 'headroom' and, also, examines the constraint on lending provided by the institutions' statutory lending limits. Section 8 concludes. A series of appendices provide additional information on technical and data issues.

2. Risk Profile of the Two Institutions

2.1 Indicators

This section presents the financial and risk profiles of the IBRD and IDA. This is important context for the subsequent discussion.

To 'profile' the institutions, we focus on a set of publicly available indicators, namely:

1. Balance sheet variables, such as the volume of loans and Treasury assets
2. An externally generated risk indicator, the Risk Adjusted Capital (RAC) ratio employed by Standard & Poor's
3. The internal ratios that the IBRD and the IDA employ in managing their balance sheet, the equity-to-loans ratio, in the case of IBRD, and the Deployable Strategic Capital (DSC) ratio of IDA
4. The country breakdown of the two MDBs' loan portfolios

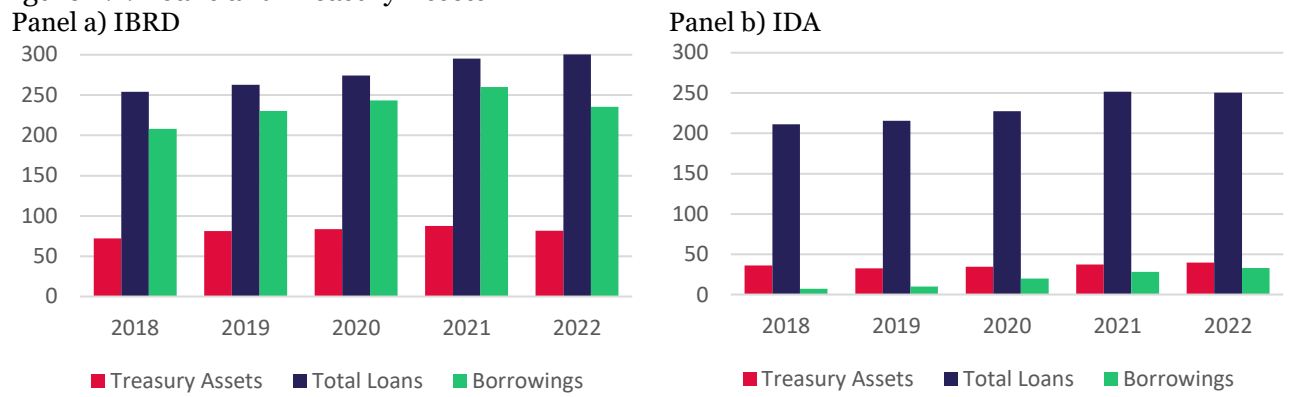
2.2 Balance sheet variables

Figure 2.1 presents data on the evolution from 2018 to 2022 of the loans and Treasury assets of the two MDBs. IBRD loans (shown in dark blue in Panel a) have grown by 20% in the period from 2018 to 2022 (from $254bn to $304bn). IDA's loans have similarly increased by 18% over the same period (from $211bn to $250bn).

The two MDB's Treasury assets have growth at slower rates over the four-year period, 14% for IBRD and 11% for IDA. To finance the growth, IBRD's borrowings grew by 13% (from $208bn to $235bn). Starting from a low base, IDA's borrowings increased by 371% (from $7bn to $33bn), reflecting the institution's newly adopted strategy of additional debt-financed lending (see IDA (2018)).

In summary, IBRD lending has exhibited steady if slow growth, with a slight acceleration in 2021 followed by a slowing the following year. In real terms, adjusting for US consumer price inflation, IBRD lending is flat. Over the four-year period, IDA loan growth appears to be steady but again it is flat in real terms.

Figure 2.1: Loans and Treasury Assets

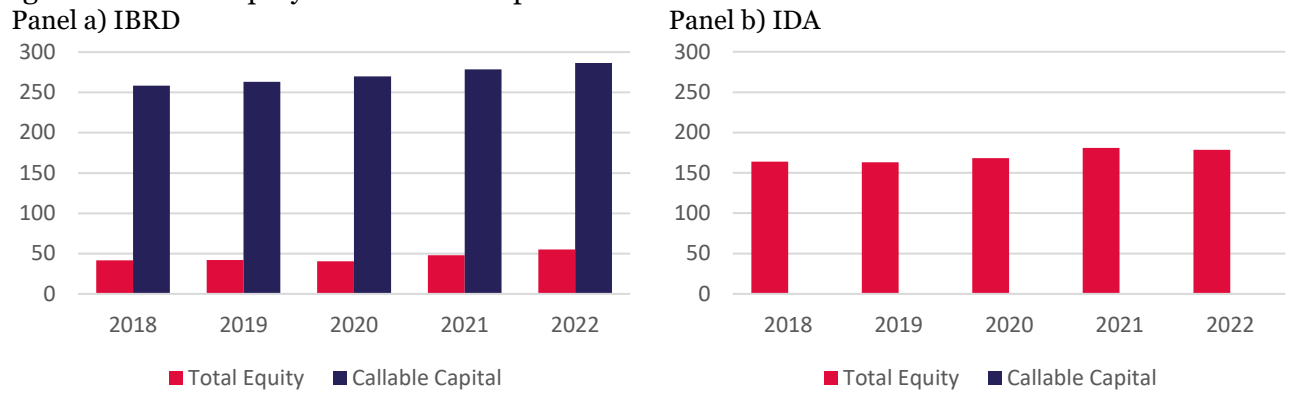


Note: Units are USD billion. The source for Panel a) is IBRD (2022), IBRD (2020) and IBRD & IDA (2018). The source for Panel b) is IDA (2022), IDA (2020) and IBRD & IDA (2018).

Figure 2.2 shows the evolution over the last four years of the two MDBs' Total Equity and Callable Capital. The IBRD's Total Equity grew by 31% over the four-year period from ($42bn to $55bn). The Callable Capital of IBRD increased from $258bn to $287bn, a rise of 11%. IDA's Total Equity increased by 9% (from $164bn to $179bn). IDA has no Callable Capital.

The sources of growth in IBRD Total Equity may be understood as follows. The percentage increase reflects a mixture of higher retained earnings (unrealized market gains), Accumulated other Comprehensive Income (AOCI)[2] and greater paid in capital. In the period 2020 to 2022, retained earnings generated about $6bn. AOCI increased by $3.3bn over the four-year period to 2022. Paid in capital grew by $4bn over the four-year period to 2022. The increase is attributable to the Transformative Capital Package (see World Bank (2018)) which aims to contribute in total additional paid-in capital of $7.5bn over a five-year period starting in 2018.
As we shall see below, the strikingly high growth rate of IBRD's Total Equity as recorded in its financial statements is not matched by that of the equity aggregate which IBRD uses in its internal capital adequacy policies. Hence, the equity growth has not triggered any expansion in lending targets.

Figure 2.2: Total Equity and Callable Capital



Note: Units are USD billion. The source for Panel a) is IBRD (2022), IBRD (2020) and IBRD & IDA (2018). The source for Panel b) is IDA (2022), IDA (2020) and IBRD & IDA (2018).

Figure 2.2 underlines the very different structure of the two MDBs' equity. IBRD has a small paid in equity capital plus reserves (Total Equity) relative to its Callable Capital, while IDA has substantial Total Equity but zero Callable Capital. The high Total Equity levels of IDA are consistent with its status as a concessional lender and grant providing multilateral.

One may compare the structure of IBRD and IDA equity with that of the major regional MDBs, Asian Development Bank (ADB), Inter-American Development Bank (IDB), African Development Bank (AfDB) and European Investment Bank (EIB). For IBRD and IDA, respectively, the ratios of Callable Capital to Total Equity

[2] Refer Note K in IBRD(2022) to check the individual items contributing to the comprehensive income.

is 5.2 and 0. For the above listed regional MDBs, the ratios (in increasing order) are 2.5 for ADB, 3 for EIB, 4.4 for IADB, and 12.5 for AfDB.

2.3 The Standard & Poor's RAC ratio

One may obtain a perspective on the capital adequacy of IBRD and IDA by considering the Risk Adjusted Capital (RAC) ratio published by Standard & Poor's for the MDBs that it rates (see Standard & Poor's (2022a)).

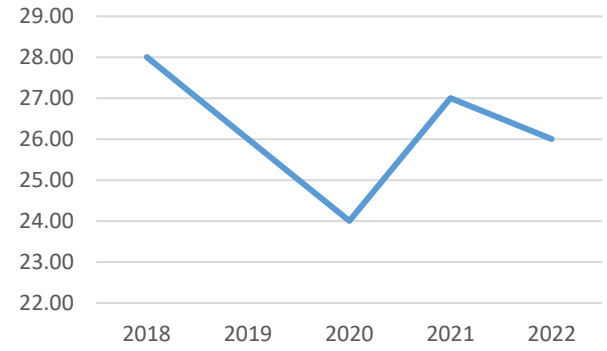
The RAC is the ratio of Total Adjusted Capital (TAC) (as defined by the agency) to Risk Weighted Assets (RWA). In turn, RWAs are defined as Exposures at Default (EAD) weighted by multipliers provided by the agency in look up tables, and then adjusted for concentration and PCT using approaches developed by Standard & Poor's.

The RAC methodology is mainly public and may be replicated by external parties (although some parameters are not published by the agency and must be guessed). Standard & Poor's considers that a RAC ratio exceeding 23% implies "extremely strong" capital adequacy (see Table 10 of S&P (2022a)). Ratios from 15% to 23% and 10% to 15% are associated with "very strong" and "strong" capital adequacy, respectively.

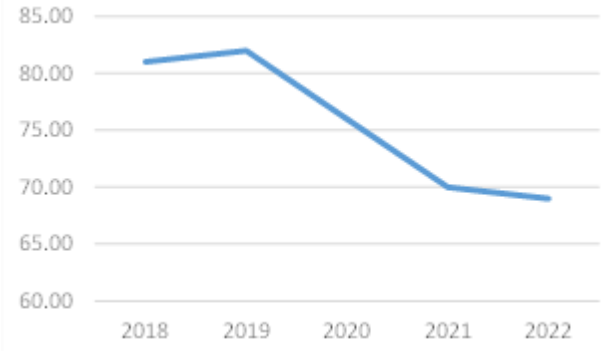
Figure 2.3 displays RAC ratios for IBRD and IDA in the years 2018 to 2022. In 2018, IBRD had an RAC ratio of 28%, well above 23%. This dipped in 2020 as Covid 19 lending grew and some sovereign ratings were downgraded. The ratio recovered to 27% in 2021 as equity increased (as discussed in the last section). IDA's RAC ratio was 81% in 2018. This dipped due to sovereign rating changes and additional lending for Covid 19 relief, leading to a RAC ratio of 70% by 2021.

Figure 2.3: S&P Risk Adjusted Capital (RAC) Ratio

Panel a) IBRD



Panel b) IDA



Note: Units are percent. The source of is S&P (2022d).

One may compare the two institutions' RAC ratios with those of the regional MDBs. EIB has the lowest RAC ratio with a value of 22.5% (see Standard & Poor's (2022c)), while ADB has the highest RAC ratio with a value of 31% (see Standard & Poor's (2022d)). In Fiscal Year 2022, all the regional MDBs are at the level of 23% or above though this was not the case in 2016. In fact, EIB had the RAC ratio as low as 15% in 2016 and yet retained AAA rating due to "extraordinary shareholder support".

2.4 Key internal risk indicators

Both IBRD and IDA employ key risk indicators as central components of their capital adequacy policies and lending decisions. In the case of IBRD, the indicator in question is the institution's Equity-to-Loans (E/L) ratio. [3] As part of IBRD's Strategic Capital Adequacy framework, a floor level for the E/L ratio is periodically calibrated. The bank manages its balance sheet to ensure that the ratio remains above the floor level.

[3] The IBRD's notion of Usable Equity is the sum of the following items:

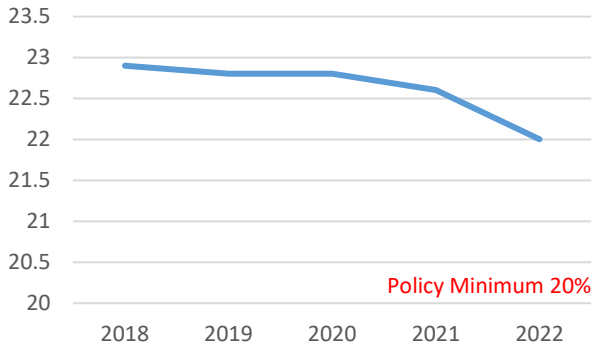
- Usable paid-in capital: It is the sum of US dollar paid-in capital and the National Currency Paid-In Capital (NCPIC) which is subjected to Maintenance-of-Value (MOV) requirements.
- Special Reserve: It is the amount held in liquid form and should be used only for meeting IBRD's liabilities on its borrowings and guarantees according to IBRD's articles.
- General Reserve: It is the retained earnings from previous years based on the approval of the Board.
- Cumulative Translation Adjustments: These are translation adjustments due to the revaluation of euro-denominated balances to US dollars for reporting purposes.

In the past, IBRD operated with a minimum threshold E/L ratio of 23%. In 2014, the target floor was reduced to 20%. This was justified by the institution on the basis that the credit quality of its portfolio had improved since 2008. Recently, IBRD has proposed a reduction in the floor to 19%. The institution has said this would be consistent with increased risk appetite by its shareholders (see World Bank (2023a)).

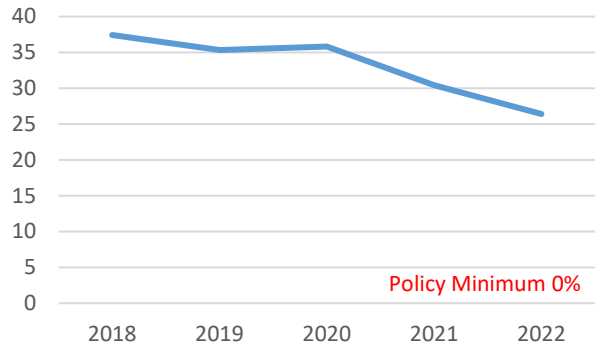
Figure 2.4 Panel a) shows the time path of the IBRD's E/L from 2018 to 2022. The ratio has been stable even during the Covid 19 crisis and has consistently exceeded the policy minimum of 20%.

Figure 2.4: Key Internal Risk Ratios

Panel a) IBRD Equity-to-Loan Ratio



Panel b) IDA DSC as a Percentage of TRA



Note: Units are percent. The source for Panel a) is IBRD (2022) and IBRD (2021). The source for Panel b) is IDA (2022) and IDA (2021).

The numerator of the E/L ratio employed by IBRD is based on the institution's own definition of 'Usable Equity'. This aggregate differs from the Total Equity quantity provided in the institution's financial statements. The latter Total Equity closely resembles what the ratings agencies employ in their rating evaluations (although there are some minor differences).

Figure 2.5 compares the paths of Total Equity and Usable Equity in recent years. The two variables can differ quite significantly. Usable Equity appears more stable. Total Equity declines in 2020 and subsequently rises rapidly. Usable Equity exhibits moderate and steady growth before remaining flat in 2022.[4]

- Other Adjustments: These adjustments are dependent on income earned on Post-employment Benefit Plan (PEBP) assets before FY11, and currency translation adjustments for non-functional currencies.

[4] To compare the dynamics of the two aggregates, one may consider the period from 2021 to 2022. IBRD's Usable Equity increased from $50bn in June 2021 to $50.4bn in June 2022 due to an increase in usable paid-in capital and general reserve by $0.8bn and $0.6bn respectively (see Table F4.1, Panel a)). The gain due to the capital increase was offset by the cumulative translation adjustments by -$1.1bn. In contrast, over the same period (2021 to 2022), the financial-statement aggregate Total Equity[4] grew substantially. Total Equity increased by $7.2bn to a value of $55.3bn in June 2022 (see Table F4.1, Panel b)). The increase in retained earnings was the major contributor and it saw an increase of $4bn, followed by AOCI with an increase of $2.5bn and finally paid-in capital with an increase of $1.3bn. Growth in Usable Equity was less than that of Total Equity mainly because in the allocable income from net earnings, the unrealized mark-to-market gains on non-trading portfolios are removed. These amounted to $3.4bn in FY22. Similarly, the AOCI is also not included in any item of the Usable Equity.

Table F4.1: IBRD Equity Aggregates

Panel a) Usable Equity

Items	2022	2021
Usable paid-in capital	19,352	18,583
Special reserve	293	293
General reserve	32,053	31,464
Cumulative translation adjustment	-1,342	-268
Other adjustments	125	-75
Equity (usable equity)	50,481	49,997

Note: Units are USD million. The source is IBRD (2022)

Panel b) Total Equity

Items	2022	2021
Paid-in capital	20,499	19,244
Non-negotiable, non-interest-bearing demand obligations on account of subscribed capital	- 316	- 332
Receivable amounts to maintain value of currency holdings	- 354	- 343
Deferred amounts to maintain value of currency holdings	- 424	67
Retained earnings	34,997	31,007
Accumulated other comprehensive income (loss)	918	- 1,565
Total equity	55,320	48,078

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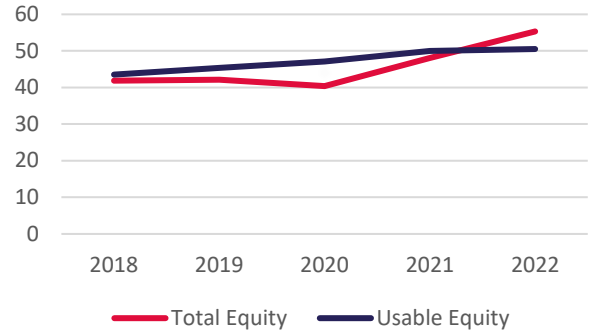
The key financial indicator used by IDA in its balance sheet management is Deployable Strategic Capital (DSC). DSC is defined as the available capital to support future commitments, over and above the current portfolio. DSC is calculated as the difference of Total Resources Available (TRA) and Total Resources Required (TRR), plus a Conservation Buffer (CB). IDA has set the minimum allowable DSC to be 0%.

Figure 2.5: Total Equity and Usable Equity



Note: Units are USD billion. The source for Panel a) is IBRD (2022), IBRD (2020) and IBRD & IDA (2018).

The TRA is the sum of IDA's equity and accumulated provision for loan losses and other exposures. The TRR is the minimum capital required to cover expected and unexpected losses subjected to stress scenario as per the solvency-based capital adequacy model. In broad terms, the TRA is, therefore, the Capital Adequacy Ratio (capital available divided by capital requirement) minus 1 and minus a buffer. Here, the Unexpected Loss is calculated using risk models and, hence, the approach may be characterised as one based on Economic Capital. model. The CB is 10% of TRA. Note that IDA's TRR includes, in addition to classic EC, a loan subsidy valuation adjustment that we discuss further in Section 2.8 below.

The DSC has declined in the past two years from 35.8% in 2020 to 26.4% in 2022, a fall of 9.4% percentage points. The fall in 2022 was essential due to the higher TRR (higher capital requirements to support conditional development grants). The ratio, nevertheless, remains safely above the policy threshold of 0% (see Panel b) of Figure 2.4.

2.5 Portfolio composition

The International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA) provide data on their sovereign exposures in their financial statements. These are based on information for the fiscal year end in June of each year. The exposures analysed here are those contained in the latest annual report dated June 2022.

Table 2.1: Exposures in June 2022

	IBRD	IDA
Outstanding Loans	229,344	177,721
Undisbursed Loans	74,523	71,365
Total EAD	266,606	213,404

Note: The amounts are in millions of USD. CCF of 50% is applied to the undisbursed loans to calculate EAD.

We calculate the total exposure at default (EAD), applying a Credit Conversion Factor (CCF) of 50% to the face value of undisbursed loans, i.e., $EAD = Outstanding\ Loans + 50\% \times Undisbursed\ Loans$. The total EAD for each institution is displayed in Table 2.1. The exposure amounts of the two institutions are broadly comparable although IDA has a somewhat lower volume of outstanding loans.

The loans of IBRD and IDA have very different geographical distributions. The IDA lends to Low-Income Countries (LICs) whereas the IBRD mainly lends to Medium- and High-Income Countries (MICs and HICs).[5] 133 unique countries have loans from either IBRD or IDA. Table 2.2 shows the regional distributions of the two institutions' loan books. Just 14% of IBRD loans by EAD are to African countries whereas the comparable percentage for IDA is 51%. IDA has almost no exposure to Europe and Middle East or to Latin America.

Table 2.2: Number of Exposures and Total EAD per Region and MDB

Region	IBRD				IDA			
	Count	Count (%)	EAD	EAD (%)	Count	Count (%)	EAD	EAD (%)
Africa	17	22%	37,822	14%	45	47%	108,158	51%
Asia	18	23%	96,605	36%	28	29%	96,106	45%
Europe and Middle East	19	24%	51,993	20%	13	14%	4,989	2%
Latin America	24	31%	80,187	30%	10	10%	4,151	2%
Total countries	78	100%	266,606	100%	96	100%	213,404	100%

The effective number of exposures in a portfolio may be measured (approximately) using the inverse of the Herfindahl-Hirschman index[6] (HHI). If they are of equal size, the inverse index equals the number of exposures and otherwise may be thought of as an approximate measure of effective exposure number. Hence, the inverse HHI is often regarded as the notional "equivalent equal-sized exposure number".

For IBRD's sovereign loan portfolio, the inverse HHI is 21.8, whereas it is 19.6 for the sovereign loan portfolio of IDA (see Table 2.3). Hence, one may regard the IBRD and IDA's portfolios are having concentration comparable to portfolios with 22 and 20 equal-sized exposures.

Table 2.3: Inverse Herfindahl-Hirschman Index

	IBRD	IDA
Number of Loans	78	96
Inverse HHI	21.8	19.6

2.6 Statutory and Country Limits

IBRD Articles of Agreement define a Statutory Lending Limit (SLL) which constrains the scale of the institution's total lending. Article 3 (Section 3) of the Articles (see IBRD (2012)) states that: "*The total amount outstanding of guarantees, participations in loans and direct loans made by the Bank shall not be increased at any time, if by such increase the total would exceed one hundred percent of the unimpaired subscribed capital, reserves and surplus of the Bank.*" Hence, the SLL equals the sum of unimpaired subscribed capital, reserves and surplus of IBRD. In contrast, IDA's Articles of Agreement do not specify a Statutory Lending Limits (see IDA (1960)).

In planning its future lending commitments, IBRD makes use of a Sustainable Annual Lending Limit (SALL). The SALL equals the maximum annual commitment level sustainable in real terms for 10 years based on Capital Adequacy Framework and SLL. The SALL is required by the Financial Sustainability Framework (FSF) for all sustainable lending activities and implements an additional buffer to respond to a crisis. The adjusted SALL (SALL-Adj) for the crisis buffer is the upper bound for regular lending.

[5] The IDA website (see https://ida.worldbank.org/en/about/borrowing-countries) reports: "Eligibility for IDA support depends first and foremost on a country's relative poverty, defined as GNI per capita below an established threshold and updated annually ($1,255 in the fiscal year 2023)". IDA also supports some countries, including several small island economies, that are above the operational cut-off, but lack the creditworthiness needed to borrow from the International Bank for Reconstruction and Development (IBRD). Some countries, such as Nigeria and Pakistan, are IDA-eligible based on per capita income levels and are also creditworthy for some IBRD borrowing. They are referred to as "blend" countries." Currently, 75 countries are eligible to receive IDA resources. IBRD lends to 69 middle- and high-income countries.

[6] The Herfindahl-Hirschman index (HHI) is defined as $HHI = \sum_{i=1}^{N} s_i^2$ *where*, N is the number of loans, s_i is the share of each loan and $\sum_{i=1}^{N} s_i = 1$.

