

Appendix B:

CDO Risk Characteristics (Excerpted from CRMPG II)

The following material originally appeared in the July 2005 CRMPG II Report. While some of the references to spread levels, as well as market size, composition and practices reflect structured credit products in the years up to and including 2005, the discussion of CDO products in the corporate and asset-backed markets is still quite relevant.

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C. Structured Credit

1. Instrument Description and Market Developments

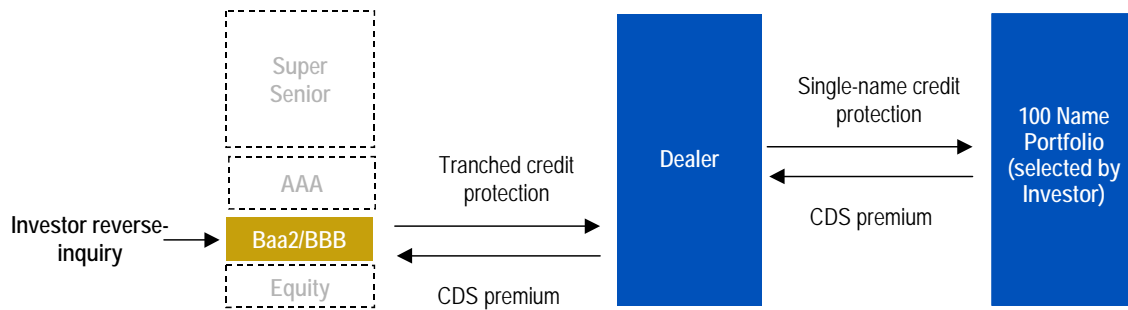
The structured credit market has existed since 1988, and issuance began in earnest in 1997. The last two years, however, has seen the transformation of the market from a niche sector to a core asset class within fixed income. In some ways, this transformation can be attributed to a maturing market with improved liquidity and transparency, established analytic platforms, increased standardization, increased acceptance of credit derivatives technology and a growing track record. But what has truly pushed structured credit into the mainstream is a growing understanding by investors motivated to increase yields in the current low-spread environment. Structured credit still offers a spread pick-up versus nearly all other like-rated credit products, although that premium is diminishing.

The structured credit market can be broadly separated into synthetic and cash instruments.

- **Synthetics:** Each vehicle sources exposure to a pool of pure credit risk using credit default swaps (CDS) on 100 or more single-names. Risk is tranching into distinct attachment and detachment points, meaning that investors can customize any number of loss exposures. Most pools are referenced to single-A/BBB corporate credits, although asset-backed securities (ABS) may also be

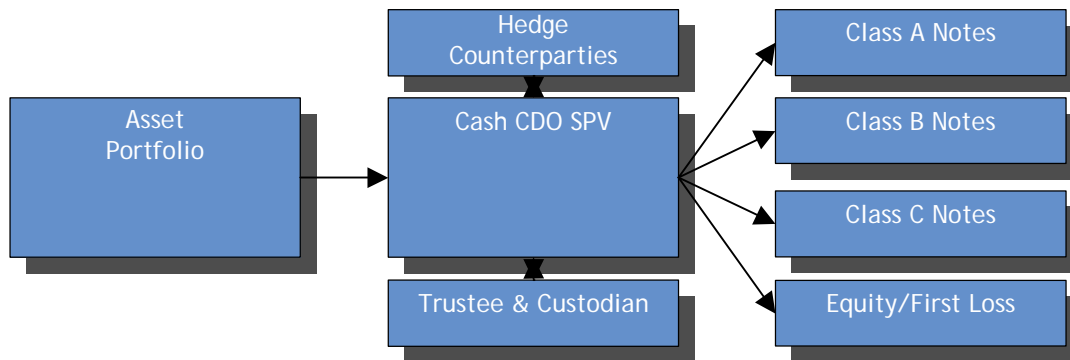
referenced. Equity leverage is typically 20-30x, and deals generally have maturities of five to ten years, depending on the maturity of the underlying CDS. In most synthetics, like the one depicted in Chart 4 below, the motivation for issuance has shifted from issuer balance sheet risk management (early deals) to investor desire to take on a customized risk profile (current deals).

Chart 4
Indicative Synthetic CDO (Baa2/BBB Tranche)



- **Cash:** Cash CDOs gain exposure to credit risk via a bankruptcy remote special purpose vehicle that purchases a diversified pool of cash assets (100+ names). The portfolio is generally managed by a third party but may be static in some cases. Risk is tranching into various loss exposures with customized structures. Each structure contains extensive rules that restrict asset exposures and triggers that help protect the notes if the collateral deteriorates. Weighted average lives are typically 7 to 12 years.

