MOODY'S INVESTORS SERVICE

RATING METHODOLOGY

Project Finance and Infrastructure Asset CLOs Methodology

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This rating methodology replaces *Project Finance and Infrastructure Asset CDOs Methodology* published in April 2020. We added a section that explains our approach to country risk. Additionally, we have clarified the Other Considerations section and added a new section that mentions our approach to evaluating the risk from environmental, social and governance considerations. We also made editorial updates to enhance readability. These updates do not change our methodological approach.

Scope

This rating methodology applies to securities backed by project finance and infrastructure assets.

In this methodology, we explain our approach to assessing credit risks for collateralized loan obligations backed by project finance and infrastructure assets (PF CLOs), including quantitative and qualitative factors that are likely to affect rating outcomes in this sector. PF CLOs comprise a range of project finance[1] (PF) assets, which include, public private partnership or private finance initiative (PPP/PFI),[2] regulated utilities and renewable energy projects as well as large infrastructure- and power-related sectors, among others.

We discuss the asset and liability analysis of the underlying portfolios of PF assets, including associated modeling, as well as other considerations. We also describe our monitoring approach. Our methodology does not address the analysis of financing arrangements for individual projects.

[1] Although utilities and infrastructure are sister sectors to PF (not a subset of it), in this methodology the generic term PF includes utilities and infrastructure as well. Most PF borrowers are highly leveraged, thinly capitalized special purpose vehicles (SPVs) with limited financial flexibility. PF loans are structured to be both highly resistant to a wide range of potentially severe risks and to minimize any post-default economic loss.

[2] Public Private Partnerships (PPPs), including projects procured under the UK government's Private Finance Initiative (PFIs).

Rating Approach

In this section, we summarize our approach to assessing credit risks for securities backed by project finance and infrastructure assets, including quantitative and qualitative factors that are likely to affect rating outcomes in this sector.

Analytical Overview

PPP and PFI projects are the more widely represented asset classes in PF CLO transactions we analyze. Our analysis of the underlying PPP/PFI projects differentiates the construction phase from those projects that have transitioned to the operational phase. Some of the most significant distinguishing features of PF assets and PF CLOs are this dual-phase profile of the underlying ratings or credit estimates, the rating uplift in operation, the asset-specific recovery rate assumptions, and the correlation frameworks.

Most of the PF CLO transactions we analyze contain senior debt obligations originated to finance PF assets within one or several PF industry sectors. The borrowing entity is typically a project funding special purpose entity (SPE) or a regulated utility operating with the consent of a statutory authority. Such authority usually holds the power to award monopoly licenses, concessions, or project agreements in the relevant eligible sectors.

Recovery Rates

We assume recovery rates follow beta distributions in which the means and standard deviations depend on both the type of credit (e.g., PPP/PFI vs. utilities) and on the country in which the reference obligor is domiciled.[3] Additionally, we assume recovery rates to be correlated within a given Monte Carlo scenario through a single-factor Gaussian copula.

Asset Default Probabilities

For each portfolio asset, we use the respective mean recovery rate, the current rating or credit estimate, and average life to infer an unadjusted default probability by referring to our Idealized Expected Default Rates table.[4]

Asset Correlation

When rating PF CLOs, we employ a "tree" framework to determine the asset correlations among the portfolio assets and assign each asset into one of the branches on the tree. The tree branches represent conceptualized sectors and sub-sectors within the universe of PF assets. We assign each portfolio asset to sectors with varying levels of refinement. The more narrowly defined the sector to which two projects belong, the higher the assumed pairwise asset correlation between the projects. We also assume that asset correlations depend on the extent to which any pair of projects are located within the same continental region, country, or share the same transaction parties, identified as "key agents."

Expected Loss for Each CLO Tranche and Model Output

We calculate the expected loss (EL) for each tranche of an issuer's liabilities using a model which produces a series of default scenarios. In each default scenario, we calculate the corresponding loss for each class of notes given the incoming cash flows from the assets and the outgoing payments to third parties and noteholders.

We derive such collateral loss distributions by applying our Monte Carlo simulation-based CDOROM™ (CDOROM), which is most suitable for modeling PF collateral pools since such pools often display

[3] For more information, see "Country Risk" section.

[4] For more information, see the discussion of Idealized Probabilities of Default and Expected Losses in *Rating Symbols and Definitions* (a link can be found in the "Moody's Related Publications" section) and in the "Loss Benchmarks" section.

heterogeneity along some dimensions, such as large industry concentrations and overall low portfolio granularity. We may also use other alternative models to calculate the loss distribution in PF pools.

Our approach described in this report to rating PF CLOs includes both quantitative and qualitative elements. Rating committees will, where appropriate, consider additional quantitative and qualitative factors they deem relevant. As such, the ratings assigned by a committee may differ from the model output.

Asset-level Analysis and Related Modeling

In this section, we explain how we analyze the underlying assets that back PF CLO securitizations and how we estimate potential losses on those assets.

Managed vs. Static PF CLOs

PF CLOs may be either static or managed transactions. We model static and replenishable (not actively managed) PF CLO portfolios using the actual (rather than assumed) portfolio in CDOROM. In these cases, we use each asset's outstanding principal and remaining weighted average life (WAL), with the most recent credit estimates or Moody's public finance ratings on each asset.

In actively managed PF CLOs, the collateral manager can buy and sell assets subject to a set of covenants in the PF CLO transaction documentation. However, trading activities may sometimes be limited to the disposal of defaulted obligations and/or obligations with elevated credit risk and the subsequent reinvestment of such sale proceeds. In line with our approach to rating collateralized loan obligations (CLOs),[5] we could model PF CLO transactions using assumptions that reflect the transaction covenants, rather than the PF CLO's current portfolio. Typical examples of covenants include, among others, limitations relating to maximum WAL, the maximum weighted average rating factor, and/or portfolio concentration limits. Moreover, we could base the initial ratings of cash PF CLOs on these covenants since the portfolios may not be fully ramped up at closing and can change over time. Should the portfolio deteriorate over time, we typically model the transaction assuming the more conservative of the actual portfolio characteristics and the transaction covenants. In these instances, when the reinvestment period has expired and the transaction effectively becomes static, our modeling then reflects the actual characteristics of the collateral pool.

Mixed Pools of PF and Corporate (Non-Project) Debt

CDO portfolios may contain a mix of PF and non-PF corporate debts. We review such mixed-pool transactions on a case-by-case basis.

In mixed-pool transactions, we model the collateral pool using recovery rates relevant to the given asset's composition. Similarly, we consider such correlations on a case-by-case basis, given the broad range of possible sets of pairwise correlations between PF and non-PF assets.

