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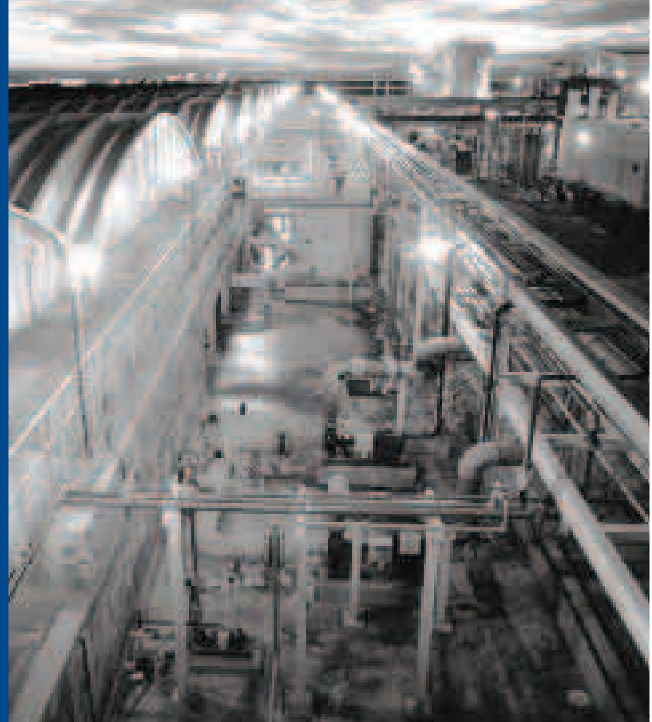
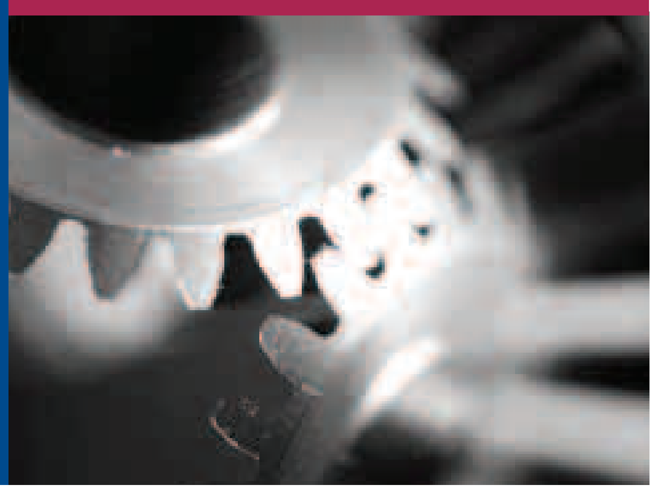


FIRST EDITION 2005

Structured Credit Insights

Instruments, Valuation and Strategies

Primary Analysts: *Sivan Mahadevan*
Peter Polanskyj
Vishwanath Tirupattur
Ajit Kumar, CFA



The First Edition

This first edition of our *Structured Credit Insights* handbook contains 44 reports on tranched credit instruments, markets, and investment strategies, many of which come from our *Credit Derivatives Insights* and CDO research publications. Section A, entitled "Getting Started," contains primers on both basic and state-of-the-art cash and synthetic CDOs, the tranched indices, first-to-default baskets, an intuitive guide to correlation, and common sensitivity measures. The remaining sections focus on valuation and sensitivity, investment strategies, market themes, performance, and cash and synthetic convergence themes. There is also a glossary of over 100 terms used in the market.

We hope Morgan Stanley clients find this handbook useful, and we welcome any feedback so that we can improve future editions.

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Morgan Stanley & Co. Incorporated
April 14, 2005

Structured Credit Insights

Instruments, Valuation and Strategies

SECTION D. MARKET THEMES

SECTION E. PERFORMANCE

SECTION F. CASH AND SYNTHETIC CONVERGENCE THEMES

SECTION G. FTD BASKET INVESTMENT THEMES

Introduction

"Everything should be made as simple as possible, but not simpler."
- Albert Einstein

In strategically approaching the structured credit market, one of the most daunting tasks is balancing complexity and simplicity. As in the physical sciences, expressing concepts in their simplest form is appealing. Yet, the state-of-the-art in financial engineering, combined with increasing demand for complexity from credit investors, can make this reverse-engineering process a rather challenging task. Thinking about concepts intuitively and strategically in a straightforward manner remains one of our key goals in the structured credit research process.

The term structured credit means different things to different people, but we tend to think of it quite literally. We define structured credit as the process of taking plain vanilla credit instruments and "structuring" them to meet certain goals, which can include diversification, loss or payment redistribution, hedging, principal protection, achieving ratings targets or stability, and altering a portfolio's sensitivities to spread movements and defaults. Structured credit instruments can be focused on single names or portfolios, but for the purposes of this book, we think of structured credit in portfolio form and focused on corporate credit risk. We have addressed single names in a separate book (see "Credit Derivatives Insights – Single Name Instruments and Strategies," February 2005).

Tranched credit, by far the largest portion of the structured credit business today, is really two markets that share a common lineage, one in which underlying collateral is cash assets (bonds and loans) and the other in which it is synthetic (credit default swaps). In our view, the two markets are conceptually more similar than they are different, but for many reasons that we shall discuss throughout this book, they have important structural differences and can be culturally disparate, as well. Nevertheless, we have devoted quite a bit of our research efforts over the years to both markets, and in this book we will discuss them from many different perspectives and also comment on how they might converge again in the future.

WHAT'S IN A NAME?

Perhaps one of the most confusing aspects of the tranched credit market is the plethora of names used to describe and differentiate what is essentially a single idea. The French word *tranche* means slice, as in *tranche de pain* (slice of bread). If one thinks of the full loaf as being a blended credit portfolio, then the slices are the pieces that investors can use to gain exposure to the portfolio, although these slices can differ in terms of thickness, exposure to portfolio losses and cashflows.

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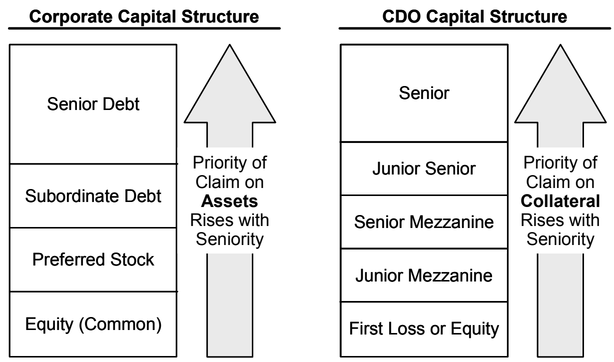
A commonly used product term that describes tranched credit risk is CDO, or collateralized debt obligation. As the term suggests, a CDO is a series of obligations that are dependent on the performance of an underlying portfolio (the collateral). There are many similarly used terms, including CBO, CLO, CSO and Synthetic CDO, which essentially differentiate bonds, loans, or synthetic collateral. As we address in great detail throughout this book, the correlation of default events is critical to valuing CDO products, and, as such, the term "correlation products" is often used synonymously with CDOs. Finally, while they look like credit default swaps on paper, first-to-default baskets (FTDs) certainly feel like tranched credit products from a risk perspective but differ from CDOs in important ways, which we will address in this book, as well.

