The Alchemy of CDO Credit Ratings

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Preliminary – please do not quote or cite without permission

Abstract

In this paper we present new evidence on the relation between CDO credit ratings and the quality of the underlying collateral backing these securities. Using novel hand-collected data on 3,912 tranches of Collateralized Loan Obligations (CLO) we document three main findings. (i) A large fraction of the CDOs in our sample are AAA rated; out of all the tranches in our sample 70.7% of the amount issued and 79.2% of the dollar value of the rated tranches are AAA rated. (ii) There is a mismatch between the rating of CDO tranches and the credit quality of the underlying assets supporting these tranches; while the credit rating of the majority of the tranches is AAA, the average credit rating of the collateral is B+. (iii) There is a large degree of uniformity among cash-flow CDOs. The uniformity across CDOs in our sample suggests that most issuers were using the rating agencies model to target the highest possible credit rating at the lowest cost.

JEL Classifications:
Keywords: Collateralized Debt Obligations, Credit Rating

This paper is being prepared for the Carnegie-Rochester conference series. We are grateful for comments from Amit Seru, Andrei Shleifer and Jeremy Stein and seminar participants at Harvard University and the Stockholm Institute for Financial Research. We thank Shaunak Vankudre, Alex Radu, Daniel Oshima, and Akilah Crichlow for excellent research assistance. All remaining errors are our own. (a) effi_benmelech@harvard.edu (b) jdlugosz@hbs.edu.

1. Introduction

The Collateralized Debt Obligations (CDO) market has grown substantially since 2001 with issuance volume reaching $551.7 billion in 2006. While securitization makes financing more accessible for firms and households[1], it also presents regulatory challenges, as rating agencies and institutions struggle to keep up with the rapid pace of financial innovation on Wall Street.

Since summer 2007, both academics and practitioners have blamed complex CDOs for being, in part, responsible for the current subprime crisis and credit crunch.[2] While more than 85% of the dollar value of CDO securities issued was rated AAA by either Moody's or Standard and Poor's (S&P),[3] several major banks and financial institutions eventually had to write-off substantial portions of their balance-sheets related to investments in CDOs, largely those backed by subprime mortgages. In 2007, Moody's downgraded $76bn in CDO securities and another $150bn remained on credit watch as of January 2008. Downgrades in November 2007 alone numbered 2,000 and many downgrades were severe, with 500 tranches downgraded more than 10 notches.[4] The ensuing confusion about the true value of these complicated securities and the extent of exposure by financial institutions, incited a credit crunch with effects beyond subprime mortgage related investments. In September 2007 Princeton economist Alan Blinder wrote:

> *Part of the answer is that the securities, especially the now-notorious C.D.O.'s, for collateralized debt obligations, were probably too complex for anyone's good…. Investors placed too much faith in the rating agencies — which, to put it mildly, failed to get it right. It is tempting to take the rating agencies out for a public whipping. But it is more constructive to ask how the rating system might be improved. That's a tough question because of another serious incentive problem. Under the current system, the rating agencies are hired and paid by the issuers of the very securities they rate — which creates an obvious potential conflict of interest. If I proposed that students pay me directly for grading their work, my dean would be outraged. Yet that's exactly how securities are rated.*

In this paper we present new evidence on the relation between CDO credit ratings and the quality of the underlying collateral backing these securities. CLOs are less sensitive to drops in

[1] Evidenced by the buyout boom and mortgage lending boom (to some detriment in the latter case)
[2] See Rajan (2005) who was among the first to identify the dark side of securitization.
[3] See Hu (2007) for data on Moody's rating distribution.
[4] "CDO downgrades break new records", Financial Times, 12/13/2007

real estate prices compared to CDOs since their underlying collateral is comprised mostly of corporate loans rather than and mortgages or mortgage-backed securities. However, the detailed information about the collateral pool of CLOs, and the availability of comparable information such as credit rating, maturity, and seniority for the underlying collateral enables us to document empirically the process of securitization by comparing the characteristics of the assets and liabilities in the CLOs. Using novel hand-collected data on 3,912 tranches of Collateralized Loan Obligations (CLO) we document the structure of CLO tranches and the credit quality of the underlying collateral supporting these tranches. While we provide detailed information on underlying structures of CLOs, our findings can be summarized as follows.

First, a large fraction of the CDOs in our sample are AAA rated. Out of all the tranches in our sample, 70.7% of the amount issued is AAA rated. When focusing only on rated tranches (i.e. excluding unrated tranches), AAA tranches account for 79.2% of the dollar value of the CDOs in our sample.

Second, there is a large gap between the rating of CDO tranches and the credit quality of the underlying assets supporting these tranches. We find that 85% of the CDOs in our sample have collateral pools with a weighted average credit rating of B, 8% have a weighted average credit rating of BB, and for 7% the information is missing. We use the term "alchemy" to describe the mismatch between the credit rating structure of CDOs and the credit quality of the collateral.

Third, we document a large degree of uniformity among cash-flow CDOs; 63% of the CDOs in our sample had one of four major liability structures ("deal types"): 40% are {AAA, AA, A, BBB, BB, NR} deals; 13% are {AAA, AA, A, BBB, NR}; 7% are {AAA, AA, A, BBB-, BB-, NR}; 4% are {AAA, A, BBB, BB, NR}. Moreover, there is very little variation in the collateral restrictions in our sample.

We argue that our evidence is consistent with a boiler-plate model that was used to rate CDOs. Anecdotal evidence suggests that the S&P rating model was known to CDO issuers and was provided to them by the rating agency. The CDO Evaluator software that was provided to CDO issuers by S&P probably led to the creation of CDOs with the minimum possible collateral needed to obtain an AAA credit rating (See Figure 6 for excerpts from the CDO Evaluator Manual). The uniformity across CDOs in our sample suggests that most issuers were using the model to target the highest possible credit rating at the lowest cost. Any mistake that was

embedded in the S&P credit rating model could have been compounded over the CLOs structured by issuers using this model.

Our paper is related to the recent papers that describe the market for structured finance (Ashcraft and Schuermann (2008) Coval, Jurek, and Stafford (2008b)) and to a growing literature arguing that credit ratings of structured finance products like CDOs are different from the credit rating of traditional debt products, and do not represents the their underlying risk accurately (Coval, Jurek, and Stafford (2008a), Mason and Rosner (2007)).

The rest of our paper is organized as follows. In Section 2 we describe the market for CDOs, presenting statistics on global issuance and the economic motivation for CDO issuance. Section 3 describes our data. Section 4 presents our empirical analysis of the structure of CDOs. Section 5 discusses S&P's rating model and lays out future directions for further evaluating the rating model. Section 6 examines our findings in light of particular institutional details. Section 7 concludes.

2. The Market for Collateralized Debt Obligations

Collateralized debt obligations (CDOs) are special-purpose vehicles that buy portfolios of assets and issue securities backed by the cash flows from those assets. The collateral assets, in turn, are sold to a special-purpose entity, often located in the Cayman Islands or Ireland, to ensure bankruptcy remoteness from the issuer. While the first CDOs were created in the 1980s, global issuance remained low, under $100 billion annually, until the mid-1990s.[5] Since 2002, CDOs have been the fastest growing sector of the asset-backed securities market.

2.1. Collateralized Debt Obligation Types and Issuer Motivation

Table 1 presents summary statistics on global CDO issuance for the period 2004-2007.[6] Issuance is broken down by type of structure and by issuer motivation. There are three main types of CDOs: (i) cash-flow CDO, (ii) synthetic CDO, and (iii) market-value CDO. In a cash-flow CDO, an SPV issues notes to investors and uses the proceeds to invest in primary financial assets such as loans, mortgages, bonds, etc. As interest and principal are generated by the

[5] See Fabozzi (2006), p. 3.
[6] The information in Table 1 is reproduction of data from the Securities Industry and Financial Markets Association (SIFMA) and Thomson Financial reports.

underlying collateral, proceeds are distributed to the CDO investors in a pre-specified way, according to the interest and principal 'waterfalls'. In contrast, Synthetic CDOs obtain their credit exposure through derivatives contracts instead of assets purchases. For example, a funded synthetic CDO will issue notes to investors and enter into a series of credit default swaps (selling protection). The proceeds from issuance are kept as collateral and invested in risk-free securities. Investors in this synthetic CDO receive swap premiums and when entities in the reference portfolio default, their principal is written down.[7] The third type – Market-value CDOs – accounts for the smallest share of the CDO market. They are similar to cash-flow CDOs except that the amount of liabilities the CDO can issue is determined by advance rates for each asset in the pool and collateral is marked-to-market frequently. When the liabilities outstanding exceed the advance rates, the manager must sell collateral and pay down notes until compliance is restored. While both cash-flow and synthetic CDOs can manage their pools of underlying collateral, trading is in general less frequent than it would be in a market-value CDO.[8] As Table 1 demonstrates, during the 2004-2007 period, 78% of the issued securities were cash-flow or cash-flow/synthetic hybrid variety, 17% were synthetic funded, and 9% were market-value CDOs.

Table 1 also decomposes CDO issuance by issuer motivation. There are two main reasons for CDO issuance: (i) arbitrage transactions, and (ii) balance-sheet motives. Balance-sheet transactions are motivated by a financial institution's desire to achieve relief from regulatory capital requirements or to free up capital for lending. Under both Basel I & II accords banks incur an 8% capital charge for risky loans held on their balance sheets. Institutions can reduce the capital charge by selling loans outright to a CDO (even if they retain the first-loss portion, which incurs a 100% capital charge, because it is often smaller than 8% of the loans amount) or by transferring the credit risk synthetically with swaps (Goodman, 2002).

The manager of an arbitrage CDO on the other hand, typically acquires the assets that are used as collateral for the CDO in secondary markets. The spread between the interest generated by the underlying assets, and the cost of funding for the CDO, is being used to pay equity or

[7] In contrast, investors in an unfunded synthetic CDO do not make any upfront payments. The CDO enters into default swaps and investors are required to post funds on-demand when reference entities default.
[8] Most managed cash-flow CDOs limit trading to certain types of securities (e.g. – defaulted securities, credit-risk securities for which the mark has widened by 100bp) and/or limit discretionary trading to 10-20% over the life of the CDO or annually.

preferred shareholders a return of 12-15%. Our data on the ratings transformation that occurs in CDOs (Section 4) shows how this is possible.

The arbitrage versus balance-sheet label is provided to Thomson Financial by the underwriter. We were not able to get any additional information from Thomson about how the distinction is made but an examination of the transactions that S&P labels as balance-sheet reveals that these transactions typically contain assets from a single originator. As Table 1 shows, during the 2004-2007 period, 85% of CDOs were motivated by arbitrage and 15% were balance-sheet transactions.

2.2. The Economic Role of Collateralized Debt Obligations

The defining feature of a CDO is its multi-tiered liability structure (see Figure 1). Each CDO typically issues multiple classes of securities, or tranches, with different levels of seniority. When assets in the collateral pool default or miss payments, losses are assigned in order of reverse seniority. Subordinate investors absorb losses first and more senior investors only suffer losses once the cushion below them has been depleted.

The process of tranching reallocates risk across different securities. In a Modigliani-Miller world with perfect markets, there would be no benefit to this kind of repackaging, however in the presence of various market imperfections, gains from securitization may exist. DeMarzo (2005) lists three kinds of market frictions that are important in explaining securitization: (i) transactions costs, (ii) market incompleteness, and (iii) asymmetric information. Furthermore, according to DeMarzo and Duffie (1999) and DeMarzo (2005), asymmetric information plays a major role in explaining the existence of tranched securities.[9] The issuer's information advantage potentially stems from private information about asset quality (due to ties with originators, or data disbursement) or expertise in valuing portfolios of assets. For example, in DeMarzo (2005), an issuer with private information about asset valuations maximizes revenue from selling these assets, as the number of assets gets large, by pooling and tranching as opposed to simply pooling or selling the assets individually. Intuitively, pooling assets with imperfectly correlated returns provides diversification which allows the seller

[9] DeMarzo (2005) notes that market incompleteness cannot explain the existence of pass-through pools or most CBOs because they do not augment the span of tradeable claims. Transactions costs explain why pooling is valuable but not tranching.

to issue a tranche that is information insensitive, decreasing the overall adverse selection and lemons premium on the sale.