[5] For more information, see our approach to rating CLOs. A link to a list of our sector and cross-sector methodologies can be found in the "Moody's Related Publications" section.

Inputs to the Model

Recovery Rate

UNADJUSTED RECOVERY RATE

To estimate recovery rates, we first classify each asset according to one of several categories (see Appendix A). The main factors determining the recovery rate assumptions include sector classification, the relevance of the construction phase, and the degree of government support.

We differentiate projects that are less exposed to market risk, particularly availability-based PPP/PFI. A typical PPP/PFI issuer is a limited-purpose entity established to purchase or construct and then operate a public infrastructure asset pursuant to a long-term project agreement with a sponsoring government or agency (the project off-taker). PPP/PFI issuers earn a majority of their revenue from availability-based payments by off-takers and are therefore not subject to a material element of price, patronage, or volume risk.

For example, as a mean recovery assumption, we use a project-phase-weighted average assumption of 75% for most PPP/PFI projects during their operation phase and 65% for PPP/PFI projects during their construction phase.

We recognize that the actual recovery upon a default may vary a great deal around the assumed mean recovery rate for a given asset category (as defined by its sector type, presence of construction phase, the existence of structural subordination, the relative seniority in the capital structure of the obligor and the obligor's country of domicile). Therefore, in addition to the mean recovery rate, we also associate a measure of recovery rate volatility (standard deviation) for each PF asset.

We assume the standard deviation of the recovery rate for the PPP asset in the operation phase to be about 15%. We model recoveries for PPP assets in the construction phase and non-PPP assets such as utilities with a standard deviation of up to 30%.

In determining our recovery rate assumptions, we utilize the results of our studies of defaults and recoveries for PF bank loans, among other statistics. In these studies, recovery rates are based on cash flows arising post-default discounted to the last date on which cash was paid prior to default.

The mean recovery rates and standard deviation assumptions that we may apply in modeling availability-based PPP assets incorporate a degree of qualitative assessment as a result of 1) subjectivity in the classification of projects as PPP/PFI, which include some that we might not classify as availability-based PPP; 2) the limited sample of PPP/PFI defaults identified by the study; and 3) the scope of the study being limited to bank loans.

ADJUSTEMENTS TO RECOVERY RATE

The recovery rates outlined in Appendix A are typical for each asset class. These rates may be modified for certain assets if, for example:

» Its intrinsic credit risk appears significantly different from its typical sector peers.

» Its deal and security structure falls short of what is typical.

» A project has weak performance monitoring controls and a sub-par servicing regime.

On the other hand, we may consider a higher recovery rate assumption for certain assets, such as availability-based PPP projects in advanced stages of the operation phase if they exhibit features such as exceptional levels of support from highly rated off-takers, lower-than-typical operating risk, or an unusually strong regime for compensation upon termination. Similarly, we assume higher recovery rates for project

loans benefiting from meaningful external credit support such as political risk insurance or commercial risk insurance (covered loans) provided by export credit agencies, insurers or multilateral financial institutions. Typically, under these support agreements, the issuer will be able to recover losses from the support provider in the event a loan defaults.

We take into account the regulatory regime relevant to the regulated assets contained in the portfolio. As a result of such analyses, we may apply additional haircuts to the assumed recovery rates.

SIMULATION OF RANDOM RECOVERY RATES

For cash PF CLOs, we typically simulate recovery rates as described above. Unless a recovery rate associated with a credit event is specified as being fixed in a synthetic PF CLO's documentation, we also simulate random recovery rates in a manner that is consistent with the approach that we apply to cash transactions.

CORRELATION BETWEEN RECOVERIES

We assume that recoveries on defaulted assets are correlated with each other. We use a single-factor Gaussian copula framework to generate random recovery values, typically with a correlation of 10% between all pairs of defaulted assets. However, a rating committee may adjust this assumption based on either the market environment or the particulars of the collateral portfolio. We model exposures from the same project or utility family (e.g., NHS-related projects or several nursing homes by one contractor in the same region) as having a 100% correlation between their recovery rate processes.

RECOVERY TIMING

When transaction documents do not mitigate the "fire sale" of the defaulted assets, we assume that recoveries for both cash and synthetic instruments occur immediately after default. In cases where the risk of fire sale is mitigated, we typically assume a recovery lag of two to three years.

Notwithstanding the above base-case range, we may choose to model a different lag in recoveries depending on the asset type, structural features of the deal, the market environment, or other relevant factors. When analyzing scenarios in which we assume a recovery lag of one year or more, we may gross up our recovery rate assumptions from Appendix A using a low estimate of the defaulted loan interest rate.

In some jurisdictions, regulated assets such as regulated utilities may be subject to a special insolvency regime, which is designed to ensure the continuity of the regulated activity (and related service provision to the general public) both during the insolvency and afterward. Such a regulatory framework may require secured lenders to notify the relevant authority and to observe a standstill or moratorium period before enforcement. The insolvency process in these cases may take longer (and be more expensive) than an insolvency process for non-regulated entities. The process may have an adverse impact on recoveries, which is reflected in our mean recovery assumptions for such regulated assets.

Furthermore, some of the obligors in PF CLO portfolios are SPVs that were established to acquire equity stakes in regulated infrastructure assets (RIA). These obligors may therefore be structurally subordinated to the RIA's debt. The subordination implies a significantly lower recovery and longer recovery time than for the senior debt, which has a first claim on the underlying assets or cash flows. There may be further licensing or regulatory restrictions over who may own such shares.

Default Probability

OUR RATING AND CREDIT ESTIMATES

For rated PF assets in general, we use in our analysis the current published rating adjusted for watch status (see the "Assets with a Negative Outlook or On Review for Upgrade or Downgrade" section). In the absence of our public ratings, we instead base our analysis on credit estimates. When using credit estimates we apply

various additional stresses.[6] To refresh credit estimates, we obtain from the manager regularly relevant information. In the absence of such information, we will not refresh the credit estimate.

UNADJUSTED DEFAULT PROBABILITY INFERRED FROM THE RATING AND RECOVERY RATE

We use the collateral asset's mean recovery rate, current rating, and average life to infer an unadjusted default probability. "Unadjusted" means that we have not yet modified the default probability for rating uplifts, credit estimate stresses, and adjustments for assets being on review for upgrade/downgrade. We generally calculate the unadjusted default probability as follows:

FORMULA 1

Unadjusted Default Probability

$$DP = EL/(1\text{-}RR)$$

Where:

» *DP* : The default probability associated with the rating of the project and the WAL of the obligation
» *EL* : The expected loss associated with the rating of the project and the WAL of the obligation
» *RR* : The recovery rate mean value

Source: Moody's Investors Service

We infer the asset's idealized EL from its current rating (or credit estimate) and average life, based on our idealized cumulative EL rates.[7]

For project loans benefiting from external credit support, the covered loan expected loss is typically closely linked to the terms and coverage of the credit support arrangements and to the credit quality of the support provider, and less to the underlying project default probability. For these loans, we assume a high recovery rate which takes into account both the loan unadjusted default probability and the covered loan expected loss. In such cases, we first compute the unadjusted default probability as described above for the covered loan without accounting for the benefit of the credit support, then we compute an adjusted recovery rate that results in an expected loss for the covered loan that reflects the external credit support.