TRANCHES – THE CORPORATE CAPITAL STRUCTURE ANALOGY

Market participants tend to think of the various obligations of a CDO as a capital structure, much like the capital structure of a company. The bottom-most component is the equity, which has most of the upside of the collateral portfolio but is also the first to experience losses if the enterprise fails. As in common stock of a company, equity tranches of CDOs have limited liability, meaning that an investor's loss is limited to the principal or notional exposure. The remaining obligations in a CDO's capital structure are more "senior" than the equity, meaning that they have varying claims on the assets (remaining collateral) of the enterprise. These obligations can still be relatively risky, the corporate analogies being everything from preferred stock to senior debt. The ultimate success or failure of a CDO is a function of the amount of "losses" that are incurred in the collateral portfolio, although the road to this ending point can be bumpy as well, given fluctuations in market prices of both the underlying collateral and tranches of the CDO.

exhibit 1
The CDO Capital Structure



Source: Morgan Stanley

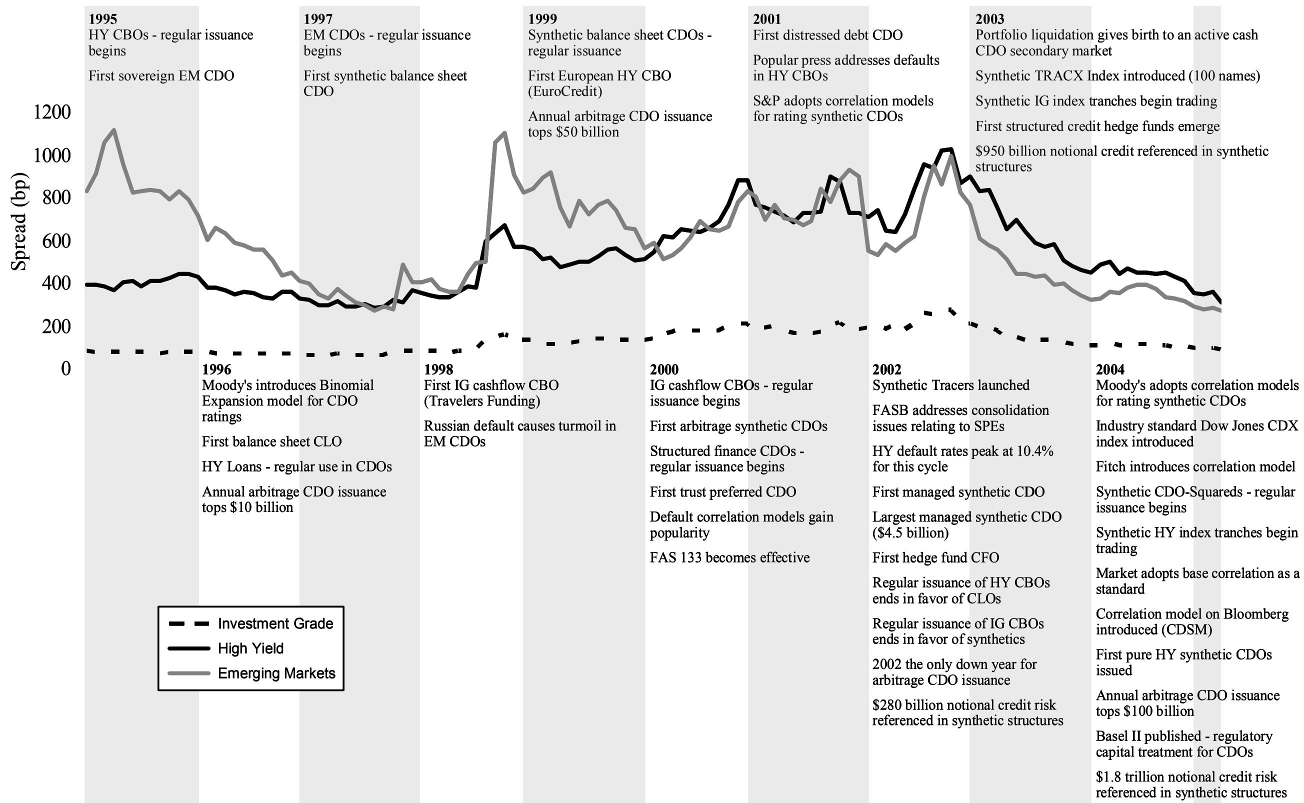
FINANCIAL ENGINEERING – PRIORITIZING PAYMENTS AND LOSSES

The simplest CDO structures are ones where payments to the various tranches are fixed, and the priority of losses follows a bottom-up pattern: the first losses go to the equity tranche, and then move up in the capital structures as losses grow beyond the "thickness" of the tranches. Today's tranched index market (CDX tranches) follows this format, which makes their valuation relatively simple. But complexity increases, both in today's state-of-the-art synthetic CDOs, and in cash CDOs, where the concept of a cashflow waterfall (top down) and triggers can make their "fair" valuation much more difficult.

THE COMMON LINEAGE – A BRIEF HISTORICAL TOUR

The first CDO transactions date to the late 1980s, when Morgan Stanley and other investment banks literally bumped into each other at the steps of the ratings agencies in an attempt to securitize portfolios and distribute the resulting collateralized obligations in rated form. Marshal Salant, and the many who have worked with him at Morgan Stanley over the years, are generally credited for building the market for CDOs in the early 1990s, through structures that were referred to as repacks (repackaging of credit risk). Regular issuance of CDOs started in 1995, and there were many varieties. In the cash space, underlying collateral ranged from high yield bonds to middle market bank loans and sovereign emerging markets debt. Balance sheet CDOs referred to transactions where financial institutions moved bonds and loans from their balance sheets to the capital markets via securitizations. Arbitrage CDOs were structures where the difference in price between the assets of the portfolio and cost of the liabilities (of the CDO, including fees) left enough of a residual payment (allocated to the equity tranche) to make the exercise worthwhile. The "CDO arbitrage," which is the excess risk premium in the market above and beyond some estimate of default risk, was (and, in many cases, continues to be) the motivation for the creation of CDOs. Moody's introduced an important ratings model for CDOs in 1996.

exhibit 2
A Structured Credit Time Line



Source: Morgan Stanley

In the cash CDO markets, 1997 marked the beginning of regular issuance of emerging markets CDOs, and the two years that followed saw quite a bit of emerging markets volatility. The short-lived history of investment grade cash CBOs started in 1998 and really ended in 2002 in favor of synthetic structures. 1999 marked the first European cashflow CBO, and in the same year, global issuance for arbitrage CDOs topped $50 billion, mainly due to CBOs backed by high yield bonds. 2002 marked the peak of high yield default rates for that credit cycle and also led to the demise of high yield CBOs in favor of leveraged loan backed CLOs. This was the only year where cashflow CDO issuance was down on a year-over-year basis.

The synthetic CDO market started in 1997 when the first synthetic balance sheet CDO was issued. Such structures were common during the late 1990s until many of the institutions (mainly banks) accomplished what they intended to do. At the same time, the underlying credit default swap market matured enough, and investment grade spreads widened enough to allow for the issuance of arbitrage synthetic CDOs in 2000. 2002 was a key year for the synthetic CDO market, with numerous fallen angel defaults causing pricing stress, leading to the popularity of managed structures.

The structured credit market, in its various forms, was largely a bespoke market, meaning that each transaction was unique, but the market was fragmented and investors never expected much secondary market liquidity. Yet in early 2003, two events served to inject a fair amount of liquidity into the secondary market. In the cash CDO markets, a financial institution with a large portfolio of senior notes hired a money manager to help liquidate its CDO portfolio, an action which overnight brought in many niche buyers and jump-started a secondary market for cash CDOs.

At the same time, in the synthetic space, an even more dramatic event occurred in 2003. The growth of the credit default swap market permitted the creation of a 100-name standard index (Dow Jones TRAC-X[SM]) traded by multiple dealers, the first time such a broad index had been created. Dealers began making markets in standardized tranches of this index, providing for the first time a two-way market and important pricing transparency. The term "correlation," previously a concept discussed only by analytics providers and risk managers, began the process of becoming more mainstream. The index tranche market itself has evolved quite a bit, with today's products centered around the Dow Jones CDX family of indices. With tranched indices in place, nearly $1 trillion of notional credit risk was referenced through synthetic structures in 2003. In 2004, volumes almost doubled, with $1.8 trillion of credit risk referenced through synthetic structures, while structural complexity increased dramatically. The rating agencies became more aggressive about catching up to a market that passed them by. Synthetic high yield CDOs emerged in 2004, as well. The early part of 2005 saw a continuation of these themes, particularly on the structural evolution front.

THE TRANCHED CREDIT MARKET TODAY

Today, the index tranche market is very much the "on-the-run" market for synthetic CDOs. Many billions of dollars in notional risk are traded each week through benchmark products in the US, Europe, and Asia, spanning investment grade and high yield markets. The index tranche market has introduced valuation transparency, to a point where a standardized correlation model has emerged. Market implied correlation has become an important basis for valuation.

