MOODY'S ANALYTICS

WHITEPAPER
JULY 8, 2020

Authors
Peter Sallerson
Senior Director

David Kurnov
Senior Director

Nicole Lawrence
Senior Director

Contact Us
Americas
+1.212.553.1658
clientservices@moodys.com

Europe
+44.20.7772.5454
clientservices.emea@moodys.com

Asia (Excluding Japan)
+85.2.2916.1121
clientservices.asia@moodys.com

Japan
+81.3.5408.4100
clientservices.japan@moodys.com

CLO Stress in the Time of COVID-19

Overview

The economic fallout from the COVID-19 pandemic caused stress throughout the markets. In a prior whitepaper, we reviewed the potential impact on CLOs if collateral rating transitions mimicked what happened in 2008-09 (Analysis of Potential Caa Rating Transitions in BSL CLOs - April 13, 2020). That paper determined that equivalent rating transitions would cause most CLOs to exceed their "triple C" limitations, causing the deals to haircut their collateral for the purpose of overcollateralization tests and resulting in many test breaches. We encourage readers to review that paper and the supporting Excel® spreadsheet for the details.

This paper furthers the research begun in our prior writing with an analysis of the implications of applying additional stress to the collateral of US and Euro BSL CLOs coupled with the aforementioned rating transitions. In this paper, the default forecast is a combination of the Moody's Investors Service (MIS) outlook (May 2020 Default Report); collateral Expected Default Frequency (EDF™); and our estimates of other metrics for the Base, Pessimistic, and Optimistic scenarios. EDF is a measure of the probability that a firm will default over a specified period of time which typically is one year (Moody's Analytics EDF Overview). These assumptions were used for both the US and European analysis. In certain tables, we also display the Base scenario results using the more severe MIS outlook from the April 2020 Default Report.

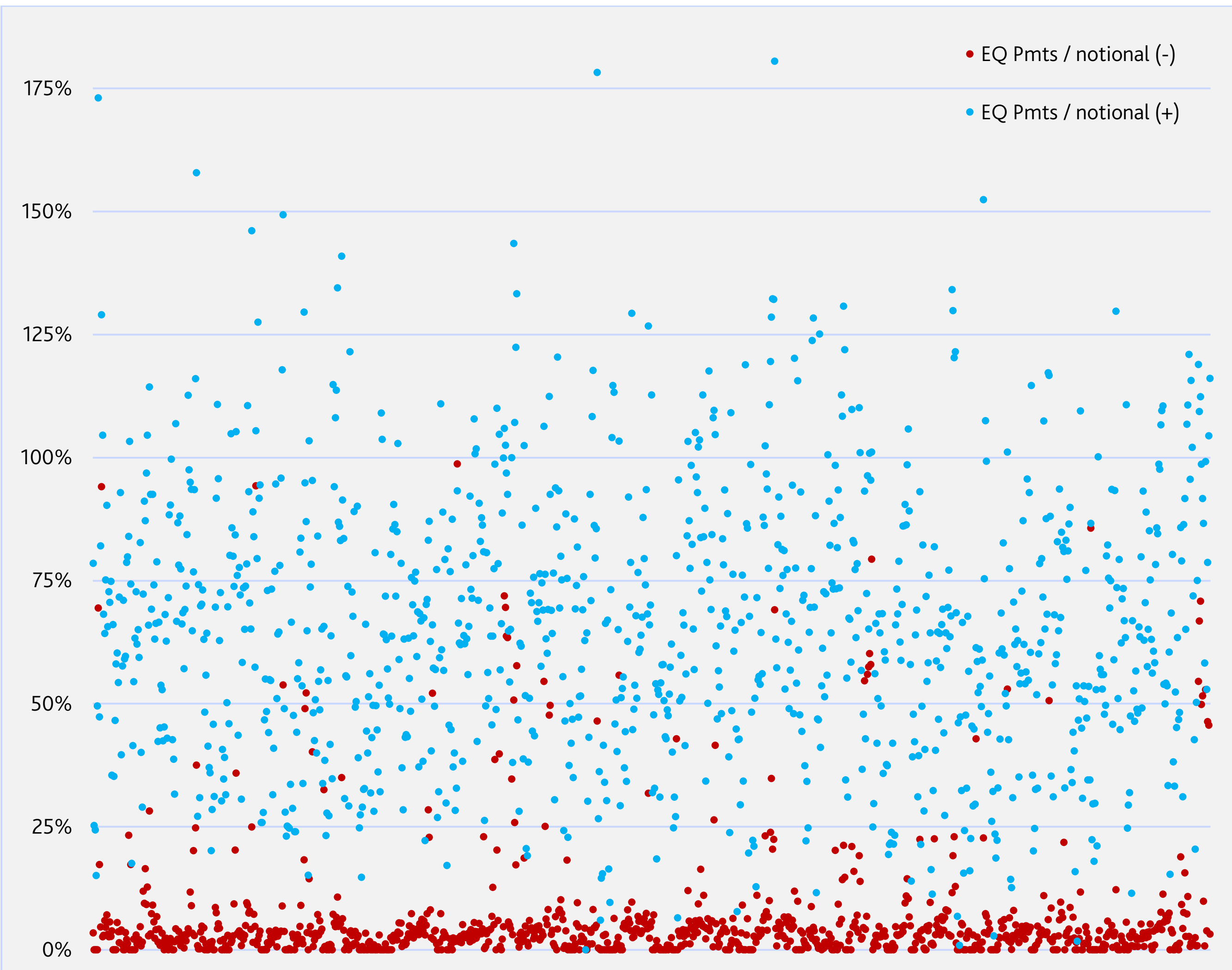
Analysis criteria and assumptions are more fully explained in Appendix A. This analysis does not seek to emulate any credit ratings methodology. Our analysis is limited to select scenarios based on a variety of market signals, Moody's Analytics assumptions, and 2008-09 ratings transition data. The key differences between the scenarios relate to the collateral default rate, prepayment rate, and the recovery rate.

US CLOs

The analysis included 1071 CLOs from 119 managers with vintages of 2012-20. Managers with at least 30 CLOs in the study are Carlyle, CSAM, Octagon, CIFC, and PGIM. Managers average 9 CLOs each, with Carlyle having 33, and 13 managers having only one CLO included. We looked at CLOs both on a deal and tranche basis and will initially focus on deals.

Exhibit 1 shows the future equity payments for US CLOs with the blue dots representing the Optimistic scenario and the red, the Pessimistic. The Base scenario is not included to focus on the more extreme scenarios. It is readily apparent that the blue Optimistic scenarios significantly outperform the red Pessimistic ones. The average *future* equity payments are a function of their notional amount with the equity returns calculated as the payments/notional. The average forecast returns are 65% in the Optimistic scenario vs. 6% in the Pessimistic case. This does not include prior distributions as well as the fact that most equity is purchased at a negotiated discount to its notional amount, both of which increase the overall return rate.

