

Comparing CLOs and CDX/iTraxx Tranches

Different investor bases and structures have created opportunities

- CLOs (Collateralized Loan Obligations) and Index Tranches (standardized tranches on CDX and iTraxx indices) offer investors a range of risk/return profiles on diversified pools of credit risk. Both asset classes have enjoyed strong growth in recent years but, despite their fundamental similarity, the investor bases remain mostly separate.
- Investors can increase their opportunity set by considering both products in their investing and hedging toolkit, as credit risk can be distributed very differently across the capital structure in the two markets.
- For example, we find that HY CDS index tranches (CDX HY & iTraxx Crossover) currently attach relatively high risk premia to idiosyncratic risks while CLOs (in USD and Euros) attach higher risk premia to systemic risks. As a result, senior CLO tranches offer attractive spreads compared to index tranches, which in turn look better suited as hedges. On the other hand, among junior tranches investors should find that index tranches offer more attractive spreads to take risk and CLO spreads look rich in comparison.
- In this note we compare the two asset classes both from a fundamental and an empirical perspective. We apply a base correlation pricing framework to judge relative value, which forms the basis for the above conclusions.
- The note is structured as follows. In the first section we summarize the product characteristics of CLOs and index tranches and their key differences. In the second section we undertake a bottom-up pricing exercise to compare traded market spreads. In the third section we take an empirical approach to compare their historical performances, accounting for funding and liquidity differences.

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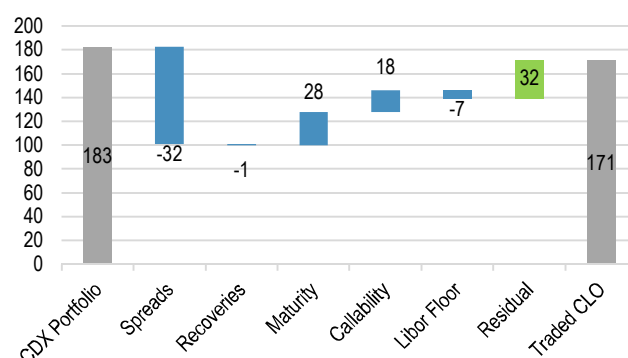
Traded spreads in index tranches and sample CLOs

CDX HY		USD CLO		
Attach.-Detach.	Spread	Attach.-Detach.	Rating	DM
35%-100%	40	40%-100%	AAA	123
25%-35%	125	24.5%-35%	AA	171
15%-25%	377	18%-24.5%	A	220
		12.05%-18%	BBB-	340
		8.5%-12.05%	BB-	651
0%-15%	2,600	0%-8.5%	NR	N/A
iTraxx Crossover		EUR CLO		
Attach.-Detach.	Spread	Attach.-Detach.	Rating	DM
35%-100%	44	40%-100%	AAA	105
		28.5%-38.24%	AA	178
20%-35%	130	23.25%-28.5%	A	259
10%-20%	475	16.14%-23.25%	BBB-	386
		10%-16.14%	BB-	609
		7.63%-10%	B-	857
0%-10%	1,994	0%-7.63%	NR	N/A

Source: J.P. Morgan. CLOs are based on two 2019 vintage deals.

Sample pricing of a US AA CLO in a base correlation framework

Calibrated to CDX HY S33 tranche spreads



Source: J.P. Morgan.

See page 23 for analyst certification and important disclosures.

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CLOs and CSOs – Comparing Tranched Credit Products

Corporate bond and loan markets have grown in parallel over the past decades as borrowers increasingly rely on institutional – rather than bank financing. In both markets, tranching pools of credit risk into non-standard risk profiles has proven to be popular with investors seeking to optimize outright or risk-adjusted returns.

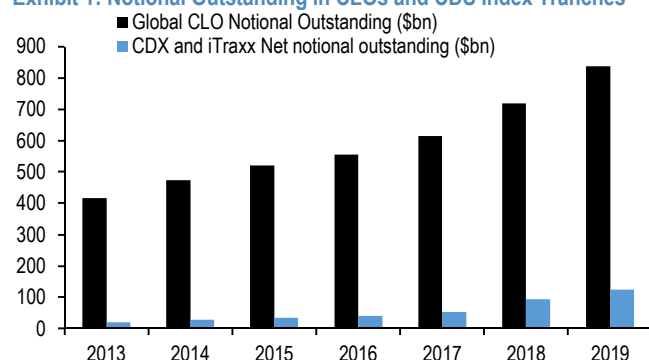
Collateralized Loan Obligations (CLOs) have existed for over 20 years, and the global market has grown to about \$840bn in size (2x larger than in 2013) (Exhibits 1/2). In bond markets, Collateralized Synthetic Obligations (CSOs) have also existed for over 15 years but the market has undergone a fundamental shift in recent years, away from bespoke- and towards standardized index tranches (the focus of this note). This has led to a surge in activity with outstanding nationals growing to over \$250bn and trade volumes topping \$210bn last year (Exhibit 3/4).

But despite the products' fundamental similarity, the investor bases of CLOs and Index Tranches remain largely distinct. Most appear happily at home in one but not the other product. In our view this is an unnecessary limitation of the opportunity set and in this note we hope to help bridge the gap by providing a comparison of the two asset classes in terms of i) fundamental product characteristics, ii) a bottom-up pricing to help judge relative value, and iii) historical return analysis.

The results of these studies show that there is great merit for structured credit investors to adopt a holistic approach and consider both CLOs and index tranches alongside each other in their toolkits.

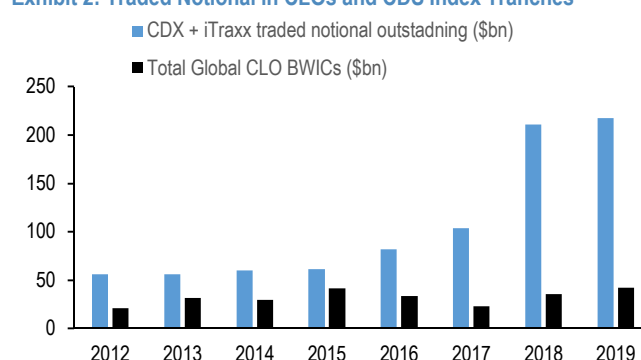
For example we find that at present, senior CLO tranches screen cheap compared to their index tranche equivalents, while the opposite seems true in the junior complex, where index tranches look cheap.

Exhibit 1: Notional Outstanding in CLOs and CDS Index Tranches



Source: J.P. Morgan, Bloomberg, DTCC. Note: Series 11 onwards are included. Gross Notional value data are calculated on a per-trade basis. Net Notional value is the sum of net protection bought (or equivalently sold) across counterparty families.

Exhibit 2: Traded Notional in CLOs and CDS Index Tranches



Source: J.P. Morgan. BWIC volumes are a proxy for secondary trading volumes. Shown for US and Euro CLO BWIC trade notional in USD. Note: Series 11 onwards are included.

The products: similarities and differences

CLOs and Index Tranches both are structured products that provide varying risk/return exposures to a diversified pool of credit risk (on corporate bonds or loans, respectively). However, there are several important differences between the asset classes that we summarize in Exhibit 3 and discuss in more detail below.

Exhibit 3: CLO and Index Tranche Overview

	CLOs	Index Tranches
Underlying Assets	Leveraged Loans (US) Loans/Bonds (Euro)	Credit Default Swaps
Income generation	Libor/Euribor + spread	Spread only (Fixed Coupon + Upfront)
Default handling	Waterfall	Attachment/detachment-based formula
Tranche Granularity	Varies deal-by-deal (generically 6 (Equity, BB, BBB, A, AA, AAA))	4 (Equity, Junior & Senior Mezzanine, Super Senior)
Attachment/Detachments	Varies deal-by-deal	Standardized
Portfolio	Varies deal-by-deal	Standardized, one new on-the-run per year.
Callability	Callable (after 2y non-call period)	Bullet
Final Maturity	13 years, typically 5yr reinvestment period (Bond WALs will vary depending on tranche)	3, 5, 7 or 10 years at inception (5y most active)
Management	Actively managed	Static
Funded/Unfunded	Funded	Unfunded
Credit enhancements	Portfolio and Coverage tests	None
Ratings	Rated (except equity tranche)	Unrated
Amount Outstanding	~\$840bn globally	~\$250bn globally
Secondary Market Trade Volumes	\$42bn globally on BWICs in 2019	\$220bn (FY 2019)
Tradeable Underlying	LevLoan TRS (proxy)	CDS Index (precise)
Number of underlying credit exposures	Varies (US ~250-500; EUR ~100-300)	CDX.IG (125), CDX.HY (100), iTraxx Main (125), iTraxx Crossover (75)

Source: J.P. Morgan.

Underlying assets

CLOs have loans as underlying securities, which are typically secured and have average historical recovery rates of ~65% since 1998, although they have been lower in recent years, with the 2019 average recovery rate at 50.5% (albeit during an environment of below-average default rates). Index tranches in the US and Europe are composed of baskets of CDS, which typically track senior unsecured corporate bonds with lower historical average recovery rates of ~40%.

Income generation

Mirroring the economics of their underlying loans, CLOs are fully funded instruments and pay the investor floating Libor/Euribor + spread and principal at expiry. On the other hand, index tranches are unfunded, i.e. they do not involve an exchange of principal, and purely pay a credit spread.

Lifecycle (Callability)

CLOs are an actively managed loan collateral portfolio where loans can prepay and be reinvested (managers can make discretionary trades) typically over a 5-year

reinvestment period. While the underlying loans can be prepaid at any time, the CLOs are typically structured with a 2 year non-call period for the benefit of creditors. After the 2 year non-call period, there is the possibility of a call (full liquidation, full or partial refinancing, or reset/deal extension) of the CLO. While many factors affect the decision to call, it is a particular risk to creditors if markets rally and liabilities can be refinanced at a lower cost. For example, there was a spike in refinancing activity totaling \$400bn in 2016-2018 when the market rallied. Of the outstanding base, ~52% of CLOs originally issued 2010-2019 have been called, refinanced or reset (extended maturity).