RATINGS UPLIFT FOR AVAILABILITY-BASED PPP/PFI PROJECTS IN OPERATION PHASE

Our PF CLO analysis differentiates PPP/PFI projects in the construction phase from those that have transitioned to the operational phase. This is because the construction-phase rating assigned will not in and of itself fully capture the scope for potential future upward rating transition. We usually rate the PPP/PFI projects in the construction phase (which typically lasts three to five years) in the Baa range. Most assets in a steady-state operation can achieve high single-A ratings. Such a dual-phase profile of the underlying ratings and the rating uplift in the operation phase are some of the most significant differentiating features of PF assets when compared with corporate loans.

Construction risk initially constrains ratings of PPP/PFI projects because of the abrupt migration risk that could arise if timely and satisfactory completion is not achieved. Typical construction-related risks include schedule delays, cost overruns, delays in the commencement of operations, failure to complete construction works to achieve minimum acceptance criteria, and construction contractor default or non-performance. Our modeling inputs for PF CLO transactions reflect the existence of two distinct phases in the majority of the securitized PF assets. We do not factor in such uplift for non-PPP/PFI projects.

[6] For more information, see our cross-sector methodology for the use of credit estimates. A link to a list of our sector and cross-sector methodologies can be found in the "Moody's Related Publications" section.

[7] For more information, see the discussion of Idealized Probabilities of Default and Expected Losses in *Rating Symbols and Definitions.* A link can be found in the "Moody's Related Publications" section.

RATING UPLIFT REFLECTED IN CDOROM

The CDOROM model reflects two lifetime phases of the typical PPP project, namely construction and operation. The construction phase also includes a period of two to three years for transitioning from the contractual completion of the construction phase to the operational phase.

Key modeling assumptions for each phase (per individual asset) reflect the EL rating of the asset, the recovery rate assumption for each phase, and the time remaining until the completion of the phase.

The principal amount of the assets in construction does not amortize. Therefore, the WAL in the construction phase is equal to the term (maturity) of the construction period. Assets in operation generally will follow a pre-determined amortization plan, which can be converted into a single WAL value.

We calculate the DP for an asset in the construction phase by multiplying the idealized DP[8] for the remaining time to steady operation (e.g. WAL in the construction phase plus two to three years for the transition from the construction to the operation phase) by (1+ DP stress[9]).

We determine the unconditional DP in the operation phase using the same formula. However, in addition, we convert the result into the conditional operation phase DP to reflect the fact that an asset can only reach the operational phase if it did not default in the construction phase. We calculate the conditional operation phase DP by multiplying the unconditional operation DP by one minus the construction phase DP as described above.

The total DP for the asset is then the sum of the construction phase and the conditional operation phase DPs.

We determine the recovery rate (RR) that we use to model the asset in CDOROM over the entire asset life (i.e., both phases) as a DP weighted average of the mean recovery rates in both phases.

FORMULA 2

Loan Recovery Rate

$$LoanRR = (OperationRR * ConditionalOperationDP + ConstructionRR * ConstructionDP) / (LoanDP)$$

Source: Moody's Investors Service

The total WAL of an asset is therefore the sum of the WAL during the construction phase and the operational phase. We enter the calculated DPs and maturities for each asset into CDOROM.

ASSETS WITH NEGATIVE OUTLOOK OR ON REVIEW FOR UPGRADE OR DOWNGRADE

Our research has shown that assets to which we assign a negative outlook or that we place on review for upgrade/downgrade do indeed have a substantially higher likelihood of actually being upgraded/downgraded than similarly rated assets that are not on review. To reflect this finding, we will treat portfolio assets whose rating we have placed on review or to which we have assigned a negative outlook as follows:

» If assigned a negative outlook, adjust the rating down by one notch;

» If on review for possible downgrade, adjust the rating down by two notches; or

[8] DP value inferred from asset's current rating (or a credit estimate) and its average life, based on our idealized cumulative expected default rates. See the discussion of Idealized Probabilities of Default and Expected Losses in *Rating Symbols and Definitions.* A link can be found in the "Moody's Related Publications" section.

[9] Our idealized cumulative expected default and loss rates imply a recovery rate of 45%. Considering that the recovery rates for PF assets are materially higher than the implied rate, the default probability for PF assets needs to be adjusted in CDOROM. The following formula is used to calculate values that are entered in the column "Add DP stress" of CDOROM: DP Stress = (PF RR-0.45)/PF LGD, Example: DP stress (for PPP/PFI in Operation i.e. RR 75%) = (75%-45%)/(1-75%)=120%

» If on review for possible upgrade, adjust the rating up by one notch

Asset Correlation

When rating PF CLOs, we employ a tree framework for asset correlations and assign each asset into one of the branches on the tree (see Appendix B). The tree branches represent factors such as sector, sub-sector, region, country, and key agent. For each pair of projects, we determine the asset correlation through the interplay of such factors. The more factors two projects have in common, the higher the assumed pairwise asset correlation between them. The impact of each correlation driver depends on the specific characteristics of such a pair of projects. As key agents play a vital role in almost any project, they also represent a crucial element of our tree framework. A construction contractor or a lead operator may represent a key agent. In some instances, we may identify regulators as key agents. However, correlation through regulatory risk is mostly relevant to the jurisdiction(s) where the project is regulated. The identity of these key agents needs to be provided by the originator or manager for each project, which our credit estimates team will cross-check.

An example of one of the highest pairwise correlations of 45% would include correlation between two liquefied natural gas (LNG) projects located in the same country that share the same lead operator. LNG projects are among the most correlated of pairs because they are highly exposed to global commodity prices as well as regional economic and political dynamics.

An example of the lowest correlation of 1% is between availability-based PPP/PFI projects that belong to different industry sub-sectors and that are located in different continents.

