Collateralized Debt Obligations (CDOs): An Introduction

Traditional credit risk transfer (CRT) activities such as loan guarantees, loan syndication and securitization have a long history. The development of credit ratings, corporate bond markets and, more recently, by credit derivatives, provided further support for the ongoing process of converting credit risk into marketable securities. One relatively recent form of tradable CRT products are collateralized debt obligations (CDOs). CDOs assemble an entire portfolio of credit risk exposures, segment that exposure into tranches with unique risk/return/maturity profiles, which are then transfered or sold to investors. A CDO's reference (underlying) portfolio can be assembled with physical cash flow assets such as *bonds, loans, MBS, ABS etc.*, or with synthetic credit risk exposures: synthetic CDOs are backed by a portfolio of *credit default swaps (CDS)*[1].

Annex 1 of the BIS "Credit Risk Transfer"[2] report provides a stylized example, replicated below including much of their comments, of a $ 1 billion synthetic CDO with three tranches:

Table 1: A stylised hypothetical CDO
(dollar amounts in millions)

Tranche	Attachment points	Notional amount	Credit rating	Spread (basis points)
Equity	0-3%	30	Not rated	1200
Mezzanine	3-10%	70	A	200
Senior	10-100%	900	AAA	10
MEMO:				
Entire portfolio	0-100%	1,000	A	60

In this example, the reference portfolio consists of 100 single-name credit default swaps of $10 million each with an average spread ("premium" for default protection) of 60 basis points and an average credit rating of single-A. The unrated equity tranche bears the first $30 million of losses from defaults within the reference portfolio; the A rated mezzanine tranche bears the next $70 million; and the AAA rated senior tranche bears any losses above $100 million (the 20-100% tranche is sometimes also referred to as "Super-senior" tranche due to its high security level and accordingly low yield) .

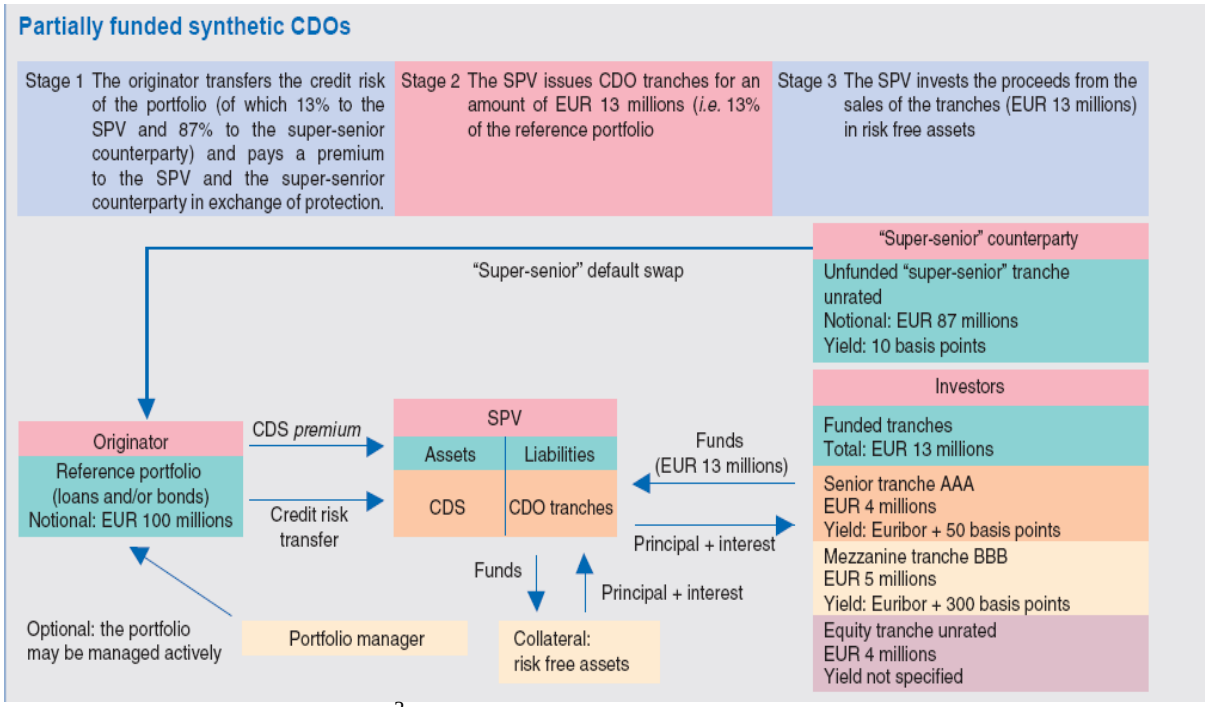
The three tranches are typically sold to different investors. In this example, the equity tranche pays a maximum of LIBOR+12% p.a. and may be sold to a professional asset manager. The mezzanine tranche, paying LIBOR+2% p.a., may be sold to banks looking to diversify their credit exposures without buying the entire portfolio of underlying