As liquidity and transparency developed in the tranche index market, it has benefited the bespoke market as well, providing a way for arrangers to hedge market risk, and motivating the creation of perhaps more complicated structures that are better suited to meet the risk and return goals of specific investors. Structures where underlying collateral are CDO tranches themselves (referred to as CDO-squared transactions) are common today, as are structures that offer some form of principal protection, fix recoveries, allow for subordination levels to adjust, and are linked to other markets (interest rates, equities, and commodities) in different ways. Furthermore, as the underlying credit default swap markets develop in the high yield space, synthetic CDOs with a pure high yield focus are becoming more feasible and provide investors with an alternative to cash CDOs.

In the corporate credit space, the cash CDO market has been dominated by structures backed by leveraged loans. These CLO structures have in many ways encouraged the leveraged loan market itself to grow. Shorter maturities, more debt seniority, and higher historical recoveries have made CLOs far more accepted in the market place versus high yield bond backed CBOs, which dominated the cash CDO markets several years ago.

One of the biggest recent changes in the structured credit markets is the popular use of "correlation" models to aid in the valuation of tranches. We have devoted quite a bit of our research efforts over the years to addressing the importance of correlated default risk from intuitive, quantitative, and market perspectives, which can be seen throughout this book (see Chapter 5 for an intuitive tour through this concept).

WHERE IS THE MARKET GOING?

Although difficult to measure, the amount of credit risk in structured credit instruments today is quite large, as is the investor base. Much like there was concern and cynicism regarding single-name default swaps years ago, we see some parallels in the structured credit markets (we have devoted an entire chapter to it – see Chapter 27). Structured credit instruments have brought in (or perhaps even created) an investor base that is more focused on capturing and even leveraging the risk premium in the market over and above some measure of default risk. This process, we argue, is a secular change for the corporate credit markets, but has been in the making for years. The net result is that there is more leverage in the credit market and more investor diversity; resulting volatility of the credit market has increased, but perhaps so has the liquidity. Analogies to the mortgage-backed securities markets and even the interest rate and equity markets can easily be drawn.

We expect structured credit instruments to continue to be an important part of the overall product makeup of the corporate credit markets, given the size and maturity of the market and demand from investors during all parts of the corporate credit cycle. We also expect more convergence in valuation themes between different parts of the market, particularly the cash and synthetic worlds, as we address in Section F of this book.

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ACKNOWLEDGEMENTS

We would like to acknowledge the many other Morgan Stanley strategists who were either involved in or who motivated some of the research ideas in the various chapters of this book, including Anisha Ambardar, Hitesh Arora, Brian Arsenault, Viktor Hjort, Rizwan Hussain, Young-Sup Lee, Rachel Ng, Greg Peters, and Andrew Sheets. We would also like to acknowledge our structured credit businesses within Morgan Stanley whose team members have played a significant role in making the tranched credit markets more liquid and transparent over the years, permitting investors and researchers to take a strategic approach to this market. We would also like to thank our creative services team, especially Dan Long, for their assistance in preparing this book. Finally, we very much appreciate the immeasurable amount of feedback that we have received on our reports from Morgan Stanley clients.

Section A

Structured Credit Insights

Getting Started

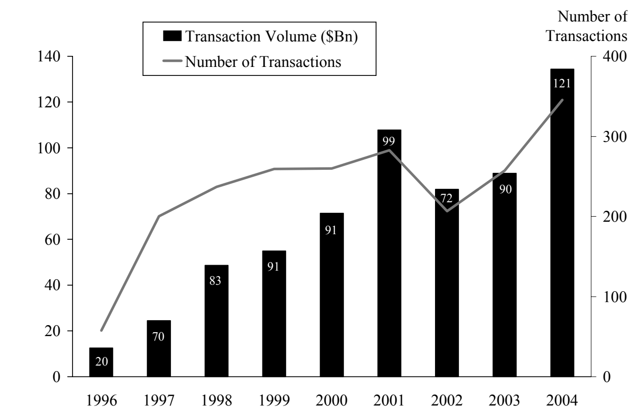
Please see additional important disclosures at the end of this report.

chapter 1 A Cash CDO Primer

INTRODUCTION

The emergence of a market for Collateralized Debt Obligations (CDOs) is a significant development in the evolving area of securitization of credit risk. The cash CDO[1] market has now been in existence for more than 15 years, with consistently substantial issuance volumes since the mid 1990s and is firmly established as a mature asset class having withstood the peaks and troughs of a full credit cycle (Exhibit 1). As depicted in Exhibit 2, CDOs have emerged as a major segment of the overall asset-backed securities market as well.

exhibit 1
Growth in CDO Issuance



Sources: Thomson Financial Service, Moody's Investors Service, Fitch IBCA, Inc., Asset-Backed Alert, MCM Corporate Watch, S&P, Morgan Stanley

While the CDO market started as an efficient mechanism for managing credit risk on bank balance sheets and for obtaining regulatory capital relief, CDOs have evolved into complex instruments to achieve leveraged returns to investors with a wide range of credit risk appetites. Today's CDOs encompass a vast array of underlying assets ranging from unsecured debt instruments such as high grade, high yield and emerging market bonds; secured debt instruments such as middle market and leveraged loans; subordinated instruments such as trust preferred securities, to all forms of structured finance obligations including ABS, CMBS and RMBS, hedge fund obligations and finally CDO tranches themselves. Exhibit 3 illustrates the diversity of CDO collateral by providing a comparison of the collateral composition of new issue CDOs between 1998 and 2004.

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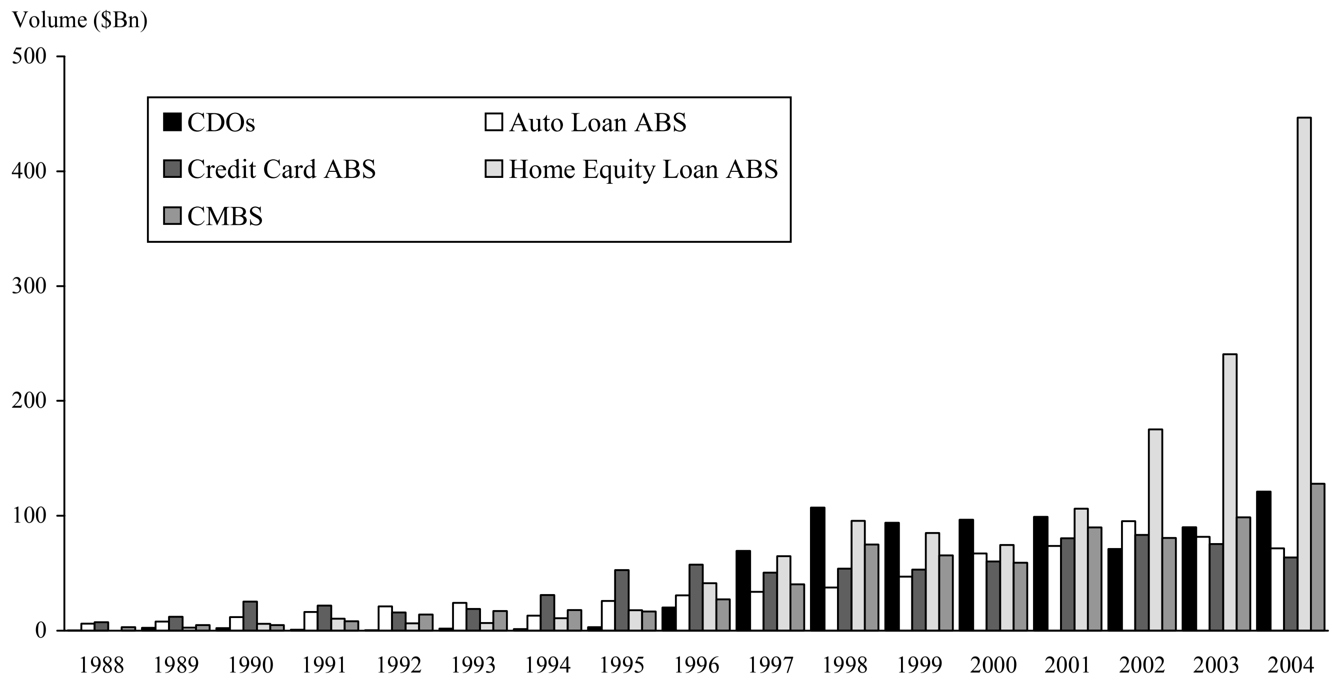
[1] *While CDO is an all encompassing term, it is common to use the terms Collateralized Bond Obligation (CBO), Collateralized Loan Obligation (CLO) and Collateralized Fund Obligation (CFO), depending upon the predominant assets in the collateral portfolio – bonds, loans and hedge funds, respectively.*