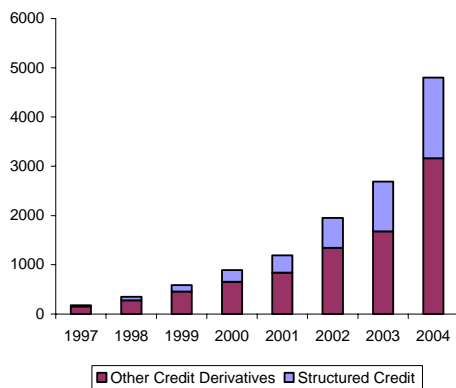
Chart 5
Indicative Cash CDO



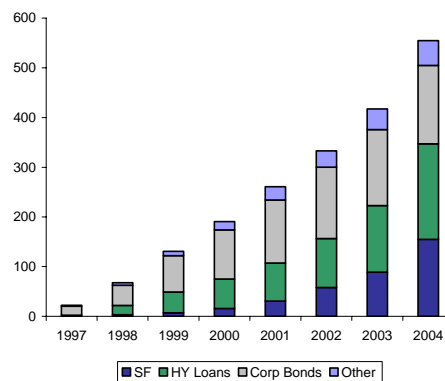
Synthetic issuance can be measured either by the amount of risk actually distributed to investors (approximately \$700 billion globally), or the amount of single-name CDS sold to support this issuance (approximately \$1.6 trillion globally). The latter number is more often cited in the market and can be thought of as the delta equivalent of the former, thereby illustrating the leverage in the transactions. In the cash market, outstanding risk is approximately \$550 billion globally.

Chart 6

Total Outstanding Global Credit Derivatives Volume (\$bn)



Total Outstanding Global Cash CDOs by Sector (\$bn)



Source: JPMorgan

The synthetic market is composed of several types of transactions.

- **Tranched Index Trades:** One of the most standardized and easy to understand products in the structured credit market, the portfolio

is linked to an index such as DJ TRAC-X. It references a static portfolio with standardized attachment points. Market inception was 2003.

- **Bespoke:** The portfolio is chosen by the investor, and is generally static but may have limited substitution rights. There may be customized or standardized attachment points. Market inception was 2002.
- **First to Default Swaps:** These tend to be based on smaller portfolios than other structured credit trades (five names). The investor receives periodic spread until the first credit event occurs. Market inception was 2003.
- **Managed:** These transactions are somewhat more complex than other synthetics due to additional portfolio tests, triggers and limitations. The portfolio is selected and managed by a third-party asset manager. The structure is based on rating agency requirements and investor demand. In older deals, risk was generally fully distributed, but since 2004 most deals have hedged part of the risk on financial intermediaries' balance sheets. Market inception was 1997, but volume grew significantly in 2000.
- **CDO-squared:** CDO-squared or CDO-of-CDOs are probably the most complex transactions in the structured credit market. They are effectively a synthetic CDO tranche referencing other CDO tranches. Subordination in "inner CDOs" protects against initial corporate credit events, and subordination in the "master CDO" protects against credit events in the inner CDOs to a threshold, beyond which losses accumulate quickly. There has been huge growth in the last year due to tight spreads in other credit markets.
- **EDS:** Equity default swaps may be used as collateral for CDOs, but only a few deals have referenced EDS exclusively. More often,

there is a 10% – 15% bucket for EDS in a CDO that mostly references CDS (although many investors have been wary of even including a bucket this size).

The cash market is composed of several types of transactions. Most outstanding deals are “Cashflow” CDOs, where cash flows sequentially through the interest and principal waterfall to equity unless certain triggers are violated. These triggers deteriorate only when the par value of collateral decreases due to defaults or trading losses (i.e., cash flows are largely independent of collateral market value fluctuations).

- **Cashflow HY CLOs:** Collateral is typically BB/B leveraged loans (8x – 12x levered). Market inception was 1996 with steady growth since (35% of outstanding issuance).
- **Cashflow SF CDOs:** Collateral is usually either AAA/AA ABS (100x levered) or BBB ABS (20x levered). Current deals have high home equity loan exposure. Market inception was 1998 with rapid growth in 2003 – 2004 (27% of outstanding issuance).
- **Cashflow HY CBOs:** Collateral is typically BB/B high yield bonds (8x – 12x levered). Market inception was 1990 with little issuance after 2001 due to problems in older deals (14% of outstanding issuance).
- **Cashflow Other:** Collateral may include emerging markets, trust preferred securities, municipals, project finance or other assets (5% of outstanding issuance.)