Index tranches on the other hand, are bullet instruments with a fixed notional and a fixed lifetime. As a result, in market rallies investor retain the full upside; the spreads they locked in at inception will be paid until maturity.

Default impact

CLOs operate a cashflow waterfall payment structure in which losses are incurred by interest diversion or back-ended principal default. CLO managers can attempt to avoid and/or make up for losses during the re-investment period (typically 5 years).

In index tranches on the other hand, default payouts are triggered “as-you-go” with a linear payout once portfolio losses reach the tranche attachment. If they reach the tranche detachment, the tranche investor will have lost their full investment.

Ability to lever and to go short

The unfunded nature of index tranches makes it straight-forward to lever a position or to go short. For CLOs, getting leverage requires access to financing, which can be costly. Similarly, in order to go short a CLO one needs to find a lender and negotiate a fee (‘borrow’).

Market Volumes

CLOs are syndicated in primary market. Secondary market trading of CLOs is small in comparison. For example, last year US primary supply was \$119bn and secondary market trading a third of that, \$35bn. In Europe, primary supply was €30bn and secondary market trading was one-fourth or about €6bn.

Index tranches are synthetic and thus trade exclusively through secondary markets. Last year \$220bn of volume was recorded, \$140bn in European (iTraxx) and \$80bn in US (CDX) tranches.

Standardization (of portfolio, maturities, strikes, etc.)

Each September a new set of ‘on-the-run’ index tranches is introduced in Europe and the US on benchmark index portfolios with a new 5y maturity¹ and standardized strikes that slice the index into four risk profiles - Equity, Junior Mezzanine, Senior Mezzanine & Super Senior (see Exhibit 4). ‘Off-the-run’ tranches that have rolled down to 4y, 3y, 2y and 1y tenors and may have accumulated losses remain actively traded, too. The latest set of on-the-run tranches on Crossover S32 and CDX HY S33 is introduced in detail in our [primer](#) from September ‘19.

Exhibit 4: Generic US CLO, CDX.HY and iTraxx Crossover tranche structures

AAA (39-100%)	Super Senior (35-100%)	Super Senior (35-100%)
AA (26-39%)	Senior Mezzanine (25-35%)	Senior Mezzanine (20-35%)
A (19-26%)	Junior Mezzanine (15-25%)	Junior Mezzanine (10-20%)
BBB (13-19%)		
BB (8-13%)		
Equity (0-8%)	Equity (0-15%)	Equity (0-10%)
CLO	CDX.HY	iTraxx Crossover

Source: J.P. Morgan. Based on an indicative US CLO.

¹ Other maturities (3y, 7y, 10y) can also be traded on on-the-run tranches but are less common.

In CLOs, the portfolios, maturities, attachment/detachment points (or 'strikes') and contractual terms vary from deal to deal, but there a basic structure will have five tranches whose strikes are calibrated such that they are rated from AAA to BB and the equity.

Ratings

CLO tranches (except for the equity) are rated at inception and throughout their lifetime. The market is largely covered by Moody's and S&P and to a lesser extent by Fitch. Index tranches are unrated.

Availability of tradeable index

CLOs reference bespoke portfolios of leveraged loans, but TRS and ETFs can be traded on the benchmark leveraged loan indices, which can serve as a proxy to the CLO portfolio. For index tranches, the underlying portfolios are tradeable in liquid CDS index format.

Bottom-up pricing of Index Tranches and CLOs

Methodology and results

Now we undertake a bottom-up pricing exercise. The aim is to create a framework that can evaluate both CLOs and index tranches to explain traded spreads in both markets and to identify relative value.

Neither the standard pricing framework of CLOs (Intex) nor that of Index Tranches (Base Correlation) are perfectly suited for this task, as each are tailored to their particular products. However, the base correlation framework is flexible enough to be carried over to loan portfolios and CLO tranches, we believe, although the lack of prepayment modelling represents a significant shortcoming that has to be handled separately.

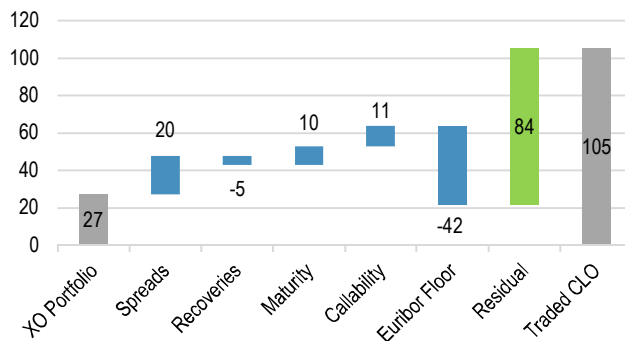
We take a step-by-step approach, starting with a base correlation framework that is calibrated to index tranches (in both Europe and the US) and then changing one variable at a time (from strikes, to spreads, to recoveries, to maturities, to rate floors) until the tranches and the underlying portfolio resemble that of a sample EUR CLO and a sample USD CLO deal, respectively. Differences between the resulting model spreads and the traded spreads of the CLOs point to differences in risk attribution between index tranche and CLO markets and potential relative value opportunities.

As an illustration, Exhibit 5 shows the results of this procedure for EUR AAA CLOs. Starting with Crossover's portfolio and base correlations, the 39.5-100% CLO AAA tranche would be priced with a 27bp spread on a 5y bullet maturity. The wider, more concentrated spread distribution of the loan portfolio gives rise to wider tranche spreads (+20bp); however, the higher recoveries largely offset this (-5bp). The maturity extension to the loan portfolio's weighted average life of 5.5y adds +10bp to spreads. Callability of the CLO explains an additional 11bp, while the Euribor floor removes -42bp. That means Index Tranche pricing would price a 5.5y bullet CLO (with Euribor floor) at 22bp, 84bp inside the traded CLO spread of 105bp. Callability of the CLO explains some but not all of this gap, so we judge the CLO to be relatively cheap.

Base Correlation models the loss distribution for a pool of defaultable claims by correlating defaults and recoveries to a single common market factor. The resulting loss distribution allocates the portfolio's credit risk across the different tranches. High(low) correlations mean a greater proportion of risk are allocated to the senior (junior) tranches. The correlations that calibrate to the traded market prices of tranches are called base correlations.

Intex is a cashflow engine that allows the calibration of a DM ('discount margin') to traded CLO prices given certain recovery, prepayment and loss rate assumptions. As such it is less of a model and more of a quotation tool (like bond yields or flat CDS spreads).

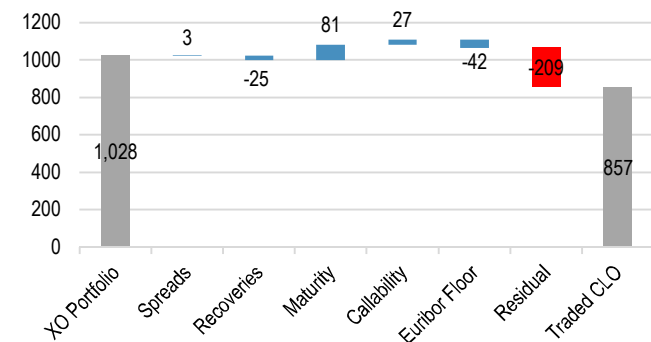
Exhibit 5: Pricing EUR AAA CLOs in Index Tranche framework



Source: J.P. Morgan.

Exhibit 6: Pricing EUR B CLOs in a base correlation framework

Calibrated to XO S32 index tranches.



Source: J.P. Morgan.

Exhibit 6 shows how for junior tranches we reach the opposite conclusion. Here CLOs look expensive and Index Tranches appear to offer better spreads. *In other words, current spreads suggest that CLOs put a high premium on systemic risk (through wide senior spreads) while index tranches put a high premium on idiosyncratic risk (through wide junior spreads).*

The full results for our exercise, including the equivalent model spreads and residuals for US CLOs and CDX HY tranches are provided in Exhibit 7 and 8. As it shows, also in CDX HY we find that the highest quality CLO spreads are comparatively wide (123bp) and are difficult to reconcile with model spreads from a base correlation framework calibrated to CDX HY tranches (42bp). Also, just like with the Euro CLOs, among junior CLO tranches the opposite appears to be the case, with model spreads of CLOs (597, 964bp for BBs, BBBs) wider than the actual traded spreads (340, 651bp for BBs, BBBs).

Before we walk through a detailed description of each step of the way of the modeling, we bring forward a discussion of these results.

Exhibit 7: From CDX HY to US CLO Pricing - Step-By-Step

See subsections for further details on each column.

CDX HY S33 5y				Sample US CLO										
Attach. - Detach.	Name	Quoted Spread	SN Par Spread	Attach. - Detach.	Rating	CDX.HY Pfolio	Spread Dist.	RR to 60%	Mat. to 5.5y	Calla - bility	3mE Floor	Implied Theo. Spread	Traded Spread	Residual
35%-100%	Super Senior	26	29	40.0%-100.0%	AAA	27	31	21	36	49	42	42	123	81
25%-35%	Senior Mezz.	133	149	24.5%-35.0%	AA	183	101	100	128	146	139	139	171	32
15%-25%	Junior Mezz.	384	416	18.0%-24.5%	A	444	231	225	277	317	310	310	220	-90
				12.1%-18.0%	BBB	957	483	477	553	604	597	597	340	-257
				8.5%-12.1%	BB	1,750	836	839	924	971	964	964	651	-313
0%-15%	Equity	2,505	2,631	0.0%-8.5%	EQ	4,634	1828	1,861	1899	1,899	1,892	1,892	-	-

Source: J.P. Morgan. As of 6-Nov-19. CLO is based on a 2019 vintage Euro CLO.