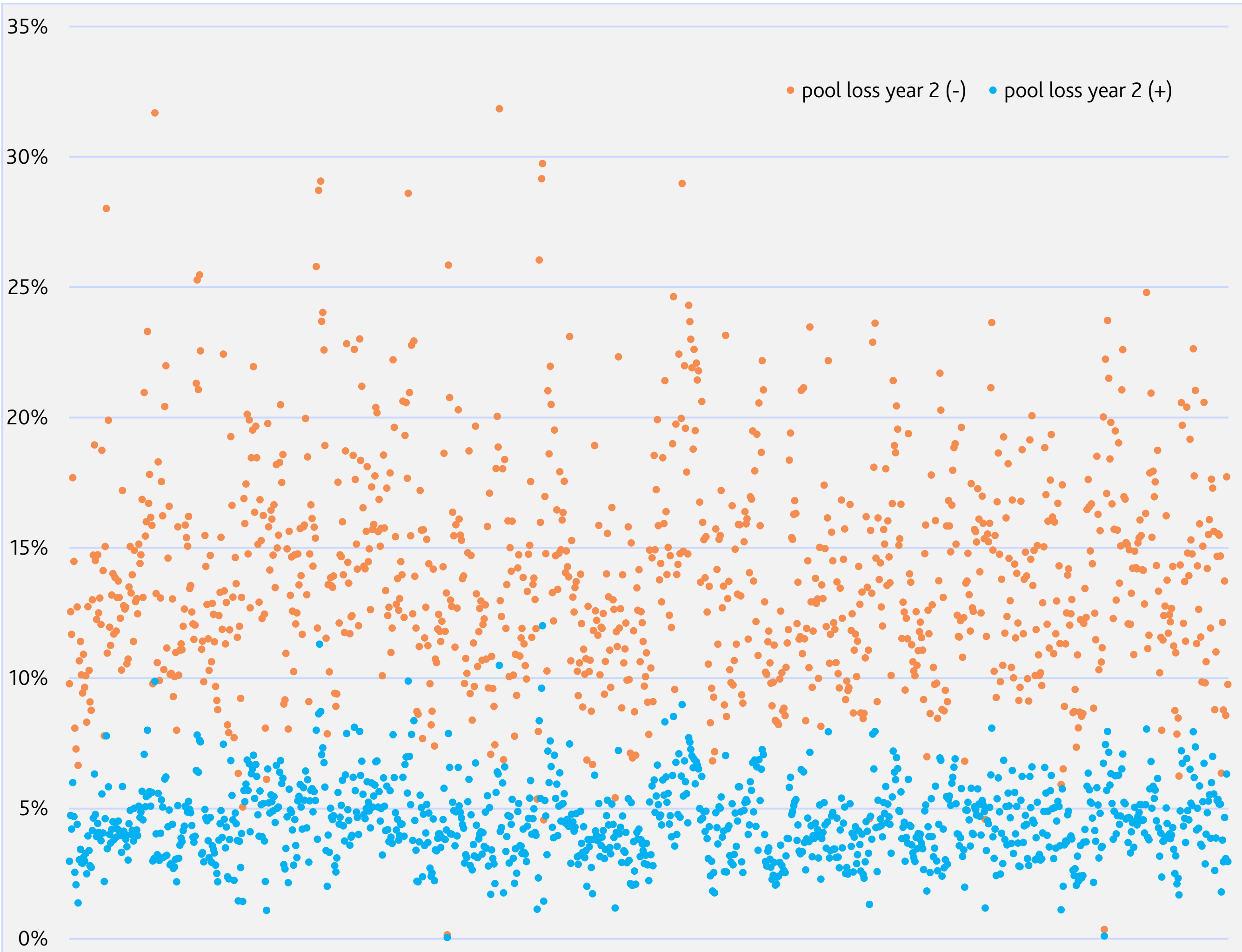
Exhibit 1: CLO equity returns under the Optimistic vs. Pessimistic scenarios



Source: Moody's Analytics Structured Finance Portal

Exhibit 2 looks at collateral losses through the first two years under the same scenarios. The Optimistic scenario losses (blue) averaged 4.5% through the first two years and greater than triple that at 14% in the Pessimistic case (red).

Exhibit 2: Comparison of two-year CLO collateral/pool losses under Pessimistic and Optimistic scenarios on a CLO-by-CLO basis



Source: Moody's Analytics Structured Finance Portal

We now also look at the Base case and examine the overall averages for the three scenarios. Exhibit 3 displays information on any overcollateralization (OC) failures, equity payment cutoffs, cutoff of interest on debt tranches, four-year collateral loss, and future equity flows as a percent of the notional amount by scenario. Even in the Optimistic scenario, 42% of CLOs have OC failures and 60% stop equity payments for at least one quarter. Further, 19% of the CLOs experience a debt payment cutoff that, on average, happens in one year under that scenario. In the Pessimistic scenario, 98% of CLOs have at least one debt tranche cut off for at least one period.

Exhibit 3: CLO performance by Stress scenario

USD 1071	BASE				PESSIMISTIC			OPTIMISTIC		
	NUMBER	MAY %	AVG DATE	APRIL %	NUMBER	MAY %	AVG DATE	NUMBER	MAY %	AVG DATE
OC Failure	983	91.8%	7/19/2021	92.3%	1067	99.6%	12/4/2020	451	42.1%	6/28/2022
Equity Cutoff	1042	97.3%	7/1/2021	99.1%	1065	99.4%	11/16/2020	642	59.9%	6/21/2022
Debt Cutoff	604	56.4%	8/3/2021	69.9%	1049	97.9%	2/3/2021	205	19.1%	2/28/2022
Equity Restarts Payments	117	10.9%	9/28/2023	3.9%	7	0.7%	4/11/2023	260	24.3%	11/22/2023
4-Year Collateral Loss		12.2%		14.0%		21.5%			8.2%	
Total Eq Cash Flow		33.7%		30.4%		6.0%			65.3%	

Source: Moody's Analytics Structured Finance Portal

Exhibit 4 shows the differences between the scenarios to determine the sensitivity of such results to the scenario. For example, 42% more CLOs have a debt tranche cutoff in the Pessimistic vs. Base scenarios as compared to 37% less in the Optimistic vs. Base cases. Four-year collateral losses increase by 9% and decrease by 4% when comparing the Base case to the Pessimistic and Optimistic scenarios, respectively.

Exhibit 4: Comparison of key metrics between stress scenarios

	PESSIMISTIC VS. BASE			OPTIMISTIC VS. BASE		
	NUMBER	%	DAYS	NUMBER	%	DAYS
OC Failure	84	7.8%	(227)	(532)	(49.7%)	345
Equity Cutoff	23	2.1%	(227)	(400)	(37.3%)	355
Debt Cutoff	445	41.5%	(182)	(399)	(37.3%)	209
Equity Restarts Payments	(110)	(10.3%)	(170)	143	13.4%	55
4-Year Collateral Loss		9.3%			(4.0%)	
Total Eq Cash Flow		(27.7%)			31.6%	

Source: Moody's Analytics Structured Finance Portal

The vintage analyses in Exhibit 5, 6, and 7 highlight the differences between vintages based on the scenarios, with 2014 generally underperforming and 2019 performing the best in the Base case. For example, under the Base scenario for the 2014 vintage, 86% of the CLOs had a debt tranche cut off while only 39% of CLOs did in 2019. Additionally, the vintage 2019 equity payments are close to four times those of 2014 partly as a result of their longer remaining average life. While 2014 underperforms, there are several strong, more recent vintages under the Optimistic and Pessimistic scenarios. Further analysis, which is outside the scope of this report, could explore the reason for the differences between vintages. However, we suspect they result from earlier stress in 2014 that used part of their initial cushions. While the 2012 and 2020 vintages are included, there are very few CLOs in the analysis from those years.