The remaining deals are “Market Value” CDOs, where de-leveraging can be triggered by market value changes. Collateral sometimes includes hedge funds and private equity, which must be liquidated to make coupon payments (3x – 5x levered). Collateral may also include liquid securities. Interest in these deals has increased in 2005 (5% of outstanding issuance).

2. Forces Driving Market Activity (both cash and synthetic)

(a) Balance sheet

Early “Balance Sheet” CDOs were initiated by holders of securitizable assets, such as commercial banks, which desired to sell assets or transfer the risk of assets. The motivation of these deals was typically to shrink the balance sheet, or reduce required regulatory or economic capital. Today, fewer Balance Sheet CDOs exist, although they are still common in Asia.

(b) Arbitrage

The motivation for most CDOs is arbitrage. These deals are inspired by asset managers, dealers and equity tranche investors, who use the CDO structure to fund collateral purchases. Asset managers gain stable management fees, grow assets under management and often achieve upside through incentive fees and retained equity risk. Financial intermediaries gain underwriting fees. Equity tranche investors hope to achieve a leveraged return between the yield on the assets and the financing cost of the debt. This potential spread is the “arbitrage” of the arbitrage CDO.

(c) Spread pick up

For rated debt investors, the key motivation is a spread pick-up versus like-rated investments in the corporate or ABS market. In addition, CDOs are a means to customize exposures that cannot be achieved any other way, gain access to a diversified pool of assets and gain access to markets such as leveraged loans.

3. Long and Short Users

Cash CDOs are sold to institutional investors and are registered as 144A or Reg S securities. Cash CDOs are overwhelmingly a long-only market. Shorts are more common in the synthetic space, although approximately 75% that market is still long only. Approximately 70% of cash transactions are originated out of the United States with US assets, although the investor base for these transactions is global. Thus far, more synthetic risk is distributed in Europe versus the United States due primarily to MTM issues for US investors.

(a) CDO equity

The arbitrage CDO market originated as a way for CDO equity investors to obtain non-recourse leverage as an alternative to repo financing. CDO equity coupons are targeted to have internal rates of return in the 10 – 20% area, and are seen as an attractive addition to alternative asset allocations, a bucket that may also include private equity and hedge funds. Unlike private equity, CDO equity coupons tend to be front-loaded (later in the deal life defaults or deleveraging typically cause cashflows to decline). Coupons are sensitive to defaults/recoveries/prepayments, but have limited exposure to market prices.

Insurers and reinsurers (largely buy-and-hold investors located in Europe) were the earliest participants in the CDO equity market and are still large participants today. More recently, hedge funds and other total return investors have also become involved. Other buyers include pension plans and endowments, who can often avoid mark-to-market requirements that other investors face. Banks are also involved, especially in Asia. Banks often desire CDO equity in the form of combination notes, where equity is combined with another bond from the CDO structure or a treasury strip to achieve a desired rating, principal-protection or some form of regulatory arbitrage. Some CDO equity has been sold to asset managers running CDO equity funds, and to private clients in Europe via brokers and investment consultants. The fact that asset managers often hold 20 – 30% of the equity in deals that they manage is seen by many as a positive.

(b) CDO debt

Investors in rated notes desire yield enhancement versus like-rated credits in the ABS or corporate market. In addition, investors are choosing systematic risk over idiosyncratic. For example, strategies such as long mezzanine tranches can decrease event risk by cushioning against initial losses in a pool. Mezzanine investors include hedge funds, banks, insurance companies and asset managers. Long senior strategies provide constant return with catastrophic-only risk. Banks are key investors, as are reinsurers, monolines and insurance companies. Today, most cash senior tranches are sold as part of negative basis trades, where a bank goes long the senior tranche and

simultaneously buys protection from a monoline on the same tranche. Older AAA risk often has a monoline guarantee.

CDO-squared have historically been buyers of cash CDO mezzanine tranches, which are then re-securitized into CDO-squared vehicles. More recently synthetic CDO-squared have been creating synthetic mezzanine CDO tranches for inclusion in CDO-squared, or Senior CDO tranches as a 20% bucket in a High Grade SF CDOs.