2.2. Institutional Demand for Collateralized Debt Obligations

Institutional constraints and clientele demand provide further practical impetus for securitization. Pension funds, banks, thrifts, insurance companies, and other financial institutions are subject to rating-based regulations and internal investment and disclosure rules that depend on credit ratings. Pension funds are a huge source of investment capital. Federal Flow of Funds data for the 4th quarter of 2007 shows private pension funds own financial assets worth $5,841 billion; state, local, and federal government retirement plans own $4,349 billion. 13% of assets owned by private pension funds are credit instruments versus 21% in government plans. Modifications to the Employee Retirement Income Security Act of 1974 (ERISA) over the past twenty years have gradually expanded the range of asset-backed and mortgage-backed securities that pension plans can hold. In 1989, the Department of Labor began allowing ERISA plans to invest in highly-rated asset-backed securities by granting a prohibited transaction exemption, PTE 89-88 (Cantor & Packer, 1994). The extent to which investment allocation decisions of pension fund managers depend on credit ratings goes beyond legal regulations like ERISA. A recent survey of 200 pension plan sponsors and investment managers in the US and Europe (Cantor, Gwilym, and Thomas, 2007) found that 75% have minimum rating requirements for bond purchases and 50% set limits on portfolio distribution by rating class. Only a small proportion of those who build credit ratings into their investment contracts do so because it is mandated by law (20% of US fund managers, 4% of US plan sponsors). Minimum capital requirements as banks, insurance companies, and broker-dealers, also depend on the credit ratings of the assets on their balance sheets.[10] This matrix of regulation creates institutional demand for highly-rated securities, yet the supply of single name highly rated securities is fairly limited. For example, only few sovereigns and 5 nonfinancial corporations have AAA ratings as of 2007. Thus, it is not surprising that highly rated CDOs, especially those that are AAA rated, are attractive to many of these financial institutions. Highly-rated securities incur smaller capital charges, may be

[10] Basel II allows banks to choose between two methodologies for calculating capital requirements for credit risk. The standardized approach, a modification of Basel I, is credit-rating based. The internal ratings based (IRB) approach allows banks us their internal estimates of risk components (e.g., expected default, loss given default, unexpected loss) to calculate the capital required for a given exposure. (http://www.bis.org/pubs/bcbs107b.pdf)

accepted as collateral, and simultaneously provide a higher-yield than similarly-rated single-name securities.

3. Data and Sample Construction

CDO securities are largely sold in private markets (registered under 144A or Reg S) hence data on their structures is not publicly available. The SDC Platinum New Issues database tracks issuance in these markets but assembling a sample of CDOs from these data is difficult due to inconsistencies in SDC's classification of CDO.[11] Moreover, SDC Platinum only provides information on the liability side of the CDO (the notes that have been issued), but does not contain detailed information about the underlying collateral that supports the notes.

3.1. Sample Construction

We construct our sample of CDO using Standard & Poor's RatingsDirect database, by hand-collecting micro-level data on the structure of a large sample of CDOs. The S&P data allows us to observe both the asset side and the liability side of a CDO, in addition to a host of information about the ratings decision. RatingsDirect provides real-time access to S&P's credit research and ratings for currently-rated fixed income securities. At the time we gathered the data, October 2007, the database contained 3,237 CDOs (1,704 cash-flow, 970 synthetic, and 563 market-value or hybrids). We focus on cash-flow CDOs for which the collateral is primarily corporate loans (collateralized loan obligations or CLOs). There are 744 such transactions in the database, comprising 44% of cash-flow CDOs and 23% of all CDOs by number. This is the largest single category of CDO in Ratings Direct, by number.

Figure 2 plots issuance volume by year for our sample, while Table 2 reports the corresponding numbers for Figure 2. Our sample contains 531 cash-flow CLOs that were issued between 2000 and the 3rd quarter of 2007.[12] The phenomenal growth of the CDO market is reflected in this segment of the market that we observe. During the period 2004-2006, the par value of issuance increased by about 75% annually. While the year 2007 was on track to surpass the record issuance numbers of 2006, the credit crunch crisis of summer 2007 brought CDO

[11] For example, SDC often labels CDO tranches as floating rate notes, collateral bonds, preferred shares, and collateralized loan obligation.

[12] We get our descriptive data from S&P analyst reports, which were only available for 534/744 cash-flow CLOs. Reports for three of these CDOs were missing critical information hence the CDO sample size of 531.

issuance to a complete halt. The number of CDOs issued 2000-2002 that are in our sample is fairly low, probably since many of the older securities have been called by the issuer and thus were not covered by S&P as of October 2007. Most cash-flow CDOs allow for redemption by the issuer after a 5-7 year non-call period, subject to the approval of a majority or supermajority of the preferred shareholders. According to S&P, 77 cash-flow CLOs issued since 1997 had been called as of November 2007 (Bentham, Albulescu, 2008). Since the non-call period is usually at least 5 years, we have no reason to suspect that the CDOs in our sample issued after 2002 are subject to any selection bias. As Table 2 demonstrates, the majority of CDOs – 72% by amount, 75% by number over the whole period – are US-dollar denominated. Issuance of Euro-denominated CDOs increased over time from 20% of the dollar volume of issuance in 2002 to 36% in the first three quarters of 2007.

Figure 3 and Table 3 provide a detailed description of CDO deal structures. The average CDO in our sample has 7.3 tranches but deals range from 2 tranches to 21 tranches (Figure 3). Average deal sizes, and tranche sizes have risen over time. In 2002, the median CDO issued securities totaling $397 million; by 2007, the median deal was $500 million. Likewise, in 2002, the median tranche size was $17 million, while in 2007, the median tranche size was $35 million.[13]

For each CDO, we gather data from two sources in RatingsDirect: (i) an analyst report, Presale report or New Issue report, and (ii) Current Ratings reports. Around the time a transaction closes, S&P releases the Presale report or New Issue report: an analyst report summarizing the rating decision and the deal structure which contains the following information:

1. A high-level transaction profile including closing date, maturity date, and the parties involved in structuring the deal (underwriter, arranger, collateral manager, bond insurer).
2. A complete description of the liability structure: tranches issued, par value of each tranche, initial ratings.
3. A detailed profile of the assets in the collateral pool including:
    a. A verbal description of the types of assets in the pool.

[13] 2000 and 2001 have only 4 and 10 CDOs respectively.

b. Summary statistics for the collateral pool that include: weighted average maturity, weighted average rating, annualized expected default rate, and standard deviation of default rate.
c. Restrictions on types of eligible collateral.

4. Benchmark statistics from the rating model, i.e., the level of portfolio defaults that a tranche must withstand to earn its rating versus the level of defaults that it can withstand according to the simulation
5. Information on structural features:
    a. Payment priority structures (waterfalls) and par-value and interest coverage test ratios that must be met by each tranche.
    b. Other restrictions on trading, reinvestment, etc.

We supplement the information from the Presale Report with data from the Current Ratings report. We also record the tranche structure in the Current rating report and check it against the structure in the analyst report.

Presale Reports are typically released 2-3 days before the expected closing date of a transaction. New Issue Reports appear anytime from one day to one year after a transaction has closed (median= 73 days after). At least one of these reports is available for 534 of the 744 cash-flow CLOs in Ratings Direct. We hand-collected data from these reports, using the New Issue Report when available (19% of the time) and the Presale Report otherwise. One concern about Presale reports is that they are issued prior to issue date, and may not reflect the actual collateral pool or the deal structure. To address this concern, we use the Current Ratings report that has up-to-date information on tranche structures and ratings and check whether actual deal structures match the ones in the Presale reports. In 405 out of 534 CDOs (75.8%), the tranche structures are similar across the two reports so we are confident that the Presale Report is as reliable as the New Issue report in describing actual deal structures. If any back-and-forth occurs between CDO arrangers and the rating agency it probably happens before any analyst reports are issued.[14]

4. The Credit Ratings of CDOs

[14]It is unlikely that such negotiations are necessary. S&P's CDO Evaluator software is distributed freely to arrangers so they know, for the most part (the rating agency may raise concerns that are outside the scope of the model, e.g., about the manager's track record), how changing the structure changes the amount of each class of rated notes that can be supported before the rating committee's review begins.

4.1. Credit-Rating Arbitrage

Managers of cash-flow arbitrage CDOs make money by buying assets such as loans in secondary markets, refinancing them by issuing tranches that are secured by these assets, and taking a share of the profits. Part of the cost-of-capital advantage that CDOs enjoy is due to their legal status as special-purpose entities,[15] but mostly it is a result of the structuring process that results in highly rates securities. As their name suggests, cash-flow arbitrage CDOs make money by exploiting credit-rating arbitrage; in the process of pooling and tranching, low-rated securities are transformed into highly rated tranches. To illustrate this point, Table 4 displays the liability structure for one of the CDOs in our sample, Octagon Investment Partners V Ltd. After issuing $300 million in securities, the SPV invests in a pool of assets consisting primarily of non-investment grade loans as well as a limited amount of high-yield bonds and structured finance securities. The purchase of these assets was funded with a mix of liabilities: 91% investment grade and 9% below investment grade. Tranche ratings are determined via cash flow simulations in a rating agency model, which we will discuss later in this section. In the Octagon V CDO, 79% of the capital structure is rated AAA and pays 60 basis points over Libor while the assets, which have a weighted average credit rating of BB-, pay around 325 basis points[16] over Libor on average.[17] The 'excess spread' between the interest earned on the collateral and the interest paid to investors in CDO debt must be large enough to provide equity investors a return of at least 12-14% for the structure to be marketable.

Table 4 also depicts the 'waterfalls' that govern how interest and principal cash flows from the collateral are allocated to investors in Octagon V. In cash-flow CDOs, waterfalls are the mechanism for prioritizing investor claims. After taxes and administrative fees have been paid, interest receipts are used to pay CDO investors in the most senior class, A. As long as par coverage and interest coverage ratios meet their required levels (specified in the CDO indenture),

[15] Not subject to capital requirements like most financial institutions and located in low-tax jurisdictions.
[16] This is the average spread on leveraged loans rated BB/BB- made in the year the CDO was issued, 2002. Source: S&P LCD.
[17] Many CDOs restrict the maximum amount of securities rated below CCC+ to 7.5% so estimating the return on assets using their weighted average rating does not seem too inaccurate. This particular CDO does not have such a limit but it is required to haircut the par value of securities rated below CCC+ by 25% for the purpose of its par value coverage tests.

interest flows down the capital structure to the next most senior class, B.[18] If the ratios are not met, proceeds must be used to pay down class A, and restore compliance before subordinate investors receive any payments. Preferred shareholders collect the residual interest after all the classes senior to them have been paid. In Octagon V, the manager has an incentive to make sure that the equityholders will receive a minimum IRR of 14% because his incentive fee is conditional on it.[19] It is clear that the manager's objective is to tranche the issue in a way that minimizes his own cost of capital, but it is hard to make general prescriptions about the optimal asset and liability mix since they depend on market spreads and simulation outcomes in the rating agencies' proprietary models. The data we have collected provides some indirect evidence on optimal structuring and the extent of rating agency models influence on securitization.