exhibit 2

CDOs in the Context of Overall ABS Market

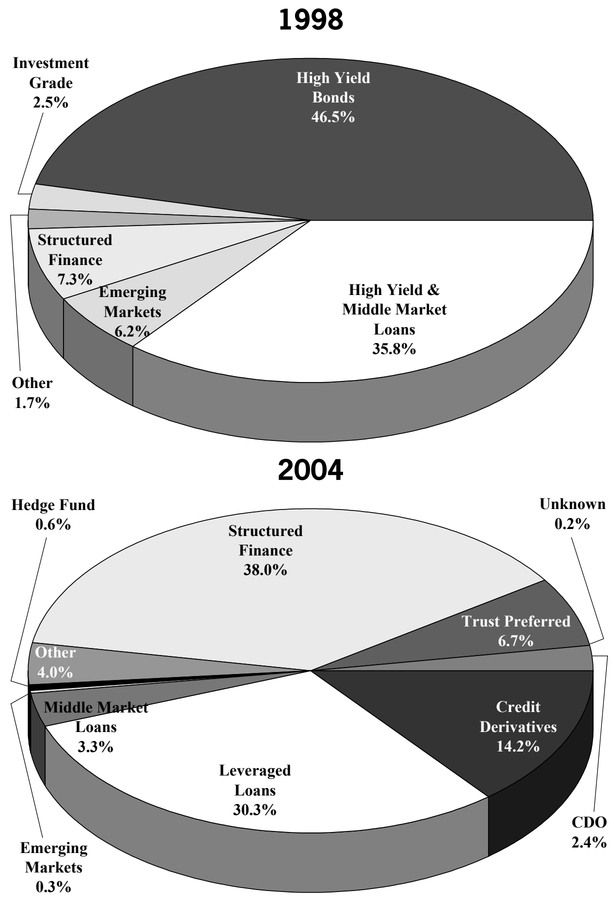


Note: (1) As of December 31, 2004. All issuance numbers are global.
Sources: Moody's Investors Service, Fitch IBCA, MCM Corporate Watch, Asset-Backed Alert, Morgan Stanley

chapter 1

exhibit 3

A Comparison of Collateral Composition of CDO Issuance – 1998 and 2004



Source: Thomson Financial, Moody's Investors Service, Standard & Poor's, Fitch/IBCA, MCM Corporate Watch, IFR

While CDO issuance using credit derivatives technology has become popular over the last few years (see Chapter 2 for a primer on synthetic CDOs), the issuance of CDOs in their original form as cash instruments remains substantial. In this chapter, we focus on cash CDOs to provide an overview of the basics of types, structures, motivations and performance metrics of cash CDOs.

WHAT ARE CASH CDOs?

CDOs are stand alone special purpose vehicles (SPV) that invest in a diversified pool of assets. These investments are funded through the issuance of multiple classes of securities, the repayment of which is a function of the performance of the pool of assets which serve as collateral. These classes of securities are sold to investors who assume the risks of the pool of assets in different orders of seniority, with each class representing a priority of cash flows generated by the underlying collateral. When the SPV purchases the pool of assets outright, as opposed to acquiring risk exposure using credit derivatives, the CDOs are called cash CDOs.

HOW DO CASH CDOs WORK?

Exhibit 4 provides a diagrammatic representation of the working of a cash CDO. In this simplified illustration, the SPV issues three classes of securities, all at par – one class each of senior notes, junior notes and preferred shares[1]. The senior and junior notes are the debt tranches and the preferred shares constitute the equity tranche of the transaction. The proceeds are used to purchase a diversified collateral pool of assets. Cash flows from the assets are used to pay the manager and trustees of the transaction and make principal and interest payments to the note holders in the order of seniority – senior notes first, followed by the junior notes. Preferred shares are the residual of the transaction and receive a current coupon out of the residual interest proceeds generated by the collateral. The coupon may be deferred or eliminated depending upon available cash flow.

As assets in the portfolio default, residual cash flows and consequently, the payments to the preferred shareholders decrease. If defaults reach a certain level, the principal amounts invested by the preferred shares may be written down, followed by the principal of the junior notes and so on. The coupons on the senior notes are set to be lower than the coupons on the junior notes reflecting the lower risk assumed by the senior note holders. The preferred shares represent a leveraged investment in the underlying collateral pool of assets. Being in a first loss position, they have the highest risk exposure and consequently the highest return potential. They also face higher volatility of return than the underlying collateral pool.

In some cash CDOs, the collateral pool of assets may predominantly have fixed rate coupons while the liabilities may be predominantly floating rate. This mismatch introduces interest rate risk into the transaction, which is usually addressed through an interest rate hedge (fixed-floating rate swap or an interest rate cap/swaption) at deal inception. The notional amount of the hedge is a function of the expected amortization of the floating rate liability tranches. If the realized amortization differs from the expected amortization at deal inception, the hedge itself may introduce a degree of risk into the transaction. We explore this topic in detail in Chapter 34.

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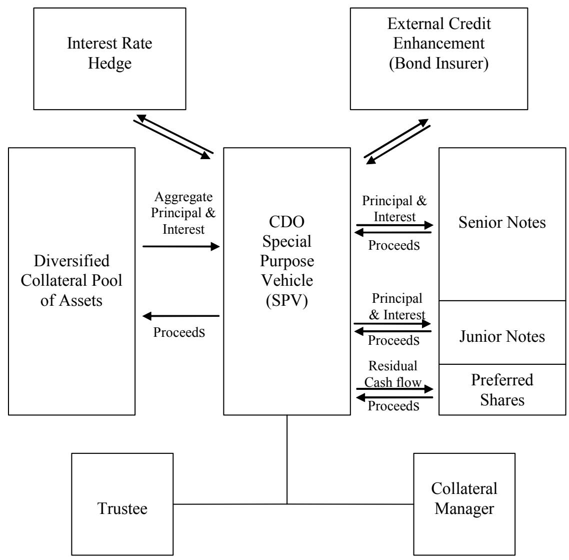
[1] *Throughout this chapter, we use the terms preferred shares and equity tranche interchangeably.*

In some transactions, the SPV enters into an insurance contract with a monoline bond insurance company to purchase external credit enhancement. The bond insurer guarantees the payment of principal and interest on one or more classes of the debt tranches. The notes so insured are said to have been "wrapped." Usually, the ratings of these notes reflect the financial strength rating of the bond insurer.

The assets are purchased and managed by a collateral manager in accordance with a set of guidelines, which are designed to provide investors with an exposure to a diversified pool of assets. Typically, trading within the portfolios ceases 3-5 years after the CDO issuance. Around that time, the debt tranches start to amortize. Structural mechanisms are put in place to protect the integrity of the capital structure and to maintain the balance between the interests of the debt and equity tranches. We discuss the structural mechanisms in detail in a later section of this chapter.

exhibit 4
How a Typical Cash CDO Works



Source: Morgan Stanley

Each transaction also involves a trustee who acts as the custodian responsible for the safe custody of the assets and for ensuring compliance with the trading guidelines and other structural features. Frequently, the trustee is also the calculation agent for the transaction responsible for computing the payments due to the different parties in the transaction according to deal documentation. Periodically, the trustee provides reports to investors regarding the status of the CDO's assets and liabilities as well as compliance with regard to structural mechanisms specified in the CDO documentation at deal inception. These reports are critical for the ongoing monitoring of a transaction.

Finally, debt tranches are typically callable at the option of the preferred share holders after a stated non-call period, usually 2-5 years. The call option embedded in senior CDO notes is generally a Bermuda-style option, in that the call is exercisable on discrete exercise dates after the non-call period. Structurally, the embedded callability is intended to provide a means for equity investors to unwind the CDO transaction once it has de-levered to the point that on a forward-looking basis, returns are no longer deemed attractive. In addition, the call enables equity investors to realize capital appreciation in the underlying collateral pool. In some cases, callability involves make-whole premiums, which require payments greater than the par amount of outstanding liabilities of the CDO.

CASH CDOs: A TAXONOMY

CDO investors are faced with an overabundance of terminology to describe different types of structures. In this section, we provide simple explanations of some key terms.