(c) Short positions

Most short positions are synthetic, as there is no shorting of cash bonds other than with total return swaps, which are limited in use. Synthetic short positions have been increasing, especially in more liquid index trades, but they are still a small portion of the overall market. Shorts may be used by investors with assets on balance sheet to hedge at a reduced cost versus hedging an entire portfolio (short mezzanine), or to hedge idiosyncratic risk (short equity). However, shorts are more often used by total return investors as part of carry trades (e.g., long equity, short mezzanine), or long correlation trades (e.g., sell equity protection with delta hedges).

4. Risk Management Issues

Participants in the structured credit market are subject to a number of risks, including exposure to market moves, counterparty risk, model risk, valuation and liquidity issues, legal risk and operational risk.

(a) Exposure to market moves

The chart below provides a synopsis of the key risks faced by different structured credit products. A more detailed discussion on related issues follows below.

Chart 7

Risks	Instruments			
	CDS	Cash CDO	Synth CDO	CDO-Squared
Credit Spreads	✓	✓	✓	✓
Recovery Rates	✓	✓	✓	✓
Correction		✓	✓	✓
Overlap (within a single deal)				✓
Serial Dependence				✓
Warehousing		✓		

(i) Credit spreads

A position's sensitivity to credit spreads depends on its seniority in the structure (degree of leverage). Equity tranches or first loss pieces, for example, can be highly sensitive to credit spread moves, as illustrated in Chart 8 below.

(ii) Recovery rates

There are potentially low or zero recoveries on junior tranches, especially if risk is systemic and tranches are thin. The downside to single-name risk is the recovery rate, and the downside on a tranche is zero. Depending on tranche width, CDO-squared starts to look like being short a digital option.

(iii) Correlation

The value of a tranche within a structure is determined in part by assumptions regarding correlation. The relationship of the tranche value to the correlation assumptions is not always intuitive. As illustrated in Chart 10 below, first loss tranches increase in value under high correlation assumptions while senior tranches decrease in value under such assumptions.

(iv) Overlap

Risk is increased to the extent that a limited investment universe for reference pools leads to high overlap across pools. CDO-squared often have the same names in multiple portfolios. These issues may be exacerbated by the fact that structured credit remains largely long only, which means that investors have similar risk exposure.

Although CDO-squared get the most attention, overlap is an issue for all CDOs. One large financial intermediary has estimated that the overlap between two CLOs from the same manager can be 50 – 70%. CLOs from different managers still have name overlap in the neighborhood of 25%.

(v) Serial dependence

For CDO-squared, risk is serial dependent (i.e., the exact sequence of credit events matters).

(vi) Warehouse risk

The ramp-up period for new cash deals can be over six months, leaving dealers and asset managers exposed to market moves during this period if the deal cannot close. This is less of a risk for synthetics, which can ramp up quickly.

(b) Counterparty risk

(i) Exposure measurement

Properly measuring the exposure of these transactions can be challenging due to, among other things, the large number of underlying risk factors, the non-linearity associated with a potential change in value of positions and the relatedness of reference entities in multi-name structures.

(ii) Risk mitigation

As much of this activity is in derivative form, counterparty risk is usually mitigated by upfront payments for risky tranches, minimum counterparty ratings for more senior tranches and collateral arrangements. Treating collateral consistently with the supporting agreements is yet another challenge for counterparty exposure measurement.

(c) Model risk

(i) Dealer hedging

Dealers run a balanced rather than perfectly hedged book. The entire capital structure is not always distributed and residual risk (delta, gamma, recovery rate, correlation) must be hedged.

(ii) Ratings arbitrage

Many CDO investors buy tranches based on ratings, with the implied assumption that CDO performance should at least approximate other like-rated fixed income securities. To the extent that CDO defaults or recoveries are worse than the rating indicates, investors may have more risk than they realize (some CDO sectors have clearly performed worse than single-name CDS with equivalent rating/risk). Other investors buy CDO tranches as a form of ratings arbitrage, which could lead to less required economic and regulatory capital than would otherwise be the case.

(d) Valuation and liquidity

(i) Mark-to-market

Derivatives accounting rules result in high MTM sensitivity for synthetic tranches, which may lead to forced selling in a downturn, especially given a “youthful” market. Europe has been moving more to MTM accounting, and it may be a challenge for banks to buy as this progresses. Although cash CDOs have less MTM sensitivity than synthetics, buyers are not immune to this risk and may also have to sell based on ratings triggers.

(ii) Valuation and liquidity

Valuation for Cash CDOs and managed synthetics is generally market based with daily pricing on Bloomberg for recent large synthetic deals. Market liquidity has improved greatly in the last two years. Cash CLOs and widely distributed managed synthetics are the most liquid, with the best liquidity at the top of the capital structure (largest and easiest to analyze tranches). SF CDOs (complex underlying ABS) and CDO equity (sensitive cash flows) are less liquid.