Country Risk

PF CLOs backed by assets domiciled in countries with a foreign currency ceiling (FCC)[10] of Aa1 or lower are exposed to country risk[11]. For assets that are free of both transfer and convertibility risk, we might use the local currency ceiling rather than the FCC. The country risk framework entails a two-step process. In the first step, we simulate the occurrence of a country ceiling event for all countries represented in the portfolio. In the second step, we assess the impact of the outcome of our country ceiling event simulation on the assets. If a country ceiling event does occur, we assume all obligors in that country will default and if the country ceiling event does not occur, we simulate the default of obligors using our standard PF default and correlation assumptions. In both scenarios we use the corresponding PF recovery assumptions.

Structural Analysis and Liability Modeling

In this section, we explain how we analyze the structural features of a PF CLO securitization, including how we model and allocate cash flows to different classes of securities, taking into account asset cash flows and available credit support.

Cash Flow vs. Synthetic CLOs

There are generally two main types of PF CLO structures: cash PF CLOs and synthetic PF CLOs.

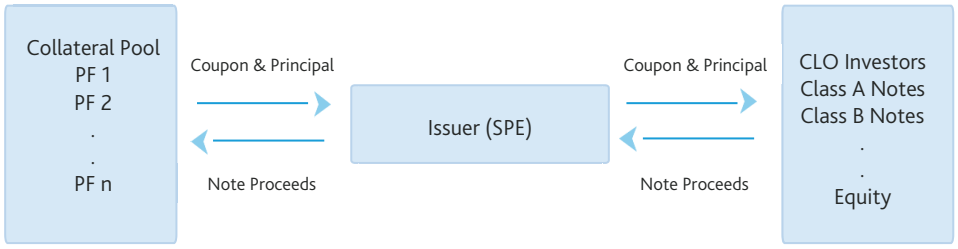
[10] All references to country ceilings are bond ceilings. For more information, see our cross-sector methodology for assessing local currency country ceilings. A link to a list of our sector and cross-sector methodologies can be found in the "Moody's Related Publications" section.

[11] For more information, see our approach to rating corporate synthetic CDOs. A link to a list of our sector and cross-sector methodologies can be found in the "Moody's Related Publications" section.

In cash transactions, the originator typically transfers PF loans and bonds to the CLO issuer under a true-sale arrangement. As a result, the CLO issuer physically holds the PF assets and issues the CLO liabilities in funded form (see Exhibit 1).

EXHIBIT 1

Structure of Typical Cash PF CLO

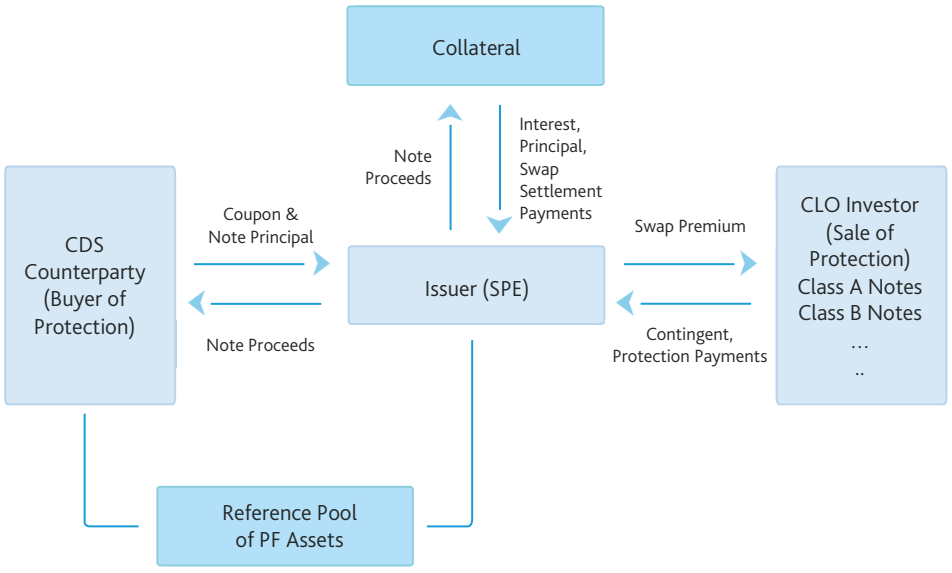


Source: Moody's Investors Service

In purely synthetic transactions, the CLO is exposed to PF assets via a portfolio credit default swap (CDS) between the issuing SPE (the protection seller) and the CDS counterparty (the protection buyer), which references PF assets. The CLO liabilities usually take a funded (note) form, where the issuer uses note proceeds to purchase collateral.

EXHIBIT 2

Structure of Typical Funded Synthetic PF CLO



Source: Moody's Investors Service

Our Modeling Approach for PF CLOs

Below, we describe how we calculate the EL and compare it to our benchmarks.[12] The result of the calculation and comparison is a model output.

[12] For more information, see "Loss Benchmarks" section.

Expected Loss for Each Tranche and Model Output

Model Components

A model, which calculates the EL for each rated PF CLO liability, incorporates the default and recovery characteristics of the PF CLO assets. Any such model consists of two primary components:

» a mechanism for associating collateral loss scenarios with the likelihood that each scenario will occur (a "collateral loss distribution")

» a cash flow (or a simple capital structure) component that relates each collateral default scenario to the cash that flows to the rated liability classes within the scenario

Once we have applied such collateral default scenarios to the cash flow model, it is possible to calculate the EL for each rated liability. The final step is to compare the computed EL for each tranche to a set of benchmarks to determine the model output for the liability.

Our Idealized Expected Loss rates represent the benchmark ELs associated with each rating category over various time horizons.[13] We assess the model output by comparing the instrument's calculated EL and weighted average life (WAL) to these benchmarks.

Modeling Approach and Complexity of CLO Waterfall

The approach we take to defining the default distribution for the PF CLO collateral depends on the structure of the CLO itself (i.e., synthetic PF CLOs and simple cash CLOs with a single subordinated liability).

We model the loss distribution and the loss allocation to each liability using CDOROM for PF CLOs that do not have complex features in their priority of payments (for example, cash diversion mechanisms such as principal deficiency ledgers or over-collateralization tests and triggers) or for PF CLOs whose premium/coupon payments are not directly related to defaults within the collateral pool. CDOROM is a Monte Carlo simulation model, which assumes a Gaussian copula dependence structure for defaults and recoveries.

We also typically use the portfolio loss distribution generated by CDOROM for static or replenishable cash PF CLOs with a cash flow waterfall (i.e., for which interest proceeds available are directly linked to the coupon on the underlying assets) as an input to a cash flow model in which we model the resulting cash flows to each liability. We occasionally require other alternative models such as the binomial expansion technique (BET) to calculate the loss distribution of PF assets for actively managed portfolios. This is rarely the case as most PF CLOs have tended to be static so far and merely allow for replenishing principal amortizations.