[1] http://www.creditflux.com/resources/single+name+credit+default+swaps.htm
[2] http://www.bis.org/publ/joint13.pdf

assets. The senior tranche pays LIBOR+10 basis points p.a. and might be sold to a reinsurer looking for low-risk, low return assets.

The credit risk transfer from the CDO manager to investors can occur either on a funded, unfunded, or partially funded basis. In a funded structure, as assumed in this example, investors pay in the principal (notional) amount of their tranches to the CDO manager who in turn puts this capital in a risk-free collateral account with government debt securities and triple A bonds. The CDO arranger is usually a special purpose vehicle/SPV that underwrites and warehouses the entire portfolio's credit risk. All counterparty risk is eliminated with a funded structure. Of course, the CDO structure is still subject to valuation fluctuations and reference default risk.

CDOs with unfunded credit risk transfer are more common: in these, investors make no up-front payments. Instead, they receive periodic premium (spread) payments in return for making a payment when a default in the reference portfolio affects their tranche. Credit risk transfer by credit default swaps in an unfunded structure thus exposes the CDO manager to additional counterparty risk that must be managed – typically by mark-to-market with collateral transfer.



(Cousseran/Rahmouni, Box 2)[3]

Assume now that no defaults occur in the reference portfolio during the first three months of the synthetic CDO's existence. At the first quarterly interest payment date, the CDO receives quarterly premium payments on the reference portfolio's 100 single-name CDS, as well as interest on the collateral account (remember: tranches are funded by assumption in our example). It distributes the interest received according to a "payment

[3] http://www.banque-france.fr/gb/publications/telechar/rsf/2005/etud1_0605.pdf

waterfall" to investors: First, the senior tranche receives (LIBOR+0.1%)/4 on its principal\notional balance of $900 million. Next, the mezzanine tranche receives (LIBOR+2%)/4 on its principal balance of $70 million. Then, the equity tranche receives up to a maximum of (LIBOR+12%)/4 on its $30 million principal (parties agree on disposal of any remainder beforehand).

Suppose in the fourth month one name in the reference portfolio defaults. The BIS: "If the recovery rate on X's debt is 40%, the CDO will take a loss of $6 million on the $10 million notional single-name CDS referencing X. This loss will cause a writedown of the principal amount of the equity tranche by $6 million. Other tranches would not suffer principal writedowns, but their mark-to-market value would fall because the smaller equity tranche now provides less credit enhancement than before the default."

Leverage of CDO Tranches

Since the equity and mezzanine tranches bear the first 3 to 10% of default losses of the entire reference portfolio, they concentrate most of the credit risk despite their lower notional amount. Equity and mezzanine tranches are accordingly more sensitive to changes in the underlying credit spreads than the senior tranche or the reference portfolio as a whole, and hence more leveraged. (Note: leverage is computed using each tranche's sensitivity to a 10bp shock to credit spreads: this dollar amount, expressed in percent of the notional, is then divided by the sensitivity of the entire portfolio. The sensitivity of a derivative to the price of the underlying is also known as *Delta*[4])

	Tranche		
	Attachment points	Notional amount	Sensitivity
Equity	0-3%	30	15x
Mezzanine	3-10%	70	7x
Senior	10-100%	900	0.3x
MEMO:			
Entire portfolio	0-100%	1,000	1x

The numbers in table 2 show that the equity tranche in this example bears 15 times the risk of a cash investment in the bonds or loans portfolio. Similarly, the mezzanine tranche, although it may have an investment grade credit rating, bears 7 times the risk of a cash investment (the higher tranche return is meant to compensate for that). In fact, ratings reflect only the tranche's average credit risk but not the market risk leading to mark-to-market valuation changes. This makes CDO tranche ratings more volatile and more subject to frequent and severe downgrades than traditional securitization products (see discussion in Cousseran/Rahmouni, Box 5[5].)