Depending upon the motivation behind the transaction, cash CDOs can be categorized into two types – balance sheet and arbitrage transactions.

Balance sheet transactions are intended to obtain regulatory and/or economic capital relief for financial institutions holding bonds and/or loans, and achieve a higher return on assets through redeployment of capital. The financial institution often retains the equity tranche of the CDO. Usually, the assets securitized through balance sheet CDOs are already on the balance sheets of these financial institutions; therefore, balance sheet CDOs require very short ramp-up periods. In addition, during the life of the transaction, they experience only limited trading in the underlying collateral pool of assets.

Arbitrage transactions are motivated by the aspirations of the equity tranche investors and the collateral managers. The former seek to achieve a leveraged return as the spread between the post-default yield of the collateral pool of assets and the cost of financing the assets through the issue of the debt tranches. This spread, also known as the funding gap, is the arbitrage that the equity investors are seeking to capture. The collateral managers seek to expand assets under management in order to realize fees for the management (acquisition, trading and monitoring) of the collateral pool of assets[2].

Depending upon the mechanics of structural protection to the debt tranches, cash CDOs are categorized into cash flow and market value structures. Cash-flow structures are based on the ability of the collateral to generate sufficient cash flow to pay the coupon and principal on the debt tranches. If the credit quality of the collateral decreases below certain specified levels, cash flows are diverted from subordinated tranches to the senior tranches to pay their coupons. If certain triggers are breached, cash flows are diverted to repay the principal of the senior tranches in an accelerated fashion until the metrics of collateralization revert to the levels above the triggers.

Market value structures, in contrast, depend upon the ability of the fund manager to maintain the market value of the collateral to pay the CDO debt tranches. In a market value transaction, assets in a CDO's collateral pool are valued (marked-to-market) periodically, incorporating cushions to account for future variability in the market value of the assets. If the value of the assets falls below the sum of the par amounts of the debt tranches, some assets are sold and a part of the debt tranches is repaid until the market value of the assets exceeds the par value of the remaining debt tranches.

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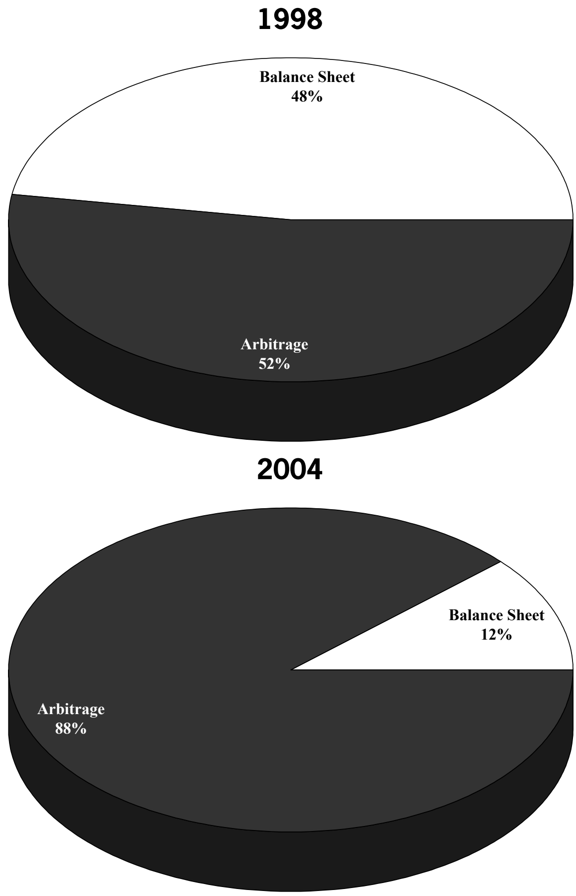
[2] *In order to ensure an alignment of interests, collateral managers often invest in a portion of the equity tranches and subordinate a portion of the management fees to the debt and equity tranches.*

Though it was not always the case, currently a vast majority of cash CDOs are arbitrage transactions. Exhibit 5 contrasts the composition of the new issue CDO market composition in 1998 and 2004.

exhibit 5

Composition of New Issue CDO Market – 1998 and 2004



Sources: Thomson Financial Service, Moody's Investors Service, Fitch IBCA, Inc., Asset-Backed Alert, MCM Corporate Watch, S&P, Morgan Stanley

While both cash flow and market value structures are used in arbitrage CDOs, for the most part, balance sheet CDOs deploy cash flow structures. Even within arbitrage CDOs, cash flow structures constitute the vast majority of the currently outstanding transactions.

A key determinant of a CDO structure pertains to the amount of leverage within a structure. Leverage refers to the size of the equity tranche relative to the total size of the transaction. For example, if the equity tranche is $100 million in a CDO of $1 billion, it is said to have a leverage equal to 10 times. While there is a significant variation in the degree of leverage in different transactions based on the nature of risk in the collateral portfolio, arbitrage cash flow transactions generally have a higher degree of leverage than market value transactions (8-12 times versus 4-6 times) and balance-sheet cash-flow transactions have much higher levels of leverage (25-50 times).

AN OVERVIEW OF STRUCTURAL FEATURES AND PERFORMANCE TESTS IN CASH CDOs

In this section, we focus on arbitrage cash flow CDOs to describe typical structural features and performance tests that determine the priority of payments[3] designed to maintain the integrity of CDO capital structure. Senior notes in a cash flow CDO transaction have a priority claim on all cash flows generated on the underlying collateral pool and are protected by subordination, overcollateralization and coverage tests, which serve to accelerate the redemption of the senior notes if the tests are violated. A number of other structural features and limitations are imposed to ensure that the collateral pool is well diversified and remains consistent with the intended credit quality at deal inception.

Subordination: The priority of claims of the senior notes means that the claims of junior notes and the equity tranches are subordinated, in that order. The size of the junior and equity tranches therefore describes the amount of subordination available to the senior note holders. The amount of subordination is a function of the credit quality of the underlying pool of assets, their expected losses given default and the desired rating. The lower the credit quality of the underlying pool of assets, the higher the level of subordination required for the senior notes to obtain a desired rating.

Overcollateralization (O/C) and Coverage Tests: The mechanisms most used to ensure the priority of payments are various collateral coverage tests. Over-collateralization is the excess of the par amount of the collateral available to secure a class of CDO notes. If $100 of par assets are available to service $80 of senior notes, the ratio 100/80 = 125% suggests that the senior notes are overcollateralized by 25%. Generically, senior and junior par coverage tests[4] are calculated as shown below.

Senior Tranche Par Coverage Test = (Par Value of Performing Assets + Adjusted Par Value of Defaulted Assets[5]) / Par Amount of the Senior Notes

Junior Tranche Par Coverage Test = (Par Value of Performing Assets + Adjusted Par Value of Defaulted Assets) / Par Amount of the Senior and Junior Notes

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[3]The priority of payments is also referred to as the cash flow waterfall.
[4]The par coverage tests are also called O/C tests.
[5]Adjusted par value of defaulted assets reflects expected recoveries for defaulted assets whose final valuation is yet to be determined.

Along the same lines, interest coverage tests are calculated as:

Senior Tranche Interest Coverage Test =	Interest expected to be collected on the performing assets for the current period / Interest due on the senior notes for the current period
Junior Tranche Interest Coverage Test =	Interest expected to be collected on the performing assets for the current period / Interest due on the senior and junior notes for the current period

Trigger levels for each of these tests are covenanted in the deal documentation. In general, junior notes will have par coverage triggers set at lower levels than the senior notes. At deal inception, the actual values for each of these tests will be well above the trigger levels. A breach of the coverage tests below the trigger levels results in additional trading restrictions and/or potential diversion of cash flows as identified in the deal indenture's priority of payments (see Exhibits 6 and 7).

If the par coverage test for the senior tranche is breached, the senior notes will be redeemed until the test comes back into compliance. Likewise, if interest coverage tests are breached, all interest payments will be redirected to the senior bonds until the trigger is cured. In general, interest coverage tests are relatively less onerous than par coverage tests. Still, the presence of these tests contributes to maintenance of higher levels of current coupon income than would otherwise be the case.