Exhibit 8: From iTraxx Crossover to Euro CLO Pricing - Step-By-Step

See subsections for further details on each column.

iTraxx Crossover S32 5y

Sample EUR CLO

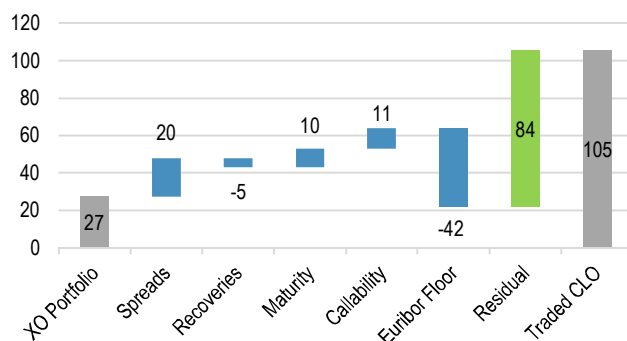
Attach. - Detach.	Name	Quoted Spread	SN Par Spread	Attach. - Detach.	Rating	XO Pfolio	Spread Dist.	RR to 60%	Mat. to 5.5y	Calla-bility	3mE Floor	Implied Theo. Spread	Traded Spread	Residual
35%-100%	Super Senior	44	35	40.0%-100%	AAA	27	48	43	53	64	22	22	105	84
				28.5%-38.2%	AA	107	141	136	161	179	137	137	178	41
				23.3%-28.5%	A	147	175	169	201	234	192	192	259	67
20%-35%	Senior Mezz.	130	138	16.1%-23.3%	BBB	279	316	304	352	399	357	357	386	29
10%-20%	Junior Mezz.	475	481	10.0%-16.1%	BB	575	601	583	651	670	628	628	609	-19
				7.6%-10.0%	B	1,028	1,025	1,001	1,081	1,108	1,066	1,066	857	-209
0%-10%	Equity	1,994	1,894	0%-7.6%	EQ	2,258	1,984	1,965	2,025	2,025	1,983	1,983	-	-

Source: J.P. Morgan. As of 6-Nov-19. CLO is based on a 2019 vintage Euro CLO.

Just like the AAA examples we discussed above, also among AA CLOs the traded spreads are wider than the model spreads we get from our pricing model, albeit to a lesser extent (32bp and 42bp in USD and in EUR, respectively, Exhibits 9-12).

Exhibit 9: Pricing EUR AAA CLOs in a base correlation framework

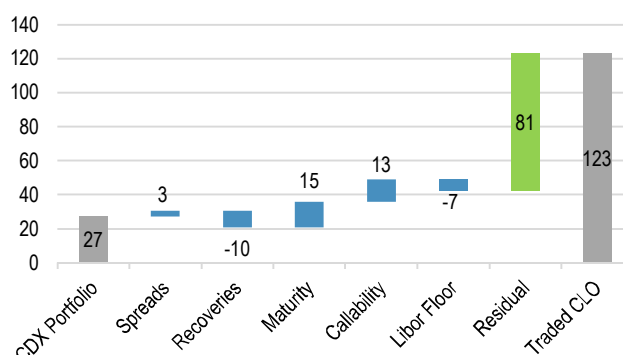
Calibrated to XO S32 index tranches.



Source: J.P. Morgan.

Exhibit 10: Pricing US AAA CLOs in a base correlation framework

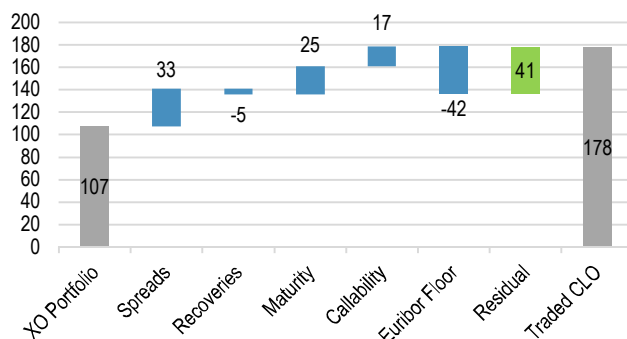
Calibrated to CDX.HY S33 index tranches.



Source: J.P. Morgan.

Exhibit 11: Pricing EUR AA CLOs in a base correlation framework

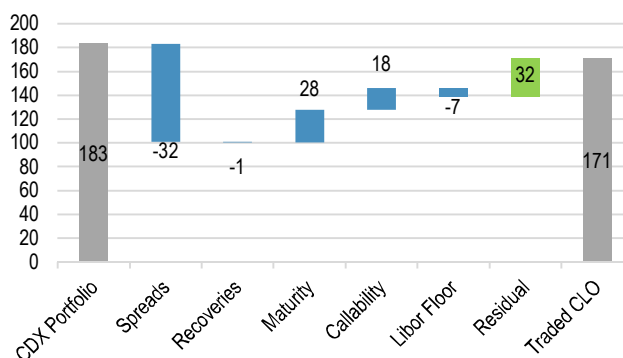
Calibrated to XO S32 index tranches.



Source: J.P. Morgan.

Exhibit 12: Pricing US AA CLOs in a base correlation framework

Calibrated to CDX.HY S33 index tranches.

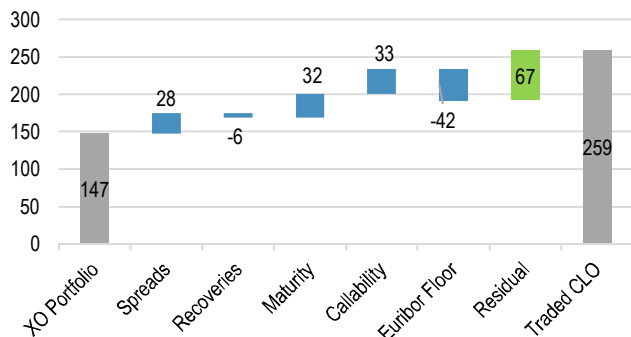


Source: J.P. Morgan.

For A and BBB CLOs, model- and traded spreads are closer in line but we find that EUR CLOs trade marginally wide, while USD CLOs trade rich (Exhibits 13-16).

Exhibit 13: Pricing EUR A CLOs in a base correlation framework

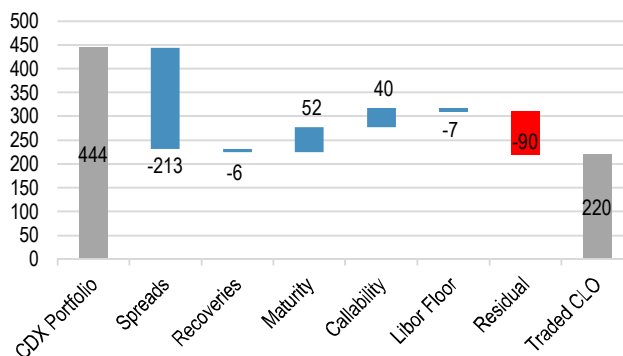
Calibrated to XO S32 index tranches.



Source: J.P. Morgan.

Exhibit 14: Pricing US A CLOs in a base correlation framework

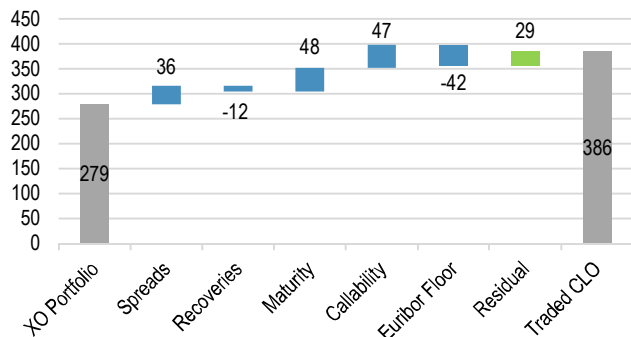
Calibrated to CDX.HY S33 index tranches. Source: J.P. Morgan.



Source: J.P. Morgan.

Exhibit 15: Pricing EUR BBB CLOs in a base correlation framework

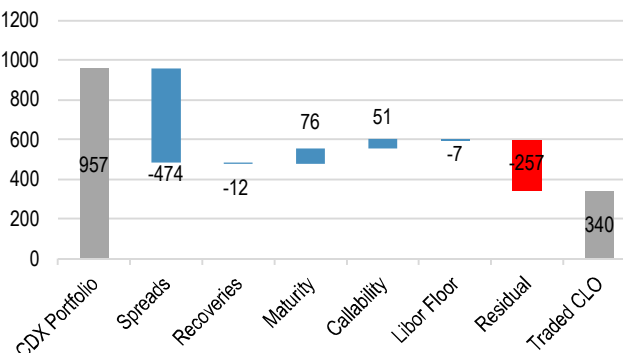
Calibrated to XO S32 index tranches.



Source: J.P. Morgan.

Exhibit 16: Pricing US BBB CLOs in a base correlation framework

Calibrated to CDX.HY S33 index tranches. Source: J.P. Morgan.

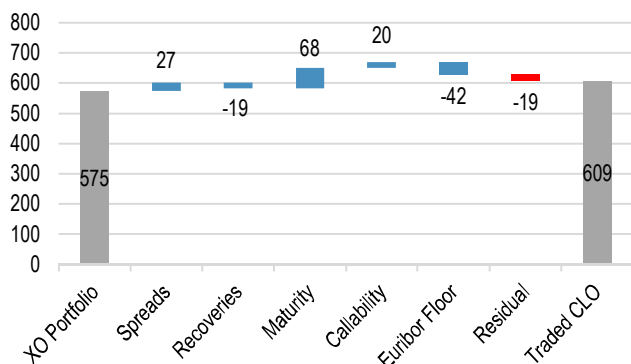


Source: J.P. Morgan.

For the more junior CLO tranches (BB, B), the traded spreads of the CLO are rich relative to the modelled (bullet) spreads in both EUR and USD. (Exhibits 17-19).