Exhibit 5: Vintage analysis of the Base scenario

	COUNT	DEBT CUTOFF (BASE)	OC FAIL (BASE)	EQUITY CUTOFF (BASE)	EQ RESTART (BASE)	EQ PMTS / NOTIONAL (BASE)	POOL LOSS YEAR 1 (BASE)	POOL LOSS YEAR 2 (BASE)	POOL LOSS YEAR 3 (BASE)	POOL LOSS YEAR 4 (BASE)
2012	16	81.25%	93.75%	100.00%	12.50%	18.09%	4.76%	10.04%	13.72%	8.46%
2013	77	80.52%	94.81%	93.51%	5.19%	17.84%	3.50%	7.34%	9.89%	7.44%
2014	73	86.30%	97.26%	98.63%	5.48%	13.74%	4.36%	9.09%	12.19%	9.42%
2015	138	68.84%	94.20%	96.38%	4.35%	25.98%	3.80%	8.08%	10.28%	7.19%
2016	137	48.91%	94.89%	97.81%	7.30%	31.18%	3.52%	7.50%	10.28%	5.97%
2017	160	50.00%	93.75%	99.38%	13.75%	35.39%	4.03%	8.64%	11.92%	8.66%
2018	270	54.44%	94.07%	100.00%	15.19%	34.77%	3.74%	8.06%	11.07%	10.10%
2019	197	38.58%	79.70%	92.89%	13.20%	52.64%	2.82%	6.32%	8.83%	9.39%
2020	3	33.33%	100.00%	100.00%	66.67%	47.05%	2.33%	5.23%	7.25%	8.42%

Source: Moody's Analytics Structured Finance Portal

Exhibit 6: Vintage analysis of the Pessimistic scenario

	COUNT	DEBT CUTOFF (-)	OC FAIL (-)	EQUITY CUTOFF (-)	EQ RESTART (-)	EQ PMTS / NOTIONAL (-)	POOL LOSS YEAR 1 (-)	POOL LOSS YEAR 2 (-)	POOL LOSS YEAR 3 (-)	POOL LOSS YEAR 4 (-)
2012	16	100.00%	100.00%	100.00%	0.00%	4.35%	9.16%	17.58%	22.86%	21.86%
2013	77	94.81%	97.40%	94.81%	0.00%	4.96%	6.73%	13.01%	16.87%	18.98%
2014	73	100.00%	100.00%	100.00%	0.00%	1.40%	8.38%	16.04%	20.73%	22.84%
2015	138	97.10%	100.00%	99.28%	0.72%	4.75%	7.37%	14.33%	18.58%	20.23%
2016	137	96.35%	100.00%	100.00%	1.46%	4.59%	6.85%	13.41%	17.60%	19.31%
2017	160	98.75%	100.00%	100.00%	1.25%	4.62%	7.89%	15.52%	20.49%	22.13%
2018	270	100.00%	100.00%	100.00%	0.00%	5.71%	7.32%	14.43%	18.97%	19.68%
2019	197	96.45%	98.98%	99.49%	1.02%	11.78%	5.80%	11.72%	15.75%	14.03%
2020	3	100.00%	100.00%	100.00%	0.00%	1.28%	4.70%	9.37%	12.44%	14.29%

Source: Moody's Analytics Structured Finance Portal

Exhibit 7: Vintage analysis of the Optimistic scenario

	COUNT	DEBT CUTOFF (+)	OC FAIL (+)	EQUITY CUTOFF (+)	EQ RESTART (+)	EQ PMTS / NOTIONAL (+)	POOL LOSS YEAR 1 (+)	POOL LOSS YEAR 2 (+)	POOL LOSS YEAR 3 (+)	POOL LOSS YEAR 4 (+)
2012	16	25.00%	50.00%	81.25%	37.50%	46.09%	2.33%	5.79%	8.37%	6.37%
2013	77	19.48%	48.05%	67.53%	24.68%	41.22%	1.72%	4.23%	5.98%	5.54%
2014	73	42.47%	56.16%	73.97%	24.66%	42.08%	2.15%	5.24%	7.23%	6.73%
2015	138	26.81%	37.68%	62.32%	23.91%	55.02%	1.88%	4.64%	6.05%	4.57%
2016	137	6.57%	35.77%	51.09%	19.71%	67.18%	1.74%	4.30%	6.22%	4.65%
2017	160	12.50%	40.00%	52.50%	27.50%	69.23%	1.99%	4.99%	7.28%	7.97%
2018	270	22.96%	42.59%	59.63%	29.26%	68.27%	1.84%	4.66%	6.86%	7.91%
2019	197	13.71%	42.64%	60.91%	16.75%	83.42%	1.39%	3.64%	5.62%	7.16%
2020	3	0.00%	33.33%	66.67%	33.33%	75.16%	1.15%	3.04%	4.79%	6.35%

Source: Moody's Analytics Structured Finance Portal

Next, we explore what happens to the various tranches under the differing stress runs. The analysis includes 7669 tranches from the 1071 CLOs (7.2 tranches per CLO). Non-traditional debt and equity tranches such as the X note were excluded as much as possible. For example, there are 1546 Aaa tranches (Aaa for the purpose of this analysis means Aaa or AAA from MIS, S&P, or Fitch) and only 307 B-rated tranches. As is apparent from the numbers, several deals have multiple Aaa tranches. While there are multiple classes with the same rating for other ratings, this is mostly a Aaa phenomenon.

Exhibit 8 through 11 display the performance of the tranches by rating across the scenarios and comparing the performance both by seniority and by stress. Additionally, the results under the MIS April default forecast are also included. The derived marks for the Aaa to A tranches are all greater than 90 in each scenario (as well as the Baa in the Base scenario) while those for lower-rated tranches drop precipitously. Also noteworthy is the improvement in the marks and percent of collateral with a loss since April. Very few tranches rated A or above experience a loss. Over one-third of the B-rated tranches have a loss even in the Base scenario (vs. 59% with the April data) and 88% of the Ba tranches and almost all of the B-rated tranches in the Pessimistic scenario experienced a loss.

Exhibit 8: Average price and percent of tranches with a loss by rating/scenario

	AVG. PRICE				% OF TRANCHES WITH LOSS			
RATING	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC
Aaa	98.32	99.06	99.13	98.80	0.00%	0.00%	0.00%	0.00%
Aa	97.07	99.31	99.07	99.23	0.00%	0.00%	0.16%	0.00%
A	94.34	97.74	94.18	97.56	0.00%	0.00%	11.05%	0.00%
Baa	79.79	93.36	55.14	93.61	11.45%	3.18%	74.45%	0.00%
Ba	53.69	78.37	16.12	88.89	36.66%	21.14%	88.09%	0.65%
B	28.94	48.25	4.20	72.47	58.96%	38.44%	97.72%	0.65%
NR	15.36	18.99	4.26	35.74	97.33%	98.47%	99.35%	97.33%

Source: Moody's Analytics Structured Finance Portal

Exhibit 9 shows the percent of tranches by rating/scenario that have their payments cut off and the number of months in the future in which that happens. Even though a very small percentage of Aaa-rated tranches are cut off for at least part of one payment, these are subordinated Aaa notes. It is not until the Ba notes that a significant number of tranches are cut off and even in the Base scenario—when about 38% are—it takes place in almost two years. It is only with the Ba and below tranches that greater than one-third of the tranches in the Base scenario are cut off. This drops to 1.3% for the Ba tranches in the Optimistic scenario. Almost all the B and non-rated tranches are cut off in all scenarios other than the Optimistic and generally in 6-14 months.

Exhibit 9: Percent of tranches cut off and months to cutoff by rating/scenario

	% TRANCHES CUTOFF				MONTH TO CUTOFF			
RATING	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC
Aaa	0.26%	0.13%	0.45%	0.13%	14.8	7.1	13.9	13.2
Aa	1.12%	0.72%	1.52%	0.24%	17.3	16.0	13.0	20.7
A	2.11%	1.14%	16.93%	0.26%	26.1	18.0	23.6	20.7
Baa	23.27%	8.91%	79.73%	0.55%	45.6	48.5	20.9	29.3
Ba	59.28%	37.95%	98.80%	1.29%	16.0	21.7	10.7	31.9
B	95.77%	96.09%	99.67%	44.30%	10.3	14.0	6.6	24.9
NR	92.57%	96.12%	98.87%	56.14%	10.6	14.1	6.6	25.4

Source: Moody's Analytics Structured Finance Portal

While being cut off is detrimental to a tranche's performance, a key mitigant is how long it is cut off. Exhibit 10 displays the percent of cutoff tranches that restart their payments and how long until that occurs. In the Base and Optimistic scenarios, tranches that are rated Baa and above restart payments. 85% or greater of the Baa tranches in the Pessimistic case also restart. The Ba and B tranches are much more scenario dependent.

