

Collateralized Debt Obligations

Structures and Analysis

Agenda

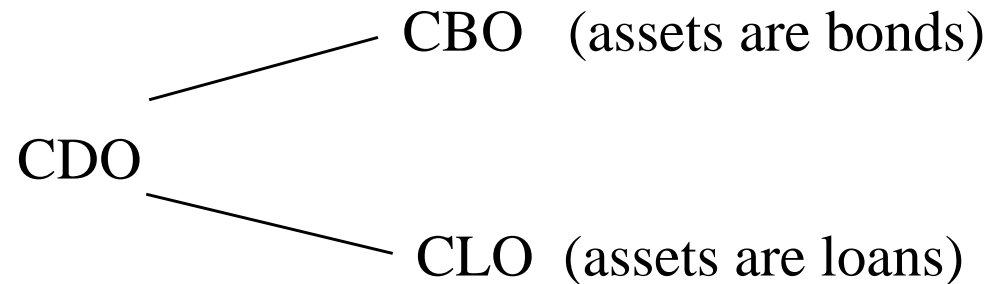
- General introduction of CDO's
 - regulatory arbitrage (address market imperfections, otherwise the cost of structuring and marketing would prohibit their existence)
 - securitization improves liquidity: increase the market values of illiquid loans
- Cash Flow and Market Value deals
- Synthetic CDO's: Product Nature and Uses
- Credit Ratings and Valuation
 - Moody's diversity scores

Definition of CDO

A *collateralized debt obligation* (CDO) is an asset-backed security (e.g. corporate bonds, mortgage-backed securities, bank loans).

- The funds to purchase the underlying assets (called collateral assets) are obtained from the issuance of debt obligations (also referred as tranches).

It is a *special purpose vehicle* that invests in a pool of assets – high-yield bonds, loans, emerging market debts, asset-backed securities, investment-grade bonds etc.



Growth of markets for CDOs

Notional amount of CDO's as rated by Moody's Investors Services

\$1 billion in 1995 to \$120 billion in 2000

Regulatory wedge – what market requires (economic capital)
and what regulators require (regulatory capital)?

Loans are 100% risk weight items and capital charges of 8% are levied on them.

- Active management of credit risk: To reduce industry-specific and geographical-specific concentrations.

Types of CDOs

Two basic types – categorized according to the motivation of the sponsor

Arbitrage transaction

Sponsors want to earn the spread between the yield offered on the collateral assets and the payments made to various tranches in the structure.

- Cash flow deals
- Market value deals

Balance sheet transaction – synthetic CDO

1. Sponsors want to remove debt instruments (loans) from its balance sheet.
2. Banks and insurance companies seek to reduce their capital requirements by removing loans due to their higher risk-based requirements.
3. Freeing of capital: Banks are better for originating and servicing loans.

Incomes and credit Structures

Ability to make interest payments and principal depends on the performance of the collateral assets. The sources are coming from

- Coupon interest payments from the collateral assets.
- Par payment at maturity of collateral assets.
- Sale of collateral assets.

1. *For cash flow CDO, ratings are based primarily on the portfolio ability to generate sufficient cash flows to pay interest and principal on the CDO securities.*
2. *For market value CDO, ratings are based on the maintenance of a minimum market value of the underlying portfolio.*

There are restrictions imposed (restrictive covenants) as to what the asset manager may do and certain tests that must be satisfied for the debt obligations in the CDO to maintain the credit rating assigned at the time of issuance.

Early termination

1. Failure to comply with certain covenants.
2. Failure to meet payments to the senior tranches.
3. Bankruptcy of the issuing entity of the CDO.
4. Departure of the asset management team if an acceptable replacement is not found.

Motivations of investors

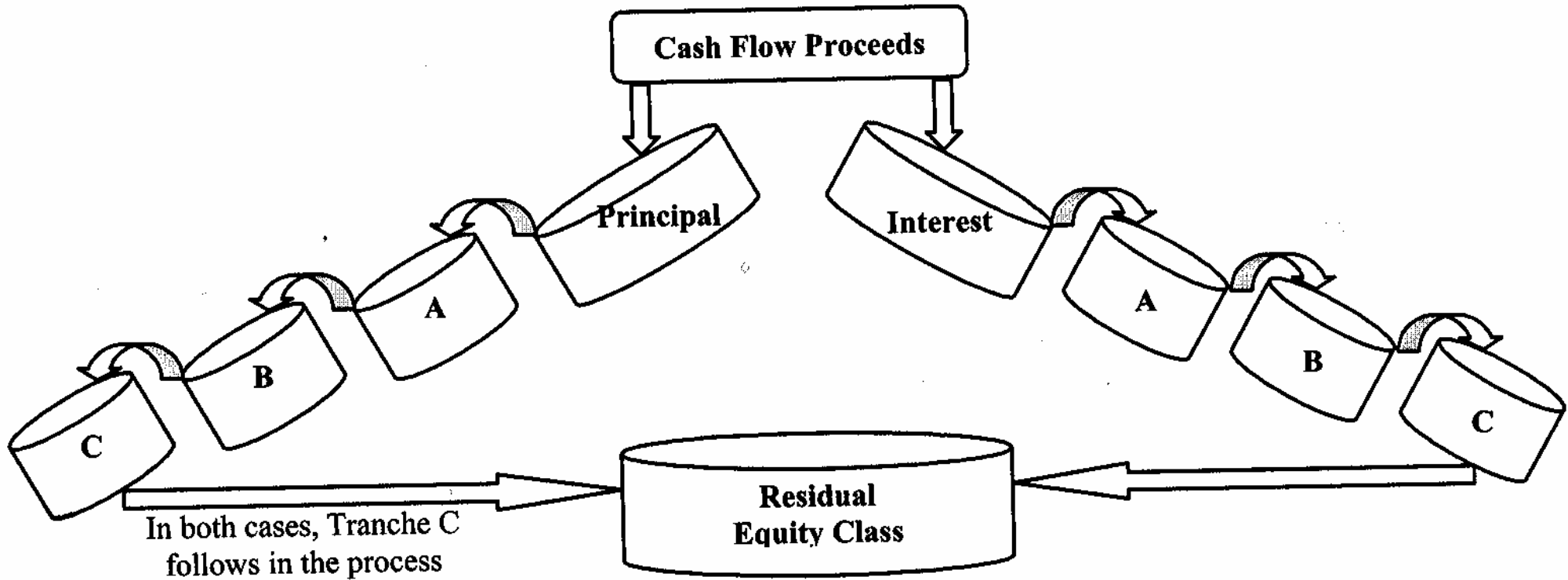
- Attractive yield opportunity for investors seeking a yield premium over the more traditional investment alternatives.
- Allow investors to participate indirectly in a diversified high-yield or investment-grade portfolio with a collateral manager of their choice.