Exhibit 17: Pricing EUR BB CLOs in a base correlation framework

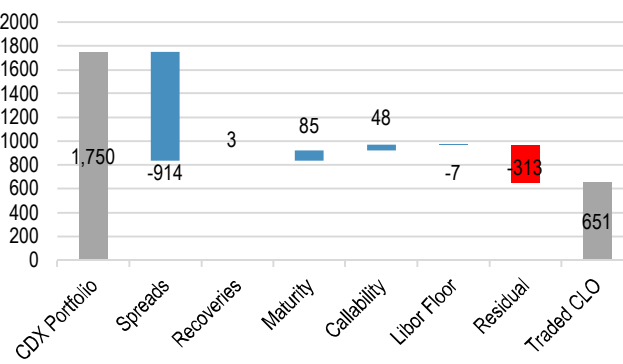
Calibrated to XO S32 index tranches.



Source: J.P. Morgan.

Exhibit 18: Pricing US BB CLOs in a base correlation framework

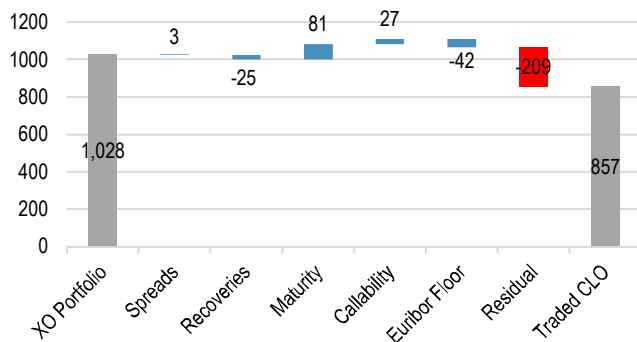
Calibrated to CDX.HY S33 index tranches.



Source: J.P. Morgan.

Exhibit 19: Pricing EUR B CLOs in a base correlation framework

Calibrated to XO S32 index tranches.



Source: J.P. Morgan.

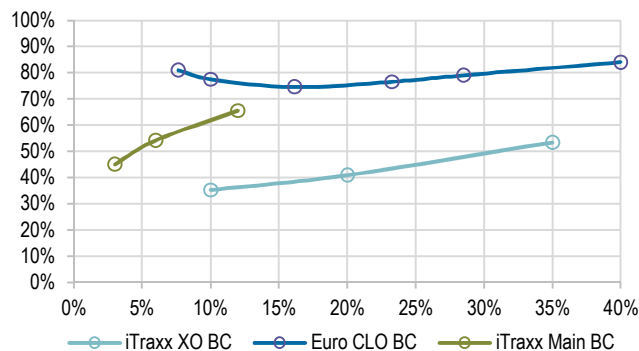
Discussion: Implied Correlations

Rather than taking the base correlations of index tranches to price CLO spreads, we could have also set out to calibrate base correlations to the traded CLO spreads directly, and then compared those to the base correlations of iTraxx and CDX.

In doing so, we find that the implied correlations of CLOs are significantly higher than in index tranches, with implied correlations in the range of 75-80% for Euro CLOs (relatively flat), high above the 35-55% range for iTraxx Crossover. Similarly, the 50-80% range of implied correlations for US CLOs (upward sloping) is far higher than CDX HY's 30-50% range. The CLOs' implied correlations are somewhat more in line with the base correlations of IG index tranches CDX IG and iTraxx Main, in particular in the US. But IG tranches typically warrant higher implied correlations than their HY counterparts as investors ascribe higher sensitivity to systemic risk, especially in Europe, where iTraxx Main includes banks.

Exhibit 20: Implied Correlations of Euro CLOs vs iTraxx XO & Main

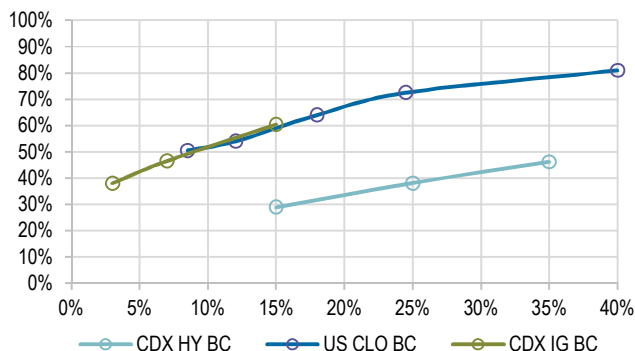
Implied Base Correlation in % vs Detachment (%)



Source: J.P. Morgan.

Exhibit 21: Implied Correlations of US CLOs vs CDX HY & IG

Implied Base Correlation in % vs Detachment (%)



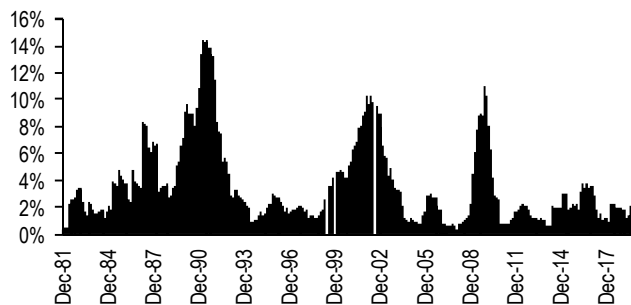
Source: J.P. Morgan.

Is this justified? Should defaults in loan portfolios be considered more highly correlated than defaults in bond portfolios? As we will show, the loan portfolios' spread distributions are more concentrated, which could support this hypothesis, but on the other hand they are also more diversified across a greater number of issuers. Also, when considering historical default rates between bond- and loan markets, defaults appear similar in size and in nature throughout time, so it does not appear

that loan defaults are structurally higher correlated than bond defaults (i.e. occurring in clusters).

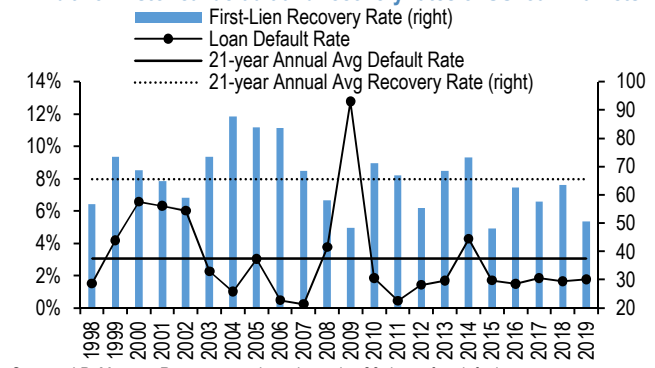
Exhibit 22: Historical default rates in US bond markets

Rolling 12 month HY Bond Def. rate by volume



Source: J.P. Morgan.

Exhibit 23: Historical default and recovery rates of US loan markets

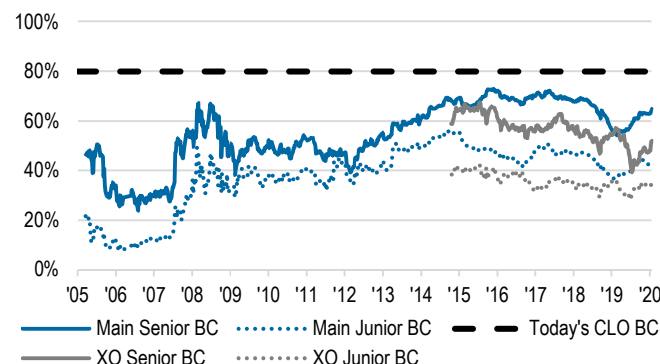


Source: J.P. Morgan. Recovery rate based on price 30-days after default.

Have index tranches in the past traded with implied correlations as high as today's CLO figures of around 80%? In short, the answer is no. Senior correlations in iTraxx Main have reached levels as high as 70% during the Global Financial Crisis and during '15/'16 when political risk in Europe coupled with a weakening banking sector stoked fears of systemic risks. However, for the most part of history implied correlations in both Main and Crossover traded in a range of 30-70%. In the US our data goes back to 2013 and implied correlations have been relatively stable since then, never reaching the levels of today's CLO implied correlation.

Exhibit 24: The Euro CLO Implied Correlations in historical context

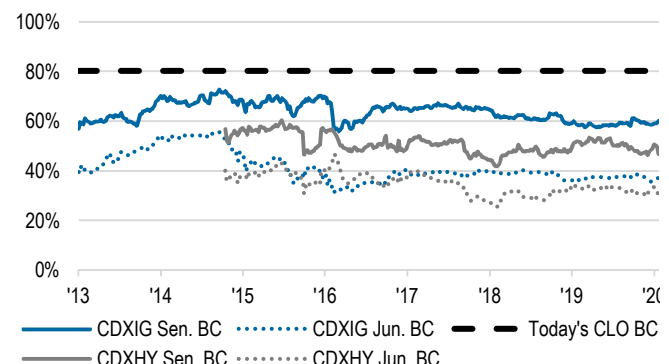
Senior BC = Super Senior attachment, Junior BC = Equity Detachment.



Source: J.P. Morgan.

Exhibit 25: The Dollar CLO Implied Correlations in historical context

Senior BC = Super Senior attachment, Junior BC = Equity Detachment.



Source: J.P. Morgan.

So in summary, today's traded CLOs spreads can be thought of as pricing in significantly higher implied correlations than index tranches but we find little support for this to be fundamentally justified, in turn supporting our conclusion that senior spreads in CLOs currently offer attractive spread pick-up, while junior spreads appear relatively rich compared to index tranches.

Discussion: Leverage

The unfunded nature of index tranches allows investors to lever their positions with ease. Initial margin requirements tend to be fractions of the notional, so returns on invested capital can be scaled up significantly, a strategy that is particularly common

among super senior tranches. The economics of leveraging CLO AAAs are less straight-forward due to the need to find and pay for financing. This may explain in part why super senior tranches trade tighter than their CLO equivalents.