In Fiscal Year 2022, the SALL-Adj was $28bn. This has been increased to $36.5bn for Fiscal Year 2023 and it includes an additional board-approved crisis buffer of $5bn and a carryover of unutilised crisis buffer of $4.5bn from Fiscal Year 2022.

The SLL also serves as the basis for a set of country limits within which the IBRD operates. Specifically, IBRD limits exposure[7] to a single country to the lower barrier of two quantities: the Equitable Access Limit (EAL) and the Single Borrower Limit (SBL).

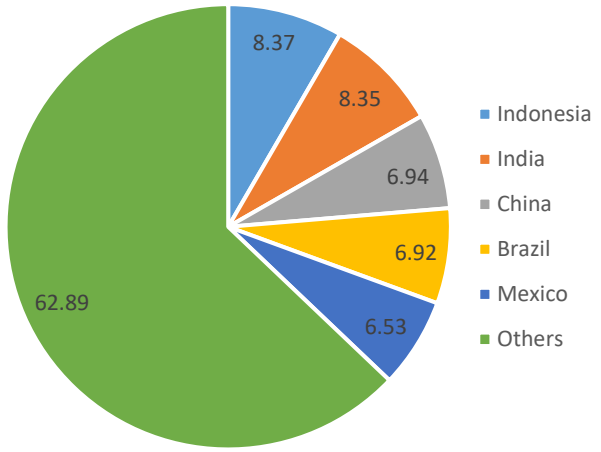
The EAL is 10% of the SLL. In June 2022 SLL was $339bn thus EAL is $34bn. The SBL is the maximum exposure for the most creditworthy and largest borrowing country in terms of population and economic size. The amount is decided by the IBRD based on the impact of SBL on overall portfolio risk relative to equity.

On SBLs, IBRD operates a dual system in that the SBL amount depends on whether the country's income exceeds the Graduation Discussion Income (GDI) or not.[8] For countries with income above the GDI, the SBL is lower. In Fiscal Year 2022, the SBL was $21.2bn for highly creditworthy countries above the GDI and $24.9 for the highly creditworthy countries below the GDI.[9] [10]

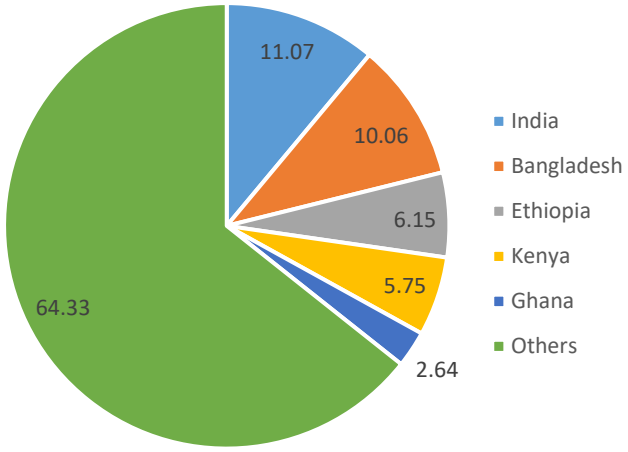
The EAL exceeds the SBL by $10bn, so the SBL is the primary constraint for the IBRD. This makes it more difficult for the IBRD to boost lending to highly creditworthy sovereigns, potentially inducing it to lend more to countries with lower ratings.

Figure 2.6: Country Distributions of Total Outstanding Loan

Panel a) IBRD



Panel b) IDA



Note: The data for Panel a) is based on Total Outstanding Loans as of June 30, 2022, from IBRD (2022). The data for Panel b) is based on Total Outstanding Loans as of June 30, 2022 from IDA (2022).

IDA also operates Single Borrower Limits (SBLs) to reduce portfolio concentration. To determine SBL, IDA relies on Basel maximum exposure limit which constrains exposure to be less than 25% of equity. For Fiscal Year 2023, the IDA SBL is $45bn (25% of $178.7bn equity as measured at end June 2022).
In Fiscal Year 2022, 40% of net outstanding IBRD loans were concentrated in 5 countries (see Panel a) of Figure 2.6). IDA exhibited a similar degree of loan concentration in that around 40% of total outstanding loans were to the top 5 countries.

IBRD reports that four countries had binding SBL limits in Fiscal Year 2022. Two of these were above the GDI threshold and two below. No IDA borrowing countries had binding SBL limits in Fiscal Year 2022. The

[7] The exposures considered are the aggregate balance of outstanding loans, the present value of guarantees, and the undisbursed portion of Deferrer Drawdown Options (DDO) that have become effective, plus other exposures.
[8] GDI is the level of Gross National Income (GNI) at which IBRD starts discussing whether the country has graduated (i.e., able to sustain long-term development without further financing) to be ineligible for borrowing from the IBRD.
[9] There were already four countries at the SBL limit during Fiscal Year 2022, two from above the GDI threshold and two from below.
[10] As part of its response to Covid 19, IBRD waived SBL limits in fiscal year 2022.

exposure to the highest borrowing country, India, is less than half of the SBL. Thus, SBLs do not currently constrain IDA lending decisions.

2.7 Ratings distributions

This section examines credit ratings of the individual countries that borrow from IBRD and IDA. In this, we rely on ratings from the three global agencies, Standard & Poor's, Moody's, and Fitch. However, some countries that borrow from the institutions are not rated by these agencies. To infer ratings for these latter countries, we rely on the ratings provided by the Organisation for Economic Co-operation and Development (OECD). OECD ratings are on a different scale from that employed by the major agencies. So, we convert the OECD ratings to the latter scale using a mapping inferred from a regression of the Standard & Poor's ratings on OECD ratings.

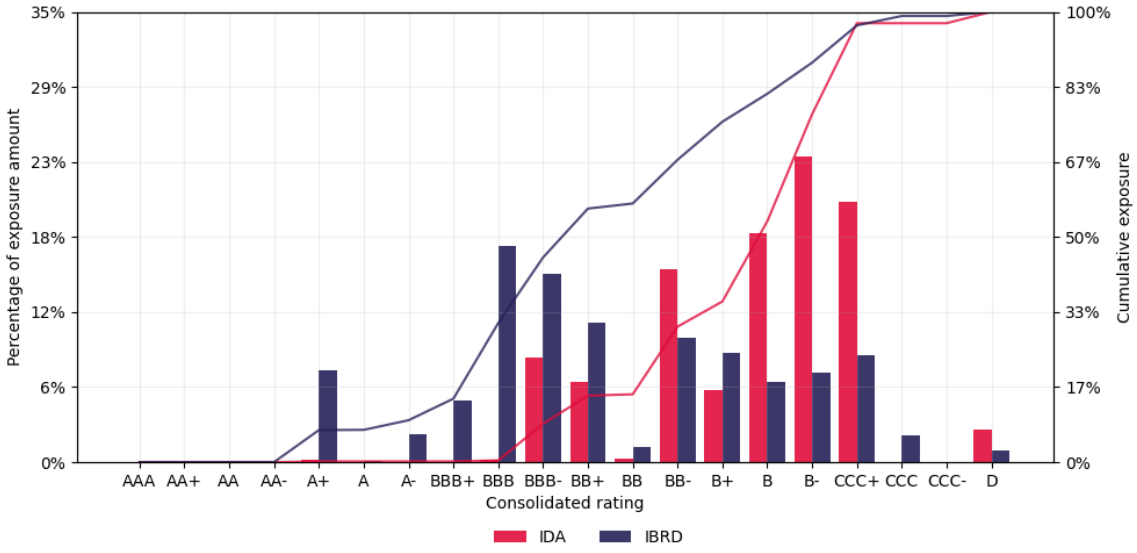
We create a consolidated set of ratings by using in order of preference and depending on availability Standard & Poor's, Moody's, Fitch and transformed OECD ratings. This provides ratings for most countries. Table 2.4 shows the rating coverage of the consolidated data. The coverage in terms of exposure amount is almost complete. Countries that borrow from IDA are less likely to have agency ratings than those that borrow from IBRD.

Table 2.4: Percentage of Exposures with Associated Ratings

MDB	% Loans covered S&P	% Loans covered S&P or Moodys	% Loans covered S&P or Moodys or Fitch	% Loans covered S&P or Moodys or Fitch or OECD	% Cases covered S&P	% Cases covered S&P or Moodys	% Cases covered S&P or Moodys or Fitch	% Cases covered S&P or Moodys or Fitch or OECD
IBRD	96.46%	98.38%	98.38%	99.96%	76.92%	80.77%	80.77%	96.15%
IDA	72.27%	72.27%	72.27%	99.14%	47.12%	48.08%	48.08%	88.46%

Figure 2.7 displays the distribution of ratings. More than half of IBRD's exposure amount is from countries with ratings higher than or equal to BB+. On the other hand, IDA exposures have lower ratings. Half of them being in ratings higher than or equal to B. In IDA's portfolio, there are many countries that do not have an agency rating and we rely on the OECD rating. In most of those cases, the ratings are CCC+, as we can observe in Figure 2.7, this is the rating of a fifth of the portfolio exposure measured in terms of exposure value.

Figure 2.7: Rating Distribution of IBRD and IDA Loan Portfolio



Three countries in IBRD's portfolio are regarded as in default by the rating agencies: Lebanon, Sri Lanka and Suriname. In IDA's portfolio, the agencies similarly regard three countries as being in default: Lebanon, Sri Lanka and Zambia. These countries are not in default to the MDBs according to the MDBs' arrears data, however. We map all ratings below CCC+ (including defaults) to a consolidated rating of "Cs" for use in subsequent sections. Following this approach, the weighted average rating of IBRD's portfolio is BB+/BB and the weighted average rating of IDA's portfolio is B+/B.

2.8 Valuing IDA's interest rate subsidies

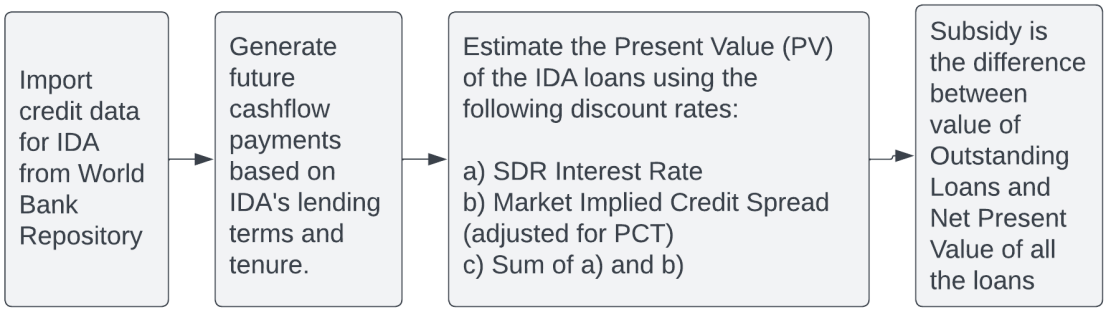
As explained in the introduction, IDA's loans contain substantial subsidy elements in that they carry, in many cases, an interest rate of zero. Such interest rates remunerate neither time preference nor the credit risk associated with possible failures to repay by the institution's sovereign borrowers. The size of the credit risk component is undoubtedly reduced by the de facto seniority that IDA enjoys, commonly referred to as Preferred Creditor Treatment (PCT). But taken together, the fact that lending rates omit both a default free interest rate component and a credit spread means that the value of these loans is substantially less than their par value.

IDA's accounts are, of course, prepared on a going concern basis. The value of IDA's loans may, therefore, be recorded at par on the basis that the loans are financed using the institution's own equity. Implicitly, this argument depends on the fact that the equity is not expected to generate dividends. However, if one wishes to evaluate IDA's assets on a non-going-concern basis, as may be appropriate for credit analysis, one may wish to record loans values less than par.[11] The three major rating agencies do not adjust IDA's loan values (and hence equity) for the institution's loan subsidies. However, IDA chooses to take a conservative approach in its internal capital adequacy analysis in that it adjusts up its Total Required Resources to include the value of loan subsidies. In our analysis below, we shall instead reduce equity resources by the amount of loan subsidies, but the adjustment may be regarded as equivalently conservative (and more conservative than the approach of the rating agencies).

In IDA's balance sheet, loans are recorded at par even though they are issued on concessional or subsidised terms. To allow for this, in its internal risk management, IDA adds an estimate of the subsidy value to the more conventional 'Economic Capital components' of its TRR. IDA (2022) briefly explains this, stating: "*Within the TRR there is also a capital allowance to reflect losses that result from valuing IDA's concessional loan portfolio in present value terms using market interest rates*."

Below, we present the results of our own valuation of the subsidy component in the value of IDA's loan book. The valuation exercise we perform starts from granular data on individual IDA loans provided by the World Bank Repository (2023). To obtain results consistent with our other calculations, we include all loans contained in IDA's loan portfolio on 30th June 2022.

Figure 2.8: Subsidy Estimation Approach

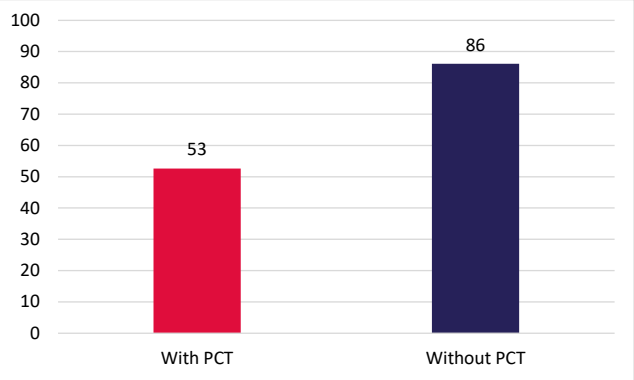


The approach followed in estimating the subsidy element is explained in Figure 2.8. From the repository data, we construct cashflow payment profiles loan-by-loan using the loan terms recorded on the WBG website. We discount these cashflows to end-June 2022 using SDR interest rate term structures to which we add credit spreads. The credit spreads are derived from market sovereign credit spreads but adjusted for PCT.

We compute the subsidy element in the value of the loan book to be $52.58 bn when SDR interest rates and PCT-adjusted credit spreads are included in the discount factors. This compares to the value of IDA's concessional lending of $171.90 bn. (Including non-concessional lending, the loan book value recorded in the accounts is $178.04 bn.) When credit spreads are employed that do not adjust for PCT, the subsidy element rises to $86.09 bn (see Figure 2.9).

[11] For example, Standard & Poor's does not reduce the numerator of the RAC ratio because of the loan subsidy element.

Figure 2.9: Comparison of Subsidy with and without PCT

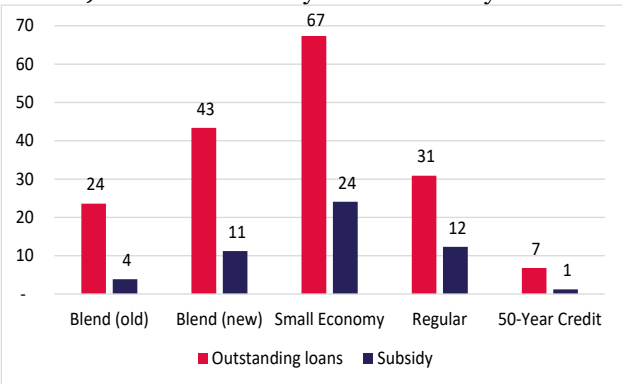


Note: The unit of Y-axis is USD billion.

One may split the subsidy element down by loan types as shown in Panel a) of Figure 2.10. The largest fraction of IDA's outstanding loans is provided under 'Small Economy' terms. This category contributes 46% of total subsidy. Panel b) of Figure 2.10 shows how the subsidy element in the end-June 2022 portfolio value is distributed across individual calendar year loan issuance. The peak contribution to the total subsidy is attributable to loans originated between 2011 and 2020. The average subsidy per year during 2012-2020 (both inclusive) is $3.07bn, compared to the lifetime average per year (i.e., 1972-2022) of $1.03bn. These calculations show the loan vintages in the end-June 2022 portfolio that contributed most to the total subsidy element. Since loans in earlier periods have fully or partly matured, one cannot deduce from this whether subsidisation has increased.

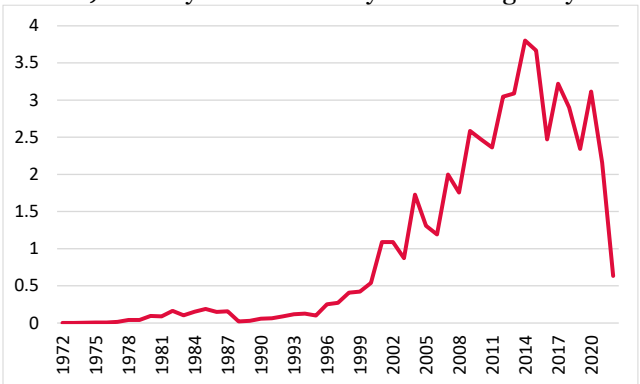
Figure 2.10: Distribution of Subsidy in end-June 2022 Portfolio

Panel a) Value and subsidy distribution by terms



Note: 'Blend (old)' also includes 'hard term' loans which were discontinued in 2017. Units on the vertical axis are in USD billions. The subsidy is adjusted for PCT.

Panel b) Subsidy distribution by loan vintage in yrs.



Note: The data is up to 30 June 2022. Units on the vertical axis are USD billions. The subsidy is adjusted for PCT. The vintages are defined by calendar years.

3. Rating Analysis of IBRD and IDA

3.1 MDB ratings

This section analyses the ratings of IBRD and IDA provided by the three global rating agencies, Standard & Poor's, Moody's, and Fitch. We consider how these ratings would evolve if the two MDBs' expanded their Development Related Assets (DRAs) and Treasury Assets, financed by additional borrowing without changes in their Total Equity or Callable Capital.

To understand the agencies' ratings, we replicate the process that the agencies go through in determining the components of their respective scorecards. The approach takes as inputs granular data on the assets, liabilities, and financial variables of the MDB in question. IBRD and IDA publish some of this data in their annual reports. Some data are missing, however, for example the maturities of individual loans and Treasury assets.

So, we are obliged to make reasonable assumptions based on the aggregate information provided. Again, the agencies' reports on MDB ratings assessments provide partial information on intermediate findings. Where information is available, we match the values provided by the agencies and otherwise, we make assumptions.

3.2 Data collection

We employ publicly available data contained in financial statements posted on the World Bank Group website (see IBRD(2022) and IDA (2022)). We utilize the most recent financial statements available, dated end June 2022. The financial statements include Development Related Assets (DRAs) broken down by country with information on disbursed and undisbursed amounts. Information is available for equity (segregated by callable and subscribed capital) for each member country.

In addition to data from the financial statements, we collect ratings for the sovereigns represented either in the portfolio or in the shareholders list. The ratings data coincide with the date of the financial statements, providing a snapshot of the IBRD and IDA portfolio at end June 2022.

To replicate the Standard & Poor's RAC calculation requires a correlation matrix for individual countries risk factors. To estimate a correlation matrix, we employ log changes in MSCI equity indices for countries.[12] Detail s of the MSCI indices employed are provided in the appendix.

Some other information is needed to populate the data required by the rating application. In particular, the rating agencies make qualitative judgments. In the case of Moody's these are mostly stated explicitly as questions in the methodology document. The possible answers are often binary or envisage several possible answers (e.g., the MDB is deemed to be high, medium, or low in some respect).

The Moody's methodology, in most cases, provides guidance on how much intermediate results should be adjusted by one or more plus or minus categories following answers to the questions. The other agencies (especially Fitch) make use of judgmental elements in a less transparent way. In these cases, our approach is to express the judgmental adjustment in the form of a clear question with a categorical answer that we map into a set of adjustments in intermediate results. This technique may be regarded, ion very general terms, as following the approach of Moody's in which qualitative questions determine which branch to select in a well-defined decision-tree.

One area in which it is necessary to make assumptions is the quantitative liquidity indicators the agencies employ. This is the case because information is lacking on the maturity of the two institutions' assets and liabilities. Starting from the aggregate information on maturity that the institutions provide in their financial statements, we infer a reasonable set of maturities for country loan exposures. In Box 3.1, we discuss issues specific to each of the rating agencies. Additional agency-specific data issues are discussed in Appendix 1.

3.3 Current and possible future ratings

As mentioned in the previous section, we take the data from 2022 as a starting point for the scenarios that we analysis in this exercise. In this, we employ the latest rating reports as available in March 2023 (for IBRD see S&P (2023a), Moody's (2023a) and Fitch (2023); for IDA see IDA S&P (2023b) and Moody's (2023b)). IBRD and IDA have the highest rating for the three rating agencies (AAA for S&P and Fitch and Aaa for Moody's).

The rating agencies specify in their reports, which factors are most likely to lead to a change in rating. In the case of IBRD, Standard & Poor's suggests that the two main reasons there could be a downgrade would be if there were more aggressive financial policies and if the members were to stop treating IBRD as a preferred creditor. The agency emphasises the fact that IBRD has substantial eligible callable capital that would keep the RAC ratio above 23%.

Moody's emphasise capital adequacy as a driver of a potential downgrade. Moody's capital adequacy is driven by the leverage ratio. This would certainly increase DRAs were to grow substantially. Another factor mentioned by Moody's is that could potentially lead to a downgrade is loss of the shareholder support that the IBRD currently enjoys.

Fitch identifies the Solvency Factor as a potential source of a downgrade. The Fitch Solvency Factor depends on the two sub-factors Capitalisation and Risks. Capitalisation is based on three ratios, the Equity to Assets ratio,

[12] Information on these indices may be found at https://www.msci.com/equity-fact-sheet-search

the ratio of Usable Capital to RWA and the Return on Equity (ROE). As we will see below, the Capitalisation Factor worsens if DRAs grow. The Risk element of the Solvency Factor could worsen due to greater concentration or a weakening of the credit quality of the portfolio.

In the case of IDA, Standard & Poor's state that their rating has a stable outlook and very low chance of suffering a downgrade. The downside scenario in which the IDA rating might be downgraded is if the RAC ratio fell below 23%. (IDA does not have Callable Capital which could provide uplift.) Another possible downgrade scenario is that liquidity deteriorate.

For IDA, the factors that could lead to a downgrade in the Moody's rating are the deterioration of IDA's capital adequacy through a default of a large borrower or if one of the key donor countries significantly reduced its contributions. However, Moody's affirms that IDA's credit metrics are very likely to remain stable if there is an expansion in leverage. This will be tested in the analysis in the next section.

Table 3.1: Current Ratings

Panel a) Standard & Poor's

Rating results / Year	2022	2023
IBRD		
Issuer Credit Rating - Foreign Currency	AAA/Stable/A-1+	AAA/Stable/A-1+
Enterprise risk profile	Extremely Strong	Extremely Strong
Policy importance	Very Strong	Very Strong
Governance and management expertise	Strong	Strong
Financial risk profile	Extremely Strong	Extremely Strong
Capital adequacy	Extremely Strong	Extremely Strong
RAC Ratio	27.2%	25.9%
Funding and liquidity	Strong	Strong
IDA		
Issuer Credit Rating - Foreign Currency	AAA/Stable/A-1+	AAA/Stable/A-1+
Enterprise risk profile	Extremely Strong	Extremely Strong
Policy importance	Very Strong	Very Strong
Governance and management expertise	Strong	Strong
Financial risk profile	Extremely Strong	Extremely Strong
Capital adequacy	Extremely Strong	Extremely Strong
RAC Ratio	70.0%	68.8%
Funding and liquidity	Strong	Strong

Panel b) Moody's

Rating results / Year	2021	2022
IBRD		
Scorecard-Indicated Outcome Range	Aaa-Aa2	Aaa-Aa2
Adjusted intrinsic financial strength	aa1	aa1
Strength of member support	Very High	Very High
Preliminary intrinsic financial strength	aa2	aa2
Qualitative adjustments	+1	+1
Capital adequacy	a1	a1
Liquidity and funding	aa1	aa3
IDA		
Scorecard-Indicated Outcome Range	Aaa-Aa2	Aaa-Aa2
Adjusted intrinsic financial strength	aa1	aaa
Strength of member support	High	High
Preliminary intrinsic financial strength	aa2	aa1
Qualitative adjustments	+1	+1
Capital adequacy	a1	aa3
Liquidity and funding	aaa	aaa

Panel c) Fitch

Rating results / Year	2021	2022
IBRD		
Capitalization	Strong	Strong
Risks	Low risk	Low risk
Solvency	aa	aa
Liquidity	aaa	aaa
Business environment	Low risk	Low risk
Extraordinary Support	aa-	aa-
Rating	AAA	AAA

Note: IDA is not rated by Fitch.