[4] http://www.creditflux.com/glossary/delta.htm
[5] http://www.banque-france.fr/gb/publications/telechar/rsf/2005/etud1_0605.pdf

Correlation Risk

When pricing the credit risk of an entire portfolio it is necessary to take into account the fact that the default of a given name in the reference portfolio may affect the default risk of other names too (WSJ[6]). A high correlation of defaults within the reference portfolio, for example, implies a higher risk of many names defaulting at the same time with the potential to inflicting losses on the senior tranche. Therefore, a high correlation reduces the value of the senior tranche. Since a swath of defaults would be interpreted as systemic event, a high implied correlation within the portfolio might be read as indicator of perceived systemic risk by investors (for caveats and discussion see ECB p.140[7]).

A high correlation does not only increase the likelihood of many firms defaulting at the same time but also the likelihood of no defaults occurring across the board. The valuation of the equity tranche rises accordingly when correlation is high. (again, purely drafting)

Conversely, a low implied correlation emphasizes the risk of firm-specific events and thus the likelihood of isolated defaults occurring. Thus, the value of the equity tranche falls with low correlation. The effect of correlation on mezzanine investors is not specified; it depends among other things on the relative tranche sizes.

Strategies that exploit supposed anomalies in the pricing of CDO tranches are known as correlation trades. They are based on assumptions about the joint loss distribution of the reference names in the portfolio. The correlation pattern among the reference names is subject to exogenous shocks and sudden changes and therefore extremely hard to estimate correctly. Episodes of when correlation traders were exposed to heavy losses due to 'correlation breakdown' include the GM/Ford downgrade in 2005 (see BIS, Box p7[8] and also here[9]).

Single Tranche CDOs

Single-tranche CDOs represent the vast majority of all new synthetic CDO issuances. The CDO manager sells only a single tranche – usually at the mezzanine level – of the capital structure to an investor instead of selling all the tranches at the same time. This particular CDO structure, which may by funded or unfunded, has the following advantages: 1) the single tranche is tailored to the specific investor's needs with regard to name composition, subordination level, and size; and 2) it is not necessary for the CDO manager to find investors across the entire capital structure simultaneously.

In a traditional CDO, the underwriter is no longer exposed to price movements in the underlying portfolio once the all tranches are sold and thus all credit risk transferred to

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6 http://online.wsj.com/article/SB112649094075137685.html?mod=mkts%255Fmain%255Ffeatured%255Fstories%255Fhs

7 http://www.ecb.int/pub/pdf/other/financialstabilityreview200612en.pdf

8 http://www.bis.org/publ/qtrpdf/r_qt0506a.pdf

9 http://en.wikipedia.org/wiki/Pairs_trade

investors. However, if just the mezzanine tranche is sold out of the entire CDO capital structure, the arranger remains exposed to the credit risk of all remaining tranches, i.e. the arranger "is long" the credit risk of the equity tranche, long the credit risk of the Triple A tranche, and long the credit risk of the super senior tranche. These retained credit risk exposures need to be hedged. Typically, the arranger delta hedges[10] the remaining credit risk (also called dynamic hedging[11]).

In practice this is done by entering offsetting positions: if selling a single tranche means effectively buying credit protection on that tranche, hedging it requires selling protection on the underlying names via CDS til the position is delta-neutral (i.e valuation immune to small spread changes in the underlying portfolio). The exact dollar amount of single-name CDS to be sold as a hedge depends on the tranche's leverage multiple delta: hedging a mezzanine tranche usually requires selling protection for a multiple bigger than one of the notional value, which contributes to the well-documented narrowing of credit spreads on the CDS market. [Note: A small difference between the portfolio CDS and the average across the single firms' CDS is known as "basis" and it is caused by differences in supply/demand effects.]