The levels at which O/C test triggers are set are an important consideration in a cash CDO, given their effect on the cash flow waterfall. For each class of notes, they should be set at levels high enough to ensure that the class can withstand a certain level of defaults in the underlying pool of assets. The higher the trigger level, the more likely it is that a given level of default will cause the O/C trigger to be breached. From the perspective of investors of subordinated tranches, O/C triggers set too high increase the likelihood that cash flows are diverted away from them. Ideally, transactions should be structured such that O/C tests for the junior notes are triggered before the senior notes.

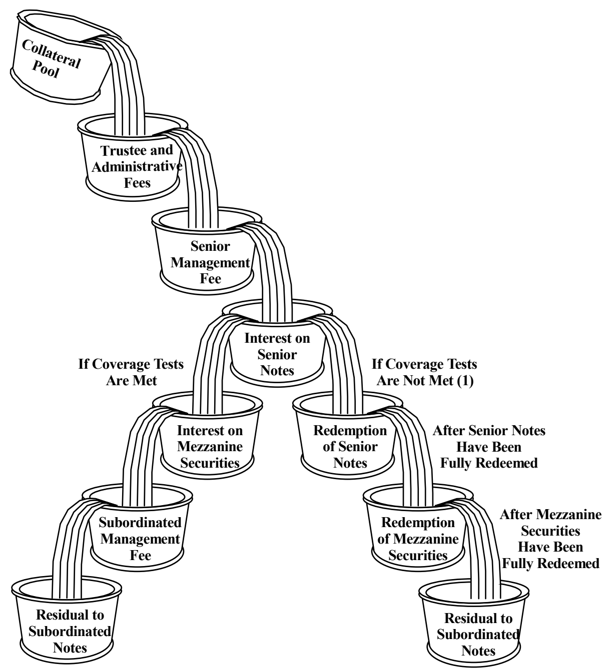
Another structural provision frequently seen in CDOs is the payment-in-kind provision ("PIKing"). Some CDOs provide for the deferment of interest to subordinated debt tranches upon the breach of certain coverage tests. PIKing results in the deferred interest being added to the principal of those tranches, where it earns interest at the same rate as the original principal.

Supplemental O/C Test: During the last downturn in credit cycle (2001-02), several CDO notes experienced downgrades that were attributed to their structural weaknesses. The argument made was that the trigger levels of par coverage tests were set at levels so low that a violation would occur only after significant deal deterioration. Such criticism was addressed by the introduction of a Supplemental O/C test that becomes binding before the par coverage tests are breached by setting its trigger level higher than the par coverage test triggers. A violation of Supplemental O/C tests results in reinvestment of excess cash flow rather than redemption of the senior notes. Some part of collateral manager fees and payments to the equity tranche are not paid until the test is cured. This mechanism enables a collateral manager to build up overcollateralization over time and offset downward pressure on ratings without paying down the least costly portion of a CDO's capital structure.

Excess CCC Haircut: Another issue that became prominent during 2001-02 was the extent of CCC-rated assets in CDO portfolios because of severe downgrades in the corporate sector. These securities were still performing but were highly likely to experience potential par losses in the near term as their downgraded ratings suggested. Nevertheless, for the purpose of the computation of par coverage tests, they were being given full par credit. In some cases, collateral managers were resorting to "barbelling" of the credit portfolio – buying deeply discounted CCC-rated bonds whose risk potential was not being reflected in the coverage tests. The excess CCC haircut was a proviso introduced to address this issue. In short, CCC-rated securities in excess of some predetermined level would be treated at their market value instead of at par value.

exhibit 6

Interest Waterfall of a Sample CDO

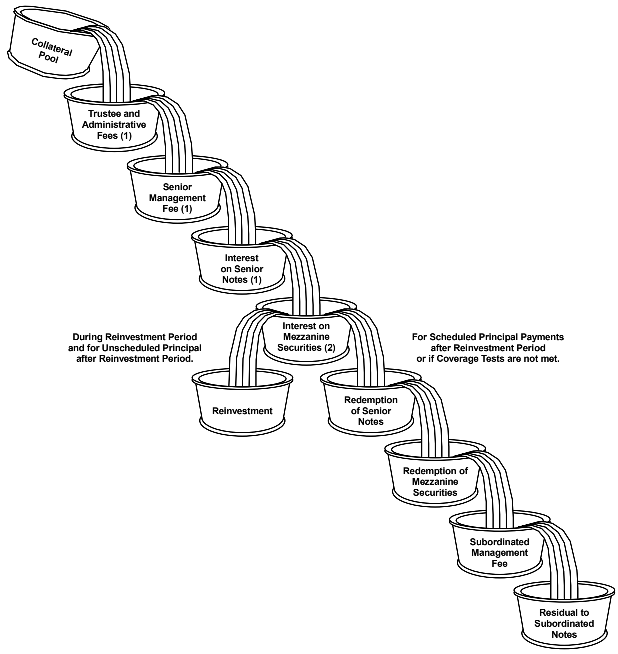


Note: (1) If coverage tests are not met, and to the extent not corrected with principal proceeds, the remaining interest proceeds will be used to redeem the most senior notes to bring the structure back into compliance with the coverage tests. Interest on the mezzanine securities may be deferred and compounded if cash flow is not available to pay current interest due.
Source: Morgan Stanley

chapter 1

exhibit 7

Principal Waterfall of a Sample CDO



Note: (1) To the extent not paid by interest proceeds.
(2) To the extent senior note coverage tests are met and to the extent not already paid by interest proceeds. If coverage tests are not met, the remaining principal proceeds will be used to redeem the most senior notes to bring the structure back into compliance with the coverage tests. Interest on the mezzanine securities may be deferred and compounded if cash flow is not available to pay current interest due.
Source: Morgan Stanley

COLLATERAL QUALITY TESTS

Unlike the coverage tests, the purpose of quality tests in CDOs is not to redirect cash flows in the waterfall but to ensure that the composition of the portfolio does not change drastically over time. When the quality tests are breached, trading within the portfolio becomes restricted. Some of the frequently used collateral quality parameters are minimum diversity score, maximum weighted average rating factor (WARF), issuer concentration limits, maturity and weighted average life (WAL) limits and weighted average spread (WAS).

Diversity Score is a statistic developed by Moody's[6] to reflect the degree of diversification within the collateral pool. Assets in the collateral pool are mapped into a hypothetical portfolio of N number of uncorrelated, homogeneous assets with identical default probabilities and equal par values. The number N in the hypothetical portfolio is the "diversity score." The higher the diversity score, the more diversified the reference portfolio. The formula for calculating the diversity score incorporates obligor

[6]See "The Binomial Expansion Method Applied to CBO/CLO Analysis," Moody's Investor Service, December 13, 1996 and "Moody's Approach to Rating Multi Sector CDOs," Moody's Investor Service, September 15, 2000 for a complete discussion of Moody's methodology for computing the diversity score and application for rating CDOs.

and industry concentrations in the reference portfolio as well as default correlations across industries.

Trading guidelines restricting the diversity score of a CDO's portfolio to a minimum level are frequently used to prevent the portfolio from becoming overly concentrated in a single issuer or sector. A manager may not execute a trade that will result in a breach of the minimum diversity score restriction. In the same vein, individual issuer, sector, country and currency concentration limits are also frequently used to ensure that the collateral pool of assets remains diversified during the life of a CDO.

Weighted Average Rating Factor (WARF) is a numerical metric used by Moody's[7] and Fitch to express the credit quality of a collateral pool of assets. It is derived by computing the weighted average of a numerical measure assigned to each rating category to reflect the expected defaults for that rating category. Exhibit 8 shows the values that Moody's and Fitch equate to each rating level. Averaging these values across the collateral pool, weighted by the par balance of the respective asset in the collateral pool results in the computation of the WARF statistic. The higher the WARF, the more likely the portfolio is to experience defaults. As with diversity score, trading guidelines restrict a collateral manager from adding or removing an asset from the portfolio if such an action would violate the maximum WARF test.

exhibit 8 Moody's and Fitch Rating Factors

	Moody's	Fitch
Aaa/AAA	1	1
Aa1/AA+	10	8
Aa2/AA	20	10
Aa3/AA-	40	14
A1/A+	70	18
A2/A	120	23
A3/A-	180	36
Baa1/BBB+	260	48
Baa2/BBB	360	61
Baa3/BBB-	610	94
Ba1/BB+	940	129
Ba2/BB	1,350	165
Ba3/BB-	1,780	210
B1/B+	2,220	260
B2/B	2,720	308
B3/B-	3,490	356

Source: Moody's Investors Service, Fitch IBCA

[7] *Moody's interprets WARF as the expected 10-year cumulative default probability for a rating level. For example, for a B3 rating, 3,490 implies a cumulative default probability of 34.90% over 10 years.*

Maximum **Weighted Average Life (WAL) and Weighted Average Maturity (WAM)** tests are intended to deter the collateral manager from taking duration bets inconsistent with the duration of the CDO liabilities. Other collateral quality tests include limitations on discount purchases – purchases of par assets with steeply discounted market value, payment-in-kind or deferred interest securities, and in the case of CLOs, the purchase of securities rated CCC/Caa.