3.4 Lending growth scenarios

We begin by calibrating a data set of granular data for each of the two MDBs so that the institutions' ratings (and all published intermediate indicators) match those published by the rating agencies in their latest rating assessment reports.

We then design a set of scenarios in which loans increase in proportion to the current portfolio. In our software, we define 300 scenarios in which the loan portfolio grows by 1% increments. For each percentage we calculated the rating and its intermediate elements and components. To avoid deterioration in the liquidity metrics that the agencies use as inputs to their rating evaluations, we assume that Treasury assets grow in proportion to the increase in loans. Borrowing increases to finance the higher DRA and Treasury assets while equity is assumed to remain constant.

In addition to the changes in DRA and Treasury assets just described, we expect that the agencies would change some qualitative ratings factors as the institutions adopted the new policy of loan portfolio growth. We represent these qualitative factors as responses to questions. For each agency, we adopted assumptions about how the answers to the questions would change as the portfolio grows[13]. The changes are displayed in Table 3.2, Table 3.5, and Table 3.8. For a portfolio change less than 50%, we assume that the qualitative factors would not

[13] Scenarios where the qualitative questions are not modified were calculated as well, the results can be found in the appendix.

change so the answers to the questions would remain as they were. For lending increases from 50% to 150%, we assume a particular set of changes in the answers. For increase greater than 150%, we assume that the answers change even more.

The purpose of examining different scenarios is to identify the thresholds at which the ratings change. As we increase the loans the capital adequacy indicators face more stress until they finally lead to a downgrade of the ratings. In later subsections, we discuss the results for each individual rating agency. In each case, these follow the same structure.

Take as an example
Table 3.3. In the left-hand column, one may observe the maximum growth before one of the indicators in one of the right-hand columns is downgraded. For example, take the first value in the left-hand column in
Table 3.3, i.e., 75. This indicates that, the DRAs and Treasury assets may increase up to 75% until a downgrade occurs in "Capital Adequacy." When the downgrade in a metric implies a downgrade in the overall final rating it is highlighted in red.

3.5 Standard & Poor's findings

As the scale of lending increases, the Standard & Poor's ratings for IBRD and IDA tend to deteriorate because of two different factors: (a) Capital Adequacy and (b) Liquidity and Funding. Capital Adequacy is initially evaluated based on the RAC ratio and is then notched (up or down) depending on loan performance and additional qualitative elements of the RAC ratio. The Liquidity and Funding factor is calculated using the funding rating for 6 and 12-month horizons and the gap ratio.

The liquidity ratio would deteriorate very substantially if an MDB increased DRAs only. In this case, borrowings would grow to finance the additional and outflows would exceed inflows.[14] To offset a deterioration in liquidity metrics, we assume that Treasury assets grow in proportion to the DRA. As we can see in
Table 3.3 and Table 3.4 the liquidity ratio for 12 months nevertheless deteriorates somewhat as we increase the DRAs and Treasury assets.

Table 3.2: Assumed worsening of qualitative question answers for the Standard & Poor's assessment

Factor	Sub-factor	Question	Original response	After 50% portfolio growth	After 150% portfolio growth
Loan performance and risk management	Aggressive recent organic growth	Has the Bank achieved more aggressive recent organic growth and more significant prospects for future growth than in the past, compared with other MLIs in similar regions?	No	Yes	
	Conservative risk tolerances	Compared to other MLIs, does the Bank boast stronger conservative risk tolerances and underwriting standards during periods of growth or changes in exposure (notably while fulfilling its countercyclical lending role)?	Yes		No
	Aggressive risk tolerances	Compared to other MLIs, does the Bank follow more aggressive risk tolerance policies?	No		Yes
	Weaker loan conditionality	Does the Bank have weaker loan conditionality relative to peers?	No		Yes
Liquidity	Liquidity status trend	What trend does the Bank expect in its liquidity status?	Stable	Deteriorating	

The capital adequacy and liquidity and funding factors are combined into the financial risk profile. Subsequently the financial risk profile is combined with the enterprise risk profile, the enterprise risk profiles is not affected through this exercise, for both the IBRD and IDA the enterprise risk profiles are "extremely strong."

[14] In the current case, the IBRD has liabilities of $262 bn and equity of $55 bn, DRAs are $227 bn out of Total Assets of $317 bn. When DRAs rise by one percent one must increase liabilities by 0.86%. In the case of the IDA liabilities are $41 bn and equity is $178 bn, while DRAs are $178 bn. If DRAs rise by 1%, one must increase borrowings by 4.3% to balance the rise. This adjustment of course leads to a rapid worsening in the liquidity metrics.

As we can see in
Table 3.3 and Table 3.4, the RAC ratio falls as the DRA and Treasury assets grow. The capital adequacy of the IBRD changes from its initial evaluation of "Extremely strong" to "Moderate". The points at which the values change are shown in the left-hand column of the tables. For increases up to 150%, the decline in the RAC ratio is not enough to generate a downgrade in capital adequacy. Instead, the worsening of the qualitative question which is assumed to happen at that level of portfolio expansion is what leads to the capital adequacy downgrade.

An overall rating downgrade for IBRD occurs after the DRAs and Treasury assets increase by 278%. In this case, capital adequacy goes from "Adequate" to "Moderate" which leads to a deterioration in the Stand-Alone Credit Profile (SACP) to a+. The enhanced financial risk profile that results from allowing for the Callable Capital provides an uplift that results in the final rating being AA+.

Table 3.3: Changes in the Standard & Poor's IBRD Rating as DRA and Treasury assets grow

DRA + Treasury growth (%)	RAC (%)	12 month liquidity	Capital Adequacy	Liquidity and Funding	Financial Risk Profile	Enterprise Risk Profile	SACP	Enhanced RAC (%)	Enhanced Financial Risk Profile	Enhanced SACP	Indicative ICR	Final ICR
0	25.96	204.04	Extremely strong	Strong	Extremely strong	Extremely strong	aaa	45.7	Extremely strong	aaa	aaa	AAA
75	14.99	189.47	Very strong		Very strong			26.4				
150	10.54	184.28	Strong		Strong		aa+	28.5				
164	9.98	183.66	Adequate		Adequate		aa	32.9				
278	6.99	180.38	Moderate		Moderate		a+	28.6			aa+	AA+

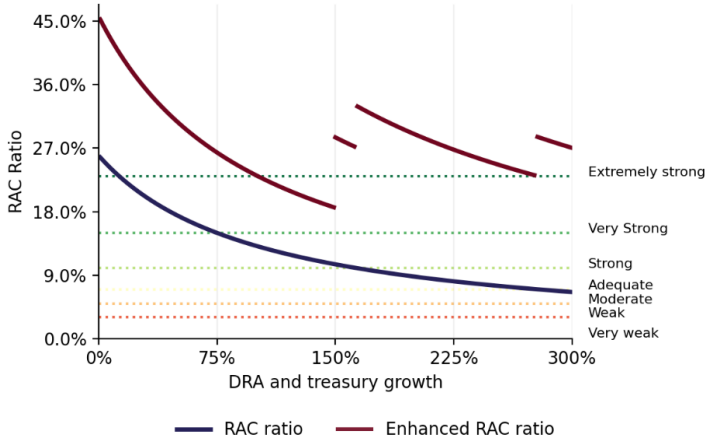
Note: Here it is assumed that the maximum uplift from callable capital is three notches. This is implied by the Very Strong Policy Importance. Other qualitative issues (including confidence in legal arrangements for the callable capital) may lead the Enhanced FRP to be notched up or down. But the Enhanced FRP is so strong for IBRD that this is not an issue.

Table 3.4: Changes in the Standard & Poor's IDA Rating as DRA and Treasury assets grow

DRA + Treasury growth (%)	RAC (%)	12 month liquidity	Capital Adequacy	Liquidity and Funding	Financial Risk Profile	Enterprise Risk Profile	SACP	Enhanced RAC (%)	Enhanced Financial Risk Profile	Enhanced SACP*	Indicative ICR	Final ICR
0	71.0	239.8	Extremely strong	Strong	Extremely strong	Extremely strong	aaa	71.0	Extremely strong	aaa	aaa	AAA
27	56.1	125.7		Adequate	Very strong			56.1	Very strong			
50	47.6	98.9		Moderate	Strong		aa+	47.6	Strong	aa+		
212	23.0	61.4	Very strong		Adequate		aa	23.0	Adequate	aa	aa+	AA+

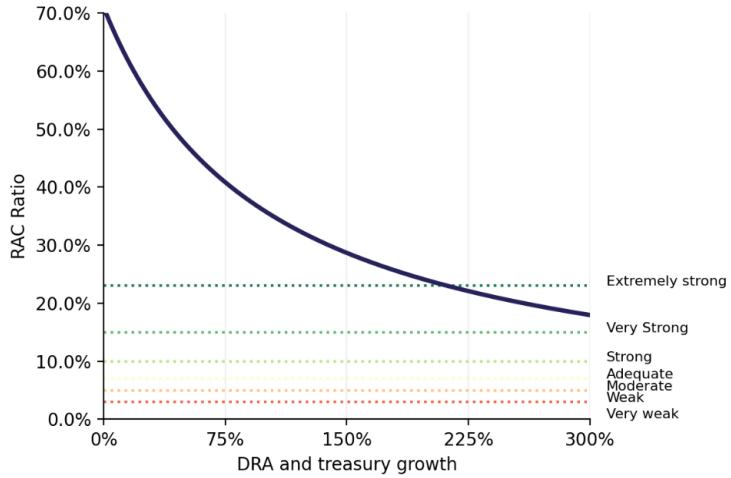
Note: IDA does not have callable capital therefore the enhanced Financial Risk Profile is not changed by eligible callable capital.

Figure 3.1: RAC ratio and enhanced RAC ratio for IBRD portfolio



Note: The enhanced RAC ratio includes the eligible callable capital in the calculation, the jumps in the enhanced RAC ratio are produced by the fact that the SACP rating deteriorates and therefore more callable capital becomes eligible. Eligible callable capital is all the callable capital from shareholders that have the same or higher rating as the SACP.

Figure 3.2: RAC ratio for IDA portfolio



Note: IDA has no callable capital so there is no enhance RAC ratio calculation.

3.6 Moody's findings

Similar as with Standard & Poor's we modify questions that we consider would be deteriorated after the increase of DRA and treasury portfolio. These questions are displayed in Table 3.5.[15]

Table 3.5: Assumed worsening of qualitative question answers for Moody's assessment

Factor	Sub-factor	Question	Original response	After 50% portfolio growth	After 150% portfolio growth
Leverage ratio	Trend	In the next 2 years, what is the expected change in the Bank's leverage?	Slight increase	Moderate increase	Significant increase
Development asset credit quality		In the next 2 years, what is the expected change in the quality of development assets?	Significant increase	Stable	Moderate decrease
Asset performance		In the next 2 years, what is the expected change in the performance of assets?	Moderate increase	Stable	Slight decrease
Availability of liquid resources		How strong is the liquidity asset coverage for a horizon beyond 18 months?	Slight weak	Weak	Very weak

Table 3.6: Changes in the Moody's IBRD Rating as DRA and Treasury assets grow

DRA + Treasury growth (%)	Leverage ratio (%)	Capital adequacy	Liquidity and funding	Preliminary intrinsic financial strength	Qualitative adjustments	Adjusted intrinsic financial strength	Contractual support ratio (%)	Strength of member support	Scorecard Indicated
0	455	a1	aa1	aa2	+1	aa1	122	Very high	Aaa
9	468	a2		aa3		aa2	110		
30	534	a3					90		
50	616	baa2		a1		aa3	77		
71	702						66	High	Aa1
112	870	baa3					53		
150	1026	ba2		a2		a1	44		Aa2

The results for the Moody's ratings displayed in Tables 3.6 and 3.7 may be interpreted as follows:

- The Moody's rating is downgraded after the portfolio has increased by 71%. The downgrade to AA+ is driven first by the deterioration in capital adequacy and in the contractual support ratio to 60%. There is a further downgrade to AA after an expansion of 150% driven by the leverage ratio and deterioration in qualitative questions related to capital adequacy.
- IDA does not suffer a downgrade even when DRAs and Treasury assets rise by 3x. The capital adequacy deteriorates to baa2. Despite this, other aspects of the rating retain their AAA rating quality.

[15] Scenarios where the qualitative questions are not modified was calculated as well, the results can be found in the appendix.

Table 3.7: Changes in the Moody's IDA Rating as DRA and Treasury assets grow

DRA + Treasury growth (%)	Leverage ratio (%)	Capital adequacy	Liquidity and funding	Preliminary intrinsic financial strength	Qualitative adjustments	Adjusted intrinsic financial strength	Contractual support ratio (%)	Strength of member support	Scorecard Indicated
0	100	aa1	aaa	aaa	+1	aaa	0	High	Aaa
18	118	aa2		aa1					
50	150	a1		aa2		aa1			
74	173	a2							
118	217	a3							
150	249	baa1	aa1	aa3		aa2			
151	250			a1		aa3			
201	300	baa2							

3.7 Fitch findings

A couple of questions were modified to have a realistic scenario. These cases are displayed in Table 3.8.[16]

Table 3.8: Assumed worsening of qualitative question answers for the Fitch assessment

Factor	Sub-factor	Question	Original response	After 50% portfolio growth	After 150% portfolio growth
Capitalisation	Leverage plans	Does the Bank plan to change its leverage in the near future?	No material change	Increase	
Strategy	Growth speed	How is the Bank's growth speed in operations relative to its resources?	Moderate	Rapid	

Table 3.9: Changes in the Fitch IBRD Rating as DRA and Treasury assets grow

DRA + Treasury growth (%)	Equity to assets ratio	Capital to RWA ratio	Capitalisation	Risks	Solvency assessment	Liquidity assessment	Business environment	Business environment adjustment	Intrinsic rating	Extraordinary support	Rating
0	17	66	Strong	Low	aa	aaa	Low risk	2	aaa	aa-	AAA
68	10	39									
89	9	35	Moderate		a				aa-	a	AA-
164	7	25	Weak		bbb				a-		A

Table 3.10: Changes in the Fitch IDA Rating as DRA and Treasury assets grow

DRA + Treasury growth (%)	Equity to assets ratio	Capital to RWA ratio	Capitalisation	Risks	Solvency assessment	Liquidity assessment	Business environment	Business environment adjustment	Intrinsic rating	Extraordinary support	Rating
0	81	104	Excellent	Low	aa	aaa	Low risk	2	aaa	a	AAA
228	25	32	Strong		a				aa-		AA-

The findings for the Fitch ratings as shown in Table 3.9 and 3.10 may be explained as follows.

- IBRD's Fitch rating is downgraded if the portfolio increases by more than 89%. This is driven both by the equity to assets ratio and the RWA ratio. IBRD does not enjoy uplift from callable capital because the contractual support rating is just aa-.
- IDA is not rated by Fitch. If it were rated, we calculate that it would be AAA rated. It would be downgraded from this if the portfolio increased by 228%. As for IBRD, the downgrade is driven by capitalisation.

3.8 Buffer analysis

In this subsection, we display results when ratings are downgraded in line with a worst-case crisis scenario. Appendix 8 provides more details of how this scenario is constructed but, in brief, it combines the sovereign rating downgrades that occurred both in the Covid 19 crisis and the Global Financial Crisis of 2007-9. We also assume that the answers to qualitative questions worsen as in the last subsection. The scenario may be viewed as conservative as it combines both a banking crisis with a pandemic and deterioration in the qualitative questions.

[16] Scenarios where the qualitative questions are not modified was calculated as well, the results can be found in the appendix.

Table 3.11: Changes in the Standard & Poor's IBRD rating with asset growth and crisis scenario

DRA + Treasury growth (%)	RAC (%)	12 month liquidity	Capital Adequacy	Liquidity and Funding	Financial Risk Profile	Enterprise Risk Profile	SACP	Enhanced RAC (%)	Enhanced Financial Risk Profile	Enhanced SACP	Indicative ICR	Final ICR
0	25.96	204.04	Extremely strong	Strong	Extremely strong	Extremely strong	aaa	45.7	Extremely strong	aaa	aaa	AAA
68	14.92	190.21	Very strong		Very strong			26.3				
150	10.07	184.28	Strong		Strong		aa+	27.3				
152	9.99	184.19	Adequate		Adequate		aa	33.0				
261	7.00	180.73	Moderate		Moderate		a+	28.2			aa+	AA+

Table 3.12: Changes in the Standard & Poor's IDA rating with asset growth and crisis scenario

DRA + Treasury growth (%)	RAC (%)	12 month liquidity	Capital Adequacy	Liquidity and Funding	Financial Risk Profile	Enterprise Risk Profile	SACP	Enhanced RAC (%)	Enhanced Financial Risk Profile	Enhanced SACP	Indicative ICR	Final ICR
0	70.98	239.75	Extremely strong	Strong	Extremely strong	Extremely strong	aaa	71.0	Extremely strong	aaa	aaa	AAA
27	55.26	125.66		Adequate	Very strong			55.3	Very strong			
50	46.88	98.93		Moderate	Strong		aa+	46.9	Strong	aa+		
208	22.95	61.73	Very strong		Adequate		aa	23.0	Adequate	aa	aa+	AA+

Table 3.13: Changes in the Moody's IBRD rating with asset growth and crisis scenario

DRA + Treasury growth (%)	Leverage ratio (%)	Capital adequacy	Liquidity and funding	Preliminary intrinsic financial strength	Qualitative adjustments	Adjusted intrinsic financial strength	Contractual support ratio (%)	Strength of member support	Scorecard Indicated
0	455	a1	aa1	aa2	+1	aa1	122	Very high	Aaa
9	468	a2		aa3		aa2	110		
30	534	a3					90		
50	616	baa2		a1		aa3	77		
71	702						66	High	Aa1
112	870	baa3					53		
150	1026	ba2		a2		a1	44		Aa2

Table 3.14: Changes in the Moody's IDA rating with asset growth and crisis scenario

DRA + Treasury growth (%)	Leverage ratio (%)	Capital adequacy	Liquidity and funding	Preliminary intrinsic financial strength	Qualitative adjustments	Adjusted intrinsic financial strength	Contractual support ratio (%)	Strength of member support	Scorecard Indicated
0	100	aa1	aaa	aaa	+1	aaa	0	High	Aaa
18	118	aa2		aa1					
50	150	a1		aa2		aa1			
74	173	a2							
118	217	a3							
150	249	baa1	aa1	aa3		aa2			
151	250			a1		aa3			
201	300	baa2							

Table 3.15: Changes in the Fitch IBRD rating with asset growth and crisis scenario

DRA + Treasury growth (%)	Equity to assets ratio	Capital to RWA ratio	Capitalisation	Risks	Solvency assessment	Liquidity assessment	Business environment	Business environment adjustment	Intrinsic rating	Extraordinary support	Rating
0	17	66	Strong	Low	aa	aaa	Low risk	2	aaa	aa-	AAA
68	10	37									
77	10	35	Moderate		a				aa-	a	AA-
148	7	25	Weak		bbb				a-		A

Table 3.16: Changes in the Fitch IDA rating with asset growth and crisis scenario

DRA + Treasury growth (%)	Equity to assets ratio	Capital to RWA ratio	Capitalisation	Risks	Solvency assessment	Liquidity assessment	Business environment	Business environment adjustment	Intrinsic rating	Extraordinary support	Rating
0	81	104	Excellent	Low	aa	aaa	Low risk	2	aaa	a	AAA
228	25	32	Strong		a				aa-		AA-

3.9 Rating conclusions

The agency's assign ratings in different ways that do not give the same weight to increases in DRA and Treasury assets. Even comparing the results for IBRD and IDA, the constraints represented by the three agencies differ significantly. The analysis shows that the main constraints (using the conservative results from Buffer Analysis section) are Moody's and Fitch for IBRD, in that the bank loses the topmost rating after expansion of 71% for Moody's (see Table 3.13) and 77% for Fitch rating (see Table 3.15). IBRD has considerable room to increase its assets as far as the Standard & Poor's rating is concerned since the highest rating is only lost when the expansion exceeds 261%.

For IDA, the first rating constraints is encountered when growth exceed 208% at which point the Standard & Poor's rating is downgraded. As Figure 3.2 shows, IDA's high RAC ratio ensures strong capital adequacy even in the absence of Callable Capital. The Moody's rating is unaffected even when the assets are assumed to grow to a multiple of their current values.

4. Capital Calculations of IBRD and IDA

4.1 Introduction

This section presents analysis of the credit risk capital of IBRD and IDA based on public data. The analysis employs an industry standard approach to computing Economic Capital (EC). This model is 'ratings-based' in the sense that the default probability of each loan is assumed to be summarised by its rating and the future path of ratings is simulated using Monte Carlo methods.[17]

The model is calibrated again using industry standard methods. Key aspects of the calibration are the estimation of sovereign default probabilities and LGDs and the calculation of correlations that employed in simulating correlated common risk factors driving the ratings. Several aspects of the calibration are repeated using alternative methods. This sensitivity analysis is performed in order to check the robustness of the conclusions.

The model is used to generate estimates of credit risk EC. Note that EC more generally should cover other dimensions of risk, most notably market, operational and pension risk. For other MDBs whose EC calculations we have reviewed in the past, credit risk EC contributes much the largest share of total EC. (The share may range up to 90%.) This reflects the fact that MDBs have very little appetite for market risk and are relatively little subject to operational risk.

To generate required capital estimates, the model yields statistics that commonly serve as the basis of capital. Specifically, these statistics are Value at Risk (VaR), the loss that is exceeded on some fraction of occasions if a portfolio is held for a given time, and Expected Shortfall (ES), which is the average loss conditional on the loss exceeding the VaR.

In the results we present below, required capital estimates are computed

- using as the basis either VaR or ES,
- under different confidence levels (1, 3 and 10 basis points which may be regarded as AAA, AA and A-grade confidence levels, respectively),
- with different calibrations (with and without PCT in the PDs and LGDs employed),
- inclusive of randomness in LGDs or not, and
- subject to different sensitivity-test-style changes in methodology.

Collectively, we believe that these capital estimates provide a rounded understanding of the credit risk EC needs of the two institutions.

4.2 Parameter assumptions in the capital calculations

We calculate required capital using a base set of parameters and then perform sensitivity analyses by changing each parameter and comparing the results.

[17] Ratings are assumed to be distributed as a time-homogeneous Markov chain. From one period to the next, this implies that ratings are multinomial distributed. Using a Monte Carlo approach, the evolution of the ratings of a portfolio of loans is simulated.