Discussion: Roll-down

We compare traded spreads in our analysis, so it should be borne in mind that CDS curves tend to be steeper than those of cash instruments, leading to stronger slide benefits (or ‘roll down’). To illustrate, the following exhibit presents the 1-year time value of CDX.HY tranches (carry + slide x duration). The ratio of time value/carry for non-equity tranches is greater than 2x, meaning that the slide can contribute even more to investor returns than the carry (assuming that spreads roll down the curve). Investors typically monetize this by rolling to the latest tranche series in September.

Exhibit 26: Relative risk roll down of CDX.HY tranches

Tranche	1-yr Carry (bp)	1-yr Slide (bp)	1-yr Time Value	Time Value / Carry
Equity	2418	65	2735	1.1
Junior Mezzanine	329	145	923	2.8
Senior Mezzanine	107	56	340	3.2
Super Senior	37	16	99	2.6

Source: J.P. Morgan

Modelling Setup

We now present the modelling framework. To begin with, we take two sample 2019 vintage sample CLO deals, one in EUR and one in USD, which are roughly half a year into their life and for which we have full portfolio information at time of writing. The AAA tranches of the CLOs were issued with coupons of 3m Euribor (floored) + 108.5bp for the EUR deal and at 3m Libor + 133bp for the USD deal. Based on secondary market prices they tightened to 105bp for the Euro and 123bp for the US tranche, respectively (based on PricingDirect). Exhibits 27 and 28 show issue- and current spreads for all other tranches in the capital structure.

On the other hand, CDX HY S33 and iTraxx Crossover S32 are the prevailing on-the-run CDS indices with 5y spreads at 310bp and 224bp, respectively. Super Senior index tranche spreads are 40bp in CDX HY and 44bp in Crossover – all other tranche spreads are shown in Exhibits 27 and 28.

Exhibit 27: CDX HY and sample USD CLO spreads (bps)

CDX HY			USD CLO			
Attach.- Detach.	Tranche	Sprd	Attach.- Detach.	Issue Rtg	Cpn (3mL+)	Curr. DM
35%-100%	Sup.Sen.	40	40%-100%	AAA	133	123
25%-35%	Sen.Mezz.	125	24.5%-35%	AA	185	171
15%-25%	Jun.Mezz	377	18%-24.5%	A	268	220
			12.05%-18%	BBB-	395	340
			8.5%-12.05%	BB-	655	651
0%-15%	Equity	2600	0%-8.5%	NR	-	-

Source: J.P. Morgan. CLO is based on a 2019 vintage US BSL CLO. Original attach/detach points

Exhibit 28: iTraxx Crossover and sample EUR CLO spreads (bps)

iTraxx Crossover			EUR CLO			
Attach.- Detach.	Tranche	Sprd	Attach.- Detach.	Issue Rtg	Cpn (3mE+)	Curr. DM
35%-100%	Sup.Sen.	44	40%-100%	AAA	108.5	105
			28.5%-38.24%	AA	185	178
20%-35%	Sen.Mezz.	130	23.25%-28.5%	A	270	259
10%-20%	Jun.Mezz.	475	16.14%-23.25%	BBB-	395	386
			10%-16.14%	BB-	599	609
			7.63%-10%	B-	862	857
0%-10%	Equity	1994	0%-7.63%	NR	-	-

Source: J.P. Morgan. CLO is based on a 2019 vintage Euro CLO. Original attach/detach points

Clearly, there appears to be quite a large discrepancy between the AAA CLO spreads which are far wider than the Super Senior index tranches in both EUR and USD markets. To a lesser extent this still applies to the AA and A tranches where a crude side-by-side comparison leaves both looking cheap relative to the Senior Mezzanine index tranches. But the more junior tranches, from BBB to B, if anything appear optically tight when compared side-by-side with the spreads of Junior Mezzanine index tranches.

We now explore to which extent these differentials can be explained by differences in the underlying tranche-, portfolio- and product-characteristics in a base correlation pricing framework. Since index tranches are native to this framework, we start off with the calibrated set of CDX HY and iTraxx Crossover tranches (and their base correlations) and then change one differentiating factor at a time (from strikes, to spreads, to recoveries, to maturities, to rates floors, to callability) to get model spreads for the CLOs.

Strikes

First we price the tranches of the CLO in the index tranche framework with a 5y maturity and the CDS index' underlying portfolio of constituents. This results in 27bp for both the EUR and USD AAA CLO, tighter than where the Super Senior tranches of both CDX HY (40bp) and Crossover (44bp) price in the market on that day mainly due to the greater degree of subordination³.

The equivalent results for all other CLO tranches are shown in the seventh column of Exhibit 29 and Exhibit 30. Note how - after this step - the junior BB and BBB tranches are suggested to warrant extremely wide spreads in the US portfolio in particular (1750bp and 957bp, respectively).

Exhibit 29: From CDX HY to US CLO Pricing - Step-By-Step

See subsections for further details on each column.

CDX HY S33 5y				Sample US CLO										
Attach. - Detach.	Name	Quoted Spread	SN Par Spread	Attach. - Detach.	Rating	CDX.HY Pfolio	Spread Dist.	RR to 60%	Mat. to 5.5y	Calla - bility	3mE Floor	Implied Theo. Spread	Traded Spread	Residual
35%-100%	Super Senior	40	29	40.0%-100.0%	AAA	27	31	21	36	49	42	42	123	81
25%-35%	Senior Mezz.	125	149	24.5%-35.0%	AA	183	101	100	128	146	139	139	171	32
15%-25%	Junior Mezz.	377	416	18.0%-24.5%	A	444	231	225	277	317	310	310	220	-90
				12.1%-18.0%	BBB	957	483	477	553	604	597	597	340	-257
				8.5%-12.1%	BB	1,750	836	839	924	971	964	964	651	-313
0%-15%	Equity	2,600	2,631	0.0%-8.5%	EQ	4,634	1828	1,861	1899	1,899	1,892	1,892	-	-

Source: J.P. Morgan. CLO is based on a 2019 vintage USD CLO. USD CLO spread to 3mLibor.

³ Note that the index tranches on that day were quoted at slightly different levels in the market, reflecting a basis between where the indices trade relative to single-names, as well as a basis due to the difference in quoted (flat) spreads and the par spreads which we rely on for modelling purposes, but we do not aim to emphasize the – typically small – impact of these technicalities in this exercise.

Exhibit 30: From iTraxx Crossover to Euro CLO Pricing - Step-By-Step

See subsections for further details on each column.

iTraxx Crossover S32 5y				Sample EUR CLO										
Attach. - Detach.	Name	Quoted Spread	SN Par Spread	Attach. - Detach.	Rating	XO Pfolio	Spread Dist.	RR to 60%	Mat. to 5.5y	Calla- bility	3mE Floor	Implied Theo. Spread	Traded Spread	Residual
35%-100%	Super Senior	44	35	40.0%-100%	AAA	27	48	43	53	64	22	22	105	84
				28.5%-38.2%	AA	107	141	136	161	179	137	137	178	41
20%-35%	Senior Mezz.	130	138	23.3%-28.5%	A	147	175	169	201	234	192	192	259	67
10%-20%	Junior Mezz.	475	481	16.1%-23.3%	BBB	279	316	304	352	399	357	357	386	29
				10.0%-16.1%	BB	575	601	583	651	670	628	628	609	-19
0%-10%	Equity	1,994	1,894	7.6%-10.0%	B	1,028	1,025	1,001	1,081	1,108	1,066	1,066	857	-209
				0%-7.6%	EQ	2,258	1,984	1,965	2,025	2,025	1,983	1,983	-	-

Source: J.P. Morgan. CLO is based on a 2019 vintage Euro CLO. EUR CLO spread to 3mEuribor (floored).

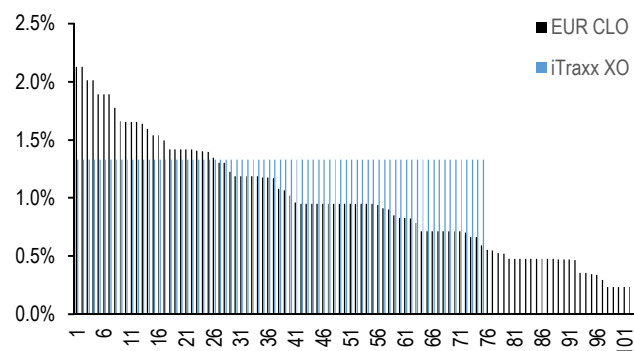
Concentration & Diversification

Next, we modify the portfolios in our pricing to be more in line with the CLOs' underlying collateral. First we change the number of names as CLOs are typically more diversified. For example the sample EUR CLO contains 133 unique loans/bonds, from 125 different issuers, with varying exposures. The issuer with the highest exposure represents 2.1% of the underlying portfolio, whereas in Crossover there are 75 equally weighted issuers, each contributing 1.33%, Exhibit 31.

For the USD CLO, there are 325 unique loans, from 286 different issuers, with varying exposures. The issuer with the highest exposure represents 1.2% of the underlying portfolio, whereas in CDX.HY there are 100 equally weighted issuers, each contributing 1% to the overall portfolio, Exhibit 32.

Exhibit 31: Issuer exposure in EUR CLO and Crossover

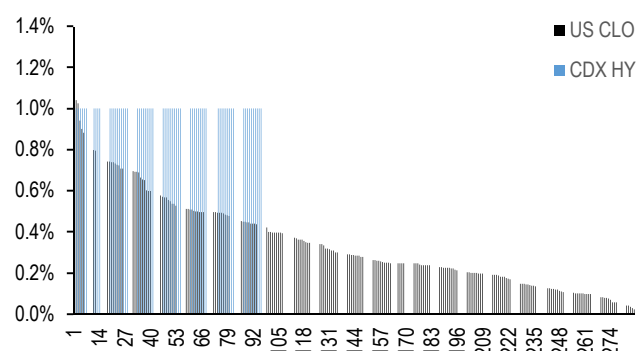
Ranked by size of issuer



Source: J.P. Morgan. CLO is based on a 2019 vintage Euro CLO.