Example

Investment-grade investors are able to participate in the high-yield market through the purchase of a senior note of a high-yield CBO.

Differences between CDO and MBS

- MBSs are backed by a fixed pool of real estate mortgages.
 - CDOs *permit trading* of the underlying collateral within established parameters relating to the characteristics of such underlying collateral.
 - (i) geographic and industry concentration limits
 - (ii) minimum over-collateralization and debt service coverage requirements.
1. For *diversification*, CDO criteria often encourage investment in a variety of asset types.
 2. At closing, the CDO issuer will commonly purchase only a portion of the underlying collateral and will employ a ramp up period (3-month to a year) to acquire the remainder of the portfolio.
 3. CDO structures permit the *reinvestment* of principal distributions on the underlying collateral in new assets during a preset reinvestment period.



Rating of Tranches

1. Relocate the risk of the underlying assets to different tranches.
 2. Rating of each tranche is determined primarily through the priority in the cash flows generated by the collateral.
- Senior notes (rated AAA, AA or A) – highest priority on the cash flows.
 - Mezzanine tranches (rated BBB to B) – claim on cash flows that is subordinate to the senior notes.
 - Equity in the CDO (subordinated notes) is the residual – represent the first-loss position [may require a cushion to be in place to safeguard the higher-rated tranches in future years].

Three key inputs to cash flow CDO ratings

- *Collateral diversification*
- *Likelihood of default*
- *Recovery rates*

Equity in a CDOs

- The lowest credit tranche – subordinated note.
- It will absorb the first loss of the portfolio (similar to insurance deductible).
- It has the highest credit risk.
- The only tranche without investment grade rating.

Cash flow CDO – Duke Funding 1

- \$260 million (87% of the deal) Aaa/AAA (Moody's/S&P)
- floating rate tranche
- \$27 million (\$17 million fixed + 10 million floating) Class B notes, rated A3 by Moody's
- \$5 million (fixed rate) Class C notes, rated Ba2 by Moody's
- \$8 million in equity

Collateral for the deal consists mainly of investment-grade commercial mortgage backed securities.

Market value CDO's

Depending on the ability of the fund manager to maintain and improve the market value of the collateral.

- Funds to be used for liability principal payments are obtained from liquidating the collateral. Liability interest payments can be made from collateral interest receipts and collateral liquidation proceeds.
- Greater portfolio trading flexibility.
- Typical assets include assets eligible for inclusion in cash flow CDO's as well as distressed debts, equities and convertibles.
- Manager focuses on maximizing total return while minimizing volatility.

Advance rates and over-collateralization tests

- Advance rate is the percentage of the market value of a particular asset that may be issued as rated debt.
 - Advance rates depend upon the price volatility and quality of price / return data and the liquidity of the assets. Assets with lower price volatility and greater liquidity are typically assigned higher advance rates.
- Market value of the collateral times the advance rate must be greater than the book value of the liabilities. Otherwise, collateral sales and liability redemption are required to bring O/C ratios back into compliance.

Over-collateralization tests

- O/C ratio for a tranche is the ratio of the principal balance of the collateral portfolio over the principal balance of the tranche and all tranches senior.
- A minimum amount of collateral par amount is ensured to secure the rated debt.
- For Duke Funding 1, OC trigger is 113% for Class A and 101% for Class B.

Cash flow transaction – based on par amount

Market value transaction – based on market value

- Equity holder can contribute assets to pass the OC tests. Otherwise, the senior-most class holders may take control of the CDO and its assets.

Interest coverage tests

I/C ratio is the ratio of scheduled interest due on the underlying collateral portfolio to scheduled interest to be paid to that tranche and all tranches senior.

For Duke Funding 1, the Class A I/C trigger is 121%, while the Class B I/C trigger is 106%.

- Suppose Class A coverage tests are violated, then excess interest on the portfolio goes to pay down principal on the class A notes.