The parameter that we vary (all of which influence the calculated capital requirement) are as follows[18]:

1. Confidence level of the capital calculation – we consider 1, 3 and 10 basis points. These may be thought of as corresponding to AAA, AA and A confidence levels. Single A is the confidence level to which the Basel capital rules are calibrated.
2. Credit ratings for each individual country – we use, as in the previous section, in order of preference Standard & Poor's, Moody's, Fitch and ratings inferred from OECD ratings.
3. Transition matrix (TM) which describes the transition probabilities from one rating to another rating and probabilities of default (PDs) – we employ three transition matrix these are, the first TM is based on historical TM from S&P (2022b), the second is PCT adjusted transition matrix based on Risk Control (2022), and the last TM is based on the historical non-accrual data of the sovereigns from 4 regional MDBs as a sensitivity analysis[19] for the second transition matrix PCT adjusted PDs.
4. Correlation matrix between the regions – we consider two correlation matrixes based on regional equity indices and regional spread of the bonds.
5. Idiosyncratic risk weights – we use two idiosyncratic risk wrights corresponding to the two correlation matrixes, i.e., (i) Equity-based idiosyncratic risk weights and (ii) Spread-based idiosyncratic risk weights.
6. Loss given defaults (LGDs) – we employ four different LGDs based on the combination stochastic and PCT adjustments as follows: (i) Non-stochastic without PCT adjustment, (ii) Non – stochastic with PCT adjustment, (iii) Stochastic without PCT adjustment, and (iv) Stochastic with PCT adjustment.
7. LGD volatilities parameters – we account for the volatilities in the stochastic LGD case based on Cruces and Trebesch (2013), we assume two different set of parameters based on without PCT adjustment and with PCT adjustment.

The parameters listed above affect required capital. We also consider different definitions of capital resources, most notably:

(i) Total Equity (paid in capital and reserves) and
(ii) 'Adjusted Capital' equal to the sum of Total Equity plus eligible Callable capital.

Here, Eligible Callable Capital is callable equity held by shareholders with a rating no less than the standalone rating of the institution we are considering. For simplicity, we here take the standalone rating to be the current rating of IBRD and IDA, i.e., AAA.

4.3 Required capital estimates for the two institutions

As base case capital calculations, we report the results using:

- Transition matrices with and without PCT adjustments,
- Both stochastic and non-stochastic LGDs with and without PCT adjustments,
- Equity-based correlation matrix and idiosyncratic weights.

Since we do not have the exact maturities of the loans that are in the portfolios of IBRD and IDA, we assume that all loans have 1-year maturity for one set of results and 3-year maturity for another set. We run 1 million simulations for each case. Value-at-Risk (VaR) and Expected Shortfall (ES) results are given in Table 4.1 for 1-year maturities and in Table 4.2**Error! Reference source not found.** for 3-year maturities.

[18] The calibration of the different parameters used in available in Appendix 3.
[19] See Appendix 4 for the methodology used in estimating PDs using historical non-accrual data.

Table 4.1: VaR and ES Results with 1-year Maturities

	IBRD				IDA			
	with PCT		without PCT		with PCT		without PCT	
	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs
Total exposure	266,606				213,404			
Total equity	55,320				178,668			
Eligible callable capital	42,062				0			
Adjusted capital (AC)	97,382				178,668			
VaR 10bp	6,067	10,947	36,172	39,740	8,841	14,998	48,697	54,313
VaR 3bp	7,949	13,949	46,797	51,209	10,709	18,777	57,086	64,189
VaR 1bp	9,984	17,738	56,575	62,371	12,525	22,213	64,007	72,117
VaR 10bp % of AC	6.23%	11.24%	37.14%	40.81%	4.95%	8.39%	27.26%	30.40%
VaR 3bp % of AC	8.16%	14.32%	48.05%	52.59%	5.99%	10.51%	31.95%	35.93%
VaR 1bp % of AC	10.25%	18.21%	58.10%	64.05%	7.01%	12.43%	35.82%	40.36%
ES 10bp	7,701	13,688	45,035	49,356	10,433	18,106	55,343	62,076
ES 3bp	9,869	17,331	56,308	61,647	12,344	21,807	62,898	71,093
ES 1bp	12,080	21,101	66,720	73,359	14,089	24,816	68,750	78,497
ES 10bp % of AC	7.91%	14.06%	46.25%	50.68%	5.84%	10.13%	30.98%	34.74%
ES 3bp % of AC	10.13%	17.80%	57.82%	63.30%	6.91%	12.21%	35.20%	39.79%
ES 1bp % of AC	12.40%	21.67%	68.51%	75.33%	7.89%	13.89%	38.48%	43.93%

Note: Eligible callable capital is the callable capital from the AAA-rated countries and adjusted capital is the sum of total equity and eligible callable capital.

What does one learn from the estimates in Tables 4.1 and 4.2? The upper part of the two tables shows capital resources. IBRD's Total Equity equals $55.3 bn. Eligible Callable Capital equals the Callable Capital held by AAA-rated sovereigns. Adding this to Total Equity, one obtains Adjusted Capital for IBRD of $97.4 bn. The equivalent figures for IDA are $178.7 bn for Total Equity and the same number for Adjusted Capital (since IDA does not have Callable Capital).

Table 4.2: VaR and ES Results with 3-year Maturities

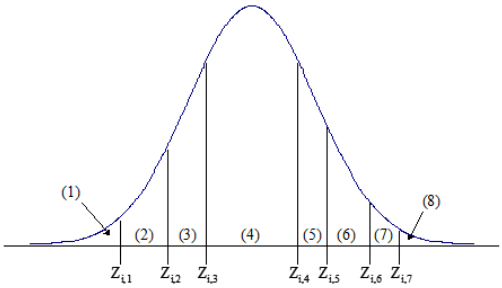
	IBRD				IDA			
	with PCT		without PCT		with PCT		without PCT	
	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs
Total exposure	266,606				213,404			
Total equity	55,320				178,668			
Eligible callable capital	42,062				0			
Adjusted capital (AC)	97,382				178,668			
VaR 10bp	8,997	15,045	50,945	55,972	11,167	19,436	53,474	61,590
VaR 3bp	11,337	19,240	62,831	68,712	13,075	23,837	60,092	70,611
VaR 1bp	13,715	23,256	71,067	78,258	14,756	27,539	65,240	77,759
VaR 10bp % of AC	9.24%	15.45%	52.31%	57.48%	6.25%	10.88%	29.93%	34.47%
VaR 3bp % of AC	11.64%	19.76%	64.52%	70.56%	7.32%	13.34%	33.63%	39.52%
VaR 1bp % of AC	14.08%	23.88%	72.98%	80.36%	8.26%	15.41%	36.51%	43.52%
ES 10bp	10,964	18,542	60,276	66,111	12,729	22,977	58,630	68,819
ES 3bp	13,404	22,874	70,594	78,010	14,442	27,137	63,989	76,860
ES 1bp	15,548	26,706	79,133	88,524	15,871	30,672	67,572	83,498
ES 10bp % of AC	11.26%	19.04%	61.90%	67.89%	7.12%	12.86%	32.81%	38.52%
ES 3bp % of AC	13.76%	23.49%	72.49%	80.11%	8.08%	15.19%	35.81%	43.02%
ES 1bp % of AC	15.97%	27.42%	81.26%	90.90%	8.88%	17.17%	37.82%	46.73%

Note: Eligible callable capital is the callable capital from the AAA-rated countries and adjusted capital is the sum of total equity and eligible callable capital.

Box 4.1: Risk Modelling Methodology

The default probability of any defaultable security is assumed to be summed up by its rating. Ratings are assumed to be distributed as a time-homogeneous Markov chain. From one period to the next, this implies that ratings are multinomial distributed.

Figure 4.1: Distribution of Latent Variable



To allow for correlations between ratings transitions, the model employs an ordered probit method in that, given an initial rating i (in a set of possible initial ratings $j = 1,2,..,J$) at date t, the rating of the exposure at date $t+1$ is determined by the realisation of a standard Gaussian latent variable A. If A lies in the interval $[Z_{i,j-1}, Z_{i,j}]$ where $Z_{i,j-1}$ and $Z_{i,j}$ are elements in a set of cut off points $Z_{i,2} < Z_{i,3} < \cdots < Z_{i,J}$, then the exposure is rated j at $t+1$. The approach is multi-period in that the model described here is applied repeatedly to generate time paths of ratings for each given exposure over the full simulation horizon.

The ordered probit approach is illustrated above in Figure 4.1. Suppose there are $J = 8$ rating classes. The initial rating of the obligor is $i = 4$ and, depending on the realisation of the latent variable A (as plotted on Figure 4.1), the terminal rating may be $j = 1,2 \ldots$ *or* 8. The areas between two consecutive thresholds Z and below the normal distribution correspond to the conditional probabilities of ending up in the various ratings.

Given an estimate of a rating transition matrix, $[\pi_{t,T}^{(i,j)}]$, the cut off points $Z_{i,j}$ may be deduced directly from the recursive equations:

$$\begin{aligned} \pi_{t,T}^{(i,J)} &= 1 - \Phi(Z_{i,J-1}) \\ \pi_{t,T}^{(i,j)} &= \Phi(Z_{i,j}) - \Phi(Z_{i,j-1}), j = 2, \ldots, J-1 \\ \pi_{t,T}^{(i,1)} &= \Phi(Z_{i,1}) \end{aligned} \qquad (4.1)$$

Here, $\Phi(.)$stands for the cumulative distribution function for the standard Gaussian.

The approach of assuming that transitions between several discrete states are driven by a latent variable with a continuous distribution is widely applied in the discrete choice econometrics literature. When the latent variable is normally distributed, it corresponds to the ordered probit approach. The major benefit of employing this approach in credit risk modelling is that it permits one to allow rating transitions by different obligors to be correlated simply by assuming that the latent variables driving transitions for different credit exposures are correlated.

The model assumes that the latent variable for the i^{th} exposure A_i can be broken down into an idiosyncratic component e_i and multiple systematic risk factors. All the factors are rescaled so that they have unit variance and a zero mean. For this study, we only use a region factor, F_i. The model simulates random shocks to the idiosyncratic and systematic factors and these translate into shocks to the latent variable A_i via a weighted sum:

$$A_i = \sqrt{1 - \eta_i^2} F_i + \eta_i e_i \qquad (4.2)$$

These capital resource figures may be compared with the required capital estimates presented in the middle (VaR estimates) and lower (ES estimates) blocks of the two tables. A conservative confidence level is 1 basis point. This may be thought of as a 'AAA confidence level' since banks that aim for extremely high credit quality commonly use confidence levels in this region. The confidence level to which Basel II and III capital charges are calibrated is 10 basis points with a 1-year VaR horizon. It is also conservative and advisable to allow for randomness in LGDs.[20]

Table 4.3: VaR and ES Results with Historical Non-accrual Transition Matrix

	1-Year, with PCT				3 Year, with PCT			
	IBRD		IDA		IBRD		IDA	
	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs
VaR 10bp	5,549	9,041	6,605	11,329	8,030	12,787	8,875	15,050
VaR 3bp	7,994	13,010	8,946	15,060	10,838	17,310	11,093	18,986
VaR 1bp	10,550	16,935	11,106	18,153	13,656	21,524	13,121	23,183
VaR 10bp % of AC	5.70%	9.28%	3.70%	6.34%	8.25%	13.13%	4.97%	8.42%
VaR 3bp % of AC	8.21%	13.36%	5.01%	8.43%	11.13%	17.77%	6.21%	10.63%
VaR 1bp % of AC	10.83%	17.39%	6.22%	10.16%	14.02%	22.10%	7.34%	12.98%
ES 10bp	7,671	12,341	8,545	14,394	10,351	16,555	10,702	18,407
ES 3bp	10,443	16,750	10,945	18,004	13,317	21,457	12,831	22,662
ES 1bp	13,076	21,107	13,100	21,094	16,004	26,078	14,762	26,655
ES 10bp % of AC	7.88%	12.67%	4.78%	8.06%	10.63%	17.00%	5.99%	10.30%
ES 3bp % of AC	10.72%	17.20%	6.13%	10.08%	13.67%	22.03%	7.18%	12.68%
ES 1bp % of AC	13.43%	21.67%	7.33%	11.81%	16.43%	26.78%	8.26%	14.92%

Table 4.4: VaR and ES Results with Spread-based Correlations and Idiosyncratic Weights

	1-Year, with PCT				3 Year, with PCT			
	IBRD		IDA		IBRD		IDA	
	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs
VaR 10bp	4,595	9,789	9,989	16,106	6,483	13,387	11,909	20,466
VaR 3bp	5,744	12,185	11,869	20,212	7,918	16,563	13,522	24,511
VaR 1bp	6,842	14,514	13,162	23,891	9,225	19,814	14,703	28,107
VaR 10bp % of AC	4.72%	10.05%	5.59%	9.01%	6.66%	13.75%	6.67%	11.45%
VaR 3bp % of AC	5.90%	12.51%	6.64%	11.31%	8.13%	17.01%	7.57%	13.72%
VaR 1bp % of AC	7.03%	14.90%	7.37%	13.37%	9.47%	20.35%	8.23%	15.73%
ES 10bp	5,558	11,774	11,477	19,425	7,671	16,113	13,139	23,827
ES 3bp	6,783	14,424	13,182	23,574	9,104	19,552	14,588	27,798
ES 1bp	8,013	16,991	14,643	27,168	10,403	22,955	15,714	31,412
ES 10bp % of AC	5.71%	12.09%	6.42%	10.87%	7.88%	16.55%	7.35%	13.34%
ES 3bp % of AC	6.97%	14.81%	7.38%	13.19%	9.35%	20.08%	8.17%	15.56%
ES 1bp % of AC	8.23%	17.45%	8.20%	15.21%	10.68%	23.57%	8.79%	17.58%

The 1-year horizon, 1 bps VaR capital estimate, inclusive of LGD risk, for IBRD is $17.7 bn. This estimate employs parameters (PDs and mean LGDs) adjusted for PCT. When non-PCT-adjusted parameters are employed, the estimate rises to $62.4 bn. The PCT adjustments draw on analysis Risk Control performed for the G20 CAF Panel, see Risk Control (2022a). This showed that PCT reduces LGD means and PDs compared to the values one may estimate using public bond market data each by more than 3 times.

[20] This is true in large part because MDB portfolios are typically concentrated in loans to a small number of sovereign borrowers, so LGD risk does not diversify away. Some MDBs do not allow for randomness in their credit risk modelling which is why it is interesting to include cases with and without such risk.

The equivalent figures from Table 4.2 which presents results using a 3-year horizon for VaR and ES calculations are $23.3 bn and $78.3 bn. Some MDBs use a risk horizon of 3-years in contrast to the 1-year horizon that is typical among large commercial banks (and which is required in the Basel rules) to achieve greater conservatism. We would tend to regard the 1-year horizon results as the primary base case although use of a 3-year horizon by non-regulated entities like MDBs is not unreasonable.

Turning to the results for IDA, on finds from Table 4.1 that the 1 basis point, 1-year-horizon VaR-based capital estimate inclusive of PCT and LGD risk is $22.2 bn. If one employs a 3-year horizon (see Table 4.2), the required capital estimate for IDA is $27.5 bn.

The capital required may be compared to the capital resources shown in the upper parts of Tables 4.1 and 4.2. To repeat, the base case credit risk EC for IBRD and IDA are, respectively, $17.7 bn and $22.2 bn. These may be compared with the Total Capital for the two institutions of $55.3 bn for IBRD and $178.7 bn for IDA. When Eligible Callable Capital is added to IBRD Total Equity, one obtains Adjusted Capital of $97.4 bn. One may consider scaling up the credit risk EC to obtain an approximate total EC. One may further boost EC by 10% to allow for a crisis buffer. The resulting estimate of total EC would be around $22 bn for IBRD or $27 bn for IDA. These are clearly a small fraction of the capital resources of the two institutions.

As a sensitivity analysis, we calculated an alternative transition matrix in which the righthand column of PDs is directly estimated from MDB historical non-accrual data of the MDBs. The results are given in Table 4.3. The capital numbers are generally slightly lower than those we obtained using the base case calibration.

As a second sensitivity analysis, we estimated a factor correlation matrix using correlations of sovereign bond spreads for different regions. The results are given in Table 4.4. Again, the capital numbers are somewhat lower than the base case results.

4.4 Buffer Analysis

In this subsection, we display the VaR results when the sovereign ratings are downgraded in line with a worst-case crisis scenario. Appendix 8 provides more details of how this scenario is constructed but, in brief, it combines the sovereign rating downgrades that occurred both in the Covid 19 crisis and the Global Financial Crisis of 2007-9.

Table 4.5: VaR Results with Worst Crisis

	1-Year, with PCT			
	IBRD		IDA	
	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs
VaR 10bp	6,376	11,261	9,420	16,769
VaR 3bp	8,311	14,111	11,169	20,629
VaR 1bp	10,302	17,886	12,918	23,800
VaR 10bp % of AC	6.55%	11.56%	5.27%	9.39%
VaR 3bp % of AC	8.53%	14.49%	6.25%	11.55%
VaR 1bp % of AC	10.58%	18.37%	7.23%	13.32%
Change from base VaR 10bp	5.09%	2.86%	6.55%	11.81%
Change from base VaR 3bp	4.56%	1.16%	4.29%	9.86%
Change from base VaR 1bp	3.19%	0.84%	3.13%	7.15%

5. Sustainable Concessional Lending Limit

5.1 Introduction

This section explains the constraint on IDA lending attributable to its use of concessional loans. We term this constraint the Sustainable Concessional Lending Limit (SCLL). A development institution can sustainably lend on a zero-interest-rate basis up to value of its capital so long as it can cover its costs and is not required to pay dividends.

Whenever a zero-interest-rate loan matures and is repaid, the lender may extend a new zero interest rate loan in the same amount. IDA charges borrowers a fee of 75 basis points but no interest rate which appears to cover the institution's costs and is not required dividends.

IDA indeed currently lends an amount approximately equal to its capital, but this lending includes (i) non-concessional loans, (ii) so-called blended loans and (iii) fully concessional (zero-interest-rate) loans. Blended loans have relatively low but still non-zero interest rates.

In this section, we calculate the headroom that IDA has available to increase its lending, allowing for the subsidy elements in much of its lending. To do this, we calculate the amounts of fully concessional and fully non-concessional loans that are equivalent to a dollar of blended lending.

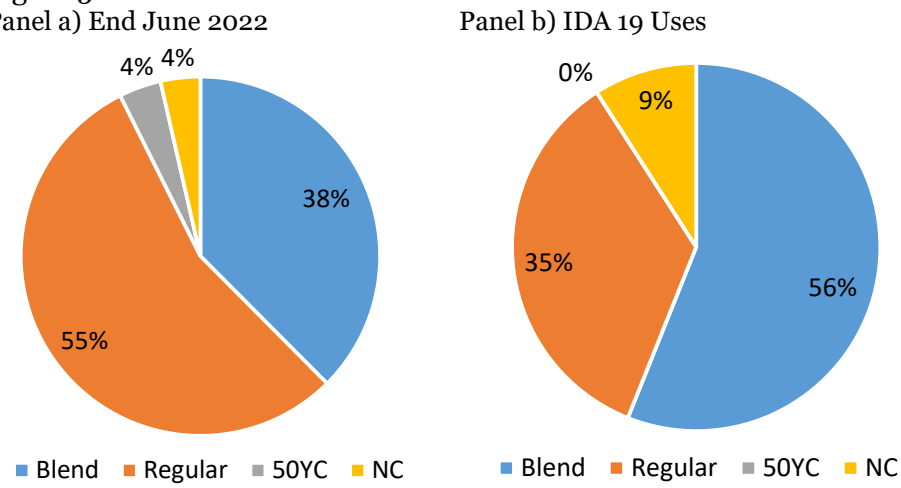
We argue that the non-concessional lending is unconstrained since the institution's available capital is sufficient to borrow extensively in capital markets. The sum of IDA's fully concessional lending and the concessional component of its blended loans is less than its capital which creates room to lend more either through more concessional or more blended loans.

5.2 IDA Portfolio

Figure 5.1 shows the breakdown of IDA lending as it stood at end-June 2022 (see Panel a)) and the same breakdown for loans made in the IDA 19 replenishment period (see Panel b)).

The figure suggests that IDA's split of activities has shifted towards blended lending. Blended loans accounted for 38% of the entire loan portfolio at the end of June 2022 (see Panel a)). In the IDA19 replenishment period, however, blended loans represented 56% of total loans approved (see Panel b)). Non-concessional loans comprised 4% of the end-June 2022 portfolio, whereas they made up 9% of approvals in the IDA19 period.

Figure 5.1: IDA Portfolio



Note: Panel a) is based on the historical data of 'IDA Statement of Credits and Grants.' Panel b) is based on the funding allocation of IDA 19 described in IDA FY22 Management's Discussion and Analysis. 50YC denotes 50-year credit, and NC indicates Non-Concessional.

The analysis presented in this note examines the headroom that IDA has available to change its different categories of lending given the constraint it faces as a concessional lender. For an institution to make zero-

interest-rate loans sustainably (i.e., in a way that permits it to maintain the same volume of lending indefinitely), it cannot exceed the institution's equity (in IDA's case, $179 bn).

To understand this, suppose that IDA lends $100 for zero interest and then re-lends the same amount after the money is repaid again at zero interest. IDA will never receive a return on the activity. So, the present value of this activity is zero. Thus, a limit on IDA's sustainable, fully concessional lending is the institution's equity. Here, we assume their periodic injections of donor cash are used up in grants and that other sources of income, notably IDA's administration charge to borrowers of 75 bps covers its operational costs.

At the end of June 2022, IDA had $105 bn of concessional loans, $66 bn of blended and $6 bn of non-concessional, so $178 bn in total. On the face of it, this does leave IDA with the possibility of lending more. The amount of capital available to IDA means that it could borrow extensively in the capital markets and make non-concessional lending. Blended loans may be thought of as a combination of concessional and non-concessional. In the next section, we break down IDA's $66 bn of blended loans into (a) fully concessional and (b) fully non-concessional loans with market and par values that sum to equal, respectively, the market and par values of the original blended loans.

5.3 Blended Loans

Suppose we have blended loans with a par value of $1. Can we split this into amount of concessional loans (LCs) and non-concessional loans (NCLs) that are equivalent in the sense that the sums of (i) the par values and (ii) the market values of the CLs and NCLs are equal to those of the blended loan with $1 par. This is our topic in this section.

Let $\bar{V}$ be the par value of a portfolio of blended loans and V be their present fair value. Then suppose we can split these as follows:

$$\begin{aligned} p + p^* &= \bar{V} \\ v + v^* &= V \end{aligned} \tag{5.1}$$

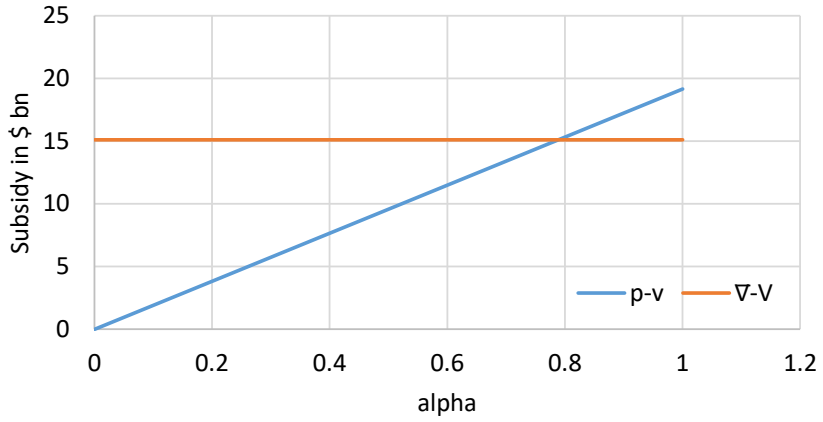
Here, p and v are the par value and fair value, respectively, of the CLs and p^* and v^* are the par value and fair value of the NCLs.

The par value (p^*) of the NCL must equal its market value (v^*). On subtracting the two equations in equation (5.1), and rearranging we obtain:

$$\bar{V} - V = p - v \tag{5.2}$$

In equation (5.2), the fair value of the CL depends implicitly on its par value, so one may consider v to be a function of p. We compute p by finding the value such that equation (5.2) is satisfied. One may understand this intuitively by saying that the subsidy element of blended loans, i.e., $\bar{V} - V$ must be equal the subsidy due to the concessional part of the blended loans (i.e., $p - v$).