4.2. CDO Credit Rating and the Uniformity of CDO Structures.

Table 5 decomposes the par value of notes issued by credit rating. In the sample as a whole, 71% of issuance is rated AAA; 5% is AA, 6% is A, 5% is BBB, 2% is BB, 0.1% is B and 11% is NR (unrated). The composition of issuance across years is almost identical to the overall composition with a slight downward trend in the amount of AAA and an upward trend in the amount of unrated tranches over time. Table 6 presents a more detailed analysis of deal structures. We find that every CDO except one[20] has a AAA tranche and the median AAA tranche represents 73% of the deal's total value. Likewise, 98% of CDOs have an unrated tranche and the median tranche, conditional on having one, comprises 8.8% of the deal. The interquartile ranges show that there is little variation in the composition of rated tranches across deals. For example, 80% of CDOs have a AA tranche and the median AA tranche represents 6% of the deal's par value. The interquartile range for the size of AA tranches is [4.7%, 7.7%]. Issuing liabilities in notched rating classes (e.g., AA+ or AA-) is relatively uncommon for every rating letter.

We also document a large degree of uniformity among cash-flow CDOs. According to Panel A of Table 7, 63% of the CDOs in our sample had one of four major liability structures

[18] Par coverage for a class = [total par of collateral assets + cash + defaulted securities at lower of MV or recovery] / [par value of securities outstanding in class & all classes senior]; Interest coverage for a class = [interest received during period + net swap payments]/[total amount of interest payable on the tranche]

[19] Not all structures have this feature. Another common setup is, after the interest-paying classes have been paid, the manager takes 50% of the residual as an incentive fee and the rest goes to equity.

[20] Bernard National Loan Investors (377516) has 4 tranches rated {AA, AA, BBB-, NR}. The AA tranches were upgraded to AAA one year after issuance.

("deal types"): 40% are {AAA, AA, A, BBB, BB, NR} deals; 13% are {AAA, AA, A, BBB, NR}; 7% are {AAA, AA, A, BBB-, BB-, NR}; 4% are {AAA, A, BBB, BB, NR}.[21] The remaining 137 deals have idiosyncratic structures that appear less than 20 times each.

4.3. The Uniformity of Collateral Restrictions

The majority the CDOs in our sample are managed, that is collateral managers can engage in limited trading[22] over the designated 'reinvestment period', typically the first 5-7 years of a 12-year CDO. In managed CDOs, the credit quality of the pool is controlled by covenants in the deal that constrain the manager's asset allocation. Table 8 summarizes the frequency and nature of collateral composition restrictions in our sample. These restrictions fall into a few broad categories:

1. Restrictions on asset type (loans, bonds, structured finance securities, etc.)
2. Restrictions on the fraction of near-default securities in the pool.
3. Restrictions on the mix of fixed/floating rate securities and the payment frequency of the collateral (to control interest mismatch with the CDO's liabilities.)
4. Diversification requirements by industry and issuer.
5. Currency and domicile restrictions on collateral.
6. Rating restrictions.

Conditioning on the presence of any given restriction, there is very little variation in the magnitude of the restriction. For example, nearly 70% of the CDOs in our sample require a minimum fraction of the collateral pool be invested in senior secured loans. When this restriction is present, in 40% of the cases it takes the value of 90%, and the interquartile range is [85%, 90%]. Furthermore, 46% of CDOs restrict the amount of second lien loans as a percent of total asset par; the median limit is 10% and the interquartile range is [10%, 12.5%]. Likewise, 60% of CDOs limit the amount of structured finance collateral as a percent of total asset par; the median limit is 5% and the interquartile range is [3%, 5%]. We find similar clustering on all other types of restrictions. According to S&P, collateral constraints "are specified by the sponsor, banker, and collateral manager based on their perceptions of what the investor community wants and can

[21] These results do not distinguish between deals that have 1 tranche per rating class or multiple tranches per rating class.

[22] Typically 10-15% of the par value of assets may be traded per year in addition to securities defaulted securities or credit-risk securities.

be comfortable with" (Global Cash Flow & Synthetic CDO Criteria, p. 19-21). In the rating process, and as ratings are monitored during the life of the CDO, collateral restrictions only affect tranche ratings insofar as default, correlation, and recovery rates assumed for individual assets depend on asset class, rating, maturity, and domicile. (We explain the details of the rating model in Section 5.1). That is, there is no additional penalty vis-à-vis the rating agencies for including for example more than 5% of structured finance collateral. So it is interesting that we observe such uniformity in the value of collateral restrictions when they are present. This suggests that investors may to some extent rely on simple rules to judge the riskiness of these complex and idiosyncratic structures. Additionally, there is reason to believe that rating agencies influence investor perceptions of what constitutes an acceptable allocation of collateral. S&P's Presale and New Issue reports have a 'Strengths, Weaknesses, and Concerns' section where they highlight collateral characteristics that they deem unusually risky; often this involves pointing out when allocations to certain baskets (e.g., rated below CCC+, structure finance securities, etc) exceed levels seen in Table 8.

5. The Alchemy of CDO Credit Rating

We now turn to analyze the relation between the underlying collateral quality, and the credit rating of the secured tranches. Our main measure of collateral quality is the weighted average rating (WAR) of all the assets in the pool. The WAR is reported in the Presale reports and is calculated as a weighted-average of all the loans, bonds and securities in the collateral pool. S&P requires that every asset in the pool will have either an actual or assessed credit rating. One concern about a weighted-average rating as a measure of collateral quality is that it does not sufficiently describe the riskiness of the overall collateral. For example, a WAR of B may represent some AA rated securities pooled together with many CCC or defaulted loans. However the majority of CDOs place a limit on the amount of collateral that can be rated CCC+ or lower (typically 7.5% of total asset par). Thus, CDOs cannot have much collateral rated above B to end up with a B average under those conditions, and probably most of the collateral in a CDO with a WAR of B is probably, in fact, B-rated

We find that 85% of the CDOs in our sample have collateral pools with a WAR of B, 8% have a WAR of BB, and for 7% the information about WAR is missing.[23] As Panel B of Table 7 demonstrates, we do not find any correlation between deal type and WAR of the collateral pool; each type of deal is more likely to be backed by collateral with an average rating of B than BB. It is interesting to note that there is a trend in weighted-average collateral quality over time: with BB-backed CDOs all but disappearing by 2006-2007. This deterioration in average collateral quality over time implies that debt or equity investments in later CDOs are potentially riskier.

Finally, there is a striking difference between the credit rating structure of CDOs and the credit quality of the collateral. Figure 5 quantifies the ratings transformation that takes place in our sample of CDOs. Cash-flow CLOs finance the purchase of junk-rated assets (typically B+) largely with AAA-rated borrowings. The red bars plot the par value of the CDOs' collateral by its weighted average rating; the blue bars plot the par value of the CDOs liabilities by rating.[24] While 70.7% of the dollar amount of CDOs in our sample was initially rated as AAA, the collateral that supports these issues had an average credit rating of B at the same time.

5.1. The S&P Credit Rating Model

The mismatch between the credit rating of the assets and liabilities implies that a pool of assets with an average credit quality of B+ and expected default rate of 23% supports 11% of securities rated below B and 89% above B. In this subsection we investigate the credit rating model used by S&P to rate CLOs. The S&P model start by modeling defaults in the asset pool and running cash-flow simulations to test what level of portfolio defaults tranches can withstand. The model requires numerous assumptions about default probabilities, correlation, interest rate movements, and more. While one could examine each assumption individually and debate its merits, there are two key statistics from the rating process that help us consider whether the rating model's assumptions seem reasonable in the aggregate, and under what conditions they would fail.

The first statistic is S&P's 'scenario default rate' (SDR) and is calculated for each tranche. The 'scenario default rate' allows us to characterize, at least partially, the loss distribution that was estimated in the rating process for each collateral pool. Given our

[23] These are compressed ratings. The full WAR distribution is: 0.2% BBB-, 0.6% BB+, 0.4 BB, 7% BB-, 65% B+, 16% B, 4% B-, 0.2% CCC+, 7% missing data.

[24] Assuming 100% of the funds raised are invested in collateral. In reality, some fraction will be used to pay expenses.

information on collateral composition by asset type and rating, we can test whether this loss distribution is reasonable.

The second statistic – 'break-even default rate' (BEDR) measures the level of portfolio default that each tranche can supposedly withstand in the underwriter's cash-flow models. This allows us to test whether it seems reasonable that a certain tranche can withstand the level of portfolio defaults that is claimed, given the CDOs liability structure.

The first step in rating a CDO is generating a portfolio loss distribution for the underlying pool of assets.[25] S&P uses historical data on rating transitions from its CreditPro database (1981-present) to assign default probabilities to each asset in the pool based on asset class (corporates, ABS, sovereigns, etc), rating, and maturity.[26] Some simple assumptions are made about default correlation. For example, two corporate securities in the same sector are assigned a 0.15 correlation; while corporate securities from different sectors obtain a correlation of 0.05. Monte Carlo simulation is used to generate a distribution of portfolio losses.[27] S&P uses this loss distribution to generate a "scenario default rate" (SDR) for each tranche – this is the level of portfolio losses that a tranche must be able to withstand in cash flow simulations to earn its rating.[28] There are two steps in calculating the SDR. First, S&P identifies the default rate on corporate bonds that have the same rating as the one being sought for the tranche and maturity equal to the weighted-average maturity of the CDO's assets ("x%").[29] Then, using the loss distribution generated for the collateral pool, they identify the default rate that has no greater chance of being exceeded than x%; this is the SDR. To fix ideas, consider a CDO tranche backed by collateral with a weighted-average maturity of 10 years that is being tested for an A rating, and that the default rate of 10-year A-rated corporate bonds is 3%. The SDR is set equal to the level of default in the CDO's collateral pool that has no greater than 3% chance of being exceeded. When the underwriter runs cash-flow simulations, he will test that the tranche can

[25] Calculations may be based on the expected composition of the asset pool to some extent because only 50-70% is typically ramped up at the closing date.

[26] According to the CDO Evaluator Technical Document, p. 5-6, S&P calculates a one-year transition matrix from historical data and generates predicted default rates by raising it to higher powers. Appendix 1 of this document shows the one-year transition matrix and the predicted default rates (up to 30yrs). This methodology implicitly assumes that current rating is the only determinant of the likelihood of default.

[27] We believe these are pre-recovery loss distributions but none of the three S&P documents we cite is definitive about this. Recovery rates assumptions are based on asset type, seniority, and jurisdiction.

[28] According to S&P "withstand" means to pay timely interest and ultimate principal by the final legal maturity of the notes.

[29] It is unclear from the three S&P documents we cite, where these bond default statistics come from. There are two tables

withstand cumulative defaults up to the SDR without missing interest or final principal payments. The logic is "if the tranche can survive defaults up to the SDR then its probability of default is no greater than 3%, as would be appropriate for an A rating" (Global Cash Flow and Synthetic CDO Criteria, p. 42).