Collateral Loss Distribution

We apply the Monte Carlo simulation framework within CDOROM to model the loss distribution for PF CLOs. Within this framework, the model generates defaults so that they occur with the frequency indicated by the adjusted default probability for each credit in the reference pool i.e., the default probability associated with the current rating, as adjusted according to the section titled "Adjusted Default Probability Inferred from the Rating and Recovery Rate." Specifically, the model simulates correlated defaults using a normal (or Gaussian) copula model that applies the asset correlation framework described in the "Asset Correlation" section. The model generates recovery rates for defaulted assets by applying within the simulation the distributional assumptions, which include the correlation between recovery values, described

[13] For more information, see the discussion of Idealized Probabilities of Default and Expected Losses in *Rating Symbols and Definitions* (a link is available in the "Moody's Related Publications" section).

in the "Correlation Between Recoveries" section. Together, the simulated defaults and recoveries across each of the Monte Carlo scenarios define the loss distribution for the reference pool.

Timing of Defaults

When using a cash flow model, we apply several scenarios for default timing. Typically, we consider cases in which the defaults within a given scenario occur over the first six years of the PF CLO, with 50% of scenario defaults occurring in one year and 10% in each of the other years. The 50% default spike is intended to mimic the bunching of defaults in a recession. The spike is moved through each of the first six years for a total of six default-timing scenarios. For synthetic transactions, CDOROM applies defaults at 60% of a tranche's life.

Expected Loss Calculation

The EL for each tranche is simply the weighted average of losses to each tranche across all the scenarios, where the weight is the likelihood of the scenario occurring.[14]

FORMULA 3

$$EL = \sum_{j=0}^{D} P_j L_j$$

Where *P* is equal to the probability that scenario *j* will occur, and *L* is equal to the percentage loss to the tranche in scenario *j*.

Source: Moody's Investors Service

We define the loss as the shortfall in the present value of cash flows to the tranche relative to the present value of the promised cash flows. Therefore:

FORMULA 4

$$L_j = \max(0, \frac{PV_{promised} - PV_j}{PV_{promised}})$$

Source: Moody's Investors Service

In Formula 4, the present values (PV) are calculated using the promised tranche coupon rate as the discount rate. For floating rate tranches, the discount rate reflects the promised spread over the applicable interest rate benchmark and the assumed interest rate scenario.

The EL of a liability is associated with a particular horizon to compare the EL to our benchmark for that horizon. The relevant horizon is the WAL of the liability. The model output reflects the comparison of the calculated EL for each liability to a set of benchmarks that represent the target EL for a given rating level and average life.

We generally take into account the model output in conjunction with a variety of qualitative inputs before we assign a rating to a PF CLO liability, based on the determination of a rating committee.

[14] Since the calculation of the EL for PF CLOs modeled using CDOROM (see the "Modeling Approach and Complexity of CLO Waterfall" section.) is based on a simulation process, the convergence of the simulation will depend, in part, on the number of iterations chosen. We apply a 99% confidence interval adjustment to the EL result using a standard error equal to the square root of the EL variance divided by the number of Monte Carlo simulations. If this confidence interval adjustment is significant, a larger number of iterations may be used to reduce the standard error.

Complementary Analysis

We may run various stressed scenarios to test the impact of various events on the rated liabilities, for example:

- Widespread multi-notch rating downgrade of all the assets in the portfolio
- Higher pairwise asset correlation
- Lower recoveries (e.g., 0% recovery rate on all non-senior tranches in the portfolio, and/or a 25% haircut on the assumed recovery for senior tranches)
- Higher recovery rate correlation (i.e., an increase in our correlation assumptions for the stochastic recovery rates)
- Various scenarios for the WAL of underlying securities

In addition, we analyze the largest exposures in the underlying portfolio in some scenarios by further stressing the corresponding default probabilities.

Loss Benchmarks

In evaluating the model output for CLOs backed by project finance and infrastructure assets, we select loss benchmarks referencing the Idealized Expected Loss table using the Wide Asymmetric Range,[15] in which the lower-bound of loss consistent with the rating category is given by the Idealized Expected Loss rate associated with the next higher rating category. For initial ratings and upgrade rating actions, the upper-bound of loss consistent with a given rating category is equal to the Idealized Expected Loss rate associated with the given rating category. When monitoring a rating for downgrade, the upper-bound of loss is computed as a 50/50 weighted average on a logarithmic scale. That is, the benchmark boundaries of loss appropriate for evaluating rating category R are given by:

FORMULA 5

$$[1]\ Rating\ Lower\ Bound_R = Idealized\ Expected\ Loss_{R-1}$$
$$[2]\ Initial\ Rating\ Upper\ Bound_R = Idealized\ Expected\ Loss_R$$
$$[3]\ Current\ Rating\ Upper\ Bound_R = exp\{0.5 \cdot log(Idealized\ Expected\ Loss_R) + 0.5 \cdot log(Idealized\ Expected\ Loss_{R+1})\}$$

Where:

- *Rating Lower Bound*$_R$ means the lowest Idealized Expected Loss associated with rating *R* and the expected loss range of rating *R* is inclusive of the *Rating Lower Bound*$_R$.
- *Initial Rating Upper Bound*$_R$ means the highest Idealized Expected Loss associated with rating *R* that is either initially assigned or upgraded and the expected loss range of rating *R* is exclusive of the *Rating Upper Bound*$_R$.
- *Current Rating Upper Bound*$_R$ means the highest Idealized Expected Loss associated with rating *R* that is currently outstanding and the expected loss range of rating *R* is exclusive of the *Rating Upper Bound*$_R$.
- *R-1* means the rating just above *R*.
- *R+1* means the rating just below *R*.
- The Rating Lower Bound for Aaa is 0% and the Rating Upper Bound for C is 100%. These are not derived using the formula.

Source: Moody's Investors Service

[15] For more information, see the discussion of Idealized Probabilities of Default and Expected Losses in *Rating Symbols and Definitions*. A link can be found in the "Moody's Related Publications" section.

Other Considerations

Along with our asset, structural and liability analysis, we consider other quantitative and qualitative factors in our credit analysis such as transaction counterparties, legal risks, reliability and completeness of historical and portfolio data, country ceilings, and environmental, social and governance (ESG) considerations.

Counterparty Risks

We consider and integrate various counterparty-related risks at different stages throughout our credit analysis. More specifically, the risks we consider include hedge counterparties, operational risks, commingling risk, and account.[16] Based on our review, we may adjust our assumptions, inputs or model results. If information is limited, we may also adjust the rating level.

Counterparty risk may be present, particularly when the counterparty in question is a weakening construction company (during the construction phase) or the government off-taker (during the operational phase or macroeconomic and political volatility). The susceptibility to counterparty risk may vary greatly and depends, among other factors, on the composition of the securitized pool.