Asset-Backed Credit Default Swaps (ABCDS)

One variety of single-tranche CDO and One of the most important developments in the credit derivatives market in 2005 and 2006 has been the growth of credit default swaps referenced to asset-backed securities (ABCDS). Most trading in ABCDS has been concentrated in US sub-prime mortgage (or home equity) securitizations. As Creditflux reports:

"The original impetus for the growth of the market came from investment banks that act as securitization underwriters. They were concerned about the amount of risk they were holding on their balance sheets through this business – particularly given concerns about a possible downturn in the US housing market – and wanted to use the market to hedge their pipeline of upcoming deals by buying ABCDS protection. The trend was generally to issue cash CDOs of ABS on mezzanine tranches […].

On the other side of the market, managers of CDOs of ABS were the main sellers of protection. However, hedge funds and other active traders have taken advantage of the fact that the instrument allows them to take a short position in asset-backed securities for the first time."

Standard Tranches of CDS Indices (see ECB report p. 140)

In June 2004, a harmonized global family of CDS indices was launched, namely iTraxx in Europe and Asia and CDX in North America (CDX.NA). The indices represent the average CDS premium of the 125 most liquid firms, and are calculated daily with the index composition being updated twice a year. The iTraxx/CDX indices of CDS on 125

[10] http://en.wikipedia.org/wiki/Delta_hedging
[11] http://www.tavakolistructuredfinance.com/ifr3.html

names can themselves be structured and traded like a traditional synthetic CDO with equity, mezzanine, and senior tranches (see Graph 3). Like in a traditional CDO, the standard tranches of CDS indices provide claims to the cash flows of the iTraxx CDS portfolio, in return for payments by the investors if a default affects their tranche. In view of their liquidity, iTraxx tranches (or the iTraxx index itself) can also be used by arrangers for the dynamic hedging of single-tranche CDOs.

A concrete example

An extract of an investment bank's trading screen is reproduced below, showing the price of 5 tranches of the iTraxx, by decreasing degree of subordination. From top to bottom: an equity tranche (0%-3%) two mezzanine tranches (3%-6%, 6%-9%), a senior tranche (9%-12%), a first super senior tranche (12%-22%). Furthermore, a second non-quoted super senior tranche (22%-100%) completes the structure.

Trading screen showing iTraxx tranches

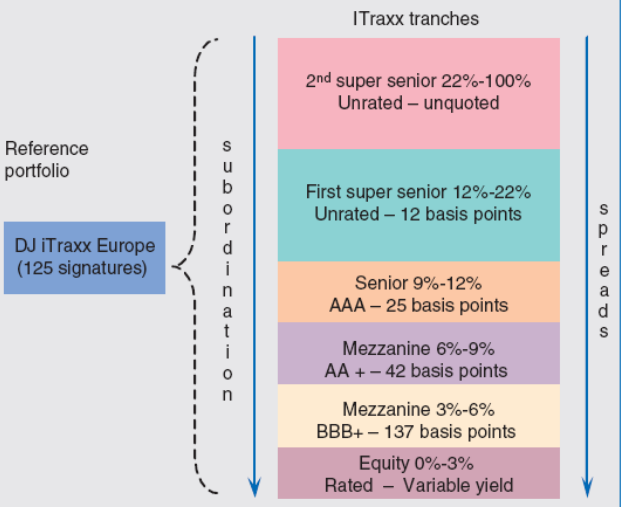
iTRAXX EXOTICS - Tranched iTRAXX

5Y DJ ITRAXX EUROPE RUN (S2)

TRANCHE	Running Spread	DELTA	MID IMPLIED CORREL
0% - 3%	500/500	18.1x	21.9%
3% - 6%	137/143	6.3x	6.8%
6% - 9%	42/47	2.4x	14.3%
9% - 12%	25/29	1.3x	21.4%
12% - 22%	12/14	0.7x	30.5%

Delta exchange	@ 37
Index maturity	Mar-10

Diagram of a standard CDO based on the iTraxx



Official ratings do not exist for iTraxx tranches.
Those displayed above are implied ratings provided by Fitch.

This screen is interpreted as follows:

- *If a client of the investment bank buys protection on the mezzanine tranche 3%-6%, it pays the bank a* premium *of 143 basis points* per *year. If the proportion of losses on the iTraxx exceeds 3%, the client will be compensated. Compensation is however limited (contrary to options) to the size of the tranche,* i.e. *6%-3% = 3% of the notional amount of the transaction.*
- *The equity and mezzanine tranches are leveraged as their sensitivity to changes in credit spreads of the underlying index* (delta) *is much higher than 1. For example, the quotations show that a 1 basis point rise in the iTraxx results in an 18.1 basis points widening of the equity tranche spread (*delta *= 18.1).*
- *The levels of implied correlation appear to vary significantly across tranches.*

[1] I.e. *The 125 most liquid underlying names of the European CDS market. See* www.djindexes.com.