SDRs allow us to back out, partially, the loss distributions that were estimated for each CLO's collateral pool. For example, the loss distribution for a CLO backed by a pool of assets with a weighted average maturity of seven years must satisfy: [30]

Pr(asset defaults as % of total par > SDR_{AAA})≤ default rate of 7 year, AAA-rated corporate bond = 0.14%

Pr(asset defaults as % of total par > SDR_{AA}) ≤ default rate of 7 year, AA-rated corporate bond = 0.40%

Pr(asset defaults as % of total par > SDR_{A}) ≤ default rate of 7 year, A-rated corporate bond = 0.96%

Pr(asset defaults as % of total par > SDR_{BBB}) ≤ default rate of 7 year, BBB-rated corporate bond = 4.6%

Pr(asset defaults as % of total par > SDR_{BB}) ≤ default rate of 7 year, BB-rated corporate bond = 14.1%

Pr(asset defaults as % of total par > SDR_{B}) ≤ default rate of 7 year, B-rated corporate bond = 32.2%

Table 9 summarizes SDRs by tranche rating for our sample. As the table shows, median SDRs by rating class are: AAA=41%, AA=37%, A=32%, BBB=26%, BB=20%. Assuming, for simplicity, that all CDOs have assets with a weighted-average maturity equal to the sample mean (7-years), the typical CDO in our sample is backed by collateral that has an expected loss distribution like the one below:

Pr (defaults as % of total asset par> 41%) ≤ 0.14%

Pr (defaults as % of total asset par>37%) ≤ 0.40%

Pr (defaults as % of total asset par>32%) ≤ 0.96%

Pr (defaults as % of total asset par>26%) ≤ 4.6%

Pr (defaults as % of total asset par>20%) ≤ 14.1%

[30] Seven-year default rates were taken from the credit curves in Appendix 1 of "CDO Evaluator Version 3.0: Technical Document", which are calculated by repeated application of a 1-yr transition matrix. It is unclear whether these are the correct figures, because these default rates do not control for the maturity of the issue; however, we could not locate any other statistics on corporate bond default rates by maturity published by S&P. For a comparison, Moody's default rates for corporate bonds with 7-year maturities are Aaa=0.31%, Aa=0.55%, A=0.78%, Baa=2.86%, Ba=15.32%, B=35.55% (Moody's Default & Recovery of Corporate Bond Issuers)

5.2. The Determinants of the S&P CDO Credit Rating Model

We proceed by studying the determinants of the S&P CDO credit rating model. We run tranche-level credit rating regressions and study the determinants of CDO credit rating. As explanatory variables we use observable characteristics of the CDO, collateral quality and structural features. The dependent variable in all regressions is tranche rating converted to an ordinal ranking (AAA=1, AA+=2, AA=3,…NR=20), so that a negative coefficient should be interpreted as a higher tranche rating. The first column of Table 10 shows that regressing the tranche rating on its scenario default rate alone explains 37% of the variation in CDO credit rating. The SDR is the level of portfolio defaults that a tranche must be able to withstand in simulations. Within a CDO, a tranche's SDR is always weakly greater than that of the tranche below it. Across CDOs, SDRs for tranches with the same rating and maturity would be the same if critical points of the loss distribution for the underlying collateral were the same.[31] Put differently, across CDOs, SDR is controlling for the loss distribution of the underlying collateral, while within CDOs, SDR is controlling for seniority. In the second column of Table 10 we examine how the average rating of a CDO tranche varies by year. The coefficients of the year fixed-effects show that the average tranche rating increased from 2001 to 2003 and then decreases during the period 2004-2007. Adding year fixed effects to SDR increases the R^2 to 62%

In the third specification, we add the weighted-average rating (WAR) of the collateral to the right-hand side. This increases the R^2 to 75%. The coefficients on collateral weighted average ratings are highly significant and their relative magnitudes point to the expected direction. Controlling for tranche SDR, tranches backed by a lower average-quality collateral pool have lower ratings than those with a higher average-quality pool. Compare a pool of collateral with WAR of B that has no greater than 0.7% of experiencing more than 45% defaults with a pool with a WAR of BB that has the same mass in the right tail. The BB-pool would be a more skewed distribution. This kind of skewness does not occur in the collateral pools chosen by arrangers. In the data, SDRs for tranches of the same rating are much higher for B-average pools than BB-average pools. For example, the average SDR for a AAA-tranche backed by a B-pool is 45%; the average SDR for a AAA-tranche backed by a BB-pool is 34%. Furthermore, the

[31] For example, if two AAA tranches have the same SDR, it implies that the underlying collateral pools of their respective CDOs have 0.14% of their probability mass to the right of the same default rate (assuming a weighted-average maturity of 7 years for both collateral pools).

relative magnitudes of the coefficients are similar to those in the second specification, with average ratings increasing until 2004 and decreasing thereafter, but only the dummies for 2005-2007 are significant. The large coefficient of the 2007 dummy (6.53, significant at the 1% level), suggests that tranches issued in that year were lower rated on average, after controlling for collateral quality, and SDR.

Adding other measures of collateral quality; the annualized expected default rate of the assets, and their weighted-average maturity, decreases the explanatory power of the weighted-average rating of the collateral pool. A one percentage point increase in the annualized expected default rate of the collateral pool is associated with a 2.56 increase on the rating scale. That is, the average rating of a tranche falls by 2.56 rating categories (notches) when the expected default rate on the underlying collateral increases by 1 percentage point. Longer-lived collateral assets are also associated with lower ranked tranches on average. A one standard-deviation increase in the weighted-average maturity of the collateral pool (1.96 years) is associated with a drop in tranche rating of 2.72 notches on average. Finally, after controlling for the annualized expected default rate, and weighted-average maturity, the B+, B, and B- collateral dummies remain significant. Collateral rated B- is associated with a 3-notches decline in the rating of notes issued, while collateral rated as B is associated with a decline of 1.5 notches.

In the final specification, we add controls for structural features of the CDO; the log of the tranche amount, the number of tranches per CDO, and the overcollateralization ratio required by tranche. Larger tranches have higher ratings on average, but this is probably driven by the fact that AAA tranches typically represent over 70% of a deal. The number of tranches in the CDO does not have any significant effect on tranche rating, while a higher overcollateralization ratio leads to a higher tranche rating on average. This result seems reasonable given that the overcollateralization ratio for a tranche is the par value of the collateral assets divided by the par value of the tranche and all tranches senior to it.

5.3. Evaluating the S&P CDO Credit Rating Model

As Table 10 demonstrates, the key ingredients of the S&P CDO credit rating model are SDR and BEDR. We now turn to evaluate the relation between these two key statistics and their corresponding credit rating. Scenario default rates provide us the level of portfolio losses that a tranche *must be able to* withstand in simulations. An additional statistic, the break-even default

rate (BEDR), measures the maximum cumulative portfolio default rate that a tranche *can* withstand, according to the underwriter's cash-flow simulations. (For a tranche to earn a given rating, its break-even default rate must be higher than the scenario default rate.) We use this information to assess the cash-flow simulation models used by the rating agencies.

Table 9 presents summary statistics for BEDR and SDR stratified by credit rating. The median BEDR for an AAA tranche is 48% which means that the median AAA tranche can withstand cumulative defaults of up to 48% in its underlying collateral pool without missing interest or ultimate principal payments. Referring back to Table 6 the median AAA tranche comprises 73% of the par value of a CDO. With only 27% of the capital structure acting as a cushion, a back-of-the-envelope calculation suggests that the recovery rate on the defaulted assets should be at least 45%, otherwise more than 27% of assets will be wiped-out and the AAA tranche will be impaired. Using the same back-of-the-envelope calculation as before, the 75th percentile of BEDR (59.1%), implies a recovery rate of at least 55%.

We calculate the implied recovery rate for every AAA-tranche in our sample using the formula (1-BEDR)+BEDR*(implied recovery)=(AAA par amount)/(total CDO par amount). The average recovery rate is 0.46 and its interquartile range is [0.41-0.54]. For comparison, according to Moody's average recovery rates for banks loans based on 30-days post default market prices was between 0.46 (senior unsecured) and 0.66 (senior secured) for loans, and between 0.17 (junior subordinated) and 0.54 (senior secured) for bonds. Thus the implied recovery rates are in line with historical recovery rates for the period 1983-2007.

However, the notion that within sector correlation is 0.15 and cross-sector correlation is 0.05 suggests that the model does not take into account economy- or industry-wide shocks. This problem is in particular severe given the low quality of the underlying collateral; an average credit quality of B+ likely represents firms with deteriorating economic conditions, as well as firms with very high leverage as in the case of buyout loans of highly leveraged deals. Whether the poor credit rating of the collateral stems from an economic distress, financial distress, or both, these assets are much more sensitive to economic downturns and credit squeeze. Thus, B+ rated assets are not very diversifiable even if the collateral is split across different sectors. We argue that in light of the concerns about the sensitivity of poor quality assets to economic downturns, a recovery rate in the range of 45% to 55% is probably too high in the event of an economy-wide downturn. Theoretical models of credit cycles and liquidation values (Shleifer

and Vishny (1992), Kiyotaki and Moore (1997)) suggest that asset values drop in economic downturns and that there is a multiplier effects that leads to further declines in asset values. Acharya, Bharath, and Srinivasan (2007) show empirically that industry-wide distress affect creditor recoveries. They find that this effect is in particular strong for bank debt, and that recovery of senior bank debt is lowered by 21 cents on a dollar in distressed industries.

While Table 9 presents summary statistics for BEDR and SDR, we compute the difference between BEDR and SDR for every AAA-tranche in our sample and present its corresponding distribution in Figure 7a. The difference between BEDR and SDR is a proxy for the distance between the minimum required portfolio default that the tranche should be able to withstand, compared to what it is predicted to withstand. The mean difference between BEDR and SDR is 8.68% and the standard deviation is 4.89%. Figure 7b illustrates the robustness of the difference between BEDR and SDR to the assumptions about the cash flow simulations. Since we cannot observe the collateral pool at the loan level we cannot test the model sensitivity to underlying assumptions such as within- and cross-sector correlation. Instead we consider a scenario in which BEDR estimates are off by one standard deviation using the sample BEDR statistics. As Figure 7b demonstrates a one standard deviation decline in BERD results in roughly 75% of the tranches simulated cash flows being lower than the minimum requirement needed to sustain an AAA rating.

6. Conclusion: Why are CLO Structures so Uniform?

As we show in Section 4, the CDOs in our sample have very similar structures and conform to very similar collateral restrictions. Moreover Figure 5 demonstrates that there is also very little variation in the quality of the underlying collateral. Taken together, these results suggest that although the 3,912 tranches in our sample were issued by different issuers they all seem to conform to the same CDO model. Furthermore, the evidence in Section 5 suggests that assumptions on both recovery rates and cash flow simulations were very close to the minimum required threshold needed to sustain their credit ratings. What caused the uniformity in CLO structures?

There are two potential explanations for the fact that CDO structures seem so uniform. The first explanation is that CDO issuers follow market convention; if some CDO structures have been perceived as more desirable then other issuers will follow the same convention. While

this explanation is reasonable it can only explain the uniformity in deal structures (i.e. the amount allocated to each credit rating category), but not the uniformity of the underlying collateral. An alternative explanation is that the issuers had access to the rating model of the credit rating agencies. According to the second explanation, the rating agencies may have provided issuers with their model such that issuers could have structured their CDOs accordingly.

Anecdotal evidence suggests that the S&P rating model was indeed known to CDO issuers and was provided to them by the rating agency. Figure 8 displays excerpts from the CDO Evaluator Manual which we have downloaded from S&P website. The CDO Evaluator software enabled issuers to structure their CDOs and simulate different scenarios of expected default given the characteristics of the collateral they have chosen. The CDO Evaluator is an optimization tool that enables issuers to achieve the highest possible credit rating at the lowest possible cost. For example, Figure 6 reports that one of the outputs that the CDO Evaluator provides to the issuer is "excess collateral" which according to S&P: "**This tells what percentage of assets notional needs to be eliminated (added) in order for the transaction to provide *just enough* (i.e. ROC equals to 100%) support at a given rating level.**"[32]

We believe that given that the CDO Evaluator (or similar models) was provided to CDO issuers probably led to the creation of CDOs with the minimum possible collateral needed to obtain an AAA credit rating. The uniformity across CDOs and the low credit rating of the underlying collateral in our sample suggests that most issuers were using the model to target the highest possible credit rating at the lowest cost. If there were mistakes embedded in the S&P credit rating model they were probably compounded over the trillions of dollars that were deliberately structured by CDO issuers using this model.

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[32] See Rajan, Seru, and Vig (2008) who provide evidence that securitization led to loans with wors fundamentals due to the tendency to rely on statistical models and reduction in the incentives to collect soft information.