Valuation for non-managed trades is generally model based, with strongest liquidity for index tranches, including pricing for standardized tranches on Bloomberg. Model risk (valuations, risk represented to investors, hedging) is highly relevant for synthetics. There have been examples where investors/asset managers have experienced serious valuation issues where fraud may have been involved.

(e) Legal risk

(i) Understanding transactions

Recent lawsuits including HSH vs. Barclays and Banca Popolare vs. BofA have sought damages for securities allegedly mis-sold (higher risk than declared), mismanaged (substitutions not in best interest of investors) and misreported (inaccurate price evaluations). Issues of whether investors understand the risk are especially relevant for complex structures such as CDO-squared. Ultimately, these disputes suggest that the intermediaries may have thought that they have sold risk when, in fact, they have not.

(ii) CDS legal risk

As many structured credit transactions involve CDS, they will tend to be exposed to the other legal risk discussed in Section B: Credit Derivatives above.

(f) Operational risk

(i) Confirmations

Faced with the complexity of transactions and technology platforms that are often incompatible, firms can experience delays in confirming transaction details.

(ii) Performance tracking

The complexity of transactions also puts strain on back office operations due to the potential need to track and modify the composition of asset pools, monitor tranche performance and book multiple legs of transactions in the appropriate finance and risk systems.

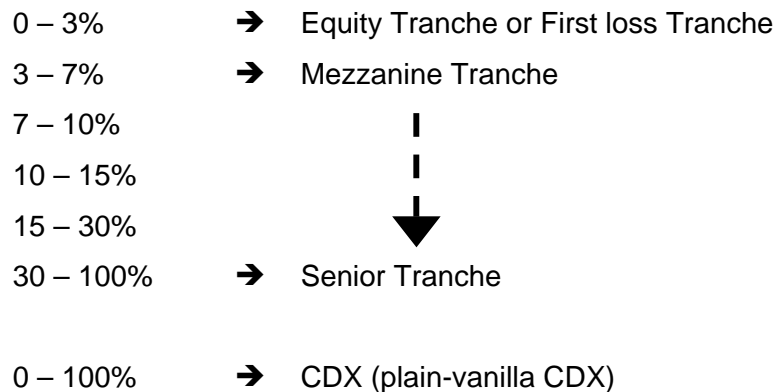
The charts below illustrate the sensitivities of a sample structured credit position to key input variables.

5. CDX and Tranched CDX Sensitivities

The charts below outline the sensitivity of the CDX and Tranched CDX to spreads, correlation and number of defaults from a long-protection perspective. It is assumed that the long-protection positions were taken on April 6, 2005.

Below is a brief description of the terminology used throughout this section:

- **CDX:** 5 yr CDX .NA.IG.4. Throughout this section, it will also be called “plain-vanilla CDX”. As of 04/06/05, the 5yr CDX.NA.IG.4 spread was 47 bps.
- **Tranched CDX:** Synthetic CDO with the same portfolio of reference entities as that defined for the 5yr CDX.NA.IG.4. The collateral is split into tranches, where each tranche bears losses at a different level of subordination. The most junior tranche may experience the first 3% of losses. The next tranche will bear any loss over 3% up to 7%, and so on.



- **MTM:** Expressed as % of tranche notional.
- **Spread Multiple:** Makes reference to multiples of the index spread. 100% refers to the index spread as of 04/06/05 (47bps). 50% refers to a spread of 23.5bps.
- **Correlation:** Refers to the correlation of probabilities of default. It tells us how likely the portfolio is to experience its expected loss.
 - Low Correlation:
 - Defaults occur independently.
 - Most likely outcome is a few number of names defaulting.

- Expected loss is likely to be reached (as of 04/06/05, the CDX expected loss was 2.43%).

- High Correlation:
 - Defaults occur in groups.
 - Most likely outcome is many defaults at the same time. In a hypothetical extreme case (correlation = 100%) either 0 names default or 100% of the names default.
 - Expected loss is not likely to be reached.