Exhibit 10: Percent of tranches that restart and months to restart by rating/scenario

	% TRANCHES RESTART				MONTHS TO RESTART			
RATING	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC
Aaa	100.00%	100.00%	100.00%	100.00%	25.6	37.7	31.9	24.2
Aa	100.00%	100.00%	100.00%	100.00%	20.7	21.5	35.3	22.2
A	100.00%	100.00%	98.45%	100.00%	17.3	18.6	20.6	22.2
Baa	100.00%	100.00%	84.83%	100.00%	14.6	11.8	33.1	15.1
Ba	79.91%	91.00%	23.74%	100.00%	34.2	27.5	45.0	18.7
B	38.44%	60.68%	1.96%	98.53%	25.1	24.0	18.6	13.6
NR	56.46%	71.85%	12.09%	92.81%	26.7	26.4	29.3	19.5

Source: Moody's Analytics Structured Finance Portal

While we have shown the components, what matters most is whether the tranche takes a loss, as shown in Exhibit 11. There are no losses for the Aa and above tranches and only in the Pessimistic case does the A tranche take a loss. The Baa tranche does fairly well with only a very small average loss in all but the Pessimistic scenario. However, there are greater than 50% losses in the Pessimistic case for the Baa tranches.

Before looking at the Ba and below tranches, we will explain the payment-in-kind (PIK) adjusted vs. unadjusted sections of the table. As shown in Exhibit 9, certain tranches have their payments cut off, which means they accrue PIK interest. This grows with each missed payment and is reduced as payments resume. The difference in the two parts of Exhibit 11 is the denominator. On the left, the denominator is the original par amount of the tranche; while on the right, the denominator increases by any PIK amount until it is repaid. Thus, based on the unadjusted amount, a tranche may lose more than 100%, while it cannot when adjusted for the PIK.

For the Baa and above tranches, there is little PIK interest, so the numbers are similar. However, the Ba and below tranches have significant PIK interest due to their interest cutoff. In the Pessimistic scenario, the loss is 87% when adjusted for the PIK and more than 100% on average unadjusted. The tranche loses both 100% of the principal and some of the PIK. The B tranche losses are significantly greater.

The non-rated tranches are slightly more complicated. Their notional amount is more of an accounting item. They receive all excess cash flows and their overall performance is better measured by its (XIRR) than nominal losses. Additionally, as there are no scheduled interest payments, there is no PIK. Thus, the right section of Exhibit 11 for the non-rated (NR) tranches is blank. Nevertheless, the nominal percent loss for the non-rated tranches does indicate their performance on a relative basis.

Exhibit 11: Tranche loss with and without the PIK adjustment

	TRANCHE LOSS %				TRANCHE LOSS % (PIK ADJ)			
RATING	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC
Aaa	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Aa	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.01%	0.00%
A	0.00%	0.00%	3.56%	0.00%	0.00%	0.00%	3.28%	0.00%
Baa	3.72%	0.81%	54.71%	0.00%	3.46%	0.78%	45.13%	0.00%
Ba	46.46%	21.53%	134.83%	0.47%	31.64%	15.99%	86.98%	0.42%
B	106.46%	69.76%	172.40%	1.30%	58.96%	38.42%	97.72%	0.65%
NR	80.40%	78.74%	97.50%	66.29%				

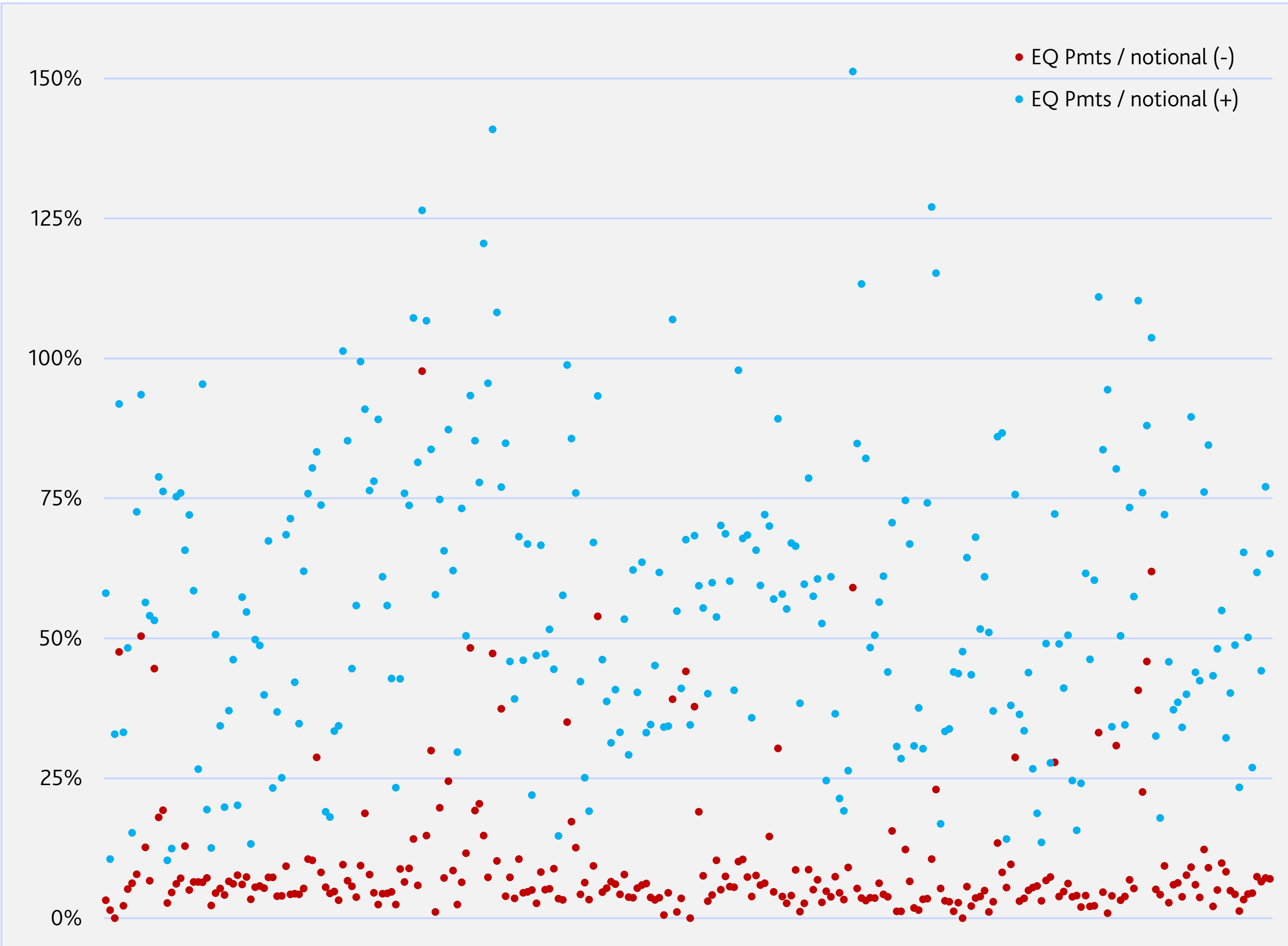
Source: Moody's Analytics Structured Finance Portal

European CLOs

The analysis included 266 CLOs from 52 managers with vintages of 2013-19. Managers with at least 10 CLOs in the study are PGIM, GSO, Investcorp, Carlyle, CVC, KKR, and Alcentra. Two of these are also among the largest US managers in the study. Managers average 5.1 CLOs each with PGIMs 17 CLOs being the most, while 11 managers only have one CLO included. Again, CLOs were analyzed both on a deal and tranche basis with the initial focus being on a deal basis.