Hedge Counterparties

We analyze the rating impact of exposures to hedge counterparties including assessing the probability of a transaction becoming unhedged and deriving additional potential losses. As part of our analysis, we may conclude that we adjust the ratings to reflect the linkage and additional loss.

Operational Risk

Operational risks can arise from various potential sources, including disruption to cash flows caused by the financial distress of a service provider to the PF CLO transaction. As part of our analysis, we consider the financial disruption risk and the roles of servicers, cash managers, calculations agents, trustees and similar parties.

MANAGER, ORIGINATOR, TRUSTEE, AND AUDITOR

Given the manager's important role and potential impact on the PF CLO performance, we assess the manager's ability to manage the transaction. The assessment is part of our qualitative analysis and sometimes leads us to adjust our quantitative analysis to appropriately capture our expectations for the manager's performance. Certain PF CLOs are executed as balance sheet transactions and the role of manager is performed by the originator, usually a bank. In these cases, we perform a similar assessment to the originator.

A fundamental question we assess is whether the trustee is capable of carrying out its responsibilities for the PF CLO. The results of our assessment will partly depend on the experience of the trustee in handling assets of the type that the PF CLO will hold.

The auditor is generally required to certify compliance with the transaction covenants on the effective date. The auditor may also perform other tasks such as annual audits of the issuer or undertaking certain agreed-upon procedures.

[16] For more information, see our methodology for assessing counterparty risks in structured finance transactions. A link to a list of our sector and cross-sector methodologies can be found in the "Moody's Related Publications" section.

Account Banks and Investments

Generally, our analysis of account banks and temporary investments consists of three steps: (1) we assess the "rating uplift" to the account bank's rating to obtain an "adjusted" rating; (2) if the adjusted rating is below a certain threshold, we assess the exposure of the transaction and categorize the risk into either "standard" exposure or "strong" exposure; and (3) we determine rating caps to the transaction ratings subject to other quantitative and qualitative factors.

A PF CLO will sometimes temporarily invest cash, such as interest and principal collections, in investments. To minimize the PF CLO's exposure to credit, duration, and counterparty risk through its holdings of investments, the transaction documents generally incorporate stipulations such as limitations on the types of investments permitted and minimum ratings on such investments. The transaction documents also typically include requirements for the minimum ratings on banks that hold the PF CLO's various accounts and procedures for replacing such entities if they fail to maintain minimum requirements.[17]

Legal Risks

We assess legal risks that may affect the expected losses posed to investors. In particular, we consider the potential legal consequences of whether the issuer is bankruptcy remote. We review legal opinions at closing to inform our views on the key legal risks identified in a transaction.

As discussed, in some jurisdictions, RIA may be subject to a special regime designed to ensure continuity of the regulated activity and the related service provision to the general public. Such a regulatory framework may require secured lenders to notify the relevant authority about the assignment of the assets to a PF CLO issuer.

We consider the regulatory regime of the regulated assets contained in the portfolio and may seek additional clarification from time to time regarding the regulatory impact on the title transfer and the crystallization process.

Domicile of the Obligor

The domicile of the obligor associated with a collateral asset may have an important impact on our asset correlation assumptions and concentration calculations. For PF CLOs, the transaction documents refer to the country in which the assets are located.

Data Quality Evaluation

We assign ratings to securities issued by a PF CLO transaction when we have sufficient information from reliable sources. Data quality is also important throughout the life of a PF CLO transaction, as described in the "Monitoring" section.[18]

Environmental, Social and Governance Considerations

Environmental, social and governance (ESG) considerations may affect the ratings of securities backed project finance and infrastructure assets. We evaluate the risk following our cross-sector methodology that describes our general principles for assessing ESG issues[19] and may incorporate it in our analysis.

[17] For more information, see our cross-sector methodology for assessing counterparty risks in structured finance, including account banks and investments. A link to a list of our sector and cross-sector methodologies can be found in the "Moody's Related Publications" section.

[18] For more information, see our approach to evaluating date quality in structured finance transactions. A link to a list of our sector and cross-sector methodologies can be found in the "Moody's Related Publications" section.

[19] For more information, see our cross-sector methodology for assessing environmental, social and governance related considerations. A link to a list of our sector and cross-sector methodologies can be found in the "Moody's Related Publications" section.

Monitoring

In this section, we describe our approach when monitoring transactions. We generally apply the same key components as we apply when assigning ratings, except for those elements of the methodology that could be less relevant over time.

As part of our surveillance analysis, we generally apply the same assumptions we use when assigning initial ratings. However, we may adjust our analysis when market and economic conditions or deal-specific performance indicate a need to refine certain assumptions. For example, elements of this methodology become less relevant over time, such as portfolio covenants for managed PF CLO transactions after the reinvestment period, which is when we model the actual characteristics of the portfolio.

Generally, the surveillance process involves the project finance and structured finance analytical teams. The PF analytical team conducts periodic reviews of the credit estimates and outstanding ratings of the underlying projects in the portfolio.

Structured finance analysts conduct the surveillance analysis, taking into account asset-level updates as well as periodic transaction information received. The periodic information outlines the current portfolio characteristics and the status of transaction specific tests, if applicable.

The ratings or credit estimates of the portfolio may reflect deterioration in the assets' credit quality, or sub-par servicing. Therefore, our analysis may use model inputs (e.g., portfolio par value, stressed ratings and recovery rates) that differ from the periodic information received but reflect our best assessment of the characteristics of the portfolio.[20]

More information is available when monitoring transactions than at the initial closing. We integrate this information both quantitatively and qualitatively in our rating committee decision.

In most instances during the monitoring process, we will not review certain components of the analysis that we conducted when we assigned initial ratings (such as the credit implications of the transaction's legal structure), unless a major market event - such as a widely publicized related legal ruling - indicates that reconsideration is warranted.

[20] For example, in methodologies where models are used, modeling is not relevant when it is determined that (1) a transaction is still revolving and performance has not changed from expectations, or (2) all tranches are at the highest achievable ratings and performance is at or better than expected performance, or (3) key model inputs are viewed as not having materially changed to the extent it would change outputs since the previous time a model was run, or (4) no new relevant information is available such that a model cannot be run in order to inform the rating, or (5) our analysis is limited to asset coverage ratios for transactions with undercollateralized tranches, or (6) a transaction has few remaining performing assets.