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Figure 1: Typical CDO Structure

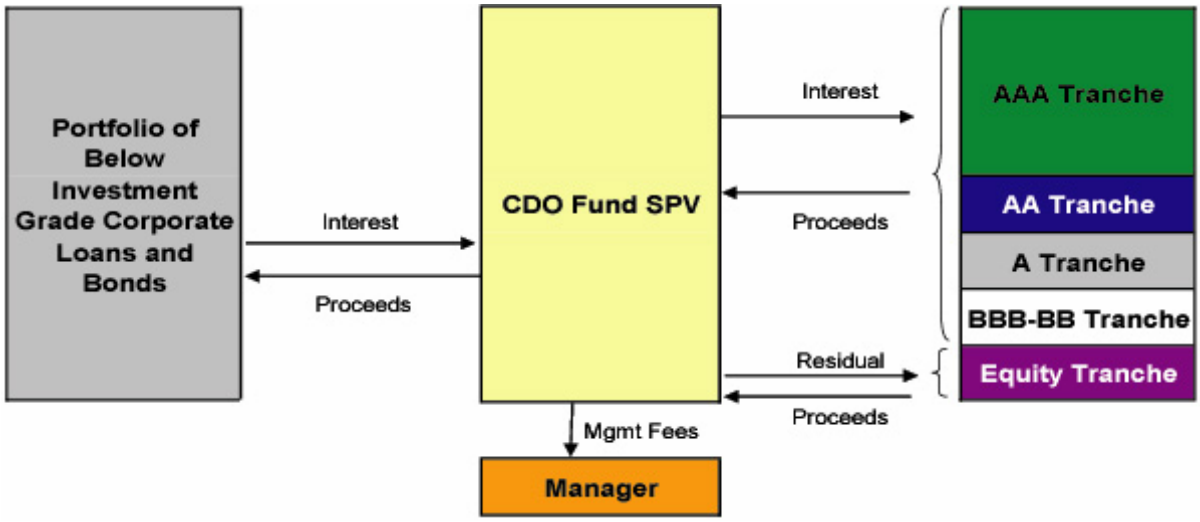


Figure 2: CDO Issuance Over Time

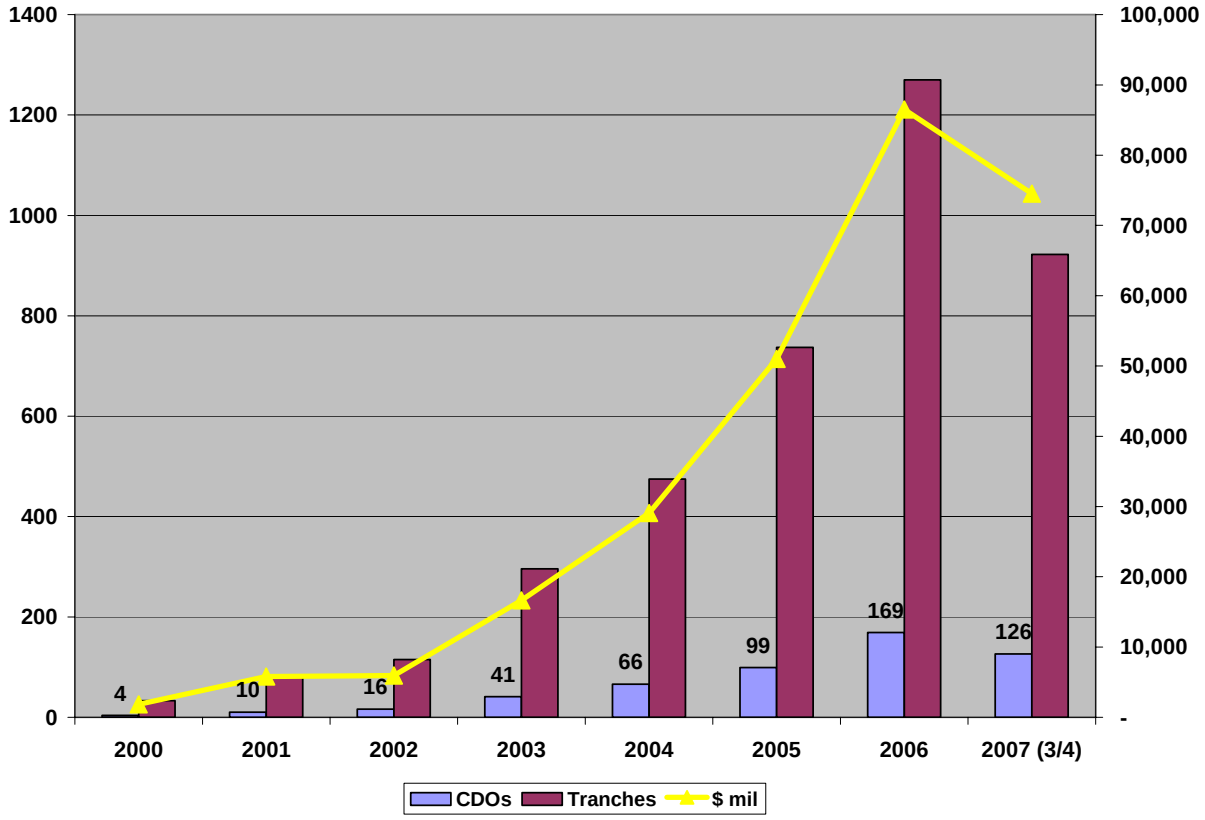
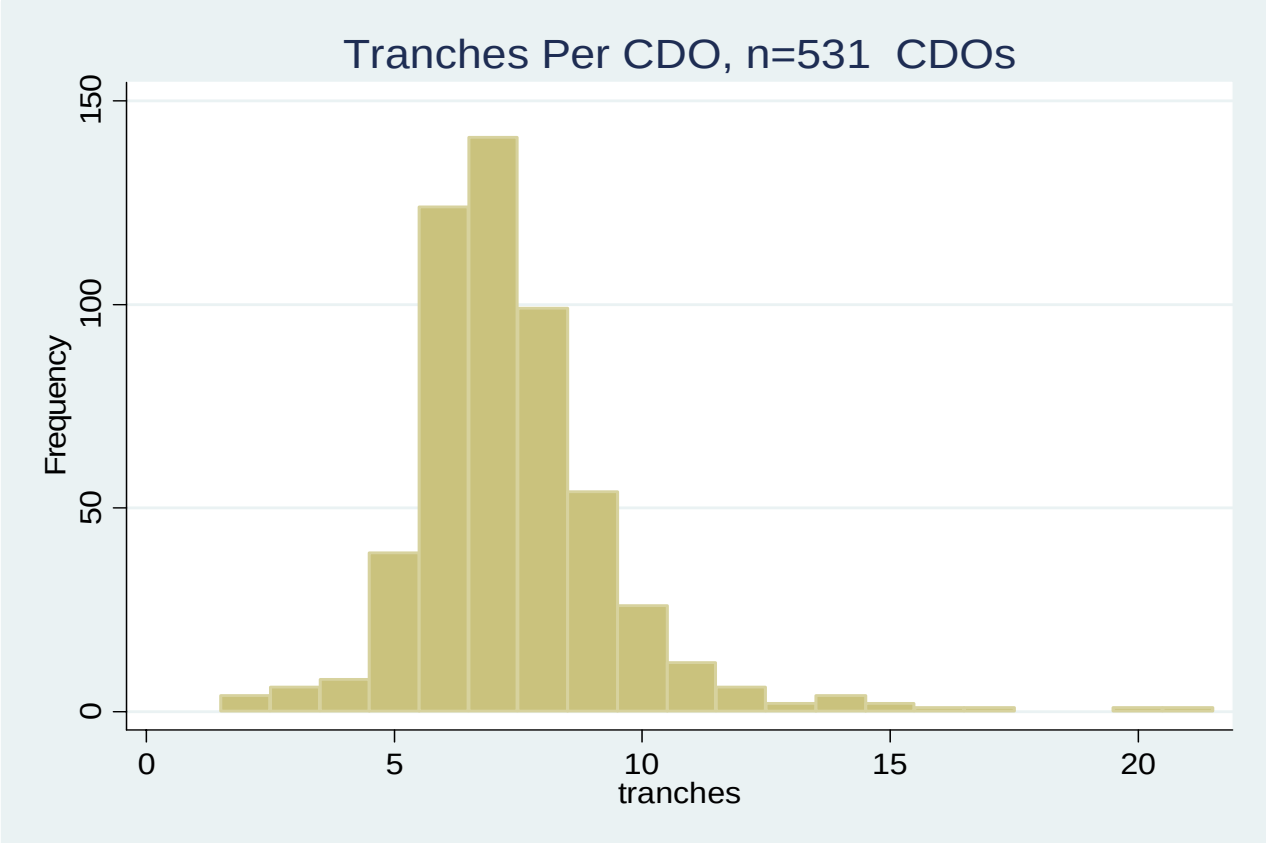


Figure 3: The Distribution of number of tranches per CDO



Total number of CDOs	Total number of tranches	Mean number of tranches	Std of number of tranches	Min number of tranches	Max number of tranches
531	3,920	7.37	7	2	21

Figure 4: CDO rating Structure

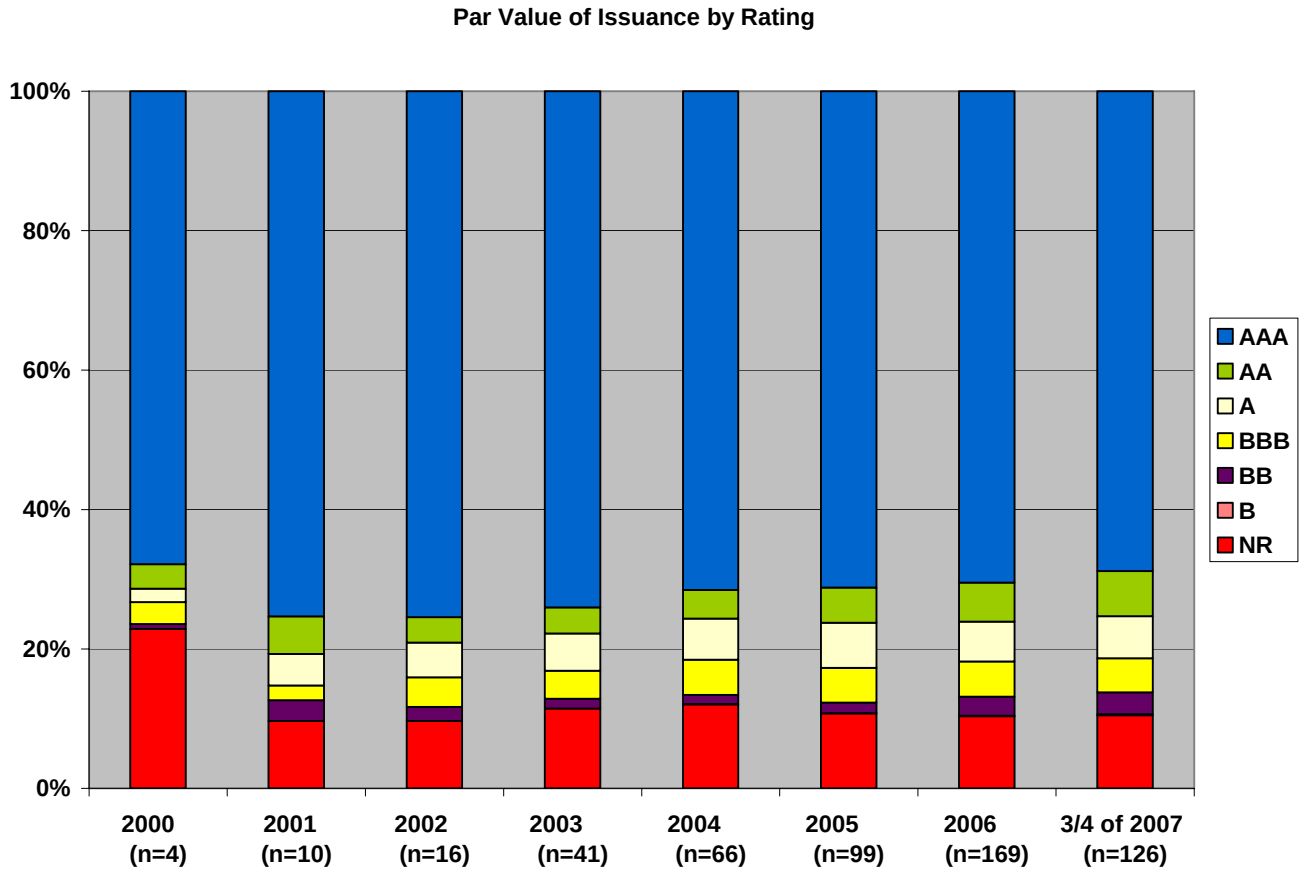


Figure 5: CDO vs. Underlying Collateral Credit Ratings (3,912 tranches)