UNDERSTANDING THE BASICS OF CDO EQUITY RETURNS

The main motivation of a CDO equity investor is to achieve non-recourse term financing of the CDO's underlying assets. The debt tranches used to fund the CDO assets are collateralized by the assets, and if the assets do not perform per expectations, the claims of the holders of the debt tranches are limited to the CDO assets. It is useful to compare this feature with the repo market, which is an alternative means of financing assets. In the repo market, the lender is not only collateralized by the pledge of the assets being financed but also has recourse to the borrower if the collateral is insufficient. With CDOs, the recourse is limited to the assets in the collateral pool of the CDO. Further, repo financing is relatively short term compared to the non-recourse financing achieved by equity tranche investors in cash CDOs. Effectively, equity investors seek to obtain a leveraged return as the positive difference between post-default yield on the CDO's assets and their cost of financing.

Recall that the pricing of credit-risky assets compensates investors for expected credit losses and incorporates risk and liquidity premiums. The spread over the risk-free rate in an asset's yield of a non-callable fixed-rate instrument is a measure of the reward for the credit risk and liquidity risk. As such, CDO equity investors are betting that the difference between the expected credit losses and experienced credit losses in the portfolio will be favorable and thus seek to capture risk and liquidity premiums in the assets in the collateral portfolio.

In contrast to competing asset classes such as hedge funds, the cash flow return profile for CDO equity investors begins from deal inception. It is front-end loaded and not dependent upon the discretion of the collateral manager but on a predetermined set of rules. At deal inception, all structural protections and compliance mechanisms are in place. Therefore, for the first few years of the transaction, there may be residual cash flow available to equity tranche investors, which explains the front-loaded nature of CDO equity investments. For investors with exposure to first-loss, the likelihood of residual cash flows being available decreases over time as assets default.

UNDERSTANDING THE BASICS OF CDO DEBT RETURNS

The risks to an investor with exposure to a portfolio of credit-risky assets may be thought of as having four dimensions – default probability, default severity or loss given default, default correlation and default timing. In a CDO, these risks are distributed to different tranches using the waterfall mechanism, with the debt tranches receiving the benefit of structural protection in the form of subordination, overcollateralization and coverage tests.

Compared to an investor holding the assets in a collateral pool directly, an investor in a debt tranche of a CDO that holds the identical collateral pool of assets will experience narrower loss default distributions because of the structural protections embedded in a CDO.

The effects of diversification on the risks to investors are well known. Not only does a CDO offer the benefits of such diversification by requiring that the collateral pool of assets be diversified through the collateral quality tests but, in addition, the structural protections ensure that each additional default in the collateral pool have a small impact on the return of the debt tranche.

The application of the CDO technology enables investors to gain exposure to asset classes they might not otherwise have access to. For example, investors mandated to limit investments to investment grade securities have very limited opportunities to invest in emerging market securities, few of which are rated investment grade. However, CDOs make it possible for such investors to get such exposure through investment grade tranches of CDOs with a collateral pool of emerging market securities. The same analogy is extendible to several other asset classes, such as leveraged and middle market loans.

RATING OF CDOs

The market for the debt tranches of cash CDOs developed as a rated market and remains so even today. There have been several important methodological innovations in risk-neutral valuation approaches to structured credit, particularly the development of correlation models[8]; however, because of the many unique features of cash CDOs, their application to cash CDOs remains challenging. As such, ratings and their stability over time have remained important considerations for CDO investors. In this section, we briefly summarize the approaches used by the three major rating agencies – Moody's, S&P and Fitch – for rating cash CDOs. While all three agencies base ratings on their own quantitative models, qualitative factors such as the experience of the collateral manager, the legal structure, and credit quality of the hedge counterparty, if any, also have a significant influence on the ultimate rating assigned to CDO tranches.

Moody's

Moody's ratings are based on an assessment of the probability that the collateral will generate sufficient cash flows to meet the obligations under each class of rated notes. Moody's assessment is based largely on a statistical analysis of historical default rates on debt obligations with various ratings, the asset and interest rate coverage requirements for each class of notes and the diversification requirements the CDO is covenanted to satisfy. For a long time, Moody's has used variations of the widely known binomial expansion technique (BET) for rating cash CDOs. Diversity score, a concept introduced by Moody's, is at the heart of the BET approach.

The BET approach maps the reference portfolio of assets into a hypothetical portfolio of N number of uncorrelated, homogeneous assets with identical default probabilities[9] and equal par values for calculating expected loss distributions, where N is the diversity score, discussed earlier. The formula for calculating the diversity score

[8] *See Chapter 35 for an analysis that contrasts rating agency approaches with risk-neutral valuation models.*

[9] *The identical default probabilities are assumed to equal the weighted average default probability of assets in the original reference portfolio of assets.*

incorporates obligor and industry concentrations in the reference portfolio as well as default correlations across industries. In the context of multi-sector CDOs, Moody's recognizes that the loss severity of an asset varies by asset type, credit rating and position within the capital structure. For asset types that are prepayment sensitive, Moody's takes into account maturity shortening or extension risk due to faster or slower prepayment speed.

The BET model calculates expected losses stemming from defaults in the hypothetical portfolio, going from zero defaults to N defaults and assigning a probability to each default scenario. Moody's then determines the level of subordination necessary to achieve the expected loss associated with the targeted rating for each of the rated tranches. A Moody's rating represents an opinion on the expected loss of each tranche, expressed as the difference between the present values of the expected payments and the promised payments.

Standard and Poor's (S&P)
The S&P approach is different from the Moody's approach in that the rating addresses the first dollar loss for a given rating category as opposed to mapping expected losses into a specific rating category. The S&P approach for rating cash CDOs is based on its proprietary model called the "CDO Evaluator." The model takes into account the credit rating of each asset in the collateral pool, the number of assets in the pool, industry concentration and a default correlation between pairs of assets. The model uses Monte Carlo simulations to generate a probability distribution of defaults for each individual asset in the pool. The higher the targeted rating for a tranche, the higher the level of defaults the collateral pool of assets must withstand.

The simulations take into account individual asset default probabilities based on rating and pair-wise correlations between the assets in the reference portfolio. The model draws a large number of multivariate normally distributed numbers, which are then compared with a default threshold based on the asset's default probability and maturity to decide whether an asset defaults. Correlations in the Evaluator model are based on historically observed defaults, with asset correlation calibrated to default correlation. As we understand it, while explicitly incorporating intra-industry correlations, the S&P model currently treats inter-industry correlations as being zero. S&P classifies corporate industries at local, regional and global levels, and gives an additional credit for geographically diverse portfolios.

Fitch
Fitch's ratings are based on its Monte Carlo simulation platform, VECTOR, which was introduced in 2003. Like S&P, Fitch's approach also addresses the probability of a first dollar loss. The model CDO portfolio default distributions are based on Monte Carlo simulations using individual asset default rates and asset correlations as the key inputs. The default rates are derived from a matrix that provides default rates by rating and maturity based on historical realized defaults. Pair-wise correlations are based on estimates of intra- and inter-industry correlations, as well as geographical correlations of equity returns. The underlying statistical model for estimating correlations is a factor model that expresses the return of the equity security of a firm as a function of statistically determined factors and company-specific idiosyncratic risk. Using this approach, average factor loadings and average idiosyncratic risk exposures are

computed for each industry-geographic region grouping and used to derive asset correlations.