OC/IC tests

$$\text{fees} = 0.5$$

$$\text{Accrual time} = 0.4$$

	<i>par</i>	<i>coupon</i>	<i>min OC</i>	<i>min IC</i>	<i>OC test</i>	<i>Pass</i>
Portfolio	100	10%				
Class A	50	6%	1.5	2.0	100/50	Y
Class B	30	8%	1.2	1.8	100/(50 + 30)	Y
Class C	15	9%	1.1	1.5	100/(50+30+15)	N

IC test calculations

$$\text{A: } [100 \times 10\% - 0.5] / [50 \times 6\% \times 0.4] > 2.0$$

$$\text{B: } [100 \times 10\% - 0.5] / [(50 \times 6\% + 30 \times 8\%) \times 0.4] > 1.8$$

$$\text{C: } [100 \times 10\% - 0.5] / [(50 \times 6\% + 30 \times 8\% + 15 \times 9\%) \times 0.4] > 1.5$$

- When failed, asset manager must sell assets until the structure regains the prescribed ratio (two-week cure period).

Quality tests

After the initial rating, the rating agencies are concerned that the composition of the collateral portfolio may be adversely altered by the asset manager over time.

Quality tests

Maturity restrictions

Degree of diversification

Credit ratings of the assets in the collateral portfolio

Sources of risk

- Liquidity risk – sale of assets within a short period
- Portfolio diversity – catastrophic aggregate losses
- Interest rate volatility
- Credit spread volatility – spread widening

Some typical features of synthetic CDO

1. No physical transfer of assets.
2. Trade risk via CDS and credit linked notes.
3. The first loss segment is normally retained by the originating bank.
4. The proceeds from the notes are invested in collateral (Treasury bills).
5. If a credit event occurs, the SPV pays the originating bank from the invested collateral, less any first-loss portion retained by the bank.
6. Any remaining collateral is used to pay the principal on the notes.

Synthetic CDO versus Cash Flow CDO

1. Terms of synthetic deals are well defined, not dependent on the cash flows of the reference portfolio.
2. No interest rate risk. The CDS addresses only the credit risk.
3. Cannot benefit (or lose) on any discretionary trading.
4. Ownership and economic risk of the securities have been de-linked.

“+” *Freeing of regulatory capital requirement*

Current practices require the same regulatory capital on identical loan amount, independent of quality of loans and inherent diversification.

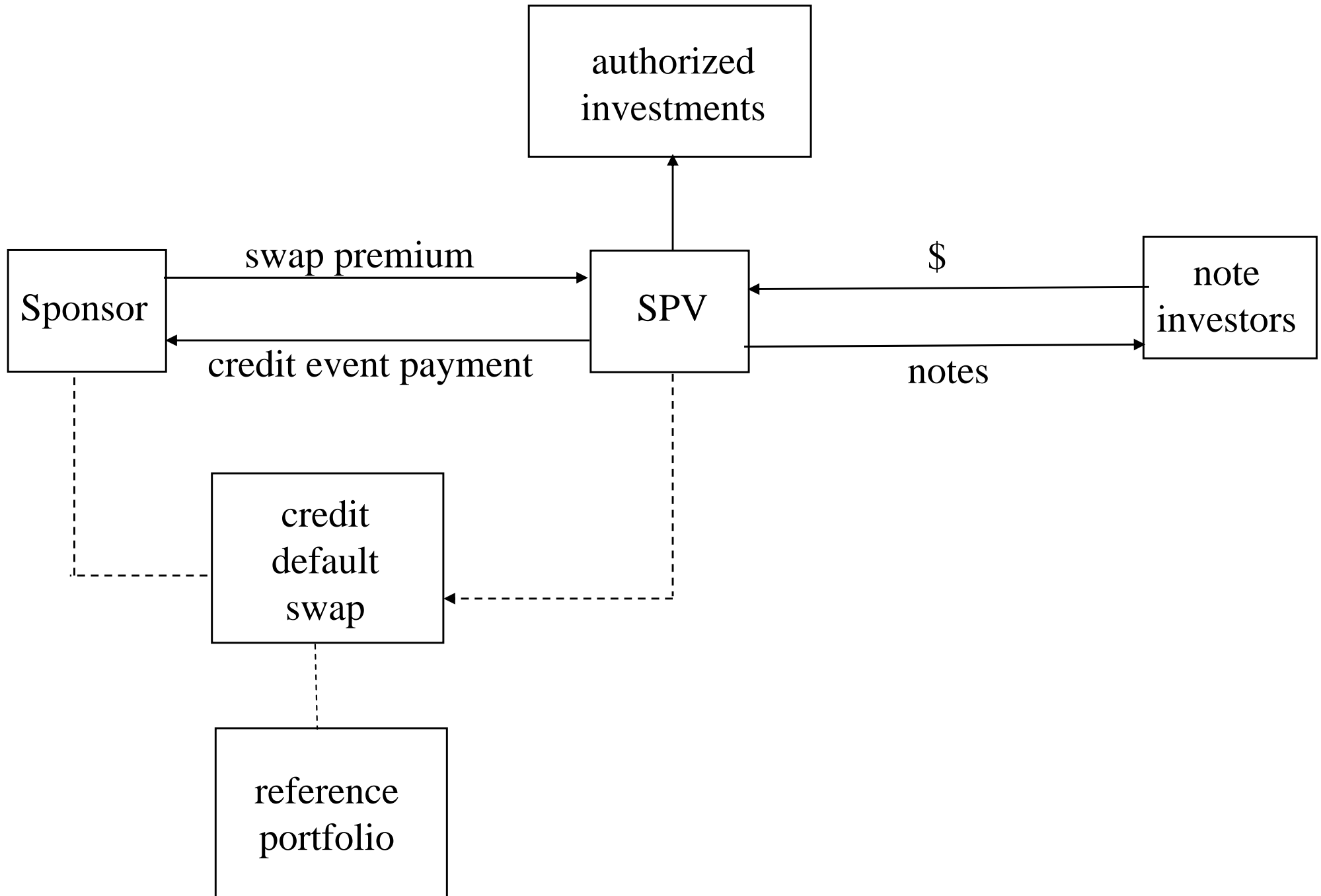
“-” *Funding cost disadvantages*

- Banks are low-cost funders.
- Buyers of notes are high-cost funders.
- Inefficient to transfer AAA risk from low-cost funder to high-cost funder.