Exhibit 32: Issuer exposure in USD CLO and CDX HY

Ranked by size of issuer

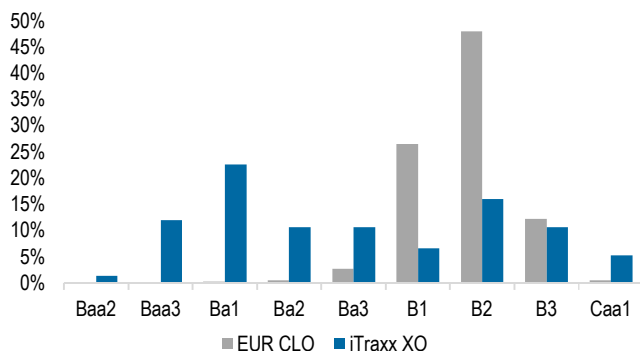


Source: J.P. Morgan. CLO is based on a 2019 vintage US BSL CLO.

Spread distribution

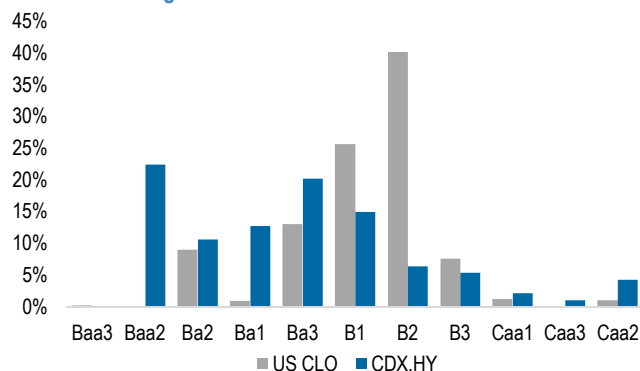
Next, we change the spread distributions to align with the CLOs. Looking first at ratings, it is evident that the CLOs feature a far more concentrated distribution, centered heavily on single-Bs. On the other hand, Crossover and CDX HY are more dispersed, featuring on the one side many higher-quality issuers with BB and even some BBB (split)-ratings, but on the other side also a number of CCC-rated issuers.

Exhibit 33: Rating distribution in EUR CLO and Crossover



Source: J.P. Morgan, Fitch, S&P, Moody's. CLO is based on a 2019 vintage Euro CLO. Based on Moody's rating for CLO.

Exhibit 34: Rating distribution in USD CLO and CDX HY



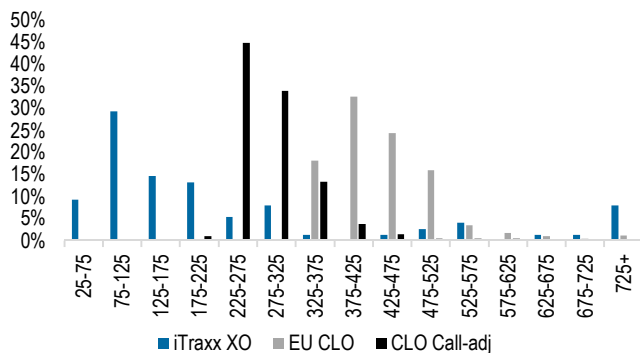
Source: J.P. Morgan, Fitch, S&P, Moody's. CLO is based on a 2019 vintage US BSL CLO. Based on Moody's rating for CLO.

A similar picture is presented by the spread distributions, with Crossover and CDX HY constituent spreads spanning a wide range of 50-700+bp while the CLO spreads concentrate between 250-500bp (Exhibits 35 and 36).

When comparing quoted spreads of loans and CDS, a critical difference is the inherent callability of the loans, which disadvantage the investor compared to bullet instruments such as the CDS, and therefore warrant a premium. In our experience (based on case studies of historical loan pricings by issuers that also feature an active CDS market), the callability is typically priced to be worth roughly 1/3rd of the headline spread, so we scale down the CLO spread distribution by 2/3rd to get "call-adjusted" bullet-like spreads (Exhibits 35 and 36).

Exhibit 35: Spread distribution in EUR CLO and Crossover

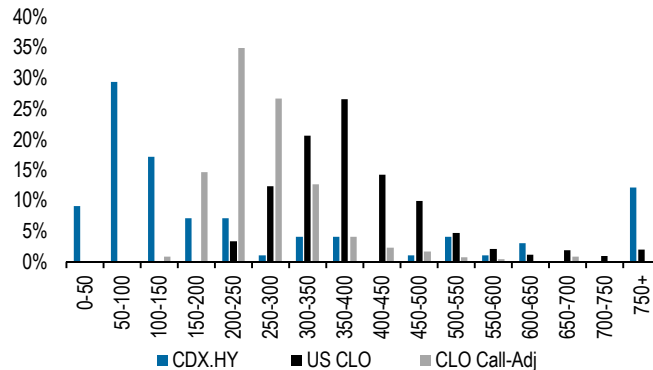
Call-adjusted spreads approximate spreads of equivalent bullet loan



Source: J.P. Morgan. CLO is based on a 2019 vintage Euro CLO.

Exhibit 36: Spread distribution in USD CLO and CDX HY

Call-adjusted spreads approximate spreads of equivalent bullet loan



Source: J.P. Morgan. CLO is based on a 2019 vintage US BSL CLO.

Applying the CLO spread distribution in our pricing framework has a notable impact on the model tranche spreads. On the one hand in EUR spreads widen for AAA-BB tranches while B tranches tighten slightly. On the other hand in the US, spreads tighten for all tranches except for the USD AAA tranche which widens from 27bp to 31bp (see eighth columns of Exhibits 29 and 30).

This is intuitive; in highly concentrated portfolios such as the CLO's, the absence of distressed names makes junior tranches safer, while the absence of tight names leaves senior tranches more vulnerable.

However, while these changes bring the model spreads closer towards the traded CLO spreads, there is still a sizeable gap across the capital structure at this point.

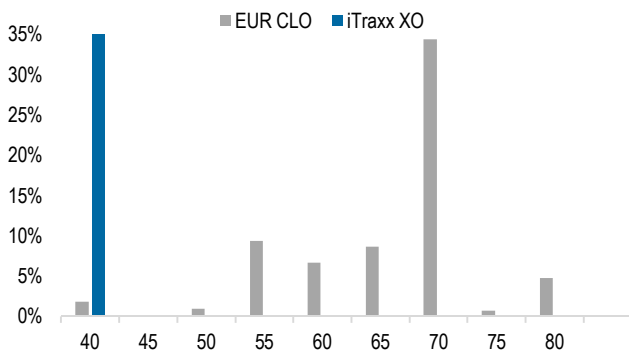
Recoveries

Next, we adjust the recovery-in-default assumptions. As CDS typically reference senior unsecured debt, the historical average rate of 40% is commonly used as the expected recovery of constituents unless names trade distressed. On the other hand, the collateral of the EUR CLO portfolio⁴ have expected recoveries (assigned by the rating agencies) between 50-85%, most commonly marked 70%, and 66% (Exhibit 37). We assign a slightly lower 60% expected recovery given the recent downward trend in recovery rates in the loan markets.

Note that while we change recoveries in this step, we are not changing the spreads. As a result, we are implicitly increasing the default probabilities since – roughly speaking – spreads equal the product of default probability and loss-given-default.

Re-pricing the CLO tranches with these higher expected recoveries leads to tighter senior spreads with EUR AAA spreads dropping from 48bp to 43bp and USD AAA spreads dropping from 31bp to 21bp due to the lowered chances of impairment (ninth column of Exhibit 29 and 30). For junior tranches, the impact is less pronounced, as the positive impact of higher recoveries is offset by the negative impact of higher default probabilities.

Exhibit 37: Recovery distribution in EUR CLO and Crossover



Source: J.P. Morgan. CLO is based on a 2019 vintage Euro CLO.

Maturity

Next, we consider maturities. The index tranches have a fixed lifetime with a little less than 5y to maturity (20-Dec 2024), as do all underlying constituents.

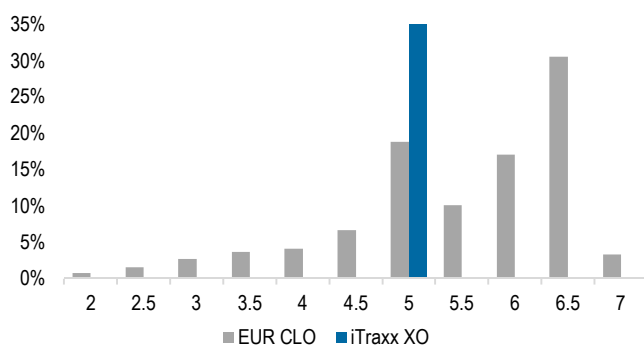
In the CLOs the underlying loans are prepayable any time but feature a variety of final maturities, with most falling between 4-7y in case of the EUR CLO and 4-7y for the USD CLO. Note also that during the reinvestment period (5y at inception, 4.5y remaining) maturing or prepaid loans are re-invested to purchase new loans in the portfolio, which can extend the maturity profile. The CLOs itself can be called at

⁴ The recovery rates on the loan level for the chosen US CLO were not available for this study.

any time after the end of the 2y non-call period (1.5y remaining). For our pricing exercise we take the expected lifetimes of the current underlying loans as a base case for the maturity, which is ~5.5y and we discuss the impact of callability in the next section.

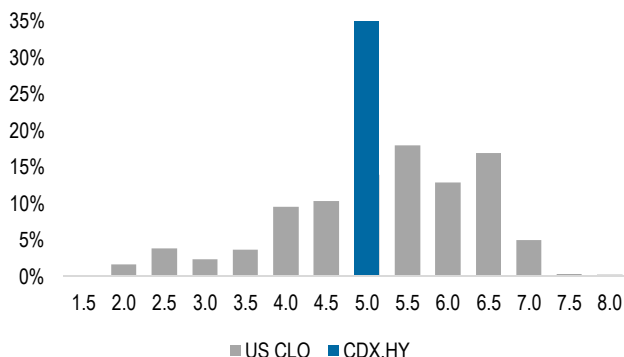
This 6m increase in maturity over index tranches warrants wider spreads across the capital structure, but in particular for the more senior tranches with AAA spreads widening 10bp for the in EUR (from 43bp to 53bp) and 15bp in USD (from 21 to 36bp, see tenth column of Exhibit 29 and 30). This is intuitive, given that time value is particularly important for far “out-of-the-money” risk premia like the spreads of senior tranches.