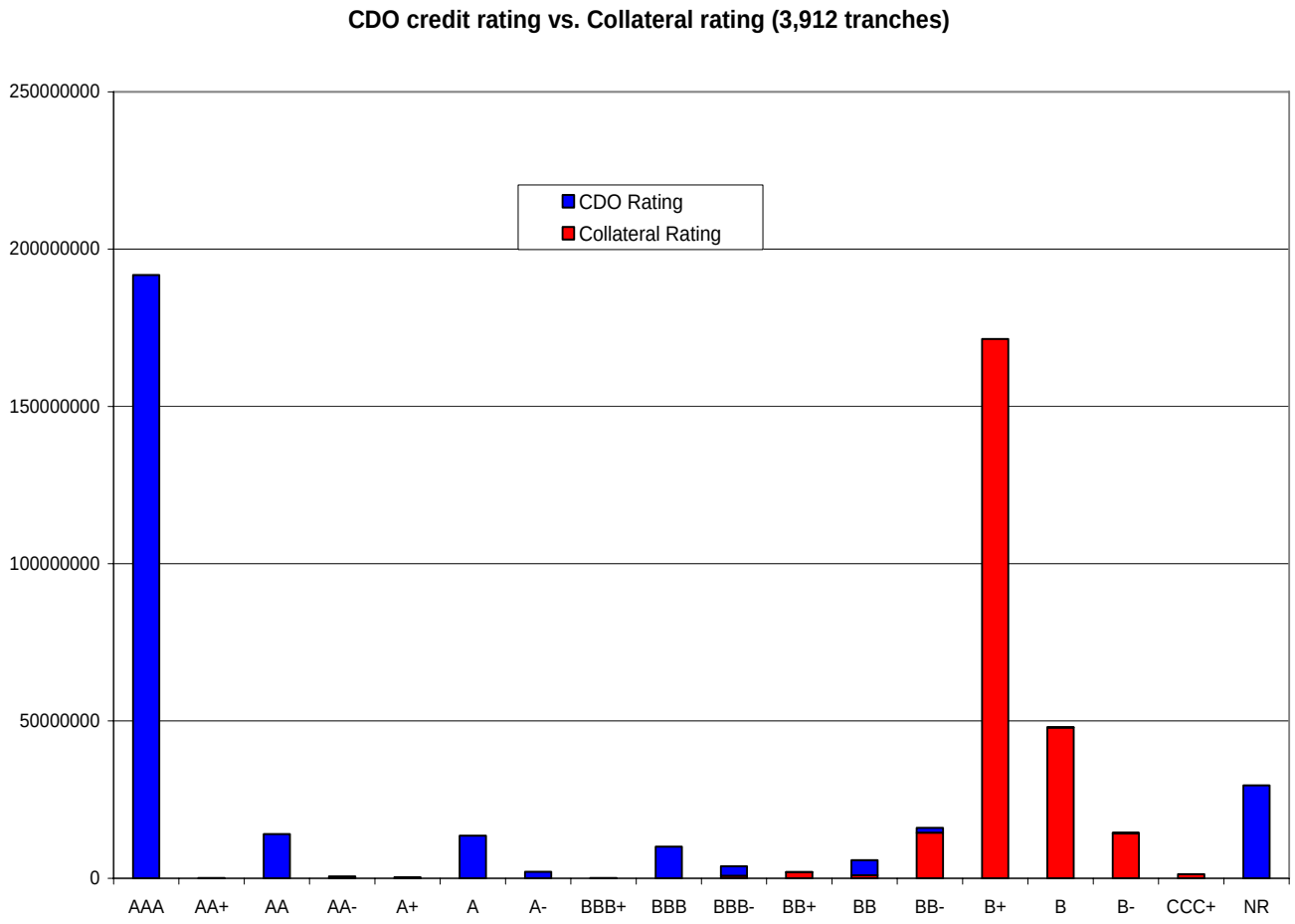
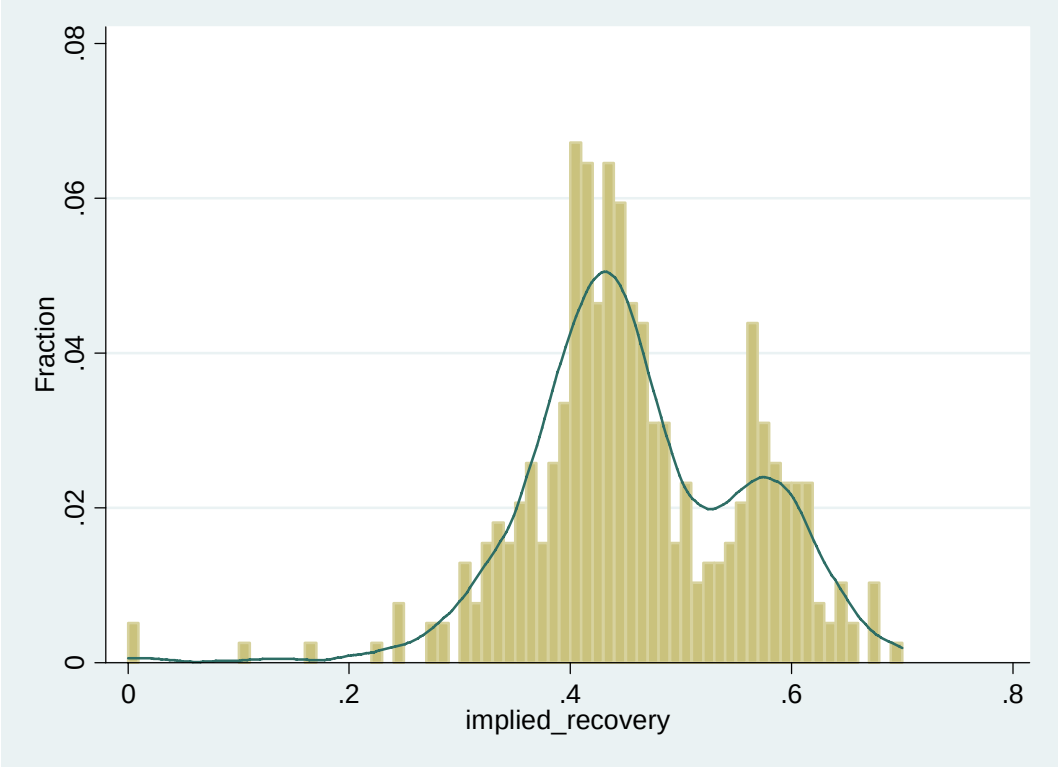
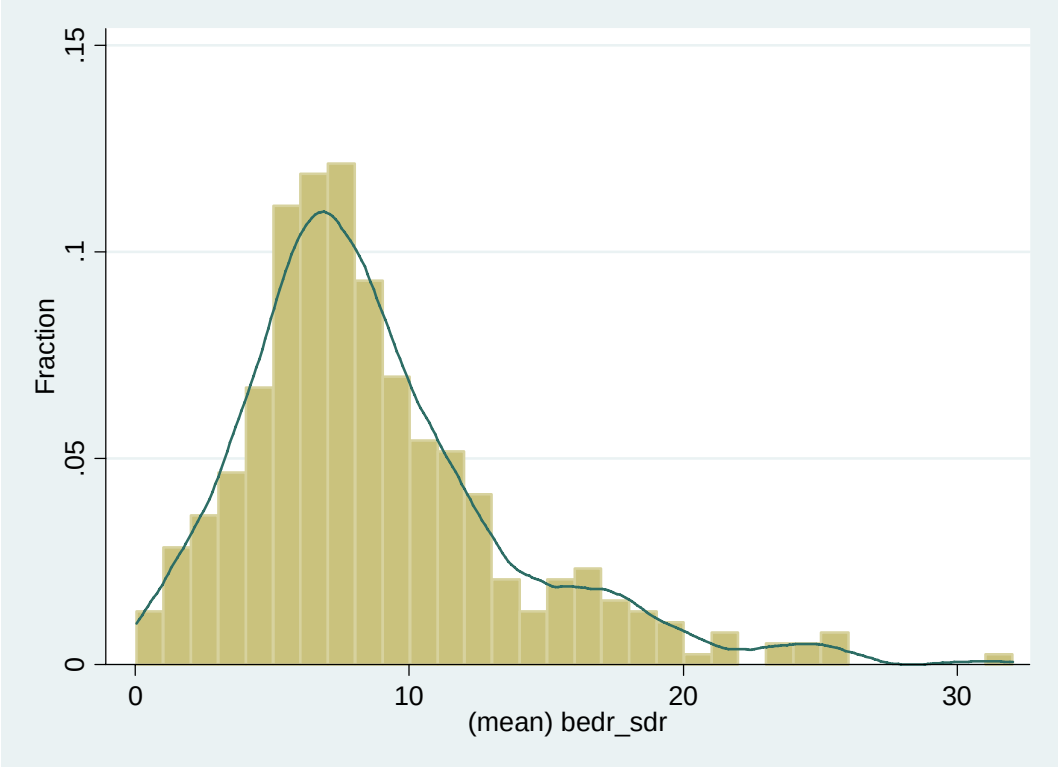


Figure 6: Implied Recovery Rates for AAA Tranches Based on Simulated BEDR



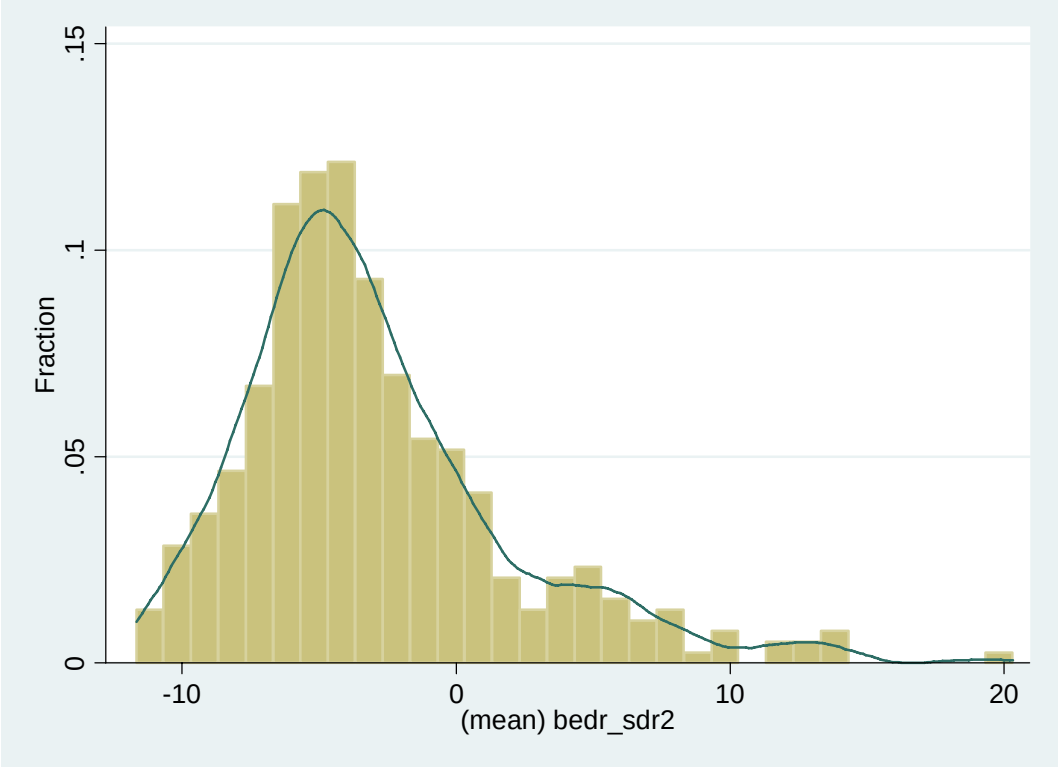
Implied Recovery					
Mean	25%	Median	75%	Std	Max
0.46	0.41	0.45	0.54	0.10	0.69