Balance sheet risk management

- Transfer the credit risk of a reference portfolio of loans to the capital market (investors) and other financial institutions using credit-linked notes and credit default swaps, respectively.
- Trade risk without the burden of transferring the loans (customer relationships are not affected).
- Individual loans may be illiquid, leading to a reduction in their market values. Securitization may improve liquidity \Rightarrow increase in value.

Typical special purpose vehicle (SPV) issuer structure



Risk-based capital requirement

Flaws in current risk-based capital regulations (1988 Accord):

All commercial loans regardless of their risk are assigned a 100% risk weight.

Proposed revised accord (2005)

Rely on external ratings to assign risk weights to bank assets.

Forcing banks to allocate the same quantity of capital to support a loan to an AA-rated company as to a B-rated company. This would bias the investment decision in favor of the B-rated loans.

Higher regulatory capital requirement leads to lower return on AA-rated loan.

Risk distillation in synthetic CLO's

Credit risk is distilled from a reference portfolio of loans, then channeled to the credit markets.

- Create a special purpose vehicle (bankruptcy-remote from the originating bank) that issues the credit-linked notes.
- Credit-linked notes will be collateralized by AAA-rated securities, that is, they are the obligations of a fully collateralized SPV.

Credit linked notes in synthetic CDO

- The interest from the investment grade security and the periodic swap payments received from the default swap payments received from the default swap buyer are passed on to the CLN investors in the form of a yield on the notes.
- The CLN issuer is protected from default risk of the reference asset.
- Higher return for investors without directly getting into credit derivatives market – same as buying a riskless FRN and selling a credit protection through a CDS.
- Conventional stream of cash flows – periodic fix/float coupons and principal at redemption, if no credit events occurs.
- The cash flows are altered upon the occurrence of a credit event experienced by a reference credit.

Moral hazard – asymmetric information

In virtually every synthetic CDO and CLN, the ‘buyer’ of protection determines whether a credit event has occurred in the reference portfolio. Also the ‘buyer’ calculates the severity of its losses following a credit event, and how much the SPV will be required to pay under the swap.

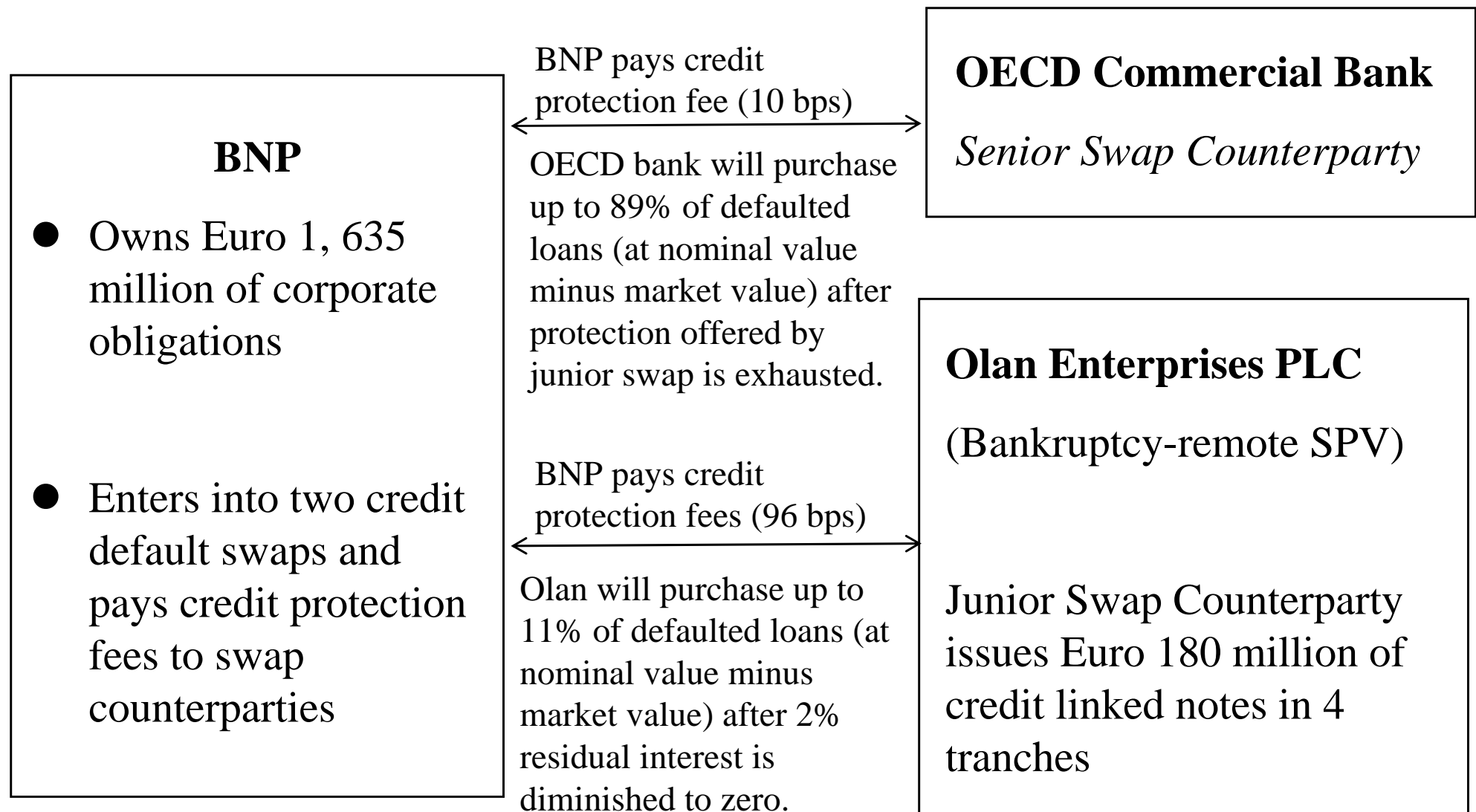
How the credit swaps be structured such that the occurrence and severity of losses can be objectively and independently identified, calculated and verified?