Exhibit 38: Maturity Distribution of EUR CLO and Crossover



Source: J.P. Morgan. CLO is based on a 2019 vintage Euro CLO.

Exhibit 39: Maturity Distribution of USD CLO and CDX HY



Source: J.P. Morgan. CLO is based on a 2019 vintage US BSL CLO.

Callability

The model spreads so far have been bullet spreads. Next we adjust them to account for callability of the CLO. For example, the Euro AAA CLO coupon of 108.5bp is earned until the end of the non-call period but thereafter might get re-set if markets rally. In our case, assuming coupons are re-set right at, say, 80bp for the remaining 4 years, the blended coupon that the investor earns over the lifetime is lowered by 21bp $((108.5-80) \times 4/5.5)$ to 88bp. There is no equivalent mechanism that would see investors re-set to wider spreads in a market sell-off. This asymmetry means that the traded CLO spreads must incorporate a premium over the bullet spreads that the base correlation framework provides.

Impact of Callability in running bp:

$$BS(S, K, \sigma, TtC) \times EL / (EL - TtC)$$

where BS represents the Black-Scholes formula, S is the current spread (proxied from secondary or primary), K is the CLO's spread, σ is a volatility parameter we choose as 20%, TtC are the years to the end of the non-call period, and EL is the expected life in years.

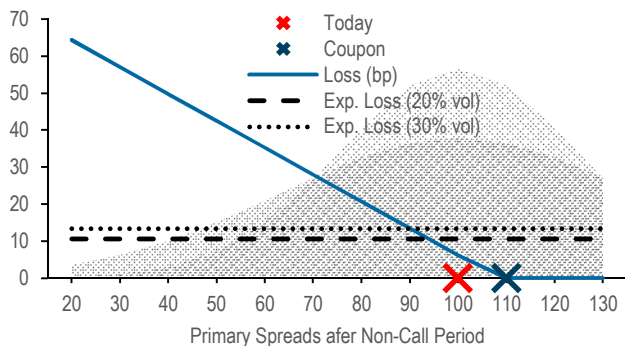
The lower spreads get re-set, the larger the loss to the investor. So to price the impact of callability accurately, we apply a probabilistic approach, stipulating a bell curve probability distribution on the range of future outcomes, centered around the current level of primary CLO spreads and calculating the expected value of the loss due to callability (Exhibit 40).

We choose the width of the bell curve according to historical primary CLO spread moves over the past 7 years, which suggest a volatility very close to 20% in both Euros and Dollars, across the ratings spectrum (Exhibit 41).

The impact of callability can then be computed as a simple manipulation of the Black-Scholes formula (see box on the left), and for the AAA tranches we arrive at an impact of 11bp for Euros and 13bp for USDs (eleventh column of Exhibit 29 and 30).

Exhibit 40: Illustrative impact of callability on CLO spreads

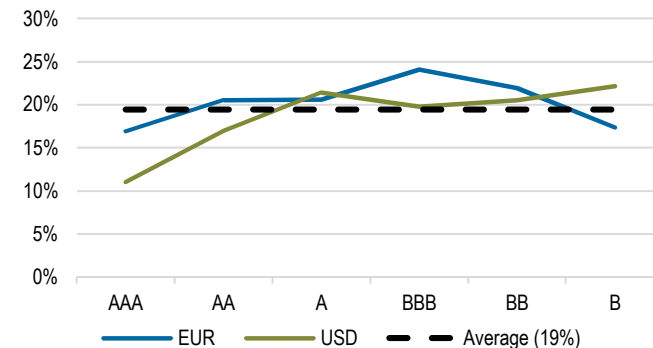
In bp



Source: J.P. Morgan.

Exhibit 41: Realized volatility of Primary CLO spreads in EUR & USD

In bp



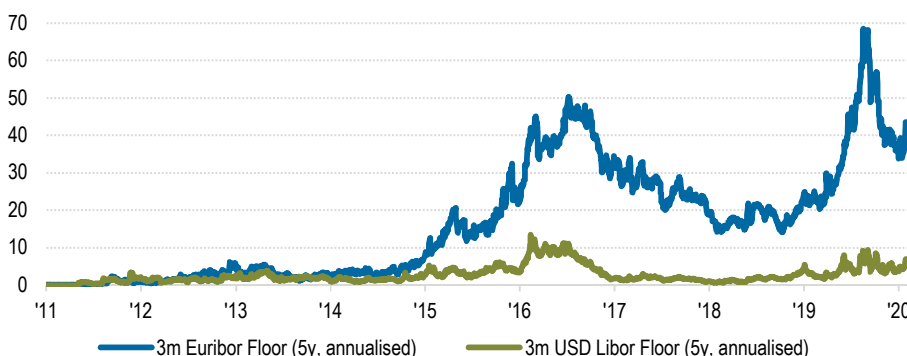
Source: J.P. Morgan.

Libor/Euribor Floor

Finally, CLOs are funded and pay 3mLibor + spread, so an unfunded index tranche spread would be directly comparable to the CLO spread *if it were not for the fact that the floating rate in the CLO is floored at zero*. This is particularly relevant in EUR CLOs where interest rates are in deeply negative territory, with 3m Euribor at around -40bp. To account for this, we need to subtract the cost of the Euribor floor from the model spread, which was 42bp on 27-Jan-19 (Exhibit 42).

In relative terms the 40bp floor has a disproportionate impact on the more senior tranches. After accounting for the Euribor floor, our pricing exercise suggests model spreads for the EUR AAA CLOs (including a Euribor floor) at +22bp, a 84bp residual to the traded levels.

Exhibit 42: Value of 3M Euribor and Libor Floors in running bp terms



Source: J.P. Morgan.

Historical Performance of CLO and Index tranches

The next question we want to answer is how the empirical characteristics of CLOs and index tranches compare. To this end we rely on the CLOIE index and on

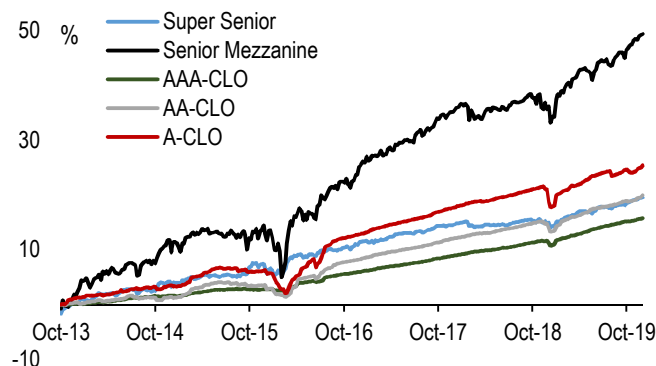
CDX.HY total return time series for tranches. CLOIE is the JPMorgan Collateralized Loan Obligation Index, which is a benchmark to track the market for US dollar denominated CLOs. While it aggregates information from numerous deals in the market and is not a tradeable index per se, CLOIE total returns can be used as a sensible proxy for the typical total returns that CLO investors would experience.

CLOs are fully funded while Index Tranches are unfunded products. In addition, secondary market activity of CLO tranches is lower than in Index Tranches. In order to make a fair comparison of historical performance of these products, we need to consider these two factors in particular.

Outright return comparisons

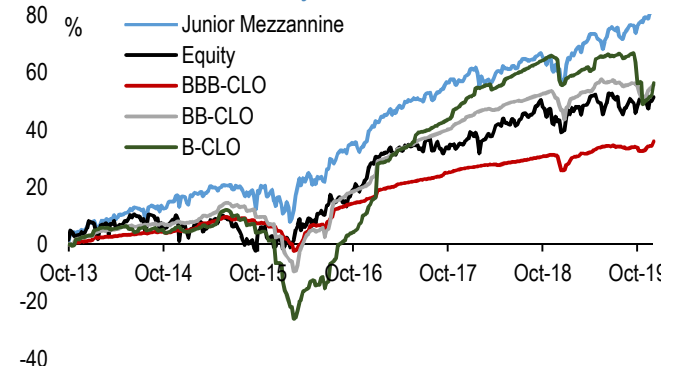
To start, Exhibits 43 and 44 show the raw returns for Index Tranches (unfunded) and for CLOs (funded) across senior and junior tranches. The time period we study covers Q4-2013 until 4Q-2019. Visually, the CLO and index tranche markets are somewhat correlated, with most major market moves shared in common. Both markets experienced sharp losses during the '15/'16 energy sell-off and the Q4 '18 "taper tantrum" and both rebounded sharply in the '16 and '19 market rallies. However, there were also periods of divergence. For example, the 4Q-19 weakness in the loan market lead to losses in the CLO Single-Bs, but was not mirrored by weakness in any index tranche.

Exhibit 43: CDX.HY and CLOIE senior tranches returns



Source: J.P. Morgan.

Exhibit 44: CDX.HY and CLOIE junior tranches returns



Source: J.P. Morgan.

Exhibit 45 presents the most common empirical summary statistics for both products (annualized averages & standard deviations of returns, as well as their ratio, the information ratios) for Index Tranches and CLO tranches. First to note, all tranches have served their purpose in delivering investors income, and – for the most part – the magnitude of the realized returns scales with the subordination of the tranches, ranging from 2.5% for CLO AAAs and 3.1% for CDX HY Super Senior tranches to 9% for CLO BBs and 13.2% for CDX HY Junior Mezzanine tranches. Note how CDX HY equity tranches are the only exception to the rule that greater risk leads to greater reward over this period as realized defaults were unusually high over the past few years.