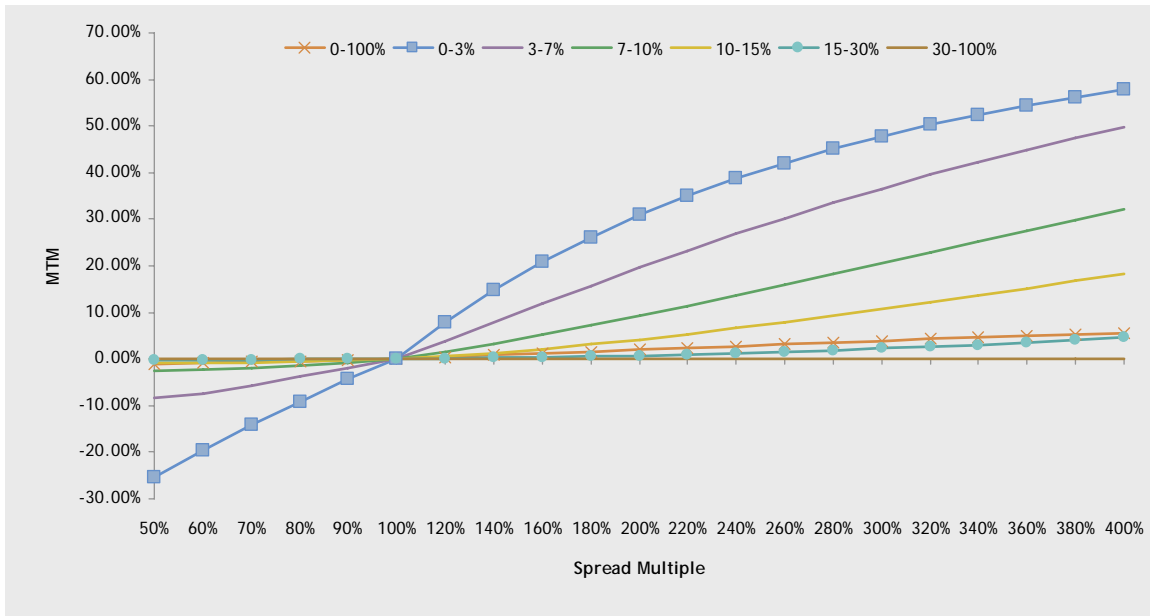
(a) Chart 8: Sensitivity to Spreads

The chart below describes the sensitivity of the CDX (0 – 100%) and the CDX tranches to changes in the CDX Index Spread (in this example, a spread multiple of 100% makes reference to 47bps). The positive slope of both the plain-vanilla CDX and the CDX tranches confirms that a spread widening increases the value of a long protection position. Intuitively, if an investor bought protection and then spreads widen, the value of that trade increases.

The sensitivity is larger in the junior tranches than in both the plain-vanilla CDX and the senior tranches because the most junior tranches (in particular 0 – 3%) are those affected for sure with the first defaults. The likelihood of names defaulting increases as spreads widen.

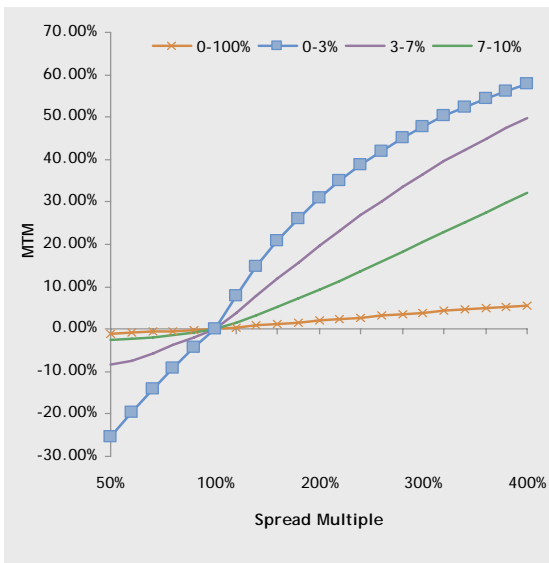
Chart 8

MTM vs. Spread Multiple - all tranches



Note: 0 - 3% assumes no upfront

CDX (0-100%) and Junior Tranches



Senior Tranches

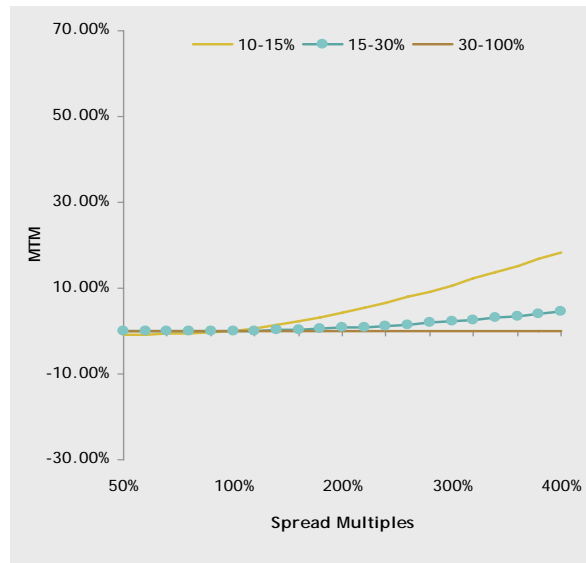


Chart 9 below quantifies the impact that a 100% widening in the index spread (from 47 bps to 94 bps) will have on the MTM of a protection buyer with contracts of \$1 million on each tranche.