Figure 5.2: Computation of $\alpha \equiv p/\bar{V}$ for Blended Loans



We take the blended loan portfolio and compute the present value of the portfolio assuming all the blended loans are lent at zero interest rate.[21] This exercise is repeated for various possible shares of the ratio of $\alpha \equiv p/\bar{V}$ from 0% to 100%.

Figure 5.2 shows that $\alpha \equiv p/\bar{V}$ is just less than 80% (actually, 0.79). This could be now used in the estimation of the lending headroom.

6. Risk Transfer Analysis

6.1 Introduction

MDBs are key institutions in the effort to achieve the Sustainable Development Goals (SDGs) proposed by the United Nations. Even if they increase their lending substantially, this will not alone produce the hundreds of billions required to attain the SDGs. The efficiency of MDB capital utilisation must be increased by risk transfer techniques that bring private and donor risk bearing capacity to bear. This section considers such transactions and examines constraints that may limit MDB risk transfer.

Risk-transfer transactions undertaken by MDBs in the past are discussed by Galizia et al. (2019). These include:

1. Portfolio exchanges between MDBs.
2. A landmark securitization of corporate loans by the African Development Bank (AfDB) (see Risk Control (2019)).
3. A series of financial transactions through which the European Commission has implemented (via the European Investment Bank—EIB) its Investment Plan for Europe.
4. Guarantees provided by the Swedish International Development Agency (SIDA) to the Inter-American Development Bank (IDB) and Asian Development Bank (ADB).
5. A further synthetic securitisation by the AfDB involving sovereign loans in which the protection providers included the UK's Foreign, Commonwealth and Development Office (FCDO) and private sector insurers.

Since the CAF Panel report was published, many MDBs have started reviewing risk transfer transactions that they might implement. One such possible transaction that has been publicly discussed is the ADB's Innovative Finance Facility for Climate in Asia and the Pacific (IF-CAP) (see ADB (2023)).

These techniques could further increase MDB lending when supported by a broader and deeper investor base. The nature of the protection providers varies according to the deal. In several, risk capacity is provided by donor governments or public entities. The AfDB transactions listed are particularly notable because, in both cases, private sector protection providers participated.

To assess the constraints that limit scope for risk transfer, in this section, we analyse synthetic securitisations involving IBRD and IDA portfolios of sovereign loans. For simplicity and concreteness, we consider transactions comparable to the AfDB's Room2Run transaction (see Risk Control (2019)). While the precise structure might be adjusted, for simplicity, we suppose the same tranching as was used in the Room2Run transaction and that the MDB in each case retains the Junior and Senior tranches. The Mezzanine tranche is transferred to external institutions or investors.

We analyse:

- the increase in the Standard & Poor's RAC ratio that results from the transaction,
- reduction in credit risk Economic Capital (EC),
- estimate the tranche ratings using the Standard & Poor's methodology, and
- the fair value price of the mezzanine tranche following a securitisation of the portfolio and the fraction of spread income on the securitised portfolio that the MDB can achieve.

For each institution, we consider securitisations involving two portfolios. The two portfolios are denoted Portfolio A and Portfolio B, the first having the higher credit quality.

[21] A 75-basis point service charge is applied for servicing of the loan and a zero-interest rate charge is applied.

6.2 Description of a securitisation transaction

The tranche structure is described in Table 6.1.

Table 6.1: Tranche Structure

Tranches	Retained	Attachment Point	Detachment Point	Thickness
Senior	Yes	27.25%	100.00%	72.75%
Senior Mezzanine	No	17.25%	27.25%	10.00%
Junior Mezzanine	No	2.00%	17.25%	15.25%
Junior	Yes	0.00%	2.00%	2.00%

Table 6.2: Reference Portfolio A

IBRD						IDA					
Obligor	Ratings	EAD	Obligor	Ratings	EAD	Obligor	Ratings	EAD	Obligor	Ratings	EAD
India	BBB-	3,821	Philippines	BBB+	1,786	Bangladesh	BB-	2,194	Ghana	B-	1,174
Indonesia	BBB	2,185	Argentina	Cs	2,637	India	BBB-	2,003	Uganda	B	824
China	A+	1,876	Morocco	BB+	1,391	Pakistan	B-	3,605	Nepal	B	977
Brazil	BB-	3,434	Ukraine	Cs	1,248	Nigeria	B-	3,270	Senegal	B+	434
Mexico	BBB	1,556	Poland	A-	949	Vietnam	BB+	1,405	Côte d'Ivoire	BB-	366
Colombia	BB+	2,162	Romania	BBB-	827	Ethiopia	Cs	1,914	Uzbekistan	BB-	339
Egypt	B	2,015	Peru	BBB	811	Kenya	B	1,790	Sri Lanka	Cs	494
Türkiye	B+	2,661				Tanzania	B	1,579			
Total					29,359						22,368

Table 6.3: Reference Portfolio B

IBRD						IDA					
Obligor	Ratings	EAD	Obligor	Ratings	EAD	Obligor	Ratings	EAD	Obligor	Ratings	EAD
Brazil	BB-	4,292	Guatemala	BB-	504	Pakistan	B-	3,605	Burkina Faso	Cs	542
Egypt	B	3,359	Georgia	BB	419	Nigeria	B-	3,270	Niger	Cs	537
Turkiye	B+	3,327	Costa Rica	B	404	Ethiopia	Cs	2,551	Madagascar	Cs	530
Argentina	Cs	2,637	Belarus	Cs	298	Kenya	B	2,387	Myanmar	Cs	471
Ukraine	Cs	2,080	El Salvador	Cs	294	Tanzania	B	2,106	Mali	Cs	459
Jordan	B+	1,114	Lebanon	Cs	266	Ghana	B-	1,174	Zambia	Cs	425
Tunisia	Cs	1,106	Sri Lanka	Cs	256	Uganda	B	1,099	Malawi	Cs	342
Ecuador	B-	1,034	Bolivia	B+	215	Nepal	B	977	Yemen	Cs	255
Iraq	B-	953				Sri Lanka	Cs	659	Laos	Cs	198
Pakistan	B-	923				Democratic Republic of the Congo	B-	644	Nicaragua	B-	194
Angola	B-	856				Mozambique	Cs	612	Mongolia	B	168
Uzbekistan	BB-	619				Cameroon	B-	567			
Total					24,956						23,771

We consider two different reference portfolios for the transaction. These are described in Tables 6.2 and 6.3.

- Portfolio A consists of 15 exposures with the highest EAD and weights are adjusted to have a comparable weighted average rating with the overall portfolio. Table 6.2 shows the countries in Portfolio A with the exposure amounts and ratings.
- Portfolio B consists of exposures with the highest 1bp Marginal Value-at-Risk (MVaR) values according to the results in Table 4.1 with PCT adjustments and non-stochastic LGDs. Top 30 exposures are chosen according to the marginal contributions they make to the Value of Risk associated with the MDB's entire portfolio and these are further filtered by ratings. We choose exposures with ratings BB or

below for IBRD and B and below for IDA. All the weights are chosen as 25% of the EADs for IBRD and 20% of the EADs for IDA. Weighted average ratings of the reference portfolios are B and B- for IBRD and IDA respectively. Table 6.3 shows the countries in Portfolio B with the exposure amounts and ratings.

6.3 RAC ratio impact of the securitisation

This subsection calculates the effect of the securitisation on the MDB's RAC ratio and EC. Tables 5.4 and 5.5 shows the impact on the RAC ratios of IBRD and IDA, respectively. The RWAs associated with the retained Junior and Senior tranches are shown. Note that the RWAs for the senior tranche depend on the rating that the rating agency chooses to give to this tranche. The current Standard & Poor's methodology for MDB retained senior tranches permits such tranches to obtain no more than a single-A rating. The methodology is based on a single-A stress implicit in the RAC framework used by the agency to rate MDBs. The methodology could easily be extended to permit AA or AAA ratings but currently this is not permitted by Standard & Poor's. The tables show what the consequences would be in an increase in the efficiency of the transaction if the agency were persuaded to generalise its approach to permit other ratings.

The results show that with a securitisation representing 10% of the institution's portfolio of sovereign loans, the RAC ratio increases from 25.96% to 27.45% in the case of the lower credit quality portfolio B for IBRD and to 26.68% when portfolio A is securitised. In the case of IDA, the gain in the RAC ratio is from a base value of 68.9% to 78.7% for portfolio B or to 80.9% in the case of portfolio A. These represent very substantial gains in the RAC ratio.

Table 6.4: IBRD RAC calculation for different securitization portfolios

Results \ Scenario	Base	(a)			(b)		
		AAA	AA	A	AAA	AA	A
Government and central banks credit risk RWA	295,438	260,734	260,734	260,734	246,330	246,330	246,330
Securitisation RWA	0	13,454	15,929	20,878	11,138	13,186	17,284
Securitisation Sr	0	4,950	7,424	12,374	4,097	6,146	10,244
Securitisation Jr	0	8,504	8,504	8,504	7,040	7,040	7,040
Total credit risk RWA before adjustments	306,073	284,823	287,297	292,247	286,101	288,149	274,248
Geographic concentration adjustment	-33,296	-29,425	-29,425	-29,425	-29,078	-29,078	-29,078
Single name concentration adjustment	105,466	87,269	87,269	87,269	97,948	97,948	97,948
Total credit risk RWA after adjustments	213,112	199,954	202,428	207,378	195,396	197,445	201,543
Total equity	55,320	55,320	55,320	55,320	55,320	55,320	55,320
RAC ratio	25.96%	27.67%	27.33%	26.68%	28.31%	28.02%	27.45%

Note: Portfolio (a) denotes the 10% securitization portfolio that is constituted by the top 15 loans. Portfolio (b) is constituted by the top 24 exposures with highest VaR.

Table 6.5: IDA RAC calculation for different securitization portfolios

Results \ Scenario	Base	(a)			(b)		
		AAA	AA	A	AAA	AA	A
Government and central banks credit risk RWA	275,234	223,328	223,328	223,328	239,031	239,031	239,031
Securitisation RWA	0	8,982	10,634	13,939	10,054	11,903	15,602
Securitisation Sr	0	3,304	4,957	8,261	3,699	5,548	9,247
Securitisation Jr	0	5,678	5,678	5,678	6,355	6,355	6,355
Total credit risk RWA before adjustments	286,533	241,077	242,729	246,033	257,851	259,700	263,399
Geographic concentration adjustment	-21,220	-17,000	-17,000	-17,000	-19,161	-19,161	-19,161
Single name concentration adjustment	102,585	76,054	76,054	76,054	85,511	85,511	85,511
Total credit risk RWA after adjustments	259,436	216,010	217,662	220,967	221,471	223,320	227,019
Total equity	178,668	178,668	178,668	178,668	178,668	178,668	178,668
RAC ratio	68.9%	82.7%	82.1%	80.9%	80.7%	80.0%	78.7%

Note: Portfolio (a) denotes the 10% securitization portfolio that is constituted by the top 15 loans. Portfolio (b) is constituted by the top 24 exposures with highest VaR.

6.4 Economic capital impact of securitisation

This subsection presents the gains that can be achieved through reduced EC if the IBRD and IDA were to securitise portfolios A or B. The results for the two institutions are given in Table 6.6 and Table 6.7 respectively. The 1-basis-point, 1-year, stochastic-LGD, VaR-based EC for IBRD and IDA drop by 12.04% and 11.29%, respectively, for portfolio A and by 18.28% and 12.66%, respectively, for portfolio B. Again, these represent substantial reductions in EC, especially in the case of the riskier portfolio B securitisations.

Table 6.6: Results for Securitisation Portfolio A

	1 Year, with PCT				3 Year, with PCT			
	IBRD		IDA		IBRD		IDA	
	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs
VaR 10bp	5,890	9,687	8,256	13,170	8,421	13,327	10,215	16,978
VaR 3bp	7,548	12,194	9,956	16,547	10,515	16,983	11,892	20,738
VaR 1bp	9,400	15,603	11,546	19,705	12,607	20,287	13,412	24,076
Change from Base VaR 10bp	-2.91%	-11.52%	-6.62%	-12.19%	-6.40%	-11.42%	-8.53%	-12.65%
Change from Base VaR 3bp	-5.05%	-12.58%	-7.03%	-11.88%	-7.25%	-11.73%	-9.04%	-13.00%
Change from Base VaR 1bp	-5.85%	-12.04%	-7.82%	-11.29%	-8.08%	-12.77%	-9.11%	-12.57%
ES 10bp	7,342	12,044	9,683	15,914	10,175	16,373	11,611	20,077
ES 3bp	9,281	15,213	11,397	19,182	12,344	20,154	13,140	23,714
ES 1bp	11,243	18,530	12,949	21,723	14,241	23,638	14,428	26,825
Change from Base ES 10bp	-4.66%	-12.01%	-7.19%	-12.11%	-7.20%	-11.70%	-8.79%	-12.62%
Change from Base ES 3bp	-5.95%	-12.22%	-7.67%	-12.04%	-7.91%	-11.89%	-9.02%	-12.61%
Change from Base ES 1bp	-6.93%	-12.19%	-8.09%	-12.47%	-8.40%	-11.49%	-9.09%	-12.54%
Junior tranche par value	587	587	447	447	587	587	447	447
MVaR 1bp	514	689	454	600	521	1218	326	747
MVaR 1bp % of VaR 1bp	5.47%	4.42%	3.93%	3.04%	4.13%	6.00%	2.43%	3.10%
MVaR 1bp % of par value	87.57%	117.35%	101.47%	134.08%	88.73%	207.45%	72.78%	167.02%
Senior tranche par value	21,358	21,358	16,273	16,273	21,358	21,358	16,273	16,273
MVaR 1bp	0	0	0	0	0	0	0	549
MVaR 1bp % of VaR 1bp	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.28%
MVaR 1bp % of par value	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.37%

Table 6.7: Results for Securitisation Portfolio B

	1 Year, with PCT				3 Year, with PCT			
	IBRD		IDA		IBRD		IDA	
	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs	Non-stochastic LGDs	Stochastic LGDs
VaR 10bp	5,216	8,813	7,926	12,707	7,843	12,470	9,931	16,712
VaR 3bp	6,903	11,245	9,605	16,171	10,004	16,678	11,663	20,807
VaR 1bp	8,779	14,494	11,205	19,401	12,149	20,673	13,190	24,249
Change from Base VaR 10bp	-14.03%	-19.50%	-10.35%	-15.27%	-12.82%	-17.11%	-11.07%	-14.02%
Change from Base VaR 3bp	-13.16%	-19.38%	-10.31%	-13.88%	-11.77%	-13.31%	-10.79%	-12.71%
Change from Base VaR 1bp	-12.06%	-18.28%	-10.54%	-12.66%	-11.42%	-11.11%	-10.62%	-11.95%
ES 10bp	6,687	11,106	9,336	15,561	9,649	15,915	11,359	20,049
ES 3bp	8,651	14,348	11,085	18,977	11,919	20,225	12,956	23,919
ES 1bp	10,671	17,936	12,689	21,665	13,932	24,274	14,310	27,260
Change from Base ES 10bp	-13.17%	-18.86%	-10.51%	-14.06%	-12.00%	-14.17%	-10.76%	-12.74%
Change from Base ES 3bp	-12.33%	-17.21%	-10.20%	-12.98%	-11.08%	-11.58%	-10.29%	-11.86%
Change from Base ES 1bp	-11.66%	-15.00%	-9.93%	-12.70%	-10.39%	-9.11%	-9.83%	-11.12%
Junior tranche par value	499	499	475	475	499	499	475	475
MVaR 1bp	445	520	473	847	357	505	271	566
MVaR 1bp % of VaR 1bp	5.07%	3.58%	4.22%	4.36%	2.94%	2.44%	2.06%	2.33%
MVaR 1bp % of par value	89.12%	104.09%	99.48%	178.08%	71.50%	101.26%	57.06%	118.96%
Senior tranche par value	18,155	18,155	17,293	17,293	18,155	18,155	17,293	17,293
MVaR 1bp	0	0	0	620	0	434	0	570
MVaR 1bp % of VaR 1bp	0.00%	0.00%	0.00%	3.19%	0.00%	2.10%	0.00%	2.35%
MVaR 1bp % of par value	0.00%	0.00%	0.00%	3.58%	0.00%	2.39%	0.00%	3.30%

6.5 Tranche pricing

When a bank securitises a loan pool, an important consideration is the total cost of the protection in the form of protection premia. This is particularly an issue for MDBs because their lending spreads are typically very low. Table 5.11 presents a pricing analysis of the securitisations described above. The basic idea is to infer a fair price inclusive of risk premium for the protection and then to calculate what fraction of the spread income[22] on the loan pool is sacrificed by purchasing protection.

Table 6.8: Tranche Spreads for Junior and Senior Mezzanine

		Spread		EL in 5 Yr.		Pooled Parameters				
Pricing Basis	Portfolios	Junior Mezz	Senior Mezz	Junior Mezz	Senior Mezz	PD	LGD	5 -Yr. Cumulative EL	ρ_{pool}	Spread Income Retained
Expected Loss	IBRD A	0.20%	0.00%	0.97%	0.00%	6.14%	10.0%	0.61%	51.26%	94.03%
With risk premium	IBRD A	0.27%	0.00%	1.35%	0.00%	7.61%	10.0%	0.76%	51.26%	91.70%
With high-risk premium	IBRD A	0.57%	0.00%	2.79%	0.00%	12.29%	10.0%	1.23%	51.26%	82.76%
Expected Loss	IBRD B	0.72%	0.00%	3.52%	0.00%	14.39%	10.0%	1.44%	51.09%	78.16%
With risk premium	IBRD B	0.84%	0.00%	4.11%	0.00%	15.99%	10.0%	1.60%	51.09%	74.38%
With high-risk premium	IBRD B	2.04%	0.00%	9.69%	0.00%	28.79%	10.0%	2.88%	51.09%	37.81%
Expected Loss	IDA A	0.40%	0.00%	1.97%	0.00%	10.85%	10.0%	1.09%	44.22%	87.87%
With risk premium	IDA A	0.52%	0.00%	2.57%	0.00%	12.77%	10.0%	1.28%	44.22%	84.14%
With high-risk premium	IDA A	1.23%	0.00%	5.95%	0.00%	21.70%	10.0%	2.17%	44.22%	62.56%
Expected Loss	IDA B	1.00%	0.00%	4.88%	0.00%	19.57%	10.0%	1.96%	41.61%	69.46%
With risk premium	IDA B	1.12%	0.00%	5.44%	0.00%	20.93%	10.0%	2.09%	41.61%	65.88%
With high-risk premium	IDA B	3.10%	0.00%	14.37%	0.00%	39.14%	10.0%	3.91%	41.61%	5.40%

Note: The spread used to calculate spread income retained for IBRD and IDA is based on the Flexible Loan lending rate for 5-year term loans on April 24, 2023 in USD currency, that is 50 basis points.

Table 6.9: Tranche Spreads for Junior and Senior Mezzanine (Stressed LGD Case)

		Spread		EL in 5 Yr.		Pooled Parameters				
Pricing Basis	Portfolios	Junior Mezz	Senior Mezz	Junior Mezz	Senior Mezz	PD	LGD	5 -Yr. Cumulative EL	ρ_{pool}	Spread Income Retained
Expected Loss	IBRD A	0.74%	0.00%	3.65%	0.00%	6.14%	20.0%	1.23%	51.26%	77.35%
With risk premium	IBRD A	1.00%	0.00%	4.86%	0.01%	7.61%	20.0%	1.52%	51.26%	69.56%
With high-risk premium	IBRD A	1.92%	0.01%	9.15%	0.04%	12.29%	20.0%	2.46%	51.26%	41.29%
Expected Loss	IBRD B	2.38%	0.01%	11.22%	0.05%	14.39%	20.0%	2.88%	51.09%	27.17%
With risk premium	IBRD B	2.75%	0.01%	12.86%	0.07%	15.99%	20.0%	3.20%	51.09%	15.76%
With high-risk premium	IBRD B	6.27%	0.08%	26.93%	0.38%	28.79%	20.0%	5.76%	51.09%	-92.87%
Expected Loss	IDA A	1.50%	0.00%	7.21%	0.00%	10.85%	20.0%	2.17%	44.22%	54.38%
With risk premium	IDA A	1.89%	0.00%	9.03%	0.01%	12.77%	20.0%	2.55%	44.22%	42.24%
With high-risk premium	IDA A	4.07%	0.02%	18.40%	0.08%	21.70%	20.0%	4.34%	44.22%	-24.35%
Expected Loss	IDA B	3.45%	0.01%	15.83%	0.04%	19.57%	20.0%	3.91%	41.61%	-5.26%
With risk premium	IDA B	3.81%	0.01%	17.33%	0.05%	20.93%	20.0%	4.19%	41.61%	-16.25%
With high-risk premium	IDA B	9.81%	0.09%	38.77%	0.46%	39.14%	20.0%	7.83%	41.61%	-201.09%

Note: The spread used to calculate spread income retained for IBRD and IDA is based on the Flexible Loan lending rate for 5-year term loans on April 24, 2023, in USD currency, that is 50 basis points.

[22] The spread income retained is calculated as:

$$\frac{lending\ rate - \sum(thickness_i \times spread_i)}{lending\ rate} \quad (5.1)$$

The approach to pricing used here resembles approaches employed in the correlation trading market. Simple theoretical no-arbitrage models are used to infer the fair premium on a tranche. These work by the risk adjusted Expected Loss (EL) on the pool assets across different tranches using a formula that is exact in the case of a fully diversified loan pool. When applied here, this formula is an approximation, therefore. The risk adjusted EL is inferred from Credit Default Swap (CDS) spreads for sovereigns allowing for the impact of PCT on MDB loans. The approach is explained in Appendix 7.

The results of the above-described analysis are presented in Table 5.11. For the two institutions, IBRD and IDA, and for the two securitised portfolios, A and B, we present the Els for the tranches, parameters employed, and the retained fraction of the total pool spread income. We calculate prices with our central-case risk premia and then with conservative risk premia which assume stressed PDs. In most cases in Table 5.11, the fraction of pool spread income retained remains high. In Table 5.12, we repeat the calculations but with a doubled estimate of the LGD. In this latter case, there are more cases in which the retained spread income is low or even negative (in which case the transaction is scarcely viable).

7. Lending Headroom Summary

7.1 Introduction

This section brings together the results obtained in earlier sections to summarise the constraints on lending that the two MDBs, IBRD and IDA, face. We consider successively the constraints represented by

1. The requirement to maintain lending below the Statutory Lending Limit (SLL). This only affects IBRD as IDA has no such SLL.
2. The requirement to retain AAA ratings from the global rating agencies. IBRD is rated by all three major agencies, Standard & Poor's, Moody's, and Fitch. IDA only has ratings from the first two of these three agencies.
3. The requirement to maintain the ratio of equity resources to Economic Capital (EC)greater than unity (allowing for a 10% crisis buffer and an allowance of 15% for non-credit related EC).
4. In the case of IDA, a limit on total subsidised (zero-interest-rate) lending which cannot exceed its equity if the institution is to sustain this lending over time. (Here, we assume that costs are covered through fees and no dividend is required.) We refer to this limit as the Sustainable Concessional Lending Limit (SCLL).

We also evaluate the scope for the two MDBs to create greater headroom through risk transfers. In this context, we consider the constraints imposed by rating agency treatment of retained senior tranches and of market pricing given the objective of retaining a reasonable fraction of spread income on the loans subject to risk transfer.