Figure 7a: Withstanding Portfolio Default BEDR-SDR for AAA Tranches



BEDR-SDR					
Mean	25%	Median	75%	Std	Max
8.69%	5.51%	7.66%	10.89%	4.89%	31.07%

Figure 7b: Withstanding Portfolio Default (BEDR-1std)-SDR for AAA Tranches



BEDR(1-std)-SDR					
Mean	25%	Median	75%	Std	Max
-3.02%	-6.20%	-4.05%	-0.82%	4.89%	19.36%

Figure 8: S&P CDO Evaluator

STANDARD &POOR'S

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CDO EVALUATOR HANDBOOK

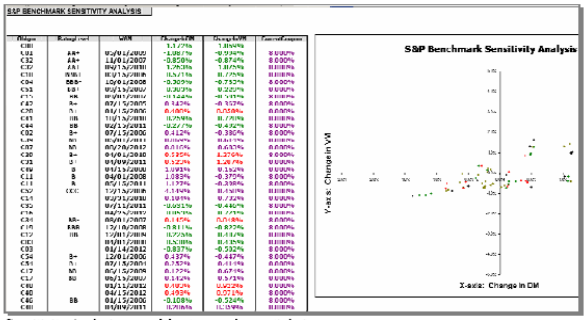
An introduction to and operational overview of Standard & Poor's CDO Evaluator tool, an automated spreadsheet application used for rapid, complex evaluation of the credit quality of CDO asset portfolios

STANDARD & POOR'S
STRUCTURED FINANCE GROUP
FEBRUARY 2006

2.10. Viewing Sensitivity Analysis

To perform Standard & Poor's benchmark sensitivity analysis on the current CDO, select the **S&P Benchmark Sensitivity Analysis** box on the *Run SDR/SLR* window (described in *Section 2.4. Running SDR and SLR Analysis* on page 37).

The sensitivity analysis is generated during SDR/SLR calculations and the results are displayed on the *Sensitivity Analysis* spreadsheet.



Sensitivity Analysis spreadsheet example, partial view

Sensitivity analysis generates a table of estimates indicating the effect of small changes in the par balance of each asset, along with an offsetting change in the par balances of the other assets, on the following figures:

* = REQUIRED INPUT

FIELD	DESCRIPTION
PERFORMING ASSETS AFTER SDR	Net asset balance of performing assets after taking out the defaulted amount based on the SDR stress, commensurate with a tranche rating. Computed as Perf.Coll.Balance*(1-SDR).
RECOVERY AMOUNT	Recovered amount that is expected to be collected on the projected defaults under SDR stress. Computed as Perf.Coll.Balance*SDR*Rec.Rate.
PV OF NET COUPON SPREAD	Principal equivalent of the excess spread left in the deal at the current tranche level.
TOTAL PRINCIPAL SUPPORTABLE	Sum of all three above components, represents tranche notional that can be supported at the given rating level.
LIABILITIES SENIOR & PARI PASSU	Actual notional amount of tranches outstanding at a given tranche level (includes all senior and pari passu tranches).
RATED OC (ROC)	The ratio of total principal supportable to liabilities senior and pari passu. Represents the effective over-collateralization at a given rating level, i.e.. how much notional can be supported vs. how much is actually issued (remains).
EXCESS COLLATERAL	Alternative representation of OC at each rating level, derived from ROC as follows: Excess Collateral = 1- 1/ROC. This tells what percentage of asset notional needs to be eliminated (added) in order for the transaction to provide *just enough* (i.e. ROC equals to 100%) support at a given rating level.

Table 1: Issuance Volume ($mil)

		BY TYPE:						BY ISSUER MOTIVATION:			
	TOTAL $	Cash Flow & Hybrid		Synthetic Funded		Market Value		Arbitrage		Balance Sheet	
		$	%	$	%	$	%	$	%	$	%
2004	157,418.5	119,531.3	76	37,237.2	24	650.0	0	146,998.5	93	10,419.8	7
2005	271,803.3	260,225.9	96	64,957.4	24	620.0	0	227,403.6	84	44,399.7	16
2006	551,709.6	414,742.9	75	89,042.7	16	47,924.0	9	472,197.7	86	79,511.9	14
2007	485,716.3	347,405.5	72	51,509.5	11	86,811.3	18	420,210.3	87	65,516.0	13
Total	1,466,647.7	1,141,905.6	78	242,746.8	17	136,005.3	9	1,266,810.1	86	199,847.4	14

Source: Global CDO Market Issuance Data, SIFMA/Thomson Financial

Table 2: Sample Issuance Volume

	All CDOs			US$ denominated			Euro denominated		
Year	**CDO (number)**	**Tranches (number)**	**Total ($mil)**	**CDO (number)**	**Tranches (number)**	**Total ($mil)**	**CDO (number)**	**Tranches (number)**	**Total ($mil)**
2000	4	33	1,840	4	33	1,840	0	0	0
2001	10	74	5,793	8	60	4,577	2	14	1,216
2002	16	115	5,955	13	88	4,789	3	27	1,166
2003	41	297	16,666	35	244	14,613	6	53	2,053
2004	66	477	29,137	53	354	22,785	13	123	6,353
2005	99	741	51,139	80	573	40,313	19	168	10,826
2006	169	1,261	86,573	126	909	62,620	43	352	23,953
2007*	126	922	74,521	86	622	47,943	40	300	26,579
Total	531	3,920	271,624	405	2,883	199,479	126	1,037	72,145

Table 3: CDO and tranche size ($mil)

Panel A Summary Statistics for CDO size							
Year	**Mean**	**25th Percentile**	**Median**	**75th Percentile**	**Std**	**Min**	**Max**
2000	460	401	414	519	102	400	612
2001	579	438	511	750	194	321	895
2002	372	307	397	432	72	250	482
2003	406	306	356	439	165	212	1,023
2004	441	354	408	500	162	200	1,107
2005	517	364	499	600	209	210	1,250
2006	512	400	467	544	254	286	3,000
2007	591	424	500	647	343	300	3,529
Entire sample	512	400	460	557	257	200	3,529
Panel B Summary Statistics for Tranche Size							
2000	56	15	23	37	90	1.2	365
2001	79	11	22	50	145	1.8	654
2002	54	8	17	34	90	2.0	381
2003	58	10	19	41	96	0.5	847
2004	63	12	24	45	99	0.1	633
2005	69	15	27	57	108	0.02	681
2006	69	18	29	53	106	1.0	1,080
2007	81	23	35	72	124	0.5	1,849
Entire sample	70	16	28	57	109	0.02	1,849

Table 4: Payment Priority Structure for Octagon Investment Partners V Ltd.

Panel A: Octagon Investment Partners V Deal Structure

Class	Rating	Original Principal Balance	Interest Rate
A	AAA	US$ 236,250,000	3-MONTH LIBOR + 60.00bp
B	A	US$ 21,000,000	3-MONTH LIBOR + 175.00bp
C	BBB	US$ 15,000,000	3-MONTH LIBOR + 300.00bp
D	BB	US$ 4,500,000	3-MONTH LIBOR + 825.00bp
Pref. shares	NR	US$ 23,250,000	Residual

Panel B: Octagon Investment Partners V Interest Waterfall

Priority	Payment
1	First, taxes, filing, and registration fees; second, trustee fees; third, capped administrative expenses
2	Hedge payments
3	Senior management fees
4	Class A interest
5	Class A coverage tests. If fail, pay down class A
6	Class B interest.
7	Class B coverage tests. If fail, pay down class A and then class B. I
8	Class B deferred interest
9	Class C interest
10	Class C coverage tests. If fail, pay down class A, class B, and then class C.
11	Class C deferred interest
12	Class D interest
13	Class D coverage tests. If fail, pay down class A, class B, class C, and then class D.
14	Class D deferred interest.
15	During the reinvestment period, if class D overcollateralization test is not satisfied, deposit to collection account as principal until class D reinvestment O/C test is satisfied.
16	Deposit to collection account as principal proceeds amount that principal proceeds were used to pay (1)-(4), (6), (8), (9), (11), (12), and (14) above.
17	Subordinated hedge termination payment
18	Payments due in clause 1 above the capped amount
19	Subordinated management fee
20	At the discretion of the collateral manager, with the consent of a majority of the preference shares, to deposit in the collection account as principal
21	Preference shares up to an internal rate of return (IRR) of 14%
22	If IRR is 14% or greater, 20% of remaining interest proceeds to the collateral manager as an incentive management fee and 80% of any remaining interest proceeds.

Panel C: Octagon Investment Partners V Principal Waterfall

Priority	Payment
1	Items 1 to 14 in the interest waterfall
2	If payment date is a redemption date, the redemption prices of all the notes and any preference shares to be redeemed. If payment date requires a special redemption, pay sequentially A, then B then C then D, until each note is paid in full as required. If payment date requires a partial redemption, pay pro rata to the class A, B, C, and D notes and the preference shares.
3	During the reinvestment period to purchase additional collateral
4	After the reinvestment period, pay down class A notes until paid in full
5	After the reinvestment period, pay down class B notes until paid in full
6	After the reinvestment period, pay down class C notes until paid in full
7	After the reinvestment period, pay down class D notes until paid in full
8	After the reinvestment period, to the payment of (17)-(19), (21) and (22) of the interest waterfall.

Table 5: Par Value of Notes Issued by CDOs, by Rating (in $ mil)

	2000	2001	2002	2003	2004	2005	2006	2007	Total
AAA	1,248 (67.8%)	4,363.9 (75.3%)	4,490.8 (75.4%)	12,316.2 (73.9%)	20,799.0 (71.4%)	36,293.7 (71.0%)	60,962.4 (70.4%)	51,284.0 (68.8%)	191,757.9 (70.6%)
AA	65.0 (3.53%)	312.6 (5.4%)	218.0 (3.7%)	620.3 (3.7%)	1,191.1 (4.1%)	2,580.2 (5.0%)	4,848.2 (5.6%)	4,816.6 (6.5%)	14,651.9 (5.4%)
A	35.0 (1.9%)	260.4 (4.5%)	297.5 (5.0%)	889.0 (5.3%)	1,720.8 (5.9%)	3,291.0 (6.4%)	4,924.6 (5.7%)	4,504.6 (6.0%)	15,922.7 (5.9%)
BBB	58.0 (3.2%)	122.6 (2.1%)	252.5 (4.2%)	670.0 (4.0%)	1,478.7 (5.1%)	2,552.7 (5.0%)	4,389.3 (5.1%)	3,658.8 (4.9%)	13,182.5 (4.9%)
BB	13.0 (0.7%)	173.0 (3.0%)	119.9 (2.0%)	236.8 (1.4%)	370.8 (1.3%)	772.8 (1.5%)	2,369.9 (2.7%)	2,329.6 (3.1%)	6,385.8 (2.4%)
B	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	10.0 (0.0%)	15.0 (0.0%)	58.0 (0.1%)	111.6 (0.2%)	194.7 (0.1%)
NR	420.7 (22.9%)	560.2 (9.7%)	576.0 (9.7%)	1,933.9 (11.6%)	3,567.5 (12.2%)	5,633.4 (11.0%)	9,020.2 (10.4%)	7,816.3 (10.5%)	29,528.2 (10.9%)
Total	1,839.7 (100.0%)	5,792.6 (100.0%)	5,954.7 (100.0%)	16,666.1 (100.0%)	29,137.8 (100.0%)	51,138.8 (100.0%)	86,572.9 (100.0%)	74,521.5 (100.0%)	271,624 (100%)