Chart 9

The MTMs in this table make reference to a Spread Multiple of 200% in the previous graphs (equivalent to an Index Spread of 94bps= 200% x 47bps)

Tranche	MTM	IF the CDX index spread goes up to 94bps AND a protection buyer has a \$1mm contract on...
0-100%	2.02%	...the gain will be 2.02% x \$1MM = \$20K
0-3%	30.84%	... the gain will be 30.84% x \$1MM = \$308K
3-7%	19.58%	... the gain will be 19.58% x \$1MM = \$196K
7-10%	9.27%	... the gain will be 9.27% x \$1MM = \$93K
10-15%	4.22%	... the gain will be 4.22% x \$1MM = \$42K
15-30%	0.74%	... the gain will be 0.74% x \$1MM = \$7K
30-100%	0.00%	... the gain will be 0.00% x \$1MM = \$0K

Were the investor a protection seller, the MTM would be negative, and the investor would report losses equivalent to the gains in the table with the sign inverted.

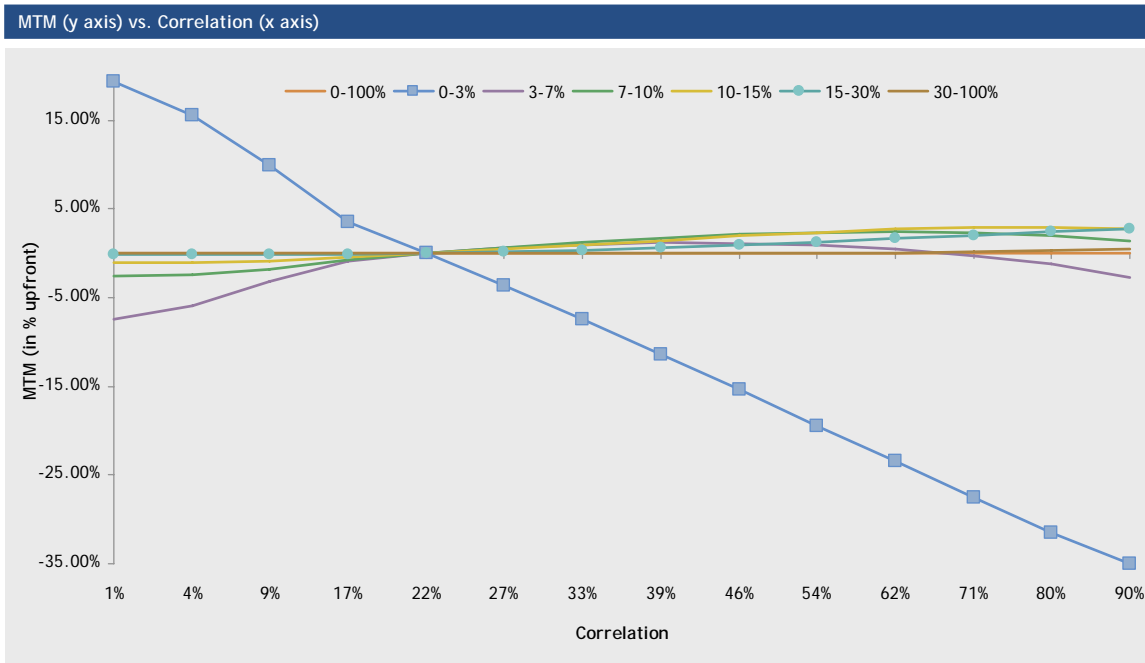
(b) Chart 10: Sensitivity to Correlation