(Graph in : Cousseran/Rahmouni)

Financial Stability Implications

The BIS reports that the market-making activities associated with CRT are concentrated with a limited number of dealer/broker firms. In addition, hedge funds are major investors in the equity tranches of CDOs and particularly active in correlation-related trading.

At the company level, Frank Partnoy and David A. Skeel[12] point at high transaction costs of these CRT structures, and the mispricing of credit they generate: "…either CDOs are evidence of a substantial and pervasive market imperfection [in the fixed income market], or they are being used to create one. The second possibility seems more likely."

Among their reform suggestions:

- stricter disclosure requirements (register credit derivatives transactions, centralized pricing service, disclose the effect of credit derivatives transactions on companies' risk exposure)
- competition in credit ratings industry
- there may be room for non-bank financial institutions to narrowly specialize on the monitoring and credit risk assessment roles that traditionally have played by banks

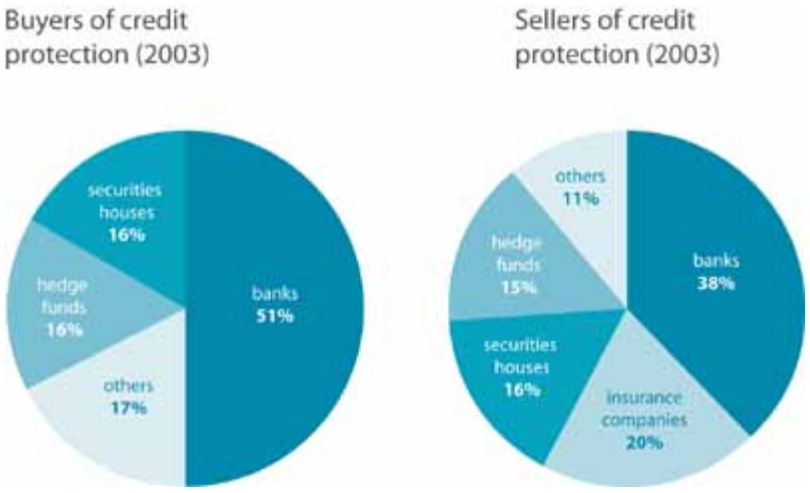
Annex: Key Facts and Numbers on Structured Credit and Credit Derivatives[13]

The volume of outstanding credit derivatives has grown from less than $1 trillion in 2001 to $26 trillion in 2006 according to Isda. See table below.

The volume of outstanding cash CDOs stands at $986 billion at the start of 2007, according to Creditflux Data+

The volume of synthetic CDO tranches traded in the past three years is $739 billion, according to Creditflux Data+

The most important users of credit derivatives have historically been banks (see chart below). But anecdotal evidence suggests that hedge funds, insurance companies, mutual funds, pension funds and other buy-side firms are the fastest growing sectors of the market.



[12] http://lsr.nellco.org/cgi/viewcontent.cgi?article=1129&context=upenn/wps
[13] http://www.creditflux.com/resources/default.htm

The largest category of cash CDOs are those backed by asset-backed securities (CDOs of ABS), closely followed by those collateralised by leveraged loans (collateralised loan obligations or CLOs) [see Fitch "Credit Derivatives Update[14]" for in-depth analysis].

The most liquid credit derivative products are credit indices. The main indices are the investment grade indices iTraxx Europe and CDX NA IG, the CDX NA HY North American high yield index, and the North American and European Xover and HiVol indices.

Credit derivatives are over-the-counter contracts almost always documented using standard templates and definitions drawn up by the International Swaps and Derivatives Association (Isda).

One of the fastest growing areas of credit derivatives is the market for credit index tranches. Volumes of this 'correlation trading' business are expected to have surpassed $5 trillion in 2006 according to Creditflux Data+.

Elisa Parisi-Capone,
March 7, 2007

[14] http://www.fitchratings.com/corporate/reports/report_frame.cfm?rpt_id=317506