7.2 Statutory ratio lending headroom

As discussed in Section 2.6, the Statutory Lending Limit (SLL) for IBRD constrains lending to be no more than 100% of the unimpaired subscribed capital, plus reserves and surplus.

The IBRD SLL may be compared with similar statutory limits included in the Articles of Agreement of several other prominent MDBs. Several other regional MDBs, including ADB, AfDB and IDB, have the same SLL as IBRD. In other words, their outstanding loans (or guarantees) are constrained to be more than 100% of the unimpaired subscribed capital, plus reserves and surplus. The important exception is EIB which has a statutory lending limit of 250% of the subscribed capital, reserves and surplus (see Article 16 (Section 5) of EIB (2020)).

Another relevant case is the relatively new MDB the Asian Infrastructure Investment Bank (AIIB) established in 2016. The AIIB's Articles of Agreement specify an SLL equal to 100% of subscribed capital plus reserves, similar to those of IBRD and other regional MDBs. However, the AIIB's articles allow for its Board of Governors to increase the SLL to 250% by a Super Majority Vote (see Article 12 Section 1 of AIIB (2015)).[23]

[23] Article 28 Section 2 of the AIIB's Articles of Agreement states: "A Super Majority vote of the Board of Governors shall require an affirmative vote of two-thirds of the total number of Governors, representing not less than three-fourths of the total voting power of the members."

Note that to operationalise its SLL, as part of its annual corporate planning process, IBRD calculates a Sustainable Annual Lending Limit (SALL). The SALL is designed to be consistent with the SLL. The SALL specifies current and projected limits on lending for each individual year over the next 10-year horizon. In this report, we do not attempt to replicate multi-year SALL-type limits, consistent with a 10-year plan. Instead, we focus simply on the lending headroom within the SLL that existed based on end year 2022 data.

Evaluating the SLL at end year 2022, we find that it implies a limit on total lending equal to $339bn. Hence, net outstanding loans could increase by no more than 45% (i.e., by a gross amount of $103.3bn) before the SLL becomes a binding constraint. We shall find, in the following subsections, that the SLL is the first constraint that would bind for IBRD if it were to increase its lending substantially. Of course, IDA faces no SLL, so the other constraints discussed below are relevant for that institution.

SLLs of the type just described have been criticised on the basis that they are unreflective of the risk profile of the institution's portfolio and make no distinction between paid in capital and reserves on one hand and callable equity on the other. Humphrey (2017) argues that statutory limits should be abolished or modified so they are based on financial ratios that are more reflective of risk.

7.3 Rating downgrade lending headroom

Table 7.1 summarises the MDBs' headroom to increase lending before their agency ratings are downgraded, i.e., lose their AAA status for at least one of the three agencies. The 'rating headroom' we report analysis is based on the critical values associated with the loss of at least one AAA rating.[24]

Of the three rating agencies, we find that Moody's is the most constraining for IBRD. The institution could increase its lending by 71% of the net outstanding loans (i.e., $162bn) before a credit downgrade by Moody's is triggered (see Table 7.1).

The most constraining agency for IDA, on the other hand, is Standard & Poor's (see Table 7.1). IDA could increase its lending by 208% of the net outstanding loans (i.e., $371.8bn) before a credit downgrade by Standard & Poor's is triggered. The higher percentage for IDA reflects its extremely strong equity base.

Table 7.1 includes calculations with and without sovereign ratings downgrades. The latter case may be thought of as inclusive of a buffer. The sovereign downgrades in question are based on the following approach. For each sovereign, we lower the rating by the maximum downgrade observed in two periods associated with (i) the Global Financial Crisis and (ii) the Covid 19 crisis.

Table 7.1: Lending Headroom based on Credit Rating Analysis

Criteria	IBRD		IDA	
	Headroom	Gross value	Headroom	Gross value
S&P's rating headroom	278%	637,549	212%	379,007
Moody's rating headroom	71%	162,827	300%	536,331
Fitch rating headroom	89%	204,107	228%	407,612
With Buffer				
S&P's rating headroom	261%	598,562	208%	371,856
Moody's rating headroom	71%	162,827	300%	536,331
Fitch rating headroom	77%	176,587	228%	407,612

Note: Green shade indicates increase in lending until a downgrade occurs. The percent measure is measured in percent of the net outstanding loans of respective institutions. The gross value is in millions of US dollars.

7.4 Economic Capital lending headroom

Table 7.2, summarises the lending headroom implied by the Economic Capital (EC) computation presented in Section 4. They are based on capital surplus defined as the difference between Total Equity (capital resources) and the EC requirement equal to the 1-basis point, 1-year VAR (using stochastic LGDs adjusted for PCT).

[24] Fitch does not trigger credit downgrade for IDA when the lending was increase up to 300% as a part of our study.

To account for market risk, exchange rate risk, liquidity risk and operation risk for the institutions, we are increasing the required EC (i.e., 1-year VAR) calculated in Section 4 by 15%. We have worked with other MDBs for which the incremental impact of risk types other than credit risk was of the order of 10% so assuming 15% appears conservative. Furthermore, we include a counter-cyclical buffer of 10%.[25]

Table 7.2: Lending Headroom based on Capital Model

Criteria	IBRD		IDA	
	Headroom	Gross value	Headroom	Gross value
VAR at 1bp	150%	398,582	354%	755,703
VAR at 1bp AC	339%	904,355	354%	755,703
With Buffer				
VAR at 1bp	147%	393,050	324%	691,065
VAR at 1bp AC	336%	894,616	324%	691,065

Note: Green shade indicates the conservative value to increase the lending. The headroom is based on Exposure at Default (EAD). The gross value is in millions of US dollars. Value at Risk is denoted by VAR, Basis Point is denoted by bp, Adjusted Capital is denoted by AC.

For IBRD, the EC lending headroom is significantly greater than the headroom implied by the rating analysis. One reason may be the allowance that the rating agencies make for PCT which is somewhat conservative. Note that we here take the conservative approach of computing lending headroom based on Total Equity not Adjusted Capital. Table 7.2[26] indicates that IBRD could increase lending by 150% (i.e., $399 bn) before the EC capital surplus is exhausted. Similarly, IDA could increase the lending by 354% (i.e., $756 bn) reflecting its extremely high capital surplus.

7.5 Sustainable Concessional Lending Limit lending headroom

One may consider 1 unit of blended lending to be the equivalent of mixture α of fully concessional lending and (1- α) non-concessional loans. If the organisation's capital is taken to be the limit on its concessional lending, IDA boost its lending by the following amounts:

Blended lending:	(179-105- α x 66)/ α
Concessional lending:	(179-105- α x 66)
Non-concessional lending:	No upper bound

For an alpha value of 0.79, the extra amounts of blended and non-concessional lending IDA could provide are as shown in Table 7.3.

IDA could issue another $26.6 bn of blended loans or $21.0 bn of concessional. If they started lending non-concessionally or used their balance sheet to support IBRD's non-concessional lending, they could do substantial amounts.

Table 7.3: Lending Headroom

Blended lending		26.6
Concessional lending		21.0
Non-concessional lending	No upper bound	

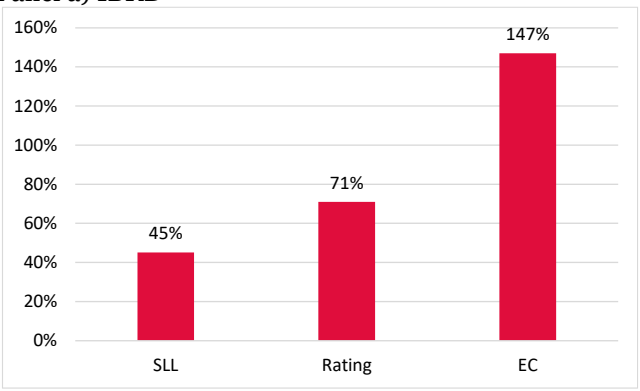
Figure 7.1 summarises the constraints on lending implied by the three primary constraints on lending by IBRD and IDA that are investigated in this study. For IBRD, the tightest constraint is the Statutory Lending Limit

[25] IDA calculates crisis buffer to be 10% of the total resources available which is total equity plus accumulated loss provision.
[26] The percentage increase in lending headroom according to the Economic Capital is based on the exposures of the bank which include net outstanding loans and 50% of undisbursed loans. This is different from the constraint due to SLL and credit rating analysis where lending headroom percentage is based on the net outstanding loans only. For example, if all the three-constraint had similar constraint value of 100% lending headroom. Then it suggests that according to SLL and credit rating analysis the bank could double their net outstanding loans. Whereas according to EC constraint it means bank could double the exposures. If the fraction of net outstanding loans and exposures remained similar in future it would imply that bank could double its net outstanding loans as well.

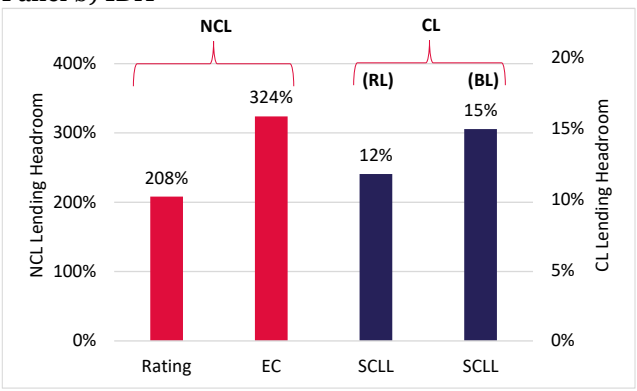
(SLL) which binds after net loans and guarantees have expanded by 45%. The rating constraint binds for IBRD when lending and guarantees have increased by 71%. This binds when the Moody's rating is downgraded from Aaa. The Fitch rating is downgrade shortly thereafter whereas there is plenty of room for IBRD to expand lending before the Standard & Poor's rating is downgraded. The Economic Capital (EC) constraint (i.e., that the Capital Adequacy Ratio (CAR) (allowing for a buffer of 10% exceeds unity) is only breached after a substantial increase in exposure (and, hence, lending) of 147%.

Figure 7.1: Summary of Lending Headroom

Panel a) IBRD



Panel b) IDA



Note: The red bars illustrate, for IBRD and IDA, the headroom for additional non-concessional lending in percent of current net lending and guarantees implied by the three sources of constraint, namely Statutory Lending Limit (indicated by 'SLL'), the requirement that the AAA-ratings of all three global rating agencies be maintained (labelled 'Rating') and that the Capital Adequacy Ratio (equal to capital resources (paid in equity and reserves) divided by capital required (Economic Capital plus a 10% buffer)) exceeds unity. IDA has no SLL constraint. In computing CARs for IDA, we have followed a conservative approach, comparable to IDA's internal risk management methodology, of adjusting capital resources downwards to allow for the value of the subsidy element in IDA's loans. More information about the computations may be found in the sister technical paper, Risk Control (2023). The dark blue bars show headroom as a percentage of IDA total lending (relative to the SCLL) if it expands its lending using subsidised loan instruments (CLs or BLs). SCLL denotes Sustainable Concessional Lending Limit, NCL denotes Non-Concessional Loan, CL denotes Concessional Loan, RL denotes Regular Loan and BL denotes Blended Loan. Note that because of the differences in the way these constraints are applied, the rating headroom (71% for IBRD) is expressed in terms of outstanding loans whereas the EC headroom (147% for IBRD) is expressed in terms of outstanding loans plus 50% of undisbursed commitments.

The red bars in Figure 7.1 Panel b) show the headroom for IDA if it were either (i) to increase NCL or (ii) to increase CL with donor-matching of the subsidy element. The finding here is that IDA's capital is so large that market borrowing is effectively unconstrained and so NCL could expand very substantially. However, a large boost in NCL would be a major change in IDA's business model and donor matching of subsidy elements is hard to obtain.

The dark blue bars Figure 7.1 Panel b) show the headroom that IDA has available before the Sustainable Concessional Lending Limit (SCLL) binds if it employs either CLs or BLs. BLs carry an interest rate, but this is still highly subsidised. Hence, BLs may be thought of as a combination of CLs and NCLs. The lending headroom for IDA if it were to boost either CLs or BLs is much smaller. The dark blue bars in Figure ES1 Panel b) show that IDA could expand its total lending using CLs or BLs, respectively by 12% and 15%.

The precise values of these calculations are, of course, subject to many assumptions. The rating calculations assume some deterioration in the qualitative questions that the rating agencies include in their rating evaluations. For Moody's in particular, the judgmental elements are reduced to precise questions that place the MDB in one or other of several discrete categories. Determining the expansion in lending but they might shift to more negative categories that triggers a deterioration in these judgmental scorings in turn requires that we make a judgment or assumption. Similarly, in the EC constraint calculations, many aspects of the Credit Portfolio Model (CPM) employed in the calculations might be questioned. We have tried several reasonable sensitivity analyses and adopted reasonable assumptions with some conservative elements.

Note we compute the percentage lending headroom based on Economic Capital by scaling up exposures rather than disbursed loans and guarantees. Exposures is a bigger aggregate than loans since it includes both loans and guarantees *and* 50% of undisbursed commitments. In our earlier discussion of constraints due to the

Statutory Lending Limit (SLL) and credit ratings, the headroom percentage computation was based on net outstanding loans only. Our justification for using a different approach here is that while the SLL and the rating agencies focus on lending, EC is usually calculated for exposures. If one supposes that the ratio of net loans and guarantees to exposures in the future equals the current level, then the calculations for the EC constraint become comparable to those based solely on net loans and guarantees.

To allow for the demands that a crisis might put on the MDBs, we consider a stress scenario in which the ratings of sovereigns deteriorate. The downgrade for each individual country is taken to equal the maximum downgrade experienced by the country in question in either the Global Financial Crisis (GFC) and the Covid 19 crisis. In fact, there is little difference in the lending headroom for IBRD. The change in the rating analysis headroom is negligible and the change in the EC surplus headroom is just 3%. Similarly, for IDA, there is no significant change in the rating headroom calculation from including stressed sovereign ratings, merely a drop of 4%. On the other hand, The EC surplus headroom for IDA falls by 42% when crisis-period sovereign rating downgrades are included.

7.6 Implications of securitisation for lending headroom

Our analysis of the effects of risk transfer on lending headroom are based on the two portfolios described in Section 5. These represent 10% of the EAD of the respective institutions. We assume that the MDB retains the senior and junior tranche while transferring the mezzanine tranche (of thickness 25.25%). We suppose that the retained senior tranche can be rated no higher than single A, applying the Standard & Poor's approach.

The lending headroom due to securitisation based on credit rating analysis is calculated through a two-step process. First, we calculate the reduction in the adjusted credit RWA after securitisation compared to the same quantity in the base case (see Table 6.4 and Table 6.5). Second, by calculating the percentage increase in the net outstanding loans for the portfolio with securitisation that would lead generate the same adjusted RWAs as in the base case.

Table 7.3 shows the additional amount that the institution could lend following a risk transfer before its Standard & Poor's RAC ratio equals the value it had before the risk transfer. This additional lending headroom is low for IBRD compared to IDA for similar amount of risk transfer in that, for IBRD the securitisation generates only an additional 3% for portfolio A and 6% for portfolio B, while for IDA it leads to 16% and 13% for the two portfolios. The difference reflects the fact that IBRD makes loans to higher rated countries. The securitisation is less effective in this case. The best outcome for IBRD is the 6% it can achieve with portfolio B.

Table 7.3: Lending Headroom due to Securitisation based on Credit Rating Analysis

Securitisation Scenario	IBRD		IDA	
	Headroom	Gross value	Headroom	Gross value
Portfolio A	3%	6,323	16%	27,757
Portfolio B	6%	12,758	13%	23,390

Note: Blue shade indicates the portfolio that leads to maximum LH. The % is based on net outstanding loans of respective institutions. The gross value is in $ million.

Table 7.4: Economic Capital Gain from Risk transfer

Risk transfer Scenario	IBRD		IDA	
	Headroom	Gross value	Headroom	Gross value
	Reduction in required EC	Reduction in required EC	Reduction in required EC	Reduction in required EC
VAR at 1bp – risk transfer of portfolio A	12%	2,669	11%	3,134
VAR at 1bp – risk transfer of portfolio B	18%	4,054	13%	3,515

Note: Blue shade indicates the portfolio that leads to maximum reduction in EC. The percentage reported is in terms of the base case VAR amount without risk transfer. The gross value is in millions of US dollars.

In Table 7.4, we show the reduction in economic capital (EC) for IBRD and IDA when they securitise their respective portfolios A and B. We find that risk transfer reduces the EC substantially if the securitised portfolio

is riskier. for IBRD the reduction in EC is 12% for portfolio A and 18% for portfolio B. For IDA, the reduction in EC turns out to be 12% for both portfolio A and B (see Table 7.4).

These findings imply that risk transfer offers an effective safety valve in relaxing some of the lending constraints that IBRD and IDA may face. But there are some significant obstacles here. For IBRD, the tightest constraint is the SLL. The definition of lending used in calculating the SLL presumably includes retained senior tranches. This severely restricts the benefit that the IBRD might obtain from a risk transfer that leaves a thick senior tranche on balance sheet. If the SLL were relaxed, the first constraint to bind would be the constraint associated with a downgrade in the Moody's rating. Again, when lending expands, the Moody's rating is affected by a deterioration in the leverage ratio. This would not be much improved by a risk transfer that left IBRD with a thick retained senior tranche.

8. Conclusion

This study examines the constraints on lending faced by the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA).

The constraints in question are:

1. The Statutory Lending Limit (SLL) included in the IBRD's Articles of Agreement. Those of IDA do not include such a limit.
2. The requirement that the two institutions retain their triple A ratings from the three global rating agencies, Moody's, Standard & Poor's and Fitch. (IDA is not rated by Fitch.)
3. The requirement that the institutions' Capital Adequacy Ratios (CARs) exceed unity. The CAR is measured as the ratio of capital resources (typically, the sum of paid in equity, retained earnings and reserves) to capital required (typically measured as the total Economic Capital for different risk types, credit, market and operational).
4. Sustainable Concessional Lending Limit (SCLL) is a limit on total subsidised (zero-interest-rate) lending which cannot exceed its equity if the institution is to sustain this lending over time (for IDA).

We show that for IBRD, the SLL binds first followed by the rating constraint (specifically because of the Moody's rating, followed by that of Fitch), and that the CAR/Economic Capital limit binds last. IDA is not subject to an SLL. The rating and CAR constraints barely limit how IDA might expand its lending but unless such increased lending were non-concessional, IDA would rapidly hit the Sustainable Concessional Lending Limit (SCLL) in that its total concessional lending (including the concessional component of blended loans) would exceed its equity. This would before long generate losses and a reduction in IDA's ability to make fully concessional (zero-interest-rate) loans.

Risk transfer appears feasible and could assist in relaxing some constraints. But, for IBRD, the SLL and the constraint associated with Moody's ratings would not be relaxed by the most standard types of transactions involving tranching since these constraints depend on a combination of the leverage ratio and the contractual support ratio (which depends on callable capital and total debt) which are not sensitive. For IDA, risk transfer is unnecessary since the constraints we examine here are far from binding.

The conclusions of this study are necessarily subject to the assumptions made as part of the analysis. Thus, the precise headroom values that we provide should be treated with caution, but we believe that the broad messages and findings are reliable.

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Appendix 1: Rating Data and Calibration Issues

Standard & Poor's rating fine-tuning
S&P provides an extensive document with a discussion of the factors that are considered for the final rating calculations. This provides detailed descriptions of individual calculations such as the RAC methodology and the liquidity indicators. The exposure at default (EAD) is not explicitly presented in the annual reports from IBRD and IDA. To match the EAD calculated from S&P we apply a factor the net outstanding loans and to the other assets.

The RAC methodology comprises many adjustments to obtain the Total Adjusted Capital (TAC). These adjustments are calculated using the ratings and the correlation matrix of the sovereigns. S&P does not specifically report the date at which the ratings are collected or the period for which correlation matrices, therefore, approximate the adjustments and, thus, ultimately the RAC ratio. We made individual adjustments so as to obtain to the original RAC ratio.

Liquidity indicators are harder to calculate as information is lacking regarding the maturity of the liabilities of IBRD and IDA. By adjusting the maturity of liabilities (we have information on the maturity of the assets), we match the liquidity and funding gap.

Moody's rating fine-tuning
Moody's have an extensive document on rating methodology. The methodology depends on fewer n quantitative elements than does that of Standard & Poor's. The leverage ratio (an important determinant on capital adequacy) may be directly inferred from the balance sheet. So, no adjustment was required. The liquidity indicator nonetheless depends on the forecast of inflows and outflows. This forecast is not obtainable from the annual report, so we infer the inflows and outflows so as to match the liquidity factor that appears in the Moody's report.

We must also infer the answer to the qualitative questions included in the Moody's methodology. In most cases, we can infer suitable answers to questions based on general knowledge of the institutions. However, some answers are inferred from intermediate indicators reported together with the final rating.

Fitch rating fine-tuning
Fitch does not calculate a rating for IDA. Consequently, we lack a reference point to calculate a Fitch rating. Nevertheless, Fitch provides a very extensive discussion of its rating calculation. This specifies some of the quantitative factors that are used to the ratings, but not in a very comprehensive list.

We, therefore, deduce some quantitative calculations from intermediate indicators in the ratings reports. As with the other rating agencies we are obliged to make assumptions regarding the maturity of liabilities to obtain liquidity indicators.

Other adjustments are performed to the answers to qualitative questions to match intermediate ratings results to those that the agency has published.

Appendix 2: Rating Analysis not Changing Qualitative Questions

In this appendix, we display results without answering qualitative questions conservatively. It is more realistic to assume that the agencies would adopt more negative answers to their qualitative questions, but the results show here represent a benchmark against which one may compare the results reported in the main text.

Table A2.1: S&P rating with DRA and treasury growth not qualitative deterioration for IBRD

DRA + Treasury growth (%)	RAC (%)	12 month liquidity	Capital Adequacy	Liquidity and Funding	Financial Risk Profile	Enterprise Risk Profile	SACP	Enhanced RAC (%)	Enhanced Financial Risk Profile	Enhanced SACP	Indicative ICR	Final ICR
0	25.9	200	Extremely Strong	Strong	Extremely strong	Extremely strong	aaa	45.6	Extremely Strong	aaa	aaa	AAA
75	15.0	189.5	Very Strong		Very Strong			26.4				
164	10.0	183.7	Strong		Strong		aa+	32.9				
278	7.0	180.4	Adequate		Adequate		aa	28.6	Extremely Strong*			

Note: * These enhanced FRP are held by the qualitative question on the loan performance

Table A2.2: S&P rating with DRA and treasury growth not qualitative deterioration for IDA

DRA + Treasury growth (%)	RAC (%)	12 month liquidity	Capital Adequacy	Liquidity and Funding	Financial Risk Profile	Enterprise Risk Profile	SACP	Enhanced RAC (%)	Enhanced Financial Risk Profile	Enhanced SACP*	Indicative ICR	Final ICR
0	68.8	240	Extremely Strong	Strong	Extremely strong	Extremely strong	aaa	68.8	Extremely strong	aaa	aaa	AAA
27	56	126		Adequate	Very Strong			54.4	Very Strong			
64	44	90		Moderate	Strong		aa+	43.0	Strong	aa+		

Note: * There is no change in the enhanced SACP as there is no callable capital for the IDA

Table A2.3: Moody's rating with DRA and treasury growth not qualitative deterioration for IBRD

DRA + Treasury growth (%)	Leverage ratio (%)	Capital adequacy	Liquidity and funding	Preliminary intrinsic financial strength	Qualitative adjustments	Adjusted intrinsic financial strength	Contractual support ratio (%)	Strength of member support	Scorecard Indicated
0	450	a1	aa1	aa2	+1	aa1	120	Very high	Aaa
9	468	a2		aa3		aa2	110		
30	534	a3					90		
71	702						66		
79	735	baa1					63	High	
144	1002	baa2		a1		aa3	45		aa1

Table A2.4: Moody's rating with DRA and treasury growth not qualitative deterioration for IDA

DRA + Treasury growth (%)	Leverage ratio (%)	Capital adequacy	Liquidity and funding	Preliminary intrinsic financial strength	Qualitative adjustments	Adjusted intrinsic financial strength	Contractual support ratio (%)	Strength of member support	Scorecard Indicated
0	100	aa1	aaa	aaa	+1	aaa	0	High	Aaa
18	118	aa2		aa1					
51	151	aa3							
84	183	a1							
118	217			aa2		aa1			
201	300	a2							

Table A2.5: Fitch rating with DRA and treasury growth not qualitative deterioration for IBRD

DRA + Treasury growth (%)	Equity to assets ratio	Capital to RWA ratio	Capitalisation	Risks	Solvency assessment	Liquidity assessment	Business environment	Business environment adjustment	Intrinsic rating	Extraordinary support	Rating
0	17	66	Strong	Low	aa	aaa	Low risk	2	aaa	aa-	AAA
68	10	39									
89	9	35	Moderate		a				aa-	a	AA-
164	7	25	Weak		bbb				a-		A

Table A2.6: Fitch rating with DRA and treasury growth not qualitative deterioration for IDA

DRA + Treasury growth (%)	Equity to assets ratio	Capital to RWA ratio	Capitalisation	Risks	Solvency assessment	Liquidity assessment	Business environment	Business environment adjustment	Intrinsic rating	Extraordinary support	Rating
0	81	104	Excellent	Low	aa	aaa	Low risk	2	aaa	a	AAA
228	25	32	Strong		a				aa-		AA-

Appendix 3: Calibration of the Capital Model

We explain in this appendix, the assumptions adopted in calibrating the Credit Portfolio Model (CPM) employed in the Capital Adequacy Ratio (CAR) analysis.