Exhibit 1E shows the future equity payments for European CLOs of the two more extreme scenarios with the blue dots representing the Optimistic scenario and the red, the Pessimistic scenario. It is readily apparent that the blue Optimistic scenarios significantly outperform the red Pessimistic ones. The average *future* equity returns are the payments/notional amount. The forecast equity return is 57% in the Optimistic scenario vs. 9.5% in the Pessimistic case (similar to US CLOs). As with the United States, this does not include prior distributions as well as the fact that most equity is purchased at a negotiated discount to its notional amount, both of which increase the overall return rate.

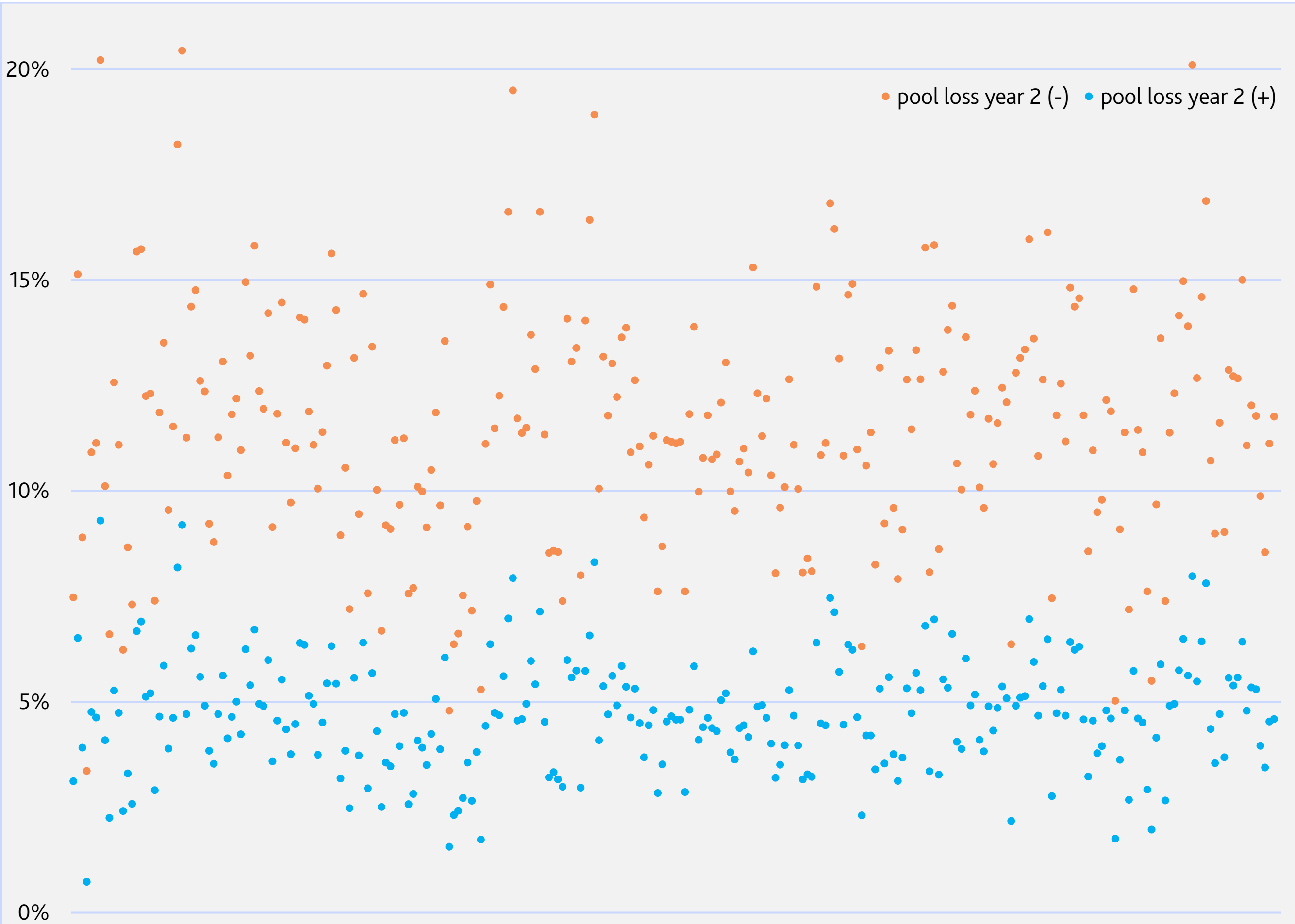
Exhibit 1E CLO equity returns under the Optimistic vs. Pessimistic scenarios



Source: Moody's Analytics Structured Finance Portal

Exhibit 2E looks at the collateral losses through the first two years under the same scenarios. The Optimistic scenario losses (blue) averaged 4.7% though the first two years and were greater than double in the Pessimistic case (red). Both scenarios are stronger than for US CLOs.

Exhibit 2E – Comparison of two-year CLO collateral/pool losses under the Pessimistic and Optimistic scenarios on a CLO-by-CLO basis



Source: Moody's Analytics Structured Finance Portal

Now, we look at the overall averages for the three scenarios. Exhibit 3E displays information on any overcollateralization (OC) failures, equity payment cutoffs, cutoff of interest on debt tranches, four-year collateral loss, and future equity flows as a percent of the notional amount by scenario. Even in the Optimistic scenario, a large percent of CLOs have OC failures and stop equity payments for at least one quarter. Depending on the scenario, 46-98% of the CLOs have a debt payment cutoff. On average, this happens in 1.7 years. In the Pessimistic scenario, 98.5% of CLOs have at least one debt tranche cut off for at least one period. Generally, the performance is worse than for the US CLOs under each scenario.

Exhibit 3E – CLO performance by stress scenario

EURO/GBP 266	BASE				PESSIMISTIC			OPTIMISTIC		
	NUMBER	MAY %	AVG DATE	APRIL %	NUMBER	%	AVG DATE	NUMBER	%	AVG DATE
OC Failure	238	89.5%	11/12/2021	89.9%	266	100.0%	2/1/2021	202	75.9%	3/25/2022
Equity Cutoff	255	95.9%	11/9/2021	97.4%	263	98.9%	1/28/2021	226	85.0%	4/1/2022
Debt Cutoff	180	67.7%	12/1/2021	77.5%	262	98.5%	3/13/2021	123	46.2%	3/20/2022
Equity Restarts Payments	34	12.8%	12/27/2022	6.4%	3	1.1%	9/28/2020	35	13.2%	3/18/2023
4 Year Collateral Loss		10.4%		11.6%		18.8%			9.4%	
Total Eq Cash Flow		45.7%		45.4%		9.5%			56.6%	

Source: Moody's Analytics Structured Finance Portal

Exhibit 4E shows the differences between the scenarios in order to determine the sensitivity of the results. For example, 31% more deals have a debt tranche cutoff in the Pessimistic vs. Base scenarios as compared to 21% less in the Optimistic vs. Base cases. Four-year collateral losses increase by 8% and decrease by 1% when comparing the Base scenario to the Pessimistic and Optimistic scenarios, respectively.