Second, even though Index Tranches have typically featured higher outright returns, when we risk-adjust them, the CLO tranches appear superior. For example, AAA CLOs boast a 4.2 Information ratio vs. 1.5 for Super Senior tranches.

Exhibit 45: Information ratio for CLO and Index tranches, funded CLOs and unfunded Index Tranches, based on weekly data

	Index Tranches				CLO					
	Super Senior	Senior Mezzanine	Junior Mezzanine	Equity	AAA	AA	A	BBB	BB	B
Average Return (Annualized)	3.1	7.9	13.2	8.3	2.5	3.2	4.1	5.8	9.0	9.1
Standard deviation of Return (Annualized)	2.1	5.8	10.8	11.9	0.6	1.2	2.0	3.6	6.0	9.8
Information Ratio	1.5	1.4	1.2	0.7	4.2	2.6	2.1	1.6	1.5	0.9

Source: J.P. Morgan.

Adding cash returns to Index Tranches

Next, we account for the fact that these Index Tranche returns are pure spread returns. A funded investor would additionally earn a return on his cash position. This provides for a fairer comparison to CLOs, which are funded instruments to begin with. This adjustment improves the characteristics of Index Tranches, boosting returns across the board by roughly 1.5% per year (which was the average 3m Libor rate over that period) without causing much additional volatility (Exhibit 46).

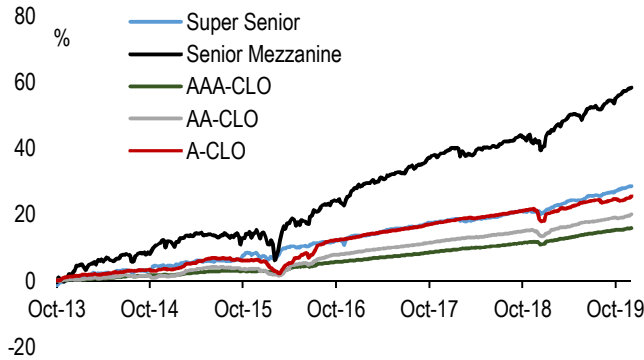
Risk-adjusted returns of the Index Tranches increase substantially as a result. For example, Super Senior information ratios increase by 33% to 2.0 from the unfunded average returns version (1.5), but are still less than half that of the AAA CLO tranches (i.e. 4.2). Similarly in the junior complex, Junior Mezzanine tranche's information ratios increase to 1.4, but are still lower than that of BBB CLOs (1.6) and BB CLOs (1.5).

Exhibit 46: Information ratio for CLO and Index tranches, funded CLOs and funded Index Tranches, based on weekly data

	Index Tranches				CLO					
	Super Senior	Senior Mezzanine	Junior Mezzanine	Equity	AAA	AA	A	BBB	BB	B
Average Return (Annualized)	4.6	9.4	14.6	9.7	2.5	3.2	4.1	5.8	9.0	9.1
Standard deviation of Return (Annualized)	2.2	5.8	10.8	11.9	0.6	1.2	2.0	3.6	6.0	9.8
Information Ratio	2.0	1.6	1.4	0.8	4.2	2.6	2.1	1.6	1.5	0.9

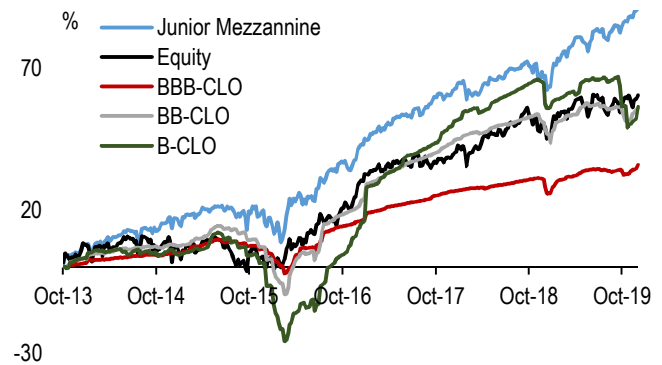
Source: J.P. Morgan.

Exhibit 47: Funded CDX.HY and CLOIE senior tranches funded returns



Source: J.P. Morgan.

Exhibit 48: Funded CDX.HY and CLOIE junior tranches funded returns



Source: J.P. Morgan.

Adjusting for liquidity

Finally we want to account for the difference in liquidity profiles. In the weekly return data that underlies the previous sections, Index Tranches pick up a lot of short-term volatility that is not reflected in the CLO data; not because the latter are less volatile but more because they are not traded as actively and remarked as frequently, we believe. We therefore switch to quarterly return data which is more robust to short-term liquidity differences. Exhibit 49, presents the funded quarterly returns for Index Tranches and CLO tranches in tabular format.

Exhibit 49: Quarterly funded returns (%) of CLO and Index Tranches

	Index Tranches				CLO					
	Super Senior	Senior Mezzanine	Junior Mezzanine	Equity	AAA	AA	A	BBB	BB	B
Q4 '19	1.8	3.9	6.2	2.7	0.7	1.1	1.2	2.0	-0.3	-10.4
Q3 '19	1.2	2.5	1.9	-2.3	1.1	1.2	0.4	-0.2	-0.7	1.2
Q2 '19	2.0	3.6	5.3	4.4	1.3	1.6	2.1	2.5	3.5	4.0
Q1 '19	3.0	8.0	14.1	9.8	1.9	2.7	3.8	5.9	6.5	5.9
Q4 '18	-0.4	-3.2	-8.3	-9.3	-0.3	-1.3	-3.0	-4.5	-5.2	-8.0
Q3 '18	1.8	3.5	5.9	9.0	0.9	0.9	1.1	1.6	2.2	4.1
Q2 '18	1.0	2.5	5.5	4.5	0.6	0.8	1.0	1.1	3.1	5.5
Q1 '18	-0.2	-1.7	-2.3	1.2	0.7	0.7	0.7	1.0	2.1	2.7
Q4 '17	1.1	3.2	4.0	4.2	0.8	1.0	1.2	1.9	5.0	8.3
Q3 '17	1.4	3.6	5.5	-0.2	0.8	1.0	1.3	2.3	2.9	3.7
Q2 '17	1.1	1.6	3.0	0.2	0.5	0.7	0.9	1.5	3.3	6.4
Q1 '17	0.6	1.9	5.1	3.3	0.7	0.9	1.3	3.9	8.3	15.9
Q4 '16	1.9	3.8	6.5	11.5	0.6	0.9	1.1	2.4	5.5	12.0
Q3 '16	1.5	7.0	13.1	6.3	1.3	2.9	5.2	9.6	15.4	18.7
Q2 '16	0.6	1.5	1.5	5.6	1.1	1.6	2.2	4.3	3.7	3.9
Q1 '16	2.1	0.9	4.3	2.8	0.2	0.1	-1.2	-4.8	-4.1	-13.0
Q4 '15	1.0	0.9	-0.3	3.1	-0.1	-0.9	-0.7	-3.8	-9.6	-13.8
Q3 '15	0.4	-0.2	-4.1	-9.7	0.2	-0.2	-0.3	-0.7	-2.0	-4.2
Q2 '15	0.5	0.2	3.0	3.3	0.5	0.9	1.5	1.8	4.4	5.4
Q1 '15	0.9	1.5	1.3	-1.0	0.6	1.9	1.8	2.6	2.1	0.8
Q4 '14	1.8	4.3	5.5	1.2	0.2	-0.1	0.3	0.4	0.6	0.3
Q3 '14	-0.4	-0.1	-1.3	-4.5	0.3	-0.2	0.5	0.8	0.9	0.5
Q2 '14	1.1	2.0	3.9	3.2	0.7	1.0	0.8	0.9	1.1	-0.9
Q1 '14	0.9	1.2	1.1	-1.3	0.4	0.4	0.4	1.4	2.0	2.2
Q4 '13	1.1	4.5	8.0	8.4	0.1	0.2	1.3	1.3	3.0	3.1
Average Return	1.1	2.2	3.4	2.2	0.6	0.8	1.1	1.5	2.5	2.6

Source: J.P. Morgan.

The first thing to note is that – as expected – the average returns are unchanged by the shift to quarterly data. More importantly, however, the variations of returns are now better aligned and easier to compare.

As Exhibit 50 shows, using quarterly data, the information ratios are very much in line between the different parts of the capital structure. In the most senior tranches, both Index Tranches and CLO tranches feature information ratios of ~2.6-2.8, while mezzanine tranches (Junior & Senior Mezz, BBB, A and AA) feature information ratios of 0.9-1.8 and the junior tranches (Equity, B & BB) feature ratios of 0.6-0.9.

Exhibit 50: Information ratio for CLO and Index tranches, funded CLOs and funded Index tranches, based on quarterly data

	Index Tranches				CLO					
	Super Senior	Senior Mezzanine	Junior Mezzanine	Equity	AAA	AA	A	BBB	BB	B
Average Return (Annualized)	4.4	9.1	14.1	9.1	2.5	3.1	4.0	5.6	8.6	8.7
Standard deviation of Return (Annualized)	1.6	4.9	9.6	10.4	1.0	1.9	3.1	6.0	9.4	15.7
Information Ratio	2.8	1.8	1.5	0.9	2.6	1.6	1.3	0.9	0.9	0.6

Source: J.P. Morgan.

Having accounted for funding and liquidity, looking very closely at the information ratios, index tranches have actually provided slightly higher risk-adjusted returns (2.8 vs 2.6 in the most senior tranches, 1.8 & 1.5 vs 1.7, 1.3 & 0.9 in the mezzanine tranches, and 0.9 vs 0.9 & 0.6 among junior tranches), which is likely influenced by the high proportion of CLOs that were refinanced in recent years as spreads rallied and is not guaranteed to be repeated in the near future, given the compressed spreads levels we are at now.

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