Olan Enterprises

1. Olan financed its commitment under the junior credit default swap by issuing Eur 180 million of credit linked notes in 4 classes (11% of the reference portfolio). This is a *partially funded synthetic CDO*. The goal of partial funding is to deliver favorable capital requirement without the funding cost disadvantage problem.
2. Olan used the proceeds from the notes to purchase 5-year French Treasury bonds (OATs) as collateral. Should a reference credit be affected by a credit event, Olan must sell OATs to pay BNP's loss.
3. Olan receives the premium from the junior credit default swap. The fee, plus the coupon the AAA-collateral, funds Olan's interest obligations on the credit linked notes.

Olan 1 Transaction structure

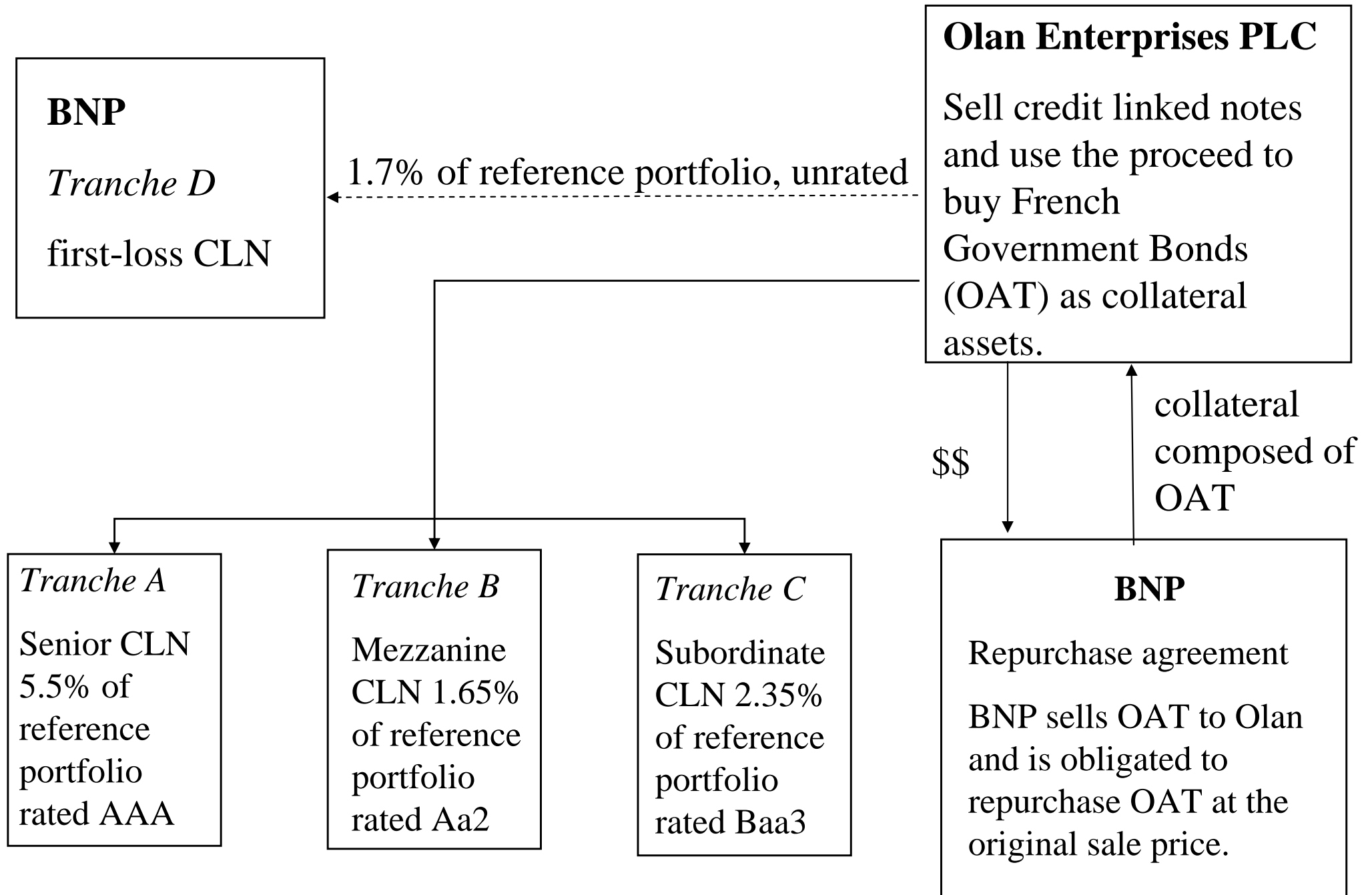
Launched by Banque Nationale de Paris (BNP) in 1999.