Exhibit 4E – Comparison of key metrics between stress scenarios

CHANGE	PESSIMISTIC VS BASE			OPTIMISTIC VS BASE		
	NUMBER	%	DAYS	NUMBER	%	DAYS
OC Failure	28	10.5%	(284)	(36)	(13.5%)	132
Equity Cutoff	8	3.0%	(285)	(29)	(10.9%)	143
Debt Cutoff	82	30.8%	(263)	(57)	(21.4%)	109
Equity Restarts Payments	(31)	(11.7%)	(820)	1	0.4%	81
4-Year Collateral Loss		8.4%			(1.0%)	
Total Eq Cash Flow		(36.2%)			11.0%	

Source: Moody's Analytics Structured Finance Portal

The vintage analyses show some differences between vintages. While 2014 underperformed for US CLOs, in Europe, 2019 had the most OC failures under the Base scenario and 2015 was the strongest. However, under the Pessimistic case, all vintages had 100% OC failures. There is no clear leader among the vintages under the Optimistic scenario.

Exhibit 5E – Vintage analysis of the Base scenario

	COUNT	DEBT CUTOFF (BASE)	OC FAIL (BASE)	EQUITY CUTOFF (BASE)	EQ RESTART (BASE)	EQ PMTS / NOTIONAL (BASE)	POOL LOSS YEAR 1 (BASE)	POOL LOSS YEAR 2 (BASE)	POOL LOSS YEAR 3 (BASE)	POOL LOSS YEAR 4 (BASE)
2013	10	50.00%	90.00%	90.00%	0.00%	46.53%	2.04%	4.83%	7.14%	5.29%
2014	28	64.29%	78.57%	96.43%	17.86%	44.21%	2.33%	5.67%	8.04%	7.36%
2015	29	41.38%	82.76%	86.21%	10.34%	49.68%	2.17%	5.22%	7.63%	5.28%
2016	37	59.46%	83.78%	97.30%	18.92%	42.74%	2.40%	5.78%	8.55%	9.14%
2017	40	57.50%	87.50%	95.00%	12.50%	51.79%	2.34%	5.61%	8.28%	8.79%
2018	67	76.12%	94.03%	100.00%	19.40%	48.46%	2.35%	5.82%	8.74%	10.55%
2019	54	88.89%	98.15%	96.30%	1.85%	38.01%	2.53%	6.30%	9.47%	11.58%

Source: Moody's Analytics Structured Finance Portal

Exhibit 6E – Vintage analysis of the Pessimistic scenario

	COUNT	DEBT CUTOFF (-)	OC FAIL (-)	EQUITY CUTOFF (-)	EQ RESTART (-)	EQ PMTS / NOTIONAL (-)	POOL LOSS YEAR 1 (-)	POOL LOSS YEAR 2 (-)	POOL LOSS YEAR 3 (-)	POOL LOSS YEAR 4 (-)
2013	10	100.00%	100.00%	100.00%	0.00%	8.77%	4.58%	9.69%	13.23%	14.57%
2014	28	96.43%	100.00%	100.00%	0.00%	8.31%	5.27%	11.47%	15.78%	18.18%
2015	29	96.55%	100.00%	100.00%	0.00%	10.08%	4.90%	10.61%	14.56%	13.72%
2016	37	100.00%	100.00%	100.00%	2.70%	7.80%	5.34%	11.54%	15.94%	17.54%
2017	40	100.00%	100.00%	97.50%	2.50%	9.36%	5.18%	11.11%	15.32%	17.17%
2018	67	100.00%	100.00%	100.00%	1.49%	11.04%	5.30%	11.62%	16.13%	18.01%
2019	54	96.30%	100.00%	96.30%	0.00%	9.21%	5.63%	12.38%	17.20%	20.05%

Source: Moody's Analytics Structured Finance Portal

Exhibit 7E – Vintage analysis of the Optimistic scenario

	COUNT	DEBT CUTOFF (+)	OC FAIL (+)	EQUITY CUTOFF (+)	EQ RESTART (+)	EQ PMTS / NOTIONAL (+)	POOL LOSS YEAR 1 (+)	POOL LOSS YEAR 2 (+)	POOL LOSS YEAR 3 (+)	POOL LOSS YEAR 4 (+)
2013	10	20.00%	50.00%	80.00%	10.00%	56.22%	1.57%	3.88%	5.89%	4.51%
2014	28	28.57%	64.29%	71.43%	17.86%	55.28%	1.81%	4.61%	6.74%	6.05%
2015	29	24.14%	62.07%	68.97%	17.24%	60.16%	1.66%	4.19%	6.30%	4.33%
2016	37	35.14%	67.57%	86.49%	13.51%	54.48%	1.85%	4.70%	7.32%	6.26%
2017	40	20.00%	72.50%	82.50%	20.00%	65.86%	1.79%	4.56%	6.99%	7.72%
2018	67	65.67%	82.09%	89.55%	10.45%	58.52%	1.81%	4.79%	7.59%	9.57%
2019	54	75.93%	96.30%	96.30%	5.56%	47.81%	1.97%	5.22%	8.28%	10.51%

Source: Moody's Analytics Structured Finance Portal

The prior focus is at the CLO level, but now we explore what happens to the various tranches under the differing stress runs. The analysis includes 2207 tranches from the 266 CLOs (8.3 tranches per CLO, which is one more than in the United States). Again, non-traditional debt and equity tranches such as the X note were excluded as much as possible. Contrary to the United States where there are more Aaa tranches than others, in Europe, Aa tranches are the largest rating class. The next largest is the Aaa tranches followed by the A-rated tranches.

Exhibit 8E-11E display the performance of the tranches by rating across the scenarios in order to compare the performance both by seniority and by stress. The derived marks for the Aaa to A are all greater than 90 in each scenario while those of the lower rated tranches drop depending upon the scenario. The lower rated tranches tend to perform better than US CLOs. The marks also improved under the May Base case analysis. Extremely few tranches rated A or above have a loss. The Baa tranche performs well other than in the Pessimistic case. For below investment grade tranches, it is about 12-13% for Europe as compared to 20% to 38% in the US for the Base case.

Exhibit 8E – Average price and percent of tranches with a loss by rating/scenario

	AVG. PRICE				% OF TRANCHES WITH LOSS			
RATING	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC
Aaa	97.95	98.99	99.07	98.94	0.00%	0.00%	0.27%	0.00%
Aa	96.49	99.72	99.19	99.71	0.00%	0.00%	0.42%	0.00%
A	94.43	98.28	96.43	98.42	0.00%	0.31%	4.94%	0.31%
Baa	87.24	95.42	77.06	95.49	1.45%	0.36%	41.67%	0.36%
Ba	71.72	86.57	30.69	89.87	17.80%	12.50%	84.47%	5.30%
B	56.74	67.08	13.99	71.92	18.75%	12.89%	86.33%	5.47%
NR	25.44	29.80	7.51	36.66	98.68%	99.56%	100.00%	99.56%

Source: Moody's Analytics Structured Finance Portal

Exhibit 9E shows the percent of tranches by rating/scenario that have their payments cut off and the number of months in the future in when that occurs. Of the top two ratings, only 0.4% of the Aa tranches in the Pessimistic case are cut off. The A notes have exceedingly small impairment other than in the Pessimistic scenario at 11.7%. It is not until the Pessimistic scenario for the Baa class that a significant number of tranches are cut off—and that is on average 17 months in the future. It is only with the B tranches that greater than two-thirds of the tranches in the Base case are cut off; in the Pessimistic scenario, it is close to 100% of the notes.