Transition matrix

We use as starting point the historical transition matrix reported in S&P (2022b). This is based on data up to 2021. The transition matrix is shown in Table A3.5.

We then scale the righthand column to allow for Preferred Creditor Treatment (PCT). Risk Control (2022) has previously analysed the effect of PCT on sovereign PDs. Using historical arrears data from multiple MDBs, it infers a multiplicative adjustment of 1/3.5 to infer PCT-inclusive PDs from those encountered in the sovereign bond market. Table A3.6 shows the PCT adjusted transition matrix we obtain after scaling PDs in this way.

As an alternative approach, we estimate rating-specific PDs inclusive of PCT directly from MDB sovereign loan non-accrual data. This is described in more detail see Appendix 4. The resulting PD vector is inserted in the righthand column of a transition matrix and other row elements rescaled to obtain unity. The resulting matrix is shown in Table A3.7.

Loss Given Default (LGD)

We present our results using 4 different sets of LGDs:

- Non-stochastic LGDs with PCT adjustments,
- Non-stochastic LGDs without PCT adjustments,
- Stochastic LGDs with PCT adjustments and
- Stochastic LGDs without PCT adjustments.

For the non-stochastic case, we assume that LGDs with PCT adjustments are 10% and LGDs without PCT adjustments are 45%.

For the stochastic case, we suppose that recoveries (equal to unity minus the LGD rate) are beta-distributed on the unit interval with the means equal to θ and volatilities equal to $\lambda \times \sqrt{\theta \times (1-\theta)}$. Cruces and Trebesch (2013) estimated mean and standard deviation of haircuts as 37.04 and 27.28 respectively. Using these results, we calculate the value of λ as $\frac{0.2728}{\sqrt{0.3704 \times (1-0.3704)}} = 0.56$. Additionally, we assume that θ is equal to 90% with PCT adjustments and 55% without PCT adjustments. Therefore, volatilities are 0.168 and 0.279 with and without PCT adjustments respectively.

Correlations

Correlation assumptions are crucial inputs to credit portfolio analysis. One common practice is to base correlations on equity return data. Alternatively, one may base correlations on spread changes or rating histories. We, here, consider two approaches based on equity index returns and bond spread changes.

For the equity-index-based approach, we use the regional equity indices that are calculated by MSCI[27]:

- MSCI EFM Africa,
- MSCI EM Europe and Middle East,
- MSCI EM Asia,
- MSCI EM Latin America.

Here, EFM stands for Emerging Frontier Markets and EM stands for Emerging Markets. The time-series index data is daily from 02/01/2006 to 14/03/2023. Firstly, we calculate the 6-month overlapping log returns by $r_t = \log(x_t) - \log(x_{t-182})$ where x_t is the index value on day t. Then, we normalise the returns by subtracting the mean and dividing by the standard deviation. Finally, we calculate the pairwise correlations between each index. The correlations are displayed in Table A3.1.

[27] Index fact sheets can be found at https://www.msci.com/equity-fact-sheet-search.

Table A3.1: Equity-based Correlation Matrix

Correlation	Africa	Europe and Middle East	Asia	Latin America
Africa	100.00%	83.09%	89.36%	89.67%
Europe and Middle East	83.09%	100.00%	86.31%	85.55%
Asia	89.36%	86.31%	100.00%	82.24%
Latin America	89.67%	85.55%	82.24%	100.00%

To calculate the idiosyncratic risk weights for each region, firstly, we obtain 33 country equity indices that are calculated by MSCI in addition to the region indices and calculate the normalised log returns of the series. We regress the individual country indices on their corresponding region index and obtain the regression coefficient β_i for each country i. The reason behind this calculation is the factor model we assumed in equation (4.2). So, $\beta_i = \sqrt{1-\eta_i^2}$ and we calculate the idiosyncratic weights for each country using $\eta_i = \sqrt{1-\beta_i{}^2}$. Finally, we average over each region to calculate the regional idiosyncratic weights. The results appear in Table A3.2.

Table A3.2: Equity-based Idiosyncratic Risk Weights

Region	Idiosyncratic risk weights (eta)
Africa	0.790
Europe and Middle East	0.651
Asia	0.645
Latin America	0.591

For the spread-based approach, the data employed consists of corporate bonds covering the universe of publicly offered straight fixed-rate U.S. bonds, a large collection of Eurobonds and government bonds. Our government bond data contains all government sovereign, municipal sovereign and government agency bonds that are issued on major markets (Canada, Eurobond, European Monetary Union, France, Germany, Italy, Japan, UK and US), denominated in US dollar, issuer domicile being non-US and Moody's rating higher than Caa3. The dataset contains the comprehensive characteristic and price data reported by Refinitiv.

We select the bonds issued by 134 countries that have loans to either IBRD and IDA and group them accordingly into their regions. Regional factor correlations are calculated based on the spread changes of the bonds as described above over the period from 01/02/2006 to 31/10/2022. The following steps are taken to obtain the regional factor correlations:

1. The price of each bond in the database is calculated using information of the bond characteristics (coupon rate, maturity, coupon payment frequency) and is discounted using the zero curve.
2. The default-free yield of each bond is calculated, which represents the internal rate of return such that the sum of the present value of the cash flow is equal to the bond price in 1).
3. The spread for each bond is calculated as the difference between the market yield and the default-free yield.
4. The spread indices are calculated as the difference of the average spreads of commonly existing bonds between two adjacent dates across the entire study period.
5. The regional correlations are then calculated between each pair of regions given the spread indices in 4) as factors.

As the observation period is long, the approach used consists of calculating moments with overlapping observations and then adjusting non-parametrically for the statistical biases induced by the use of overlapping observations. Note that the return correlations vary according to the degree to which the observations are overlapping. We use 250-day as our holding period in this exercise. The correlations are estimated using the steps above are presented in Table A3.3.

Table A3.3: Spread-based Correlation Matrix

	Africa	Europe and Middle East	Asia	Latin America
Africa	100.00%	52.14%	80.23%	72.42%
Europe and Middle East	52.14%	100.00%	51.67%	50.09%
Asia	80.23%	51.67%	100.00%	69.92%
Latin America	72.42%	50.09%	69.92%	100.00%

We also estimated the idiosyncratic risk weights based on regressions of changes in bond yield spread indices for different regions. The results are given in Table A3.4.

Table A3.4: Spread-based Idiosyncratic Risk Weights

Region	Idiosyncratic risk weights (eta)
Africa	0.565
Europe and Middle East	0.894
Asia	0.762
Latin America	0.759

Table A3.5: S&P Historical Sovereign Transition Matrix

From / To	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	Cs	Default
AAA	96.79%	2.71%	0.42%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
AA+	6.45%	85.16%	6.61%	1.77%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
AA	0.00%	6.22%	85.17%	6.74%	0.52%	0.42%	0.10%	0.52%	0.00%	0.00%	0.00%	0.31%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
AA-	0.00%	0.00%	7.82%	83.45%	7.16%	0.17%	0.50%	0.17%	0.00%	0.17%	0.44%	0.00%	0.00%	0.11%	0.00%	0.00%	0.00%	0.00%
A+	0.00%	0.00%	0.07%	13.35%	73.28%	9.30%	2.03%	1.12%	0.14%	0.63%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
A	0.00%	0.00%	0.00%	1.15%	12.33%	77.29%	5.71%	1.68%	0.77%	0.96%	0.10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
A-	0.00%	0.00%	0.00%	0.00%	0.94%	11.47%	77.82%	6.94%	0.41%	1.57%	0.67%	0.16%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%
BBB+	0.00%	0.00%	0.00%	0.00%	0.00%	2.16%	12.39%	70.86%	11.24%	2.41%	0.60%	0.24%	0.06%	0.00%	0.00%	0.00%	0.00%	0.04%
BBB	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.87%	16.60%	68.05%	11.16%	0.99%	0.11%	0.00%	0.50%	0.22%	0.11%	0.33%	0.06%
BBB-	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.93%	14.94%	74.69%	6.50%	2.13%	0.27%	0.08%	0.15%	0.12%	0.08%	0.11%
BB+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.54%	20.57%	66.38%	9.93%	1.14%	0.18%	0.06%	0.00%	1.02%	0.18%
BB	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.78%	14.20%	70.80%	11.15%	1.80%	0.68%	0.15%	0.05%	0.40%
BB-	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.03%	10.55%	73.79%	11.47%	1.19%	0.46%	0.61%	0.90%
B+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.03%	0.92%	10.20%	68.70%	15.30%	2.50%	0.85%	1.46%
B	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.61%	13.50%	70.77%	9.84%	2.91%	2.38%
B-	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.43%	15.07%	66.85%	8.05%	7.59%
Cs	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.74%	1.81%	13.90%	32.08%	51.47%
Default	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%

Note: Estimates are based on S&P (2022b).

Table A3.6: Historical Sovereign Transition Matrix with Adjusted PDs

From / To	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	Cs	Default
AAA	96.79%	2.71%	0.42%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
AA+	6.45%	85.16%	6.61%	1.77%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
AA	0.00%	6.22%	85.17%	6.74%	0.52%	0.42%	0.10%	0.52%	0.00%	0.00%	0.00%	0.31%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
AA-	0.00%	0.00%	7.82%	83.45%	7.16%	0.17%	0.50%	0.17%	0.00%	0.17%	0.44%	0.00%	0.00%	0.11%	0.00%	0.00%	0.00%	0.00%
A+	0.00%	0.00%	0.07%	13.35%	73.28%	9.30%	2.03%	1.12%	0.14%	0.63%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
A	0.00%	0.00%	0.00%	1.15%	12.33%	77.30%	5.71%	1.68%	0.77%	0.96%	0.10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
A-	0.00%	0.00%	0.00%	0.00%	0.94%	11.47%	77.83%	6.94%	0.41%	1.57%	0.67%	0.16%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
BBB+	0.00%	0.00%	0.00%	0.00%	0.00%	2.16%	12.40%	70.87%	11.25%	2.41%	0.60%	0.24%	0.06%	0.00%	0.00%	0.00%	0.00%	0.01%
BBB	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.87%	16.61%	68.08%	11.17%	0.99%	0.11%	0.00%	0.50%	0.22%	0.11%	0.33%	0.02%
BBB-	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.93%	14.95%	74.75%	6.51%	2.13%	0.27%	0.08%	0.15%	0.12%	0.08%	0.03%
BB+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.54%	20.59%	66.47%	9.94%	1.14%	0.18%	0.06%	0.00%	1.02%	0.05%
BB	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.78%	14.24%	71.01%	11.18%	1.80%	0.68%	0.15%	0.05%	0.12%
BB-	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.04%	10.62%	74.27%	11.54%	1.20%	0.46%	0.61%	0.26%
B+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.03%	0.93%	10.31%	69.43%	15.46%	2.52%	0.86%	0.42%
B	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.62%	13.73%	72.00%	10.01%	2.96%	0.68%
B-	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.58%	15.96%	70.78%	8.52%	2.17%
Cs	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.31%	3.19%	24.42%	56.38%	14.70%
Default	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%

Note: Estimates are based on S&P (2022b).

Table A3.7: Historical Non-accrual Transition Matrix

From / To	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	Cs	Default
AAA	96.79%	2.71%	0.42%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
AA+	6.45%	85.16%	6.61%	1.77%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
AA	0.00%	6.22%	85.17%	6.74%	0.52%	0.42%	0.10%	0.52%	0.00%	0.00%	0.00%	0.31%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
AA-	0.00%	0.00%	7.82%	83.45%	7.16%	0.17%	0.50%	0.17%	0.00%	0.17%	0.44%	0.00%	0.00%	0.11%	0.00%	0.00%	0.00%	0.00%
A+	0.00%	0.00%	0.07%	13.35%	73.28%	9.30%	2.03%	1.12%	0.14%	0.63%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
A	0.00%	0.00%	0.00%	1.15%	12.33%	77.29%	5.71%	1.68%	0.77%	0.96%	0.10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
A-	0.00%	0.00%	0.00%	0.00%	0.94%	11.47%	77.82%	6.94%	0.41%	1.57%	0.67%	0.16%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%
BBB+	0.00%	0.00%	0.00%	0.00%	0.00%	2.16%	12.39%	70.86%	11.24%	2.41%	0.60%	0.24%	0.06%	0.00%	0.00%	0.00%	0.00%	0.03%
BBB	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.87%	16.60%	68.06%	11.16%	0.99%	0.11%	0.00%	0.50%	0.22%	0.11%	0.33%	0.05%
BBB-	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.93%	14.95%	74.72%	6.50%	2.13%	0.27%	0.08%	0.15%	0.12%	0.08%	0.07%
BB+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.54%	20.58%	66.44%	9.94%	1.14%	0.18%	0.06%	0.00%	1.02%	0.10%
BB	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.78%	14.24%	70.99%	11.17%	1.80%	0.68%	0.15%	0.05%	0.14%
BB-	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.04%	10.63%	74.32%	11.55%	1.20%	0.46%	0.61%	0.19%
B+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.03%	0.93%	10.33%	69.51%	15.48%	2.53%	0.86%	0.29%
B	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.62%	13.76%	72.15%	10.03%	2.97%	0.47%
B-	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.61%	16.18%	71.77%	8.64%	0.79%
Cs	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.49%	3.63%	27.84%	64.26%	2.77%
Default	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%

One way to understand the conservativeness or otherwise of the calibrated correlations is to compute the pairwise correlation of the latent variables driving any two exposures. If one averages across all pairs of exposures in a portfolio, the resulting mean pairwise latent variable correlation may be compared to the correlations assumed in the Basel rules. In the Basel Internal Ratings Based Approach (IRBA), capital is calculated assuming that any loans have latent variable correlations ranging from 12% to 24% depending on the credit quality as measured by the probability of default. Computing pairwise asset correlations for the IBRD and IDA portfolios, we obtain the following results:

Equity-based IBRD average pairwise correlation: 49.33%
Equity-based IDA average pairwise correlation: 44.12%
Spread-based IBRD average pairwise correlation: 30.16%
Spread-based IDA average pairwise correlation: 40.60%

This suggests that the calibration we consider are distinctly more conservative than is assumed in Basel.

Appendix 4: Sensitivity Analysis of PDs

Sovereign Probability of Default (PD) is a key parameter in the capital calculation employed in assessment of portfolio credit risk. This appendix explains how we estimate PDs using the non-accrual data from four prominent MDBs, namely Asian Development Bank (ADB), International Bank for Reconstruction and Development (IBRD), Inter-American Development Bank (IDB) and African Development Bank (AfDB).

Use of S&P sovereign historical PDs is inappropriate for MDBs as they omit the important influence of Preferred Creditor Treatment (PCT). In our calculation, a sovereign is counted as being in default when it is placed into non-accrual status by at least one of the Multinational Development Banks (MDBs) that reports an outstanding balance for that sovereign. We employ data for the time period 1988-2019. A total of 48 non-accrual events may be found in the dataset considered.

The key inputs for the sovereign PD model are historical non-accrual (default) data from ADB, IADB, IBRD and AfDB and the historical S&P ratings of the sovereigns. Information on the data is presented in Table A4.1and Table A4.2. Some non-accrual events for AfDB and IADB are shared with IBRD since the latter has borrower countries in common with ADB, AfDB, and IADB. In the final data used for the calculation, the shared member countries are excluded from the IBRD dataset to avoid double counting.

Table A4.1: Countries Count in the Historical Non-accrual Data

Institution	Source	# Countries	# Non-Accrual Countries
ADB	Internal	47	7
AfDB	Annual Reports	52	12
IADB	IADB	24	7
IBRD	Annual Reports	162	22
Total		285	48

Table A4.2: Non-accrual Countries

Creditor Institution	Sovereign	First Non-Accrual Year	Creditor Institution	Sovereign	First Non-Accrual Year
ADB	Afghanistan	1993	IBRD	Bosnia and Herzegovina	1993
ADB	Marshall Islands	2006	IBRD	Haiti	1992, 2002
ADB	Myanmar	1998	IBRD	Iraq	1991
ADB	Nauru	2001	IBRD	Montenegro	1997
ADB	Solomon Islands	1996, 2003	IBRD	North Macedonia	1993
ADB	Vietnam	1992	IBRD	Serbia	1997
ADB	Micronesia	2009	IBRD	Syria	1988, 2012
AfDB	Cabo Verde	2017	IADB	Barbados	2012
AfDB	Central African Republic	1998, 2002	IADB	Colombia	2003
AfDB	Comoros	1999, 2004	IADB	Dominican Republic	2007
AfDB/IBRD	Côte d'Ivoire	2001, 2004	IADB/IBRD	Guatemala	1991
AfDB/IBRD	Democratic Republic of the Congo	1994, 2004	IADB/IBRD	Guyana	1988
AfDB	Djibouti	2005	IADB/IBRD	Honduras	1989
AfDB	Eritrea	2012	IADB/IBRD	Nicaragua	1988
AfDB	Guinea	2010	IADB/IBRD	Panama	1988, 2002
AfDB/IBRD	Liberia	1988	IADB/IBRD	Peru	1988
AfDB/IBRD	Republic of Congo	1992, 1998, 2004	IADB	Suriname	2000
AfDB	Senegal	2017	IADB	Trinidad and Tobago	1999
AfDB/IBRD	Seychelles	2003	IADB	Venezuela	2017
AfDB/IBRD	Sierra Leone	1988			
AfDB	Somalia	1992			
AfDB/IBRD	Sudan	1994			
AfDB	Togo	2002			
AfDB/IBRD	Zambia	1988			
AfDB/IBRD	Zimbabwe	2001			

IBRD has experienced 22 non-accrual events while the numbers for ADB and IADB are much lower at 7. IADB reports the highest number of non-accrual events per borrowing country. IBRD reports the lowest number of

non-accruals per borrowing country. Table A4.2 provides more detailed information on the non-accrual countries for each of the four MDBs.

For each sovereign in the non-accrual data, there is a historical outstanding balance record. A non-accrual event is only treated as a default if at least one MDB has an outstanding balance for that sovereign in the same time period. The non-accrual events of Nauru in 2001 and Democratic Republic of the Congo in 1994 are not counted in this respect as there was no outstanding balance data in the corresponding period in either case. All other non-accrual events are counted as defaults.

The historical sovereign ratings data includes 182 countries and covers time period from 1987 to 2020. The CCC, CC and C ratings by S&P is consolidated to 'Cs' in the capital model used in this study. Some sovereigns were not rated (NR) during the earlier periods in the data. The number of NR entries in each year is shown in Table A4.3.

There are 21 non-accruals/defaults that are NR were independently rated by RMPA – Country Ratings Desk using ADB's Sovereign Rating methodology. The new ratings for these NR entries are shown in Table A4.4

The other NR entries are filled depend on whether there is an existing rating either in previous years or in following years. A two steps approach is adopted to fill in the NR entries.

- Step 1: For each country, starting from t_1 and work forward to $t_2, t_3, \dots, t_T$, if t_i is NR replace it with the rating at t_{i-1}. T is the total number of time periods.
- Step 2: For each country, starting from t_T and work backward to $t_{T-1}, \dots, t_2, t_1$, if t_i is NR replace it with the rating at t_{i+1}

Table A4.3: Number of rated and NR countries

Year	Rated	NR	Year	Rated	NR
1987	10	172	2004	154	28
1988	18	164	2005	154	28
1989	20	162	2006	153	29
1990	23	159	2007	155	27
1991	27	155	2008	156	26
1992	24	158	2009	169	13
1993	30	152	2010	169	13
1994	34	148	2011	171	11
1995	40	142	2012	171	11
1996	56	126	2013	173	9
1997	70	112	2014	174	8
1998	76	106	2015	174	8
1999	144	38	2016	174	8
2000	150	32	2017	174	8
2001	150	32	2018	177	5
2002	151	31	2019	177	5
2003	152	30	2020	177	5

To make use of all the available data, assumptions are made to replace the NR entries with proxy ratings.

Table A4.4: New ratings for NR non-accrual

Creditor Institution	Country	Default year	NR year	Replace NR with rating
ADB	Afghanistan	1989	1988	CCC+
		1992	1991	CCC
ADB	Marshall Islands	2006	2005	CCC+
ADB	Micronesia	2009	2008	B-
ADB	Myanmar	1998	1997	CCC
ADB	Solomon Islands	1996	1995	B-
ADB	Vietnam	1992	1991	CCC+
AfDB	Central African Republic	1998	1997	CCC+
AfDB	Comoros	1999	1998	CCC
		2004	2003	CCC+
AfDB	Djibouti	2005	2004	B
AfDB	Republic of Congo	1992	1991	CCC
		1998	1997	CCC
AfDB	Somalia	1992	1991	CCC
AfDB	Sudan	1994	1993	CCC
IBRD	Haiti	1992	1991	CCC+
IBRD	Iraq	1991	1990	CCC
IBRD	Montenegro	1997	1996	B-
IBRD	Serbia	1997	1996	B-
IADB	Guatemala	1991	1990	B-
IADB	Honduras	1989	1988	B

Based on the historical ratings, non-accrual and outstanding balance data, a table of rating transition and non-accrual status is constructed. The value in each period is in format of $\frac{Rating}{Accrual}Status$.

In each year t, the 1-year Rating/Accrual Status is constructed as follows.

$$Rating = \begin{cases} 23, \ if\ it\ is\ treated\ as\ default\ in\ year\ t-1 \\ rating\ in\ year\ t-1, \ otherwise \end{cases}$$

$$Accrual\ Status = \begin{cases} 1, \ non\ accrual = 1\ in\ year\ t\ and\ \ outstanding\ balance = 1\ in\ year\ t-1 \\ 0, \ non\ accrual = 0\ in\ year\ t\ and\ \ outstanding\ balance = 1\ in\ year\ t-1 \\ NA, \ outstanding\ balance = 0\ in\ year\ t-1 \end{cases} \quad (A3.1)$$

Table A4.5 shows some examples of Rating/Accrual Status for Afghanistan.