Total premium (as % of reference portfolio) = $0.96\% \times 11\% + 0.10\% \times 89\% = 0.1946\%$.

Note that 180 million = 1,635 million x 11%.

Olan 1 Transaction structure



Credit linked notes – public issues

	Class A	Class B	Class C	Class D
Amount (Euro)	86.65m	26.97m	38.42m	27.96m
Rating	AAA	Aa2	Baa3	unrated
bp over 3-month Euro-bor	30	40	150	NA
% of corporate credit exposure	5.3%	1.65%	2.35%	1.7%

Class D will absorb the first loss experienced by the reference portfolio. This first-loss CLN was retained by BNP.

Transfer of credit risks

The 4 credit-linked notes have different exposures to credit risk

- Class D funds the first level of losses (retained by BNP)

The credit risk beyond that funded by the SPV is shifted to an Organization for Economic Cooperation & Development (OECD) bank via a *Senior* default swap.

The embedded risks in the reference portfolio of loans are shifted without having to sell the underlying loans – *synthetic CLO*.

OATs as collateral

OATs are used as collateral, first for the credit protection of BNP, then for the repayment of classes A, B, C & D.

Repurchase agreement (mitigate the market risk associated with liquidation)

BNP is committed to repurchase the OATs sold to Olan at the original price paid by Olan.

Comparison of financial charges (1)

	Equity Retained	Capital Charge Methodology	Capital Charge Incurred
Hold Loans on Balance Sheet	n.a.	100% risk weight, 8% risk-based capital (RBC) requirement	8%
CLO	4%	Low-level recourse requirements: lesser of the capital charge on the unlevered amount or 100% of bank liability.	100% of 4% equity retained = 4%

Comparison of financial charges (2)

	Equity Retained	Capital Charge Methodology	Capital Charge Incurred
Partially Funded Synthetic CLO	<p>1%</p> <p>(10% junior credit default swap, 90% senior default swap, always with OECD institution)</p>	<p>For U.S. banks and many European institutions, the super senior piece always receives a 20% risk weight, whether it is retained or laid off. Treatment on equity and junior credit default swap is the same as above.</p>	<p>If junior credit default swap is with OECD institution: $100\% \text{ of } 1\% \text{ equity} + (20\% \times 8\% \text{ on swaps}) = 2.6\%$</p> <p>If junior credit default swap is collateralized with 0% RBC securities: $100\% \text{ of } 1\% \text{ equity} + (0\% \times 10\% \text{ junior swap}) + (20\% \times 8\% \times 90\% \text{ on super senior swap}) = 2.44\%$</p>

Comparison of financial charges (3)

	Equity Retained	Capital Charge Methodology	Capital Charge Incurred
Fully Funded Synthetic CLO	1%	Low-level recourse requirement on equity. 20% risk weight on credit default swap if swap is with OECD institution. 0% risk weight if swap is with SPV and fully collateralized with 0% RBC securities (cash, cash substitutes, or Treasuries).	<p>If credit default swap is with an OECD institution: 100% of 1% equity + $(20\% \times 8\%)$ on swap = 2.6%</p> <p>If credit default swap is collateralized with 0% RBC securities: 100% of 1% + 0% on swap = 1%</p>

Regulatory capital for synthetic CLOs

Partially funded synthetic CLOs

D = sponsoring bank's first loss (class D retained by sponsoring bank)

20% = risk-weight assigned to the notional amount of the senior credit swap

Senior = notional amount of senior credit swap

K_{fed} = capital requirement for the sponsoring US bank

$$= \max (D, 0.08 \times (D + 0.2 \times \text{senior}) + 0 \times \text{junior}) = 1.7\%$$

K_{CB} = capital requirement for the sponsoring bank under Commission Bancaire (French banking regulator) regulations

$$= D + 8\% \times 20\% \times \text{senior} = 3.124\%.$$

Class D as an inverse floater

P = premium on the first call credit default swap = 0.96%

$$P \sum_{i=A}^D W_i = \sum_{i=A}^D W_i C_i - W_H C_H$$

C_H = coupon from the highly rated security (OATs) = 6.75%

Class D is a private placement retained by BNP, so the coupon does not have to be revealed.

$$W_A = 5.5\%$$

$$C_A = \text{Euribor} + 30$$

$$W_B = 1.65\%$$

$$C_B = \text{Euribor} + 40$$

$$W_C = 2.35\%$$

$$C_C = \text{Euribor} + 150$$

$$W_D = 1.7\%$$

$$C_D = \text{Euribor} + x$$

$$W_H = 11.2\%$$

$$C_H = 6.75\%$$

$$0.0096(0.112) = 0.055(\text{Eur} + 30) + 0.0165 (\text{Eur} + 40) + 0.0235 (\text{Eur} + 150) \\ + 0.017(\text{Eur} + x) - 0.112(0.0675)$$

$$C_D = 0.4735 - 0.65882 (\text{Eur})$$

Class D Coupons

Date	Euribor	C _D (%)
Jul-99	0.0269	29.636
Aug-99	0.0269975	29.573
Sep-99	0.0308813	27.013
Oct-99	0.0349	24.366
Nov-99	0.034475	24.646
Dec-99	0.0333875	25.362
Jan-00	0.0349125	24.358
Feb-00	0.0363	23.444
Mar-00	0.0383	22.126
Apr-00	0.0409438	20.384
May-00	0.0445438	18.012
Jun-00	0.0454875	17.391
Jul-00	0.046375	16.806
Aug-00	0.04885	15.175
Sep-00	0.049	15.076
Oct-00	0.051375	13.512
Nov-00	0.050475	14.105
Dec-00	0.0485438	15.377
Jan-01	0.0474188	16.118

Return on equity

The reference portfolio securitized in the Olan 1 transaction had an average spread of Euribor + 35 bp. We assume BNP's cost of funding the portfolio is Euribor.

$$\text{ROE} = [\text{Euribor} + 35 \text{ bp} - \text{Euribor}] / 8\% = 4.375\%, \text{ independent of Euribor.}$$

where 8% is the regulatory capital requirement for BNP.