Appendix A: Recovery Rate Assumptions for PF CLO Collateral

EXHIBIT 3

Recovery Rate Assumptions for PF CLO Collateral

		Recovery Rate	
Asset Classes	Sectors/Sub-Sectors	In Construction	In Operation
Availability based PPP/PFI	Airports	65%	75%
	Electric Utilities	65%	75%
	Telecoms	65%	75%
	LIFT	65%	75%
	Schools/Education	65%	75%
	Waste Management	65%	75%
	Rail	65%	75%
	NHS – Hospitals, Care Home, Healthcare	65%	75%
	Roads – Availability-Based	65%	75%
	Roads (Real toll, shadow, minimum traffic guarantee)	65%	75%
	Leisure/conference facilities (i.e. non-essential infrastructure)	65%	75%
	Defense/Military	65%	75%
	Office/Campus/Other Accommodation	65%	75%
	Street lighting	65%	75%
	Transportation	65%	75%
	Courts	65%	75%
	Prisons	65%	75%
NON PPP/PFI - Market Risk PF/Infrastructure	**Sector: Regulated Assets**		
	Sub-Sectors:		
	Gas distribution or transmission	65%	65%
	Regulated Airports	65%	65%
	Water, Sewage	65%	65%
	Electricity distribution or transmission	65%	65%
	Regulated Telecom	65%	65%
	Airport navigation and other regulated services	65%	65%
	Other Utilities	65%	65%
	Toll Roads	65%	65%
	Sector: Large Infrastructure (not regulated/not PPP) – market demand risk		
	Sub-Sectors:		
	Airports/Ports	65%	65%
	Rail	65%	65%
	Toll road networks, tunnels, bridges, car parks	65%	65%
	Airport services (baggage handling, etc.)	65%	65%
	Transportation (air cargo, vessels)	65%	65%
	LNG Terminal (other non-regulated gas or electricity infrastructure asset)	65%	65%
	Sector: Oil and Gas		
	Sub-Sector: Energy/Commodity		
	LNG	65%	65%
	Oil	65%	65%
	Sector: Power Generation		
	Sub-Sectors:		
	Power-Electricity Contracted (Coal/Gas)	N/A	75%
	Power-Electricity Merchant (Coal/Gas)	N/A	75%
	Power –Renewables: Wind	N/A	65%

EXHIBIT 3

Recovery Rate Assumptions for PF CLO Collateral

Asset Classes	Sectors/Sub-Sectors	Recovery Rate	
		In Construction	In Operation
	Power –Renewables: Solar	N/A	65%
	Power –Renewables: Hydro	N/A	65%

Source: Moody's Investors Service

Appendix B: Pairwise Asset Correlation Assumptions

The pairwise asset correlation assumptions shown in the exhibits below cover most but not all possible combinations. We may exercise judgment when analyzing PF asset pools that include loans or debt instruments from sub-sectors not listed in the exhibits below.

EXHIBIT 4

Intra-Sector Pairwise Asset Correlation Assumptions – Matrix Format

	Diff Continental Region	Same Continental Region	Same Country	Key Agent Penalties	Absolute Max Correlation per Sector (All penalties included)	Max Correlation Category	Relevant Sub-Sectors
PPP/PFI							
Different Sub-Sectors	1%	3%	7%	+15% for Lead Construction Contractor - Applied across the PPP sub-sections +3% for Lead Operator (incrementally) increased for aggressive operators. (Construction and Operator Key-Agent penalties cannot be applicable at the same time and Construction penalty will be removed upon completion of construction period not after transition period of 2-3 years.)	22%	Max PPP/PFI correlation for projects in the Different Sub-Sectors	1. Airports 2. Electric Utilities 3. Telecoms 4. LIFT 5. Schools/Education 6. Waste Management 7. Rail 8. NHS – Hospitals, Care Home, Healthcare 9. Roads – Availability Based 10. Roads (Real toll, shadow, minimum traffic guarantee) 11. Leisure / conference facilities (i.e. non-essential infrastructure) 12. Defense/Military 13. Office/Campus/Other Accommodation 14. Street lighting 15. Transportation 16. Courts 17. Prisons
Same Sub-Sectors	1%	4%	15%		30%	Max PPP/PFI correlation for projects in the Same Sub-Sectors	
Power Generation Renewables							
Different Sub-Sectors	1%	3%	7%		7%	Max Renewables correlation b/w Different Subsectors	1. Power –Renewables: Wind 2. Power –Renewables: Solar 3. Power –Renewables: Hydro
Same Renewable Sub-Sectors	1%	8%	20%		20%	Max Renewables correlation b/w Same Subsectors	

EXHIBIT 4

Intra-Sector Pairwise Asset Correlation Assumptions – Matrix Format

	Diff Continental Region	Same Continental Region	Same Country	Key Agent Penalties	Absolute Max Correlation per Sector (All penalties included)	Max Correlation Category	Relevant Sub-Sectors
Power Generation Non-Renewables							
Electricity (Coal/Gas) Contracted*	1*-3%	4*-6%	15%	+15% (Same Lead Construction Contractor, if applicable) +15% (Same off-taker, if applicable)	45%	Max Power - Electricity Contracted correlation	1. Power-Electricity Contracted (Coal/Gas) 2. Power-Electricity Merchant (Coal/Gas)
Electricity (Coal/Gas) Merchant	14%	20%	30%	+15% (Same Lead Construction Contractor, if applicable)	45%	Max Power - Electricity Merchant correlation	
Correlation b/w Contracted and Merchant Electricity (Coal/Gas) Sub-Sectors	3%	6%	15%	+15% (Same Lead Construction Contractor, if applicable)	30%	Max Correlation b/w Contracted Electricity and Merchant Electricity (Coal/Gas) Sub-Sectors	
Oil/Gas							
Different Sub-Sectors	15%	15%	15%	+10% for Lead Construction Contractor +10% for Lead Operator (Construction and Operator Key-Agent penalties cannot be applicable at the same time.)	25%	Max correlation for Different Sub-Sectors	1. LNG 2. Oil
Oil/Gas	20%	25%	30%		40%	Max Oil/Gas correlation	
LNG	25%	30%	35%		45%	Max LNG correlation	
Regulated Assets/Utilities							
Different Sub-Sectors	1%	3%	7%		7%	Max correlation for Different Sub-Sectors	1. Gas distribution or transmission 2. Regulated Airports 3. Water, Sewage 4. Electricity distribution or transmission 5. Regulated Telecom 6. Airport navigation and other regulated services 7. Other Utilities 8. Toll Roads
Same Sub-Sector	1%	3-4%**	15-20%***		15-20%***	Max Utilities Correlation	
Large Infrastructure (Market Risk)							
Different Sub-Sectors	5%	8%	10%	+15% for Lead Construction Contractor if construction is applicable	25%	Max correlation in Different Sub-Sectors	1. Airports/Ports 2. Rail 3. Toll road networks, tunnels, bridges, car parks 4. Airport services (baggage handling etc.) 5. Transportation (air cargo, vessels) 6. LNG terminal (other non-regulated gas or electricity infrastructure asset)
Airports/Ports	6-8%	10%	12-15%		27-30%	Max correlation for Airports/ Ports	
Other Sub-Sectors	8%	10%	12-15%		27-30%	Max Infrastructure Correlation	