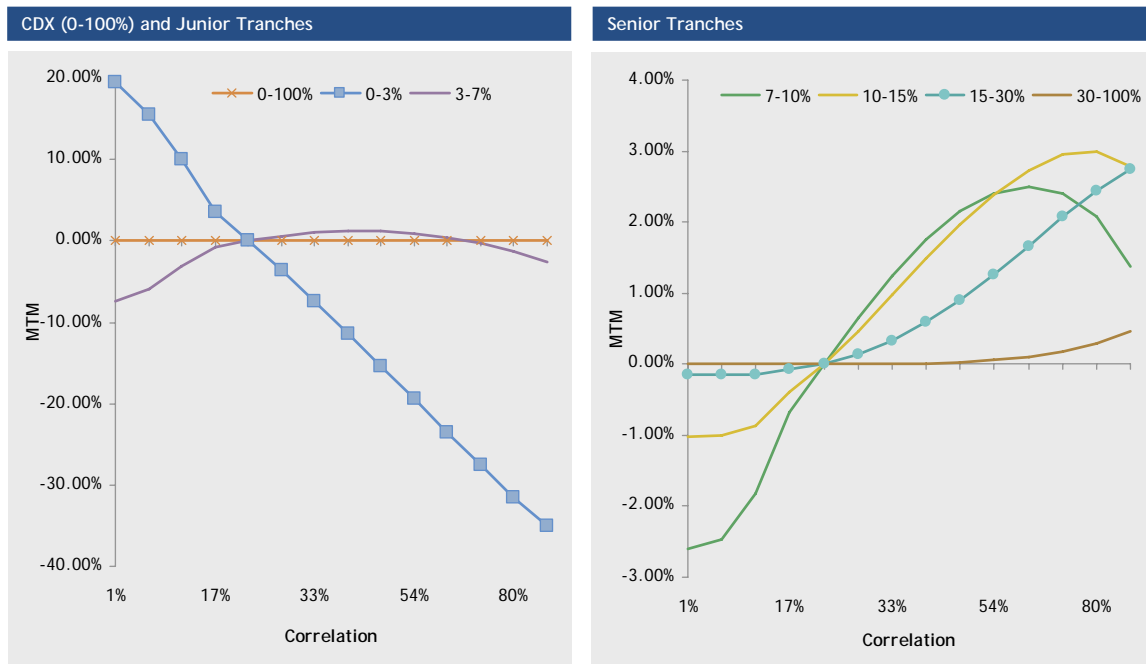
Chart 10 below describes the MTM sensitivity of the CDX (0 – 100%) and the CDX tranches to changes in correlation. Correlation is only relevant to the tranches because the impact of defaults over a specific tranche will depend on the level of tranche subordination. Few defaults (low correlation) will only affect junior tranches whereas many defaults at the same time (high correlation) will impact the more senior tranches as well. The MTM of the plain-vanilla CDX (0 – 100%) is not sensitive to different levels of correlation because any number of defaults (few or many) will affect it anyway.

When correlation is low (extreme hypothetical case: 0%), few defaults are expected and therefore the expected loss (2.43%) is likely to be reached. Being long, the equity tranche (0 – 3%) becomes riskier and as a result being long protection on equity gains value. This explains the negative slope of the first loss tranche.

When correlation is high (extreme hypothetical case: 100%), either 0% or 100% defaults are expected, and therefore the expected loss (2.43%) is not likely to be reached. Being long senior tranches becomes riskier than when correlation was low and therefore being long protection on senior tranches gains value. This explains the positive slope in the non-equity tranches.

Chart 10





(c) Chart 11: Sensitivity to Number of Defaults

Chart 11 below describes the sensitivity of the CDX (0 – 100%) and the CDX tranches to the number of defaults. The recovery rate assumption used is 40%. Since the index has 125 equally weighted names, one default will generate a loss of 0.48% of the portfolio ($1 / 125 * 0.6$). In the same fashion, six defaults will generate a loss of approximately 3% of the portfolio ($6 / 125 * 0.6$).

The positive slope of both the plain-vanilla CDX and the CDX tranches confirms that defaults increase the value of a long-protection position. Intuitively, if an investor bought protection and then credits default, the value of that trade increases.

Notice that each tranche reaches 100% of its notional at the number of defaults that produce a loss equivalent to the upper bound of the tranche. For instance, the equity tranche reaches a MTM of 100% at six defaults, which is equivalent to a loss of 3% of the portfolio. Also notice that the slope of each non-equity tranche becomes steeper exactly at the max level of defaults that the immediate junior tranche can bare. For example the 3 – 7% tranche becomes steeper at six defaults.

Defaults impact each tranche very differently. The impact over the plain-vanilla CDX is linear because the index is equally weighted. The impact over the 0 – 3% tranche is the largest (the curve is the steepest) because all the burden of the first defaults will only impact this tranche.

Chart 11

Recovery rate=40%
 Index has 125 equally weighted names
 1 default = 0.48% 6 defaults = approx. 3%