ROE when BNP uses a Synthetic CLO transaction

When BNP retains only a first-loss position in the credit risk as in the Olan transaction, ROE is as follows:

$$\text{ROE} = \{ [\text{Euribor} + 35 \text{ bp}) - \text{Euribor}] + W_D C_D - P_T \} / 3.124\%$$

where

$W_D C_D$ = percent of the reference portfolio financed by class D or the weight of class D (retained by BNP) times the coupon of class D, and

$$P_T = 0.96\% \times 11\% + 0.10\% \times 89\% = 0.1946\%$$

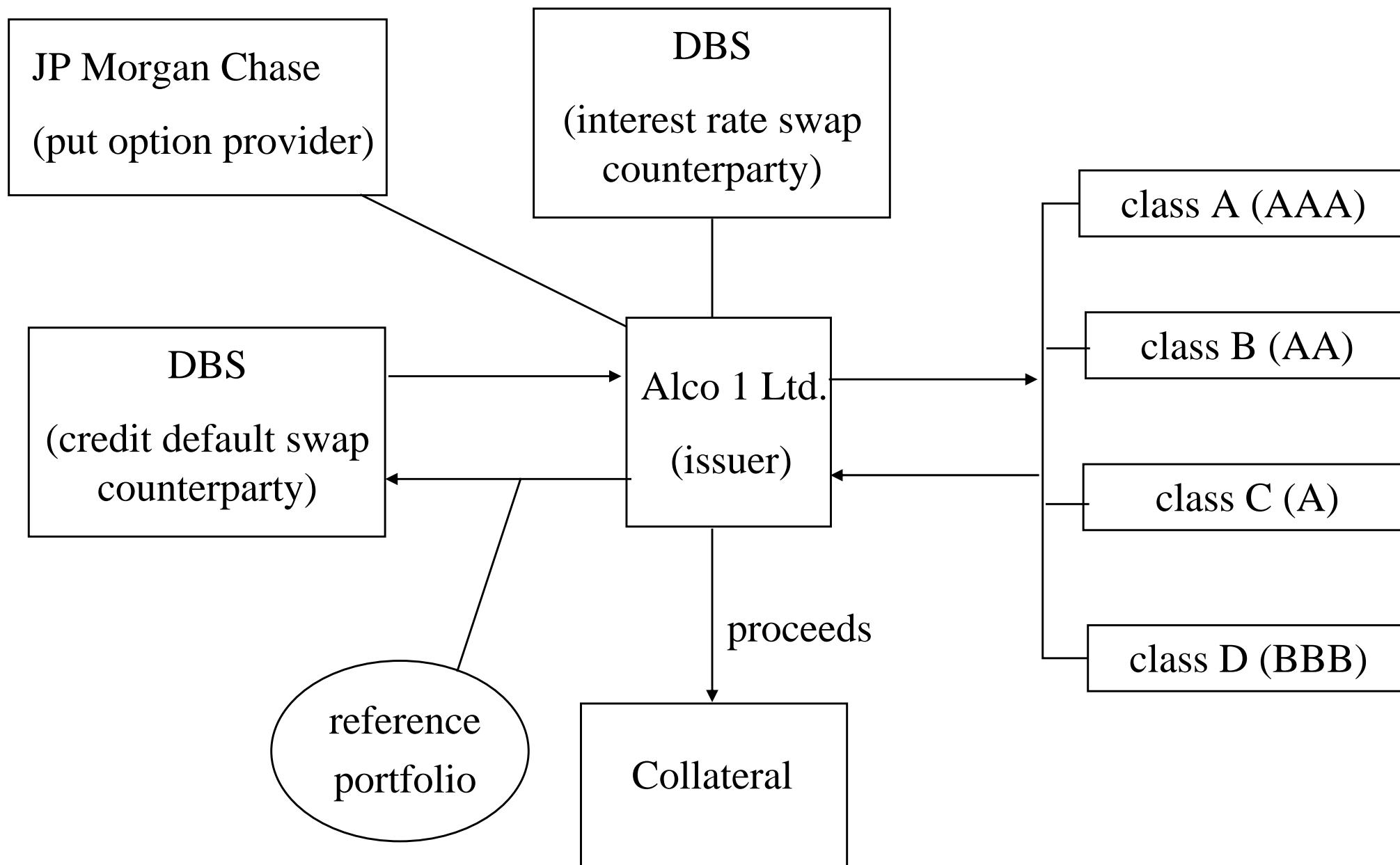
(total premium paid in first and second credit default swap).

3.124% is BNP's regulatory capital requirement under the Commisison Bancaire rules.