Exhibit 9E - Percent of tranches cut off and months to cutoff by rating/scenario

	% TRANCHES CUTOFF				MONTH TO CUTOFF			
RATING	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC
Aaa	0.00%	0.00%	0.00%	0.00%				
Aa	0.00%	0.00%	0.42%	0.00%			50.8	
A	0.00%	0.31%	11.73%	0.00%		26.6	16.8	
Baa	5.07%	4.35%	63.77%	0.72%	55.0	60.8	17.4	73.5
Ba	31.06%	17.05%	93.18%	6.44%	20.2	27.8	13.9	44.3
B	79.69%	68.36%	99.61%	44.53%	16.5	19.3	10.6	23.2
NR	90.79%	96.05%	99.56%	78.07%	14.9	18.4	9.0	22.7

Source: Moody's Analytics Structured Finance Portal

While being cut off is detrimental to the performance, a key mitigant is how long they are cut off. Exhibit 10E displays the percent of cutoff tranches that restart their payments and how long until they restart. For investment-grade notes, either they do not get cut off or only 2.6% of the A tranche in the Pessimistic scenario and 8-9% of the Baa tranche in the Base/Pessimistic scenarios fail to restart. The Ba and below tranches are more case dependent.

Exhibit 10E - Percent of tranches that restart and months to restart by rating/scenario

	% TRANCHES RESTART				MONTHS TO RESTART			
RATING	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC
Aaa								
Aa			0.00%					
A		100.00%	97.37%			36.2	18.4	
Baa	100.00%	91.67%	92.05%	100.00%	7.3	5.2	24.7	3.0
Ba	95.12%	97.78%	56.10%	100.00%	20.8	18.2	42.6	15.4
B	76.96%	81.14%	14.90%	90.35%	21.6	20.1	24.9	17.3
NR	81.64%	87.21%	16.30%	94.38%	26.4	24.2	28.3	21.8

Source: Moody's Analytics Structured Finance Portal

We have shown the European components, but again what matters most is whether the tranche takes a loss, as shown in Exhibit 11E. There are no losses for the Aa and above tranches other than the Pessimistic scenario. In the Base and Optimistic scenarios, the A and Baa tranches do well.

For the Baa and above tranches, there is little PIK interest, so the numbers are similar. However, the Ba tranches in the Pessimistic case and B-rated tranches in all cases have significant PIK interest to their interest cutoff. In the Base and Optimistic scenarios, the Ba tranche has less than 10% losses. The Ba tranche loss is 72% when adjusted for the PIK and greater than 100% unadjusted for the PIK in the Pessimistic scenario. The B tranches perform even worse. It is noteworthy that the Base case has improved since April.

The non-rated tranches receive all excess cash flows and their overall performance is better measured by their XIRR than nominal losses. Additionally, as there are no scheduled interest payments, there is no PIK. Thus, the right section of Exhibit 11E for the non-rated tranches is blank. Nevertheless, the nominal percent loss for the NR tranches does indicate their performance on a relative basis, which is comparable to the United States.

Exhibit 11E – Tranche loss with and without the PIK adjustment

	TRANCHE LOSS %				TRANCHE LOSS % (PIK ADJ)			
RATING	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC	APRIL BASE	MAY BASE	PESSIMISTIC	OPTIMISTIC
Aaa	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.02%	0.00%
Aa	0.00%	0.00%	0.42%	0.00%	0.00%	0.00%	0.42%	0.00%
A	0.00%	0.26%	1.68%	0.06%	0.00%	0.25%	1.50%	0.06%
Baa	0.13%	0.50%	24.14%	0.48%	0.13%	0.36%	20.08%	0.36%
Ba	15.43%	9.92%	107.68%	4.00%	12.20%	8.16%	72.74%	3.37%
B	34.78%	24.15%	161.31%	10.16%	18.66%	12.89%	86.04%	5.47%
NR	73.38%	71.49%	96.42%	66.88%				

Source: Moody's Analytics Structured Finance Portal

Conclusion

The economic stress caused by COVID-19 mitigants has been extensive. While some segments of the economy are still doing well, retail, gaming, travel, restaurants, and entertainment have taken significant hits. This report looked at the implications of the stress. Ratings were initially stressed as discussed in Analysis of Potential Caa Rating Transitions in BSL CLOs - April 13, 2020. This paper added default, recovery, and collateral prepayment deterioration to the ratings pressure.

For both the United States and Europe, in even the Base scenario, 90% of the CLOs fail an OC test and greater than half cut off debt distributions for at least one period. A and above tranches have no to very limited impairment. Under the Base scenario for the Baa tranches, 0.8% of US CLOs and 0.5% of Euro CLOs have a loss. The below investment-grade tranches tend to have lower losses in Europe than the United States, but are still substantial depending upon the scenario.

We hope this analysis helps you analyze potential outcomes for the CLO markets in the US and Europe. However, we encourage running these or similar stress scenarios on your portfolios or potential purchases.

Appendix A: Analysis Criteria and Assumptions

Constants:

- » BSL CLOs with a deal factor of at least 80% (a few CLOs were removed)
- » Monthly report is available
- » DMs are based on April 30, 2020 and June 5, 2020 data provided by PSL

	JUNE/MAY ANALYSIS SPREADS	APRIL ANALYSIS SPREADS
Aaa	182/176 (US/Europe)	212/224 (US/Europe)
Aa	218/219	282/316
A	300/295	389/412
Baa	496/464	836/741
Ba	900/789	1533/1294
B	1706/1595	2270/2031
Equity Yield	2000/1900	2500/2215

Base EDFs (before scaling) is based on April 30 and May 20, 2020 results from the Moody's Analytics CreditEdge™ model

- » Market values are based on April 30 and May 20, 2020 Markit prices
- » Forward Libor curves are based on April 30 and May 20, 2020 rates
- » Caa weighted average price is based on April 30 market values
- » Caa transition from Analysis of Potential Caa Rating Transitions in BSL CLOs - April 13, 2020, but adjusted to start April 30
  - Year 1 – consistent with transition report
  - Year 2 – 60% of Year 1
  - Year 3 – 20% of Year 1
  - Year 4 and onward – no adjustment
- » Recovery Delay – 9 months
- » Reinvestment price – 90 in Year 1, 100 Year 2 and onward
- » Reinvestment spread - current WAS on a deal-by-deal basis
- » Clean-up call once liability factor hits 50%
- » Non-traditional tranches are excluded where possible

Per scenario:

- » PD scaling (see below) – Average CreditEdge software one-year EDF is calculated across all loans in the United States and Europe. A scalar is calculated to increase this value to the MIS scenario-based default rate projection (May 2020 Default Report and April 2020 Default Report):
  - April Base – US – 13.3%, Europe – 7.8%
  - May Base – US – 11.6%, Europe 6.2%
  - May Pessimistic – US – 19.5%, Europe – 12.3%
  - May Optimistic – US – 5.6%, Europe – 5.3%

  For Year 2, the scalar is modified as such:

  - Baseline – (Year 1 Scalar)/2 + 0.5
  - Pessimistic – (Year 1 Scalar) *2/3 + 1/3
  - Optimistic – (Year 1 Scalar)/4 + 0.75

For Year 3, the scalar is modified as such:

- Baseline – no scalar
- Pessimistic – (Year 2 Scalar)/2 + 0.5
- Optimistic – no scalar

For Year 4 and onward, there is no scalar in any scenario

For each asset, the scaled default probability (“Scalar”) is defined as such:

$$PD(y) = cumulative\ default\ probability\ through\ y\ years$$
$$PDm(y) = marginal\ default\ probability\ for\ year\ y$$
$$PD_{scaled}(y) = PD(y), after\ applying\ scalars$$
$$PDm_{scaled}(y) = PDm(y), after\ applying\ scalars$$
$$scalar(y) = scalar\ for\ modifying\ PD(y)$$
$$PDm(y) = 1 - \frac{\left(1 - PD(y)\right)}{\left(1 - PD(y-1)\right)}$$
$$PDm_{scaled}(y) = PDm(y) * scalar(y)$$
$$PD_{scaled}(y) = 1 - \left(1 - PDm_{scaled}(y)\right) * \left(1 - PD_{scaled}(y-1)\right)$$
$$where\ PD(0) = PDm(0) = PD_{scaled}(0) = 0$$