* Lower range for the fully contracted commodity tolled project with capacity charge and energy tariff

** 4% in EU only to reflect marginally higher regional (EU) regulatory influence

*** 15% or 20% may vary depending on characteristics of European/US regulated assets.

Source: Moody's Investors Service

EXHIBIT 5

Inter-Sector Pairwise Asset Correlation Assumptions - Matrix Format

Inter-Sector Correlation	Correlation	Exceptions
Correlation between projects in different Industrial Sectors and different Continental Regions, Different countries	1%	12% Correlation between Merchant Power and Oil and Gas projects located in different Continental Regions is addressed as a separate case. The number reflects generic impact of the exposure to hydrocarbons price volatility shared by Merchant Power and Oil/Gas projects.
Correlation between projects in different Industrial Sectors, Same Continental Regions, Different countries.	2%	The 12% correlation may be increased (above 15%) to reflect additional pairwise correlation exposures via hydrocarbons/GDP/Inflation and will be considered on a case by case basis.
Correlation between projects in different Industrial Sectors, Same Continental Regions, Same countries	5%	6% Correlation between Power Generation, Electricity (Coal/Gas) Contracted on one hand AND Oil and Gas on the other. Fully contracted nature of one of the assets in the pair provides partial mitigation of the generic exposure to hydrocarbons price volatility.

Source: Moody's Investors Service

EXHIBIT 6

Intra-Sector Pairwise Asset Correlation Assumptions -Tabular Format

(Values are as per Exhibit 4 above)

Sector	Sub-sectors	Pairwise project combinations		Total (%)
PPP/PFI	Airports Electric Utilities Telecoms LIFT Schools/Education Waste Management Rail NHS – Hospitals, Care Home, Healthcare Roads – Availability Based Roads (Real toll, shadow, minimum traffic guarantee) Leisure / conference facilities (i.e. non-essential infrastructure) Defense/Military Office/Campus/Other Accommodation Street lighting Transportation Courts Prisons	2 projects in different sub-sectors	in different continental regions & different countries	1
			in the same continental region & different countries	3
			in the same continental region & same country	7
		2 projects in the same sub-sector	in different continental regions & different countries	1
			in the same continental region & different countries	4
			in the same continental region and same country	15
Power Generation Renewables	Power –Renewables: Wind Power –Renewables: Solar Power –Renewables: Hydro	2 renewable projects in different sub-sectors	in different continental regions & different countries	1
			in the same continental region & different countries	3
			in the same continental region & same country	7
		2 renewable projects in the same sub-sector	in different continental regions & different countries	1
			in the same continental region & different countries	8
			in the same continental region and same country	20
Power Generation Non-Renewables	Power-Electricity Contracted (Coal/Gas) Power-Electricity Merchant (Coal/Gas)	2 non-renewable contracted projects (contracted vs. contracted)	in different continental regions & different countries	1-3
			in the same continental region (or country if in USA) & different countries	4-6
			in the same continental region & same country (or the same Power Market grid if in USA)	15
		2 non-renewable merchant projects (merchant vs. merchant)	in different continental regions & different countries	14
			in the same continental region (or country if in USA) & different countries	20

EXHIBIT 6

Intra-Sector Pairwise Asset Correlation Assumptions -Tabular Format

(Values are as per Exhibit 4 above)

Sector	Sub-sectors	Pairwise project combinations		Total (%)
			in the same continental region & same country (or the same Power Market grid if in USA)	30
		2 non-renewable projects in different sub-sectors (merchant vs. contracted)	in different continental regions & different countries	3
			in the same continental region (or country if in USA) & different countries	6
			in the same continental region & same country (or the same Power Market grid if in USA)	15
Oil/Gas	LNG Oil	2 projects in different sub-sectors	in different continental regions & different countries	15
			in the same continental region & different countries	15
			in the same continental region and same country	15
		2 Oil/Gas projects	in different continental regions & different countries	20
			in the same continental region & different countries	25
			in the same continental region and same country	30
		2 LNG projects	in different continental regions & different countries	25
			in the same continental region & different countries	30
			in the same continental region and same country	35
Regulated Assets/Utilities	Reg Utilities Gas distribution or transmission Regulated Airports Water, Sewage Electricity distribution or transmission Regulated Telecom Airport navigation and other regulated services Other Utilities Toll Roads	2 projects in different sub-sectors	in different continental regions & different countries	1
			in the same continental region & different countries	3
			in the same continental region & same country	7
		2 projects in the same sub-sector	in different continental regions & different countries	1
			in the same continental region & different countries	3-4
			in the same continental region & same country	15-20
Large Infrastructure (Market Risk)	Airports/Ports Rail Toll road networks, tunnels, bridges, car parks	2 projects in the different subsectors	in different continental regions & different countries	5
			in the same continental region & different countries	8
			in the same continental region & same country	10
		2 airports/ports projects	in different continental regions & different countries	6-8
			in the same continental region & different countries	10
			in the same continental region and same country	12-15
		2 projects in the same subsector, other than airports/ports	in different continental regions & different countries	8
			in the same continental region & different countries	10
			in the same continental region and same country	12-15

Source: Moody's Investors Service

EXHIBIT 7

Inter-Sector Pairwise Asset Correlation - Tabular Format

(Values are as per Exhibit 5 above)

Inter-Sector Correlations	Total (%)
Correlation between projects in different Industrial Sectors and different Continental Regions, Different countries	1
Correlation between projects in different Industrial Sectors, Same Continental Regions, Different countries.	2
Correlation between projects in different Industrial Sectors, Same Continental Regions, Same countries	5
Two Exceptions to the above Inter-Sector Correlations	
Correlation between any Merchant Power and Oil and Gas projects	12
Correlation between any Electricity (Coal/Gas) Contracted AND Oil and Gas projects	6

Source: Moody's Investors Service

Moody's Related Publications

Credit ratings are primarily determined through the application of sector credit rating methodologies. Certain broad methodological considerations (described in one or more cross-sector rating methodologies) may also be relevant to the determination of credit ratings of issuers and instruments. A list of sector and cross-sector credit rating methodologies can be found here.

For data summarizing the historical robustness and predictive power of credit ratings, please click here.

For further information, please refer to *Rating Symbols and Definitions*, which includes a discussion of Moody's Idealized Probabilities of Default and Expect Losses, and which is available here.

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