ROE in Securitized Credit Risk

Date	Euribor	C _D (%)	W _D C _D	ROE (%)
Jul-99	0.0269	29.636	0.0050	21.1018
Aug-99	0.0270	29.572	0.0050	21.0668
Sep-99	0.0309	27.013	0.0046	19.6744
Oct-99	0.0349	24.366	0.0041	18.2337
Nov-99	0.0345	24.646	0.0042	18.386
Dec-99	0.0334	25.362	0.0043	18.7759
Jan-00	0.0349	24.358	0.0041	18.2292
Feb-00	0.0363	23.444	0.004	17.7317
Mar-00	0.0383	22.126	0.0038	17.0147
Apr-00	0.0409	20.384	0.0035	16.0669
May-00	0.0445	18.012	0.0031	14.7762
Jun-00	0.0455	17.391	0.0030	14.4379
Jul-00	0.0464	16.806	0.0029	14.1197
Aug-00	0.0489	15.175	0.0026	13.2324
Sep-00	0.0490	15.076	0.0026	13.1786
Oct-00	0.514	13.512	0.0023	12.3271
Nov-00	0.0505	14.105	0.0024	12.6498
Dec-00	0.0485	15.377	0.0026	13.3422
Jan-01	0.0474	16.118	0.0027	13.7455

First synthetic CLO in Asia ex-Japan (Dec. 2001)



Distillation of credit risk

1. DBS retains the first-loss portion equaling S\$126 million or 4.5% of the portfolio.
2. If the losses exceed S\$126 million, the collateral is sold to pay DBS for the losses, while note-holders see the principal value of their notes written down in reverse order of seniority.

Embedded derivative structure

Market risk

If the deal terminates earlier than the maturity date 2009 (default, non-payment etc), the put option provider (JP Morgan Chase) will buy the collateral at par plus accrued interest – minimizing the risk of having to sell the collateral at market value.

Interest rate risk

Interest rate swap between DBS and Alco 1 to ensure that assets (credit default swap premium + interest income of the collateral) match the liabilities (interest rate payments of the notes).

Moody's approach

- Diversity score, weighted average rating factor and binomial expansion technique.
- Generate the loss distribution.

To build a hypothetical pool of uncorrelated and homogeneous assets that mimic the default behaviors of the original pool of correlated and inhomogeneous assets.

Moody's diversity score

The diversity score of a given pool of participations is the number n of bonds in a idealized comparison portfolio that meets the following criteria:

- Comparison portfolio and collateral pool have the same face value.
- Bonds of the comparison portfolio have equal face values.
- Comparison bonds are equally likely to default, and their default is independent.
- Comparison bonds are of the same average default probability as the participations of the collateral pool.
- Comparison portfolio has, according to some measure of risk, the same total risk as does the collateral pool.

Binomial probability formula

Once the “average” default probability p is known, then the probability of k defaults out of n bonds will be given by the probability formula of k successes out of n independent trials.

$$P(k \text{ defaults}) = \frac{n!}{(n-k)!k!} p^k (1-p)^{n-k}$$

where default probability

$$p = \frac{\sum_{i=1}^n p_i F_i}{\sum_{i=1}^n F_i} \cdot$$

Factors required in modeling CDOs credit risk

Rating of each CDO class is determined by credit enhancement, ongoing collateral credit performance, and the priority of interest in the cash flows generated by the pool of assets.

Default correlation

- Involves default timing.
- Correlation of assets.
- Use of diversity score.

Recovery rates

- Averages across a large sample of different categories and industries.
- Estimated from other variables.

Problem of 'soft' credit events

Owning a CLN (or a synthetic CDO) can actually be more risky than actually owning the reference obligations.

- If the CLN includes credit events associated with credit deterioration short of default e.g. a broadly defined restructuring or obligation acceleration, the CLN can default (investor receives less than the full par of the CLN) when the reference obligation has not.

- *Occurrence of a credit event* – published in

- (i) well-known news source,

- (ii) a corporate filing

- (iii) court document;

deter from staying credit events for the purpose of being reimbursed under the swap.

- *Loss severity following credit event* – calculated by

- (i) obtaining bids from third parties

- (ii) going through a formal workout process

- existence of a meaningful dispute resolution mechanism.

- *Case of blind pool* – due to regulatory/legal restriction, a bank may not be permitted to disclose certain names in a reference pool – bank cannot obtain an appraisal from an objective, unaffiliated third party.

Example

- First investor owns the bonds
- Second investor owns a CLN that references *XYZ*.

Due to credit deterioration, *XYZ* violates some covenants that leads to acceleration of the loan.

The bonds are not accelerated, but are trading at 85 cents on the dollar. The credit deterioration is not serious enough to lead to a default – the bonds are ultimately paid off completely at maturity. Since “obligation acceleration” is considered as a credit events, CLN investor receives 85% of par & CLN terminates.

Moody's advice – Good faith of the sponsor

No matter how carefully the transaction is structured, an aggressive protection buyer can interpret credit events more broadly than the seller intended, or obtain pricing for defaulted obligations that is unrealistic or not meaningful.

Investors should consider

- the sponsoring institution's size
- its reputation
- its last history as a credit default swap counterparty

- its commitment to the credit derivatives market – e.g., whether it intends to access the capital markets in the future to buy credit protection
- its default and recovery
- its ability to manage and monitor the reference portfolio and abide by any portfolio guidelines
- its motivation for carrying out the transaction
- the separation between its credit underwriting/origination and portfolio management departments
- the people and resources allocated to managing the portfolio and administering the transaction.

Factors for Risk Analysis

- Cumulative default rate
- Recovery probability
- Default correlation

Approximate the heterogeneous pool with pools with fewer types of firms but more firms of each type.

Risk Analysis Modeling

1. Number of defaults up to maturity.
2. The recovery rates of these defaults.
3. Default timing.