Table 6: Deal Structure

	CDOs with tranche:		Tranche amount as a % of the par value of the CDO:						
Rating	**N**	**%**	**Mean**	**SD**	**p10**	**p25**	**Median**	**p75**	**p90**
AAA	530	100%	71.4	7.3	63.7	68.2	73.0	75.4	77.4
AA+	4	0.8%	5.4	2.7	2.6	3.3	5.1	7.5	8.9
AA	427	80%	6.5	3.8	3.7	4.7	6.0	7.7	9.1
AA-	9	2%	11.5	4.8	5.6	8.5	10.1	14.0	10.6
A+	17	3%	5.4	2.6	2.4	3.2	5	6.8	9
A	425	80%	6.3	3.8	4.5	5	5.8	6.6	8.4
A-	65	12%	6.6	2.2	4.4	4.9	6.7	8.5	9.1
BBB+	8	2%	3.3	3.4	0	1.3	2.2	4.2	10.9
BBB	411	77%	5	1.7	3.3	3.9	4.6	5.8	7.1
BBB-	97	18%	5.2	2	2.6	4.1	5.5	6.3	7
BB+	9	2%	1.4	1.1	0	0.6	1.6	2.5	3.1
BB	304	57%	3.2	0.9	2.1	2.7	3.2	3.8	4.3
BB-	69	13%	3.8	1.5	2.3	3.0	3.8	4.3	5.2
B+	0	0%							
B	10	2%	1.8	0.3	1.4	1.7	1.9	2	2.2
B-	3	0.6%	1.1	0.6	0.5	0.5	1	1.8	1.8
NR	524	99%	10.3	6.1	7.3	7.8	8.8	10.5	14.0

Table 7: Uniformity of Deal Structures

Panel A: Commonly Observed Deal Structures

	Number (CDOs)	%	Contains tranches rated:
Type 1	209	40%	AAA, AA, A, BBB, BB, NR
Type 2	69	13%	AAA, AA, A, BBB, NR
Type 3	38	7%	AAA, AA, A, BBB- , BB- , NR
Type 4	20	4%	AAA, A, BBB, BB, NR
Other*	197	37%	
All CDOs	**531**	**100%**	

*Each structure in this category appears less frequently than Type 4

Panel B: Asset & liability structures of four major deal types

Collateral quality frequency (when available)				
	Type 1	**Type 2**	**Type 3**	**Type 4**
BBB-	1			
BB+	1			
BB	1			
BB-	8	5		2
B+	153	49	19	18
B	38	10	18	
B-	5	3		
Total	**207**	**67**	**37**	**20**
Liabilities: Rated tranches as % of deal par				
	Type 1	**Type 2**	**Type 3**	**Type 4**
% AAA				
Median	73.1	74.3	66.8	76.1
Mean	71.9	70.1	66.7	75.6
SD	4.2	10.8	3.5	2.2
% NR				
Median	8	9.3	10	8.4
Mean	8.6	11.9	10	9.1
SD	2.2	9.9	1.1	1.9
% AA				
Median	5.7	5.1	8	
Mean	6	5.5	7.8	
SD	1.9	2.2	1.5	
%A				
Median	5.4	5.7	6	8.2
Mean	5.6	6.2	5.9	8.1
SD	1.2	2.3	1.1	1.4
%BBB				
Median	4.3	6.3		4.3
Mean	4.6	6.3		4.1
SD	1.3	1.7		0.8

%BBB-				
Median			6	
Mean			6	
SD			0.9	
%BB				
Median	3.2			3.1
Mean	3.3			3.2
SD	0.9			0.5
%BB-				
Median			3.6	
Mean			3.6	
SD			1.0	

Table 8: Collateral Restrictions

	CDOs with restriction		Conditional Distribution Statistics						
	N	%	Mean	SD	10th %	25th %	Median	75th %	90th %
MIN senior secured loans	355	67%	86.8	7.4	80	85	90	90	95
MIN senior loans	58	11%	84.3	10.1	75	80	85	90	95
MAX second lien loans	244	46%	11.7	10.1	5	10	10	12.5	15
MAX high-yield bonds	144	27%	6.9	4.4	5	5	5	10	15
MAX corp. bonds	25	5%	7.7	5.5	5	5	5	10	10
MAX structured fin securities	307	58%	5.1	3.9	3	3	5	5	7.5
Near default securities:									
MAX current pay	223	42%	6.0	2.2	5	5	5	7.5	7.5
MAX rated CCC+ or lower	309	58%	8.9	9.5	5	5	7.5	7.5	15
MAX debtor-in-possession loans	359	68%	6.7	3.5	5	5	5	7.5	10
MAX discounted obligations	115	22%	7.0	2.4	5	5	7.5	8	10
MAX obt. in bankruptcy exch.	14	3%	4.1	2.3	2	2	5	5	5
Collateral interest type:									
MIN floating rate	197	37%	92.8	8.1	85	90	95	95	100
MAX fixed rate	322	61%	8.1	9.4	3	5	5	8	15
Payment frequency of collateral:									
MAX paying less than quarterly	275	52%	9.1	5.1	5	5	10	10	15
MAX paying less than semiannual.	158	30%	6.3	3.6	5	5	5	5	10
MAX pay-in-kind	254	48%	5.3	3.6	2.5	5	5	5	5
MAX zero coupon	164	31%	4.2	1.5	2	2.5	5	5	5
MAX maturing after CDO	242	46%	2.6	1.3	2	2	2.5	3	4
Diversification:									
MAX conc. in single issuer	356	67%	2.2	1.0	1.5	1.6	2	2.5	3
MAX conc. in top 3 issuers, each	36	7%	2.9	1.2	2	2	2.5	3	5
MAX conc. in single industry	133	25%	8.9	2.2	8	8	8	8	10
MAX conc. in top 2 ind., each	37	7%	11.6	4.2	10	10	10	12	14
MAX conc. in top 3 ind., each	54	10%	13.0	7.3	10	10	12	12	12
Domicile of obligors:									
MAX non-US	257	63%	16.9	5.0	10	15	20	20	25
MAX non-US/UK/Canada	62	15%	10.5	6.3	3	5	10	15	17.5
Currency of obligations:									
MAX non-US dollar	21	5%	6.4	6.4	0	0	5	10	15
MAX non-Euro	111	88%	28.0	10.2	19.5	25	30	30	35
Rated by:									
MIN rated by S&P	19	4%	86.1	9.5	80	85	90	90	90
MAX rated by other agency	37	7%	10.0	2.4	10	10	10	10	10

Table 9: Level of portfolio defaults that rated tranches must/can withstand in rating agency simulation model

Scenario default rate = level of portfolio defaults that a tranche *should be able to* withstand (paying timely interest and ultimate principal by maturity) in cash-flow simulations; it is equal to the level of defaults in the collateral pool that has no greater than x% chance of being exceeded, where x% is the historical default rate on a corporate bond of the same rating and maturity as the tranche in question.

Break-even default rate = level of portfolio defaults that a tranche *can* withstand, according to underwriter cash-flow simulations

		Scenario Default Rate						Breakeven Default Rate					
Rating	**N(tranches)**	**N**	**Mean**	**SD**	**P25**	**Median**	**P75**	**N**	**Mean**	**SD**	**P25**	**Median**	**P75**
AAA	1,082	903	44.1	9.1	37.1	40.6	51.9	762	51.9	11.7	43.2	48.5	59.2
AA+	4	3	43.4	12.4	30.8	44.0	55.5	3	48.1	12.6	36.5	46.3	61.5
AA	458	403	40.5	9.3	32.8	36.9	49.0	333	47.1	10.5	39.3	43.5	55.0
AA-	13	10	32.5	4.1	27.7	32.5	36.0	3	41.0	6.0	34.0	44.5	44.5
A+	21	21	29.6	3.1	27.4	29.6	31.4	18	36.3	6.0	31.1	36.0	40.0
A	472	418	36.0	9.4	28.9	32.0	45.1	361	39.6	9.5	32.9	35.7	47.7
A-	83	74	30.4	6.6	26.3	29.1	32.2	48	33.4	5.6	29.5	31.4	35.6
BBB+	10	6	29.0	7.0	23.3	28.1	28.9	6	33.5	7.5	29.4	29.4	36.0
BBB	507	448	29.4	8.3	24.3	26.2	32.5	402	31.9	8.8	26.4	28.2	35.7
BBB-	108	88	31.7	7.8	25.4	30.5	35.1	44	32.8	8.7	26.8	28.3	40.4
BB+	12	6	22.1	2.8	20.7	22.0	23	4	28.3	2.4	26.8	28.1	29.9
BB	345	307	24.3	8.5	18.5	20.3	27.2	278	27.9	8.3	22.3	24.1	34.7
BB-	82	59	26.9	8.7	20.4	24.2	37.0	12	29.4	8.5	22.8	27.1	34.8
B+	0												
B	10	5	28.7	8.4	20.7	34.2	34.9	3	29.5	7.0	21.8	31.1	35.6
B-	3	3	22.0	9.4	16.0	17.1	32.9	3	30.4	9.6	24.7	24.9	41.5
Total	**3,210**												

Table 10: CDO Credit Rating Regressions

	(1)	(2)	(3)	(4)	(5)
SDR	-0.22 ***	-0.37 ***	-0.43 ***	-0.50***	-0.46***
	(0.0080)	(0.014)	(0.011)	(0.0086)	(0.018)
Collateral BB+			-12.84***	0	1.29
			(1.36)	(0)	(1.52)
Collateral BB			-12.85***	-1.79	0
			(1.02)	(1.58)	(0)
Collateral BB-			-11.09***	0.68	2.10
			(0.54)	(0.44)	(1.41)
Collateral B+			-9.70***	0.79*	2.42*
			(0.43)	(0.43)	(1.42)
Collateral B			-7.15***	1.479**	3.08**
			(0.49)	(0.58)	(1.51)
Collateral B-			-4.10***	3.01***	5.17***
			(0.78)	(1.02)	(1.75)
Collateral CCC+			0	-4.91**	0
			(0)	(2.41)	(0)
Exp. default rate				2.56***	1.99***
				(0.26)	(0.28)
Collateral WAM				1.39***	1.22***
				(0.076)	(0.070)
Log(tranche par)					-0.40***
					(0.055)
Num. tranches					-0.059
					(0.037)
Minimum O/C					-0.035*
					(0.021)
Year 2001		1.44***	0	0	0
		(0.51)	(0)	(0)	(0)
Year 2002		1.44**	0	-2.30***	0
		(0.58)	(0)	(0.53)	(0)
Year 2003		0.81*	-0.50	-3.05***	-0.55*
		(0.47)	(0.30)	(0.47)	(0.32)
Year 2004		1.37***	0.027	-3.27***	-0.81**
		(0.45)	(0.30)	(0.42)	(0.32)
Year 2005		2.28***	0.65**	-3.16***	-0.73**
		(0.42)	(0.28)	(0.41)	(0.30)
Year 2006		2.62***	0.96***	-3.23***	-0.77**
		(0.40)	(0.25)	(0.38)	(0.30)
Year 2007		8.19***	6.53***	0	2.68***
		(0.49)	(0.40)	(0)	(0.55)
Constant	13.45***	15.43***	28.49***	6.46***	12.14***
	(0.26)	(0.56)	(0.75)	(1.49)	(2.84)
Adjusted R^2	0.37	0.62	0.70	0.83	0.86
Observations	2,757	2,757	2,630	2,561	2,224