» Prepayment

- Senior
  - › Baseline – ramping from 5 to 20 CPR over 3 years
  - › Pessimistic – ramping from 5 to 20 CPR over 4 years
  - › Optimistic – ramping from 5 to 20 CPR over 2.5 years

2nd lien/Bonds – 5 CPR

» Recovery

- Baseline
  - › Senior – lesser of Caa weighted average price (WAP) and Market Price
  - › 2nd lien/Bonds - lesser of 20% and Market Price
- Pessimistic
  - › Senior – lesser of Caa WAP and Market Price * 0.9
  - › 2nd lien/Bonds - lesser of 20% and Market Price * 0.9
- Optimistic
  - › Senior – lesser of Caa WAP and Market Price
  - › 2nd lien/Bonds - lesser of 20% and Market Price

Appendix A-2

MANAGERS OF US CLOS	CLOS
Carlyle Investment Management LLC	33
Credit Suisse Asset Management	32
Octagon Credit Investors, LLC	31
CIFC Asset Management LLC	30
PGIM	30
GSO / Blackstone Debt Funds Management	28
MJX Asset Management LLC	26
Voya Investment Management (ING)	26
Ares Management, LLC	23
Sound Point Capital Management LP	22
Sculptor Capital Management	22
BlueMountain Capital Management LLC	21
Neuberger Berman Fixed Income LLC	21
THL Credit Senior Loan Strategies LLC	20
KKR Financial Advisors LLC	20
LCM Asset Management LLC	19
Anchorage Capital Group LLC	18
Benefit Street Partners LLC	16
Oak Hill Advisors LP	15
HPS Investment Partners, LLC	15
Barings LLC	15
Apollo Credit Management LLC	14
Bain Capital Credit	14
TPG Capital	14
BlackRock Financial Management	13
CVC Credit Partners LLC	13
PineBridge Investments LLC	12
GoldenTree Asset Management LP	12
Onex Credit Partners LLC	12
Palmer Square Capital Management LLC	12
Napier Park Global Capital, LLC	12
Intermediate Capital Group plc	11
American Money Management Corporation	11
Alcentra Inc.	11
Wellfleet Credit Partners LLC	11
Brigade Capital Management LLC	10
Symphony Asset Management LLC	10
Invesco Inc.	10
Canyon Capital Advisors LLC	10
CBAM CLO Management	10
Crescent Capital Group LP	10
Marble Point Credit Management LLC	10
AXA Investment Managers	10
Golub Capital Management LLC	10
Marathon Asset Management LP	9
Investcorp B.S.C.	9
Fortress Investment Group LLC	9
Apex Credit Partners LLC	9
DFG Investment Advisers Inc	9
ZAIS Group Inc.	9
Steele Creek Investment Management	8
OakTree Capital Management LLC	8
Trinitas Capital Management LLC	8
ArrowMark Colorado Holdings, LLC	8
Seix Investment Advisors LLC	8
Angelo, Gordon & Company LP	8

MidOcean Credit Fund Management LP	8
AEGON USA Investment Management, LLC	8
Mariner Investment Group	7
Guggenheim Investment Management LLC	7
Crestline Denali Capital LP	7
King Street Capital Management	7
Nassau Corporate Credit LLC	6
Kayne Anderson Capital Advisors, L.P.	6
Shenkman Capital Management Inc.	6
Bardin Hill Loan Management LLC	6
York CLO Managed Holdings LLC	6
DoubleLine Capital LP	5
Eaton Vance Management	5
Pretium Credit Management LLC	5
Trimaran Advisors LLC	5
TCI Capital Management LLC	5
Allstate Investment Management Company	5
Carlson Capital, L.P.	5
Columbia Management Investment Advisors, LLC	4
Greywolf Capital Management LP	4
40/86 Advisors Inc.	4
Teachers Insurance and Annuity Association of America	4
Hayfin Capital Management LLP	4
Park Avenue Institutional Advisers LLC	4
Ellington CLO Management LLC	4
Ballyrock Investment Advisors LLC	4
CFI Partners, LLC	4
Assurant CLO Management, LLC	4
Par- Four Investment Management LLC	4
Canaras Capital Management, LLC	4
Black Diamond Capital Management LLC	3
Five Arrows Managers LLP	3
Medalist Partners Corporate Finance LLC	3
Garrison Capital LLC	3
AIG Global Investment Group	3
CarVal CLO Management, LLC	3
TCW Asset Management Company	3
Kramer Van Kirk Credit Strategies LP	3
Telos Asset Management LLC	3
Partners Group	3
PPM America Inc.	3
Z Capital Credit Partners LLC	3
Elmwood Asset Management LLC	3
New York Life Investment Management LLC	3
AGL CLO Credit Management LLC	2
OFS Capital Management	2
First Eagle Investment Management	2
Credit Value Partners LLC	2
Man Group plc	2
Gallatin Loan Management LLC	2
Tall Tree Investment Management LLC	1
Principal Global Investors LLC	1
Loomis Sayles & Company LP	1
Birch Grove Capital LP	1
Saratoga Investment Corp	1
Covenant Credit Partners, LLC	1

Fort Washington Investment Advisors, Inc.	1
H.I.G. WhiteHorse Capital LLC	1
Cutwater Investor Services	1
Highland Capital Management LP	1
Newfleet Asset Management LLC	1
HalseyPoint Asset Management, LLC	1
HarbourView Asset Management Corp.	1
Grand Total	**1071**

Appendix A-3

MANAGERS OF EURO CLOS	CLOS
PGIM	17
GSO / Blackstone Debt Funds Management	17
Investcorp B.S.C.	14
Carlyle Investment Management LLC	13
CVC Credit Partners LLC	12
KKR Financial Advisors LLC	11
Alcentra Inc.	10
Intermediate Capital Group plc	9
Barings LLC	9
Cairn Capital Ltd.	9
Credit Suisse Asset Management	9
Bain Capital Credit	7
Sculptor Capital Management	6
Ares Management, LLC	6
Bardin Hill Loan Management LLC	6
Partners Group	5
Oak Hill Advisors LP	5
Tikehau Capital Europe Limited	5
Chenavari Investment Management	5
OakTree Capital Management LLC	5
BlackRock Financial Management	5
PineBridge Investments LLC	5
BlueMountain Capital Management LLC	5
Man Group plc	5
Spire Partners LLP	5
Five Arrows Managers LLP	5
Apollo Credit Management LLC	4
BNP Paribas	4
HPS Investment Partners, LLC	4
Onex Credit Partners LLC	3
Redding Ridge Asset Management (UK) LLP	3
Black Diamond Capital Management LLC	3
Accunia Credit Management Fondsmaeglerselskab A/S	3
AXA Investment Managers	3
Permira Debt Managers Group Holdings Limited	3
Anchorage Capital Group LLC	3
GoldenTree Asset Management LP	3
Guggenheim Investment Management LLC	3
Hayfin Capital Management LLP	2
Voya Investment Management (ING)	2
Commerzbank	2
Sound Point Capital Management LP	1
Capital Four CLO Management K/S	1
CIFC Asset Management LLC	1
Invesco Inc.	1
MeDirect Bank (Malta) PLC	1
Natixis Asset Management	1
Napier Park Global Capital, LLC	1
Fair Oaks Capital Ltd	1
Brigade Capital Management LLC	1
NIBC Credit Management, Inc.	1
King Street Capital Management	1
Grand Total	**266**

BX579