Table A4.5: Afghanistan rating/accrual status table

	1988	1989	1990	1991	1992	1993	1994	2000	2001	2002	2003	2004	2005	2006-2017	2018	2019
Rating	17	17	17	18	18	18	18		19	19	19	19	19	19	19	19
Non-accrual		1			1	1	1		1	1						
Outstanding balance	1	1	1	1	1	1	1		1	1	1	0	0	0	1	1
1-year Rating/Accural Status		17/1	23/0	17/0	18/1	23/1	23/1		23/1	23/1	23/0	19/0	19/NA	19/NA	19/NA	19/0

Note: The first three rows show the input historical data. The last row displays the rating transition and accrual status for 1-year transition.

A table containing all 173 sovereigns is created for the 1-year transitions accordingly. The rows represent countries and columns represent time periods. From the Rating/Accrual Status table, the marginal default rate (MDR) for each rating grade is calculated by counting the number of defaults and total number of obligors. The 1-year MDRs for rating grade i are calculated as follows:

$$MDR_{1,i} = \frac{\sum_{t=1}^{T-1} N_{t,i}^{t+1,D}}{\sum_{t=1}^{T-1}\left(N_{t,i}^{t+1,D} + N_{t,i}^{t+1,ND}\right)} \quad \text{(A3.2)}$$

$N_{t,i}^{t+1,D}$ is the total number of i-rated sovereigns at t and with first non-accrual at $t+1$. Only the obligors with outstanding balance will be counted. In another word, it is the total number of all $\frac{i}{1}$ entries in the 1-year Rating/Accrual Status table in year t. All $\frac{i}{NA}$ entries are discarded.

A well-behaved default probability curve should satisfy two important properties:
- Default probabilities should be monotonically increasing as credit quality decreases.
- Default probabilities should be non-zero.

The raw PDs displayed in Table A4.6 do not possess the above two properties. To produce a well-behaved default probability curve, the raw PDs must be smoothed so that the PDs are monotonic and non-zero.

Thus, the PD curve is smoothened using the logistic form of the PD and the parameters α and β are calculated by using the Maximum Likelihood (ML) method proposed by Yang (2017). The paragraphs below summarize the practical implementation of the method:

Under the monotonic assumption for PD curve, the PD for rating grade x is assumed to take the following logistic form:

$$PD_x(\alpha,\beta) \approx \frac{1}{1+\exp\left(\alpha+\beta\phi^{-1}(F_N(x))\right)} \quad \text{(A3.3)}$$

Table A4.6: Marginal Default Rates

Fine Ratings	From/ To	Default	Non-Default	MDR	Fine Ratings	From/ To	Default	Non-Default	MDR
AAA	AAA	0	2	0.00%	BB	BB	1	232	0.43%
AA+	AA+	0	0	NA	BB-	BB-	0	241	0.00%
AA	AA	0	12	0.00%	B+	B+	1	390	0.26%
AA-	AA-	0	30	0.00%	B	B	4	374	1.06%
A+	A+	0	28	0.00%	B-	B-	6	444	1.33%
A	A	0	61	0.00%		C	0	18	
A-	A-	0	138	0.00%		CC	0	6	
BBB+	BBB+	0	99	0.00%	Cs	CCC-	13	925	2.37%
BBB	BBB	0	146	0.00%		CCC	9	53	
BBB-	BBB-	1	218	0.46%		CCC+	6	150	
BB+	BB+	2	175	1.13%					

Here,
- N denotes non-default,
- $F_N(x) = \Pr[X \le x|N] = \frac{\sum_{j=1}^{x} N_j}{\sum_{j=1}^{J} N_j}$,
- N_j is the total number of j-rated sovereigns (total number of $\frac{j}{0}$ and $\frac{j}{1}$ entries in the Rating/Accrual Status table), and
- $\phi^{-1}(F_N(x))$ is used to transform a general non-normal distribution of the ratings conditional on survival into another distribution that is approximately normal even if the distribution is not continuous.

In the discontinuous case, $F_N(x)$ may be equal to 1. $F_N(x)$ is replaced by an average to avoid it is being equal to 1.

$$\tilde{F}_N(x) = \frac{\Pr[X < x|N] + \Pr[X \le x|N]}{2} \quad \text{(A3.4)}$$

Let D_i and N_i denote the number of defaults and the number of observations for a rating i . Let $PD_i(\alpha,\beta)$ denote MDR, $PD_i(\alpha,\beta)$ is calculated as in equation (A3.3). We assume that the default frequency follows a binomial distribution. Then we can express the log likelihood of the default/non-default sample by:

$$LL = \sum_{i=1}^{J}(N_i - D_i)\log\big(1 - PD_i(\alpha,\beta)\big) + D_i \log\big(PD_i(\alpha,\beta)\big) \qquad \text{(A3.5)}$$

One may solve for α and β by maximizing the log likelihood function.

Substituting the i-year default/non-default count data into equation (A3.5) and maximizing the likelihood function we can obtain α and β estimates for each sample count data. From the estimated α and β parameter and the corresponding count data we can calculate the 1-year MDRs using equation (A3.3).

The Maximum Likelihood (ML) approach yields high PDs for the high credit end (results not presented in the report). The parameters in the ML approach are solved by maximizing the loglikelihood function. In this case, one can impose a constraint to force the PDs at the high credit quality end of the curve to be lower in value.

Thus, the constraints are placed for rating AAA and AA estimated PDs such that it is always equal to or lower than the corresponding S&P's PDs. The estimated parameters based on CML are α equal to 5.443 and β equal to 1.865.

In Table, we can see the smoothened PDs which follows the two properties of a well-behaved default probability curve and the estimated PDs for higher credit rating is of comparable value with the S&P PDs. We compare the S&P PDs and the estimated PDs to obtain the magnitude of the PCT for historical default data of the MDBs.

Table A4.7: Smoothed PDs and Comparison with S&P PD

Fine Ratings	S&P PDs	Estimated PDs	Ratio	Fine Ratings	S&P PDs	Estimated PDs	Ratio
AAA	0.001%	0.001%	1.48	BBB-	0.107%	0.070%	1.52
AA+	0.002%	0.001%	1.75	BB+	0.180%	0.101%	1.79
AA	0.003%	0.002%	1.36	BB	0.403%	0.139%	2.89
AA-	0.005%	0.005%	1.01	BB-	0.901%	0.194%	4.63
A+	0.008%	0.008%	1.04	B+	1.463%	0.293%	4.99
A	0.013%	0.012%	1.12	B	2.377%	0.472%	5.04
A-	0.023%	0.021%	1.06	B-	7.593%	0.792%	9.58
BBB+	0.038%	0.033%	1.14	Cs	51.466%	2.775%	18.55
BBB	0.064%	0.047%	1.36			Average	3.55

Note: Ratio is between S&P PDs to the Estimated PDs.

We get an average of 3.55 across the Fine Ratings which is similar to the value of 3.5 which was used to scale down the S&P PDs to adjust for the PCT. It is interesting to note that for the lower rating values B and Cs which historically most of the default sovereigns are rated, the average ratio is 9.54 which is almost three the time the whole sample average ratio. Thus, using the value of 3.5 to scale down the PDs might be considered conservative based on the above analysis.

Appendix 5: Portfolio Loss Rate Calculation

This appendix explains how to calculate the PLR.

i) Compute the unexpected loss (UL) corresponding to a given rating i:

$$UL = RWA \times 8\% \tag{A5.1}$$

where the RWA is the Risk Weighted Assets according to S&P's RAC Framework.

ii) Compute the three-year normalized expected loss (EL) for sovereign exposures. First, the one-year normalized expected loss is calculated as follows:

$$EL_{SOV} = EAD_{SOV} \times LR_{SOV} \tag{A5.2}$$

Here, the LR_{SOV} is one-year normalized loss rate which depends on the ratings of the sovereigns.

Then the three-year normalized expected loss is three times the one-year normalized expected loss.

$$EL_3 = 3 \times EL_1 \tag{A5.3}$$

iii) Compute the total loss (TL) as,

$$TL = UL + EL_3 \tag{A5.4}$$

iv) This gives the portfolio loss rate (PLR) as:

$$PLR = \frac{TL}{Total\ EAD} \tag{A5.5}$$

Table A3.1: S&P's Normalized Loss Rates for Sovereigns

Rating	NLR (bps)	Rating	NLR (bps)	Rating	NLR (bps)	Rating	NLR (bps)	Rating	NLR (bps)
AAA	0	A	7	BB+	54	B-	199	SD	360
AA+	0	A-	11	BB	73	CCC+	245	D	360
AA	1	BBB+	18	BB-	97	CCC	299		
AA-	2	BBB	27	B+	125	CCC-	360		
A+	4	BBB-	39	B	159	CC	360		

Appendix 6: Tranche rating using the S&P RACF

In this subsection, we implement an approach to infer the rating of the retained tranche from the S&P Risk Adjusted Capital (RAC) framework. This approach, permitted by S&P, was devised by S&P for rating the senior tranche in the Room2Run deal, and is described briefly in Standard & Poor's (2018). The approach involves, in effect, treating the reference portfolio as a mini-MDB, calculating the threshold level at which such an MDB might issue debt while still retaining a single A rating (where the rating is based on only parts of the RAC approach).

It would be straightforward to generalize this "mini-MDB" approach to obtain a set of loss thresholds corresponding to ratings other than single A. But S&P has so far only endorsed this approach for inferring a single A rating. For the moment, therefore, an MDB may only achieve a single-A rating for a retained senior tranche using this method.

How does the approach work? It involves calculating a stressed level of losses, based on the pool Adjusted RACF RWAs multiplied by 8%, plus an adjustment for Expected Losses (Els). The stressed loss adjusted for Els is referred to under the RACF methodology as the Portfolio Loss Rate (PLR). If the protection provided by more junior tranches exceeds the PLR level of losses, S&P assigns a single A rating to the senior tranche.

This mini-MDB approach devised by S&P to assign an A rating is extended by calculating the Unexpected Losses (ULs) based on 15% and 23% for AA and AAA respectively. We have taken the lower limit for the "very strong" and "extremely strong" from Table A6.1 as the threshold value to be multiplied for stress level AA and AAA respectively.

Table A6.1: Initial Capital Adequacy Assessment

Assessment	RAC Ratio	Assessment	RAC Ratio
Extremely Strong	23% and above	Moderate	From 5% to less than 7%
Very Strong	From 15% to less than 23%	Weak	From 3% to less than 5%
Strong	From 10% to less than 15%	Very Weak	Less than 3%
Adequate	From 7% to less than 10%		

Note: The source is Table 10 in Standard & Poor's (2022a).

Table A6.2: Portfolio Loss Rate

Portfolio Name	Total EAD in $ Million	Risk Weighted Assets (RWA)	Unexpected Loss (UL) at 23%	Unexpected Loss (UL) at 15%	Unexpected Loss (UL) at 8%	Expected Losses (EL)	Portfolio Loss Rate (PLR) for AAA	Portfolio Loss Rate (PLR) for AA	Portfolio Loss Rate (PLR) for A	Capital Available
IBRD A	29,359	26,496	20.76%	13.54%	7.22%	2.54%	23.30%	16.08%	9.76%	25.25%
IBRD B	24,956	31,387	28.93%	18.87%	10.06%	4.84%	33.77%	23.71%	14.90%	25.25%
IDA A	22,368	28,561	29.37%	19.15%	10.21%	4.70%	34.07%	23.85%	14.91%	25.25%
IDA B	23,771	31,394	30.38%	19.81%	10.57%	5.12%	35.50%	24.93%	15.69%	25.25%

Note: Green shaded cell represents PLR lower than the attachment point, whereas the red-shaded cell represents PLR greater than the attachment point. All the percentages are expressed in terms of EAD. Capital available is the thickness of mezzanine tranche.

The methodology used for the calculation of the EL and PLR is provided in Appendix 1. The PLRs of all four reference portfolios for the senior tranche are lower than the attachment point as seen in Table A6.2. The attachment point is on average more than double the PLR for stress level A. Thus, the protection provided by the mezzanine tranches is more than the PLR for a single A stress event.

This approach assigns a rating of single A to all four reference portfolios, namely IBRD A, IBRD B, IDA A, and IDA B. Furthermore, using the extended approach all four portfolios could be assigned an AA rating, and only portfolio IBRD A could be assigned an AAA rating.

Appendix 7: Tranche Pricing

Consider a perfectly granular portfolio with total par value normalised to equal unity made up of homogeneous 1-period loans. Suppose that a given loan in the portfolio (with subscript i) defaults if a normally distributed latent variable, Zi , falls below a threshold, $-c$ where $PD = N(-c)$ is the probability of default for each homogeneous loan. We may express the latent variable for the i[th] loan as follows:

$$Z_i = \sqrt{\rho_{pool}}\, Y + \sqrt{1 - \rho_{pool}}\, \varepsilon_i \tag{A7.1}$$

Here, Y is a common factor, ϵ_i is an idiosyncratic shock and both Y and ϵ_i are standard normal random variables. Appendix 1 of Duponcheele et al (2013) shows that the Expected Loss (EL) on a tranche attaching at A and detaching at D equals.

$$EL_{Thick}(A,D) = \frac{(1-A)EL_{Senior}(A) - (1-D)EL_{Senior}(D)}{D-A}$$

$$EL_{Senior}(X) = \frac{LGD * \overline{N_2} - X * PD_{Tranche}(X)}{1-X}$$

$$(N\_2)^{-} \tag{A7.2}$$
$$= N\_2\,(N\text{^}(-1)\,(PD), N\text{^}(-1)\,(PD\_Tranche\,(X)), \sqrt{(\rho\_pool)}$$

$$PD_{Tranche}(X) = N\left(\frac{N^{-1}(PD) - \sqrt{1-\rho_{pool}}\, N^{-1}\left(\frac{X}{LGD}\right)}{\sqrt{\rho_{pool}}}\right)$$

In the above equation, $EL\_Senior\ (X)$ equals the expected loss for a senior tranche with attachment point X and $N2(,,)$ is the bivariate cumulative standard normal distribution function. This formula is well-known in the literature. It resembles expressions in Pykhtin and Dev (2002) and Pykhtin (2004) which, in turn, build on the work of Vasicek (1991).

The inputs we need for the above calculation are the pool exposure probability of default and Loss Given Default denoted PD and LGD, and the correlation parameter ρ_{pool}. If we know the Expected Loss on the pool, $ELpool$, and the pool loan LGD, we can infer $PD = EL_{pool}/LGD$ and write equation (A7.2) with inputs EL_{pool} and LGD.

The above yields Expected Losses for a thick tranche in terms of pool Expected Losses $ELpool$, loan Loss Given Default, LGD, and loan correlation $\rho pool$. Both pool and tranche Expected Losses here are under historical distributions, i.e., they correspond to Expected Losses as used, for example, by rating agencies or accountants calculating provisions.

As is well known in pricing theory, one may derive the values of prices in a frictionless market by calculating expected, discounted payoffs using risk-adjusted distributions. It is important to note that the results expressed in equations (A7.1) and (A7.2) remain correct if one replaces the actual PDs with risk-adjusted probabilities of default. (We will assume here that loss rates given default are constant and hence not subject to risk-adjustment.)

Hence, (A7.1) and (A7.2) represent pricing expressions that may be used to deduce risk-adjusted expected losses for a provider of tranche protection to the pool. To calculate the risk-adjusted expected loss using these equations, requires the inputs of risk-adjusted PD, an LGD rate and a pool correlation parameter. Consider a pool of credit exposures (bonds or loans) with a given rating R. Suppose we observe the market spread, S_τ^R , that investors require to hold these exposures. The risk-adjusted Expected Loss, $EL_{Risk\ adjusted}$, for such loans with an EAD of 1 unit may be calculated as:

$$EL_{Risk\ adjusted} = 1 - e^{-S_\tau^R \tau} \tag{A7.3}$$

Here, τ is the maturity of the loans. $EL_{Risk\ adjusted}$ may be thought of as the discount in value of the defaultable loans because of credit risk. If the loans have a constant LGD, we can infer from this a risk adjusted probability of default using

$$PD_{Risk\ adjusted} = \frac{EL_{Risk\ adjusted}}{LGD} \tag{A7.4}$$

Note that the LGD one uses to infer $PDRisk\ adjusted$ should be that appropriate to the instruments in question. For example, if spreads are taken from bond markets, one may presume that the LGD is similar to that commonly observed in historical bond market data such as 50% for senior unsecured bonds.

In contrast, the LGD that we employ in evaluating the expression $EL_{Thick}(A, D)$ should then be appropriate to the pool of loans under consideration which may well be lower. Given a value for the correlation parameter ρ_{pool}, we can infer a tranche spread using:

$$S_{Tranche} = -\frac{1}{\tau}\log\left(1 - EL_{Thick}(A, D)\right) \tag{A7.5}$$

Note that equation (A7.5) just inverts the relationship between risk adjusted Expected Losses and spread employed in (A7.3) and applies it for the exposure tranche rather than for the pool loans.

To employ the methodology described above, we need to infer a risk adjusted EL for the pool. To do this, we will scale up the historical or actual PD using a scaling factor inferred from the public bond market for which we can deduce actual PDs and risk adjusted PDs from Credit Default Swap (CDS) spreads.

For the latter spreads, we employ the mid-spread data of the senior unsecured Sovereign Credit Default Swap (CDS) for a five-year term instrument. The PDs from the mid spread data are using (5.1) and assuming constant Loss Given Default as 0.55 which is the industry standard for such instruments.

$$PD = \frac{Mid\ spread}{LGD} \tag{A7.6}$$

Here mid spread is equivalent to the expected losses of the instrument for a risk-adjusted return instrument. The Scale Factor (SF) is the ratio between PDs of the CDS and five-year S&P's sovereign PDs which are adjusted for PCT. The scale factor for Aaa and Aa is adjusted by incorporating an intercept of 35 basis points (the lower PDs of Aaa and Aa. The SF was adjusted to have a floor value of 1.

Table A7.1: Scale Factor for PDs using CDS

Moody's rating	Mid spread	PDs of CDS	5-Yr PD PCT adjusted	Scale Factor (SF)	Adjusted Scale Factor
Aaa	0.21%	0.38%	0.00%	145.80	10.52
Aa1	0.20%	0.36%	0.00%	112.06	2.14
Aa2	0.35%	0.63%	0.01%	62.62	27.99
Aa3	0.36%	0.65%	0.02%	30.75	14.21
A1	0.51%	0.93%	0.02%	46.73	29.22
A2	0.81%	1.48%	0.03%	47.96	36.62
A3	0.68%	1.24%	0.05%	22.68	16.27
Baa1	0.81%	1.48%	0.12%	12.73	9.71
Baa2	1.37%	2.49%	0.42%	5.93	5.10
Baa3	1.33%	2.42%	0.39%	6.17	5.28
Ba1	2.02%	3.67%	1.07%	3.44	3.11
Ba2	2.17%	3.95%	1.03%	3.84	3.50
Ba3	2.52%	4.58%	2.13%	2.15	1.98
B1	3.86%	7.02%	3.86%	1.82	1.73
B2	4.21%	7.66%	6.79%	1.13	1.08
B3	9.51%	17.29%	13.66%	1.27	1.24
Caa1	10.85%	19.72%	36.37%	0.54	1.00

Note: The mid-spread data is from Refinitiv based on April 6, 2023.

Thus, from the above exercise, we could scale the five-year S&P Sovereign PDs by relevant SF based on the rating of the sovereign. The pooled portfolio parameters are calculated for various scenarios considered with a constant LGD of 10% seen in Table 6.8.

The pooled correlation ρ_{pool} of the portfolio is calculated by taking the average of the correlation of individual exposure and the portfolio. Let ρ_i be the correlation between exposure i and the portfolio and η_i be the equity based idiosyncratic weight (see Table A3.2), and ρ_{ij} be the equity-based correlation coefficient (see Table A3.1) then:

$$\rho_{pool} = \frac{\sum_{i=1}^{N} \rho_i}{N} \qquad \rho_i = \frac{\sum_{j=1}^{N} \sqrt{(1-\eta_i^2) \times (1-\eta_j^2)} \times \rho_{ij}}{N} \tag{A7.7}$$

The pricing of the tranche based on expected loss is evaluated using the unscaled 5-Yr PDs which are adjusted for the PCT. The pricing of the tranche with a risk premium is calculated by taking the scaled 5-Yr PDs using the mid-spread data of the CDS. There is third scenario considered to commensurate with the market expectations of the tranching pricing which could be achieved by scaling the pooled PD by a factor of 2, this scenario is thus treated as using conservative PDs.

Appendix 8: S&P Historical Ratings

In this subsection, we analyse the sovereign ratings movements during severe financial crises affecting multiple countries. We consider three crises: (i) the Asian Financial Crisis (1997), (ii) Global Financial Crisis (GFC) (2008) and (iii) the COVID-19 crisis (2020). The data used in the analysis are summarised in Table A8.1.

We consider, in each case, panel data for sovereign ratings for a five-year window centred on the primary crisis year. Any sovereigns for which data are missing or that is not rated during the crisis period is dropped. The data is collected from the Bloomberg terminal and consists of the sovereign rating on 1st January each year. The S&P ratings are converted to a numeric scale of 1-22. Here, AAA corresponds to 1 and D corresponds to 22. An average of the rating change of sovereigns between year t and $t-1$ is calculated for a given year t. The Average Rating Shift column in Table A8.1 is based on the worst credit downgrades of the sovereign during the crisis.

Table A8.1: Summary of Sovereign Rating Data

Scenario	Years	# of Countries	Average Rating Shift
Asian Financial Crisis	1995-99	47	0.34
GFC	2006-10	101	0.18
COVID-19	2019-23	114	0.12

Note: The source is Bloomberg.

In Table A8.2 and Table A8.3, the countries that experienced rating changes during the COVID-19 crisis and the worst of GFC and COVID-19 are presented. The tables show downgrades as positive (so upgrades are measured as negative numbers). As shown in Table A8.2, in the COVID-19 crisis, 19 countries experienced downgrades in this period. Note that Argentina was upgraded by 3 notches in this period. Table A8.3 shows that a total of 27 countries experienced downgrades when the worse rating changes in the GFC and COVID-19 periods are combined.

Table A8.2: List of Countries Notched for COVID-19

Country	Down-grade	Country	Down-grade	Country	Down-grade	Country	Down-grade
Angola	1	Botswana	1	Latvia	-1	Panama	1
Argentina	-3	Cameroon	1	Lithuania	-1	Papua New Guinea	1
Bahamas	2	Costa Rica	1	Mexico	1	South Africa	1
Belize	1	Curacao	2	Nigeria	1	Trinidad and Tobago	1
Bolivia	1	Kuwait	1	Oman	2		

Note: A positive notching represents a rating downgrade and vice versa.

Table A8.3: List of Countries Notched for Worst Case

Country	Down-grade	Country	Down-grade	Country	Down-grade	Country	Down-grade
Andorra	1	Costa Rica	1	Kuwait	1	Papua New Guinea	1
Angola	1	Curacao	2	Lithuania	1	Portugal	1
Bahamas	2	El Salvador	1	Macedonia	2	South Africa	1
Belize	1	Estonia	1	Mexico	1	Spain	1
Bolivia	1	Hungary	1	Nigeria	1	Trinidad and Tobago	1
Botswana	1	Ireland	2	Oman	2	Ukraine	2
Cameroon	1	Jamaica	3	Panama	1		

Note: A negative value indicates a rating upgrade.

The notching data of the Asian Financial Crisis is not included since data are only available for half the countries for which information is available for the other two crises and the rating downgrades only involve a set of Asian countries (notably, Thailand, South Korea, Pakistan, and Malaysia). To construct a conservative stress test, we assume that, for each sovereign, the rating changes by the worst credit rating movement of the two recorded for that sovereign in the GFC and COVID-19 crises.