ANALYTICAL CHALLENGES IN MODELING CASH CDOs

The many features that distinguish CDOs from competing asset classes – their adaptability to various asset classes, structural innovations and portfolio management strategies – render them challenging to model in analytically tractable and computationally convenient means. As a result, typical models in vogue for cash CDO analysis still rely on deterministic scenario analysis using annual constant default rates incorporating prepayment and recovery assumptions. Recently, there has been a gradual shift towards Monte Carlo simulation based analysis, which is a welcome improvement.

The complex waterfall structures and the potential for diversion of cash flows because of structural protections and coverage triggers imply that analytical models have to take into account the default probabilities as well as the determinants of the different coverage ratios in a mutually consistent fashion. This, coupled with the optional redemption feature of most CDOs, calls for the modeling of interest rate risk in conjunction with the default risks of assets. Since the underlying collateral pools are managed, albeit according to predefined guidelines, the impact of future trading activities of collateral managers is difficult to model. Some analyses model the trading provisions assuming that the managers will trade at the extremes of all possible trading constraints, which has the effect of painting all managers with the same brush, constraining relative value judgment. Trading further complicates the already difficult problem of modeling and parameterization of correlation.

Ultimately, it is important to keep in mind that analytical modeling needs to be done in conjunction with regular surveillance of the performance of both the underlying collateral and the CDO, in the context of the many structural mechanisms.

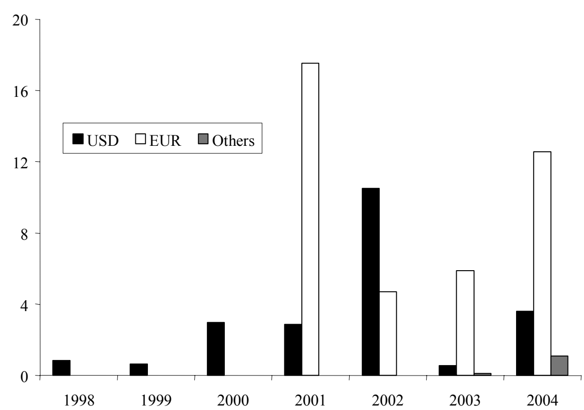
chapter 2 A Synthetic CDO Primer

INTRODUCTION

Since their first appearance in 1997, synthetic Collateral Debt Obligations (CDOs) have gained enormous popularity and have been the most fertile area of growth and innovation in the structured credit markets, having contributed to as well as benefited from the explosive growth in the use of credit default swaps (CDS). From their initial application as a mechanism of risk transfer from bank balance sheets to manage regulatory capital requirements, they now encompass every facet of credit risk covering a wide range of assets from corporate bonds and loans, structured finance obligations and CDO tranches themselves.

Given that the bulk of the synthetic CDO issuance takes place in private transactions and the amount of public data available is limited, we demonstrate the size of the synthetic CDO market by presenting two sets of data. Exhibit 1 shows the growth in the rated synthetic CDO notes over the period 1998-2004. Since the full capital structure of a synthetic CDO is typically not rated, this measurement of issuance represents only a fraction of the underlying portfolios and the embedded credit risk. Exhibit 2 is shows funded and unfunded deal volume as reported to Creditflux, a popular structured credit publication. These data represent an estimate of the credit risk that has been distributed using synthetic CDO technology to end investors, in both cash and synthetic form, and capture deals not included in the data on rated notes. These numbers compare favorably with the cash CDO issuance numbers discussed in Chapter 1. In fact, synthetic CDO issuance appears to have overtaken the cash CDO issuance. By either measure, the volume of synthetic CDO issuance and its recent rate of growth are impressive. Particularly noteworthy is that over half of the synthetic CDO market is denominated in non-USD terms, particularly in Euros.

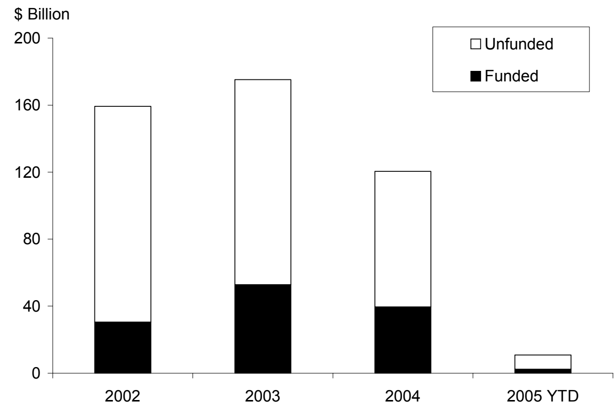
exhibit 1
Global Rated Synthetic CDO Issuance (USD Billions)



Source: S&P[1]

[1]*For each year, end of the year exchange rates were used to convert non-USD issuance into USD.*

exhibit 2
Global Total Synthetic CDO Issuance (USD Billions)



Source: CreditFlux

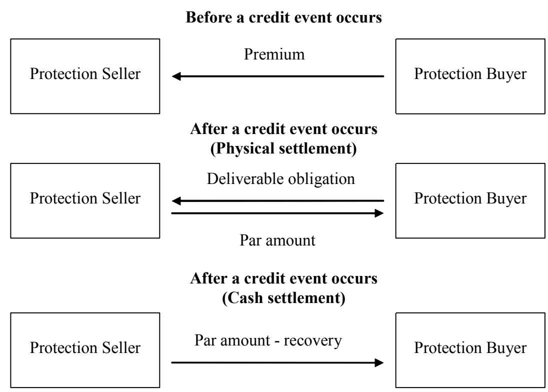
WHAT ARE SYNTHETIC CDOs?

Synthetic CDOs are the result of innovative combination of two technologies – the securitization techniques applied to transfer credit risk by cash CDOs and credit derivatives, which enable the isolation of credit risk from other components of risk. Effectively, synthetic CDOs are CDOs using CDS. Within that broad description, there is a wide variation in the underlying credit risky assets, whether or not they are managed, the extent of associated funded issuance and the motivation behind the risk transfer, each of which defines a particular type of synthetic CDO.

To motivate a discussion of how synthetic CDOs work, we revisit the basic mechanics of a credit default swap (Exhibit 3). Recall that a CDS is akin to an insurance policy that protects the buyer of protection against the loss of principal in an underlying asset when a credit event occurs. The protection buyer pays a premium, typically on a quarterly basis to the protection seller until a credit event occurs or the contract matures, which ever is earlier. The underlying asset is defined by a reference obligation, which informs the scope of the protection. When a credit event occurs, depending upon the settlement mechanism specified in the CDS contract, the buyer of protection delivers a reference obligation to the seller and receives par in return (physical delivery) or receives the difference between the par amount of the reference obligation and its recovery from the seller (cash settle). Standard credit events include bankruptcy, failure to pay and restructuring of the debt. (See Chapter 1 of *Credit Derivatives Insights – Single Name Instruments and Strategies*, February 2005 for a complete description of CDS mechanics and the associated terminology).

exhibit 3

How a Typical CDS Works



Source: Morgan Stanley

Much like a cash CDO, a synthetic CDO typically involves a special purpose vehicle (SPV) that acquires exposure to a collateral pool of credit risky assets that is distributed to investors in a tranched form with different tranches having varying levels of credit risk and correspondingly varying levels of returns. Unlike cash CDOs in which the SPV purchases the assets from the market or a sponsoring financial institution, in synthetic CDOs the SPV acquires the risk exposure through credit derivatives, typically credit default swaps.

The SPV sells protection on the collateral pool of assets to the sponsoring financial institution or other market participants and receives a premium for the risk being assumed. The credit risk so acquired is distributed to investors of different tranches who receive a portion of the premium depending upon the amount of credit risk assumed by each tranche. When a credit event occurs with respect to any asset in the collateral pool, the SPV pays the protection buyer an amount linked to the loss incurred on the asset. The loss is then passed on to investors in reverse order of seniority (i.e., the junior most tranche bears the first loss). Often, some of these tranches are funded tranches, analogous to credit linked notes with the only difference being that the risk and return are linked to a portfolio of assets as opposed to a single asset. The proceeds of the funded note issuance are invested in low-risk "eligible collateral[2]". We elaborate further on funded and unfunded synthetic CDOs in a later section.

Thus, in a synthetic CDO, investors act as the sellers of protection on a pool of underlying assets, the sponsoring financial institution or the market participants are the buyers of protection and the SPV is the intermediate vehicle that effectively distributes the cash flows involved. As such, synthetic CDOs are the derivative counterparts of cash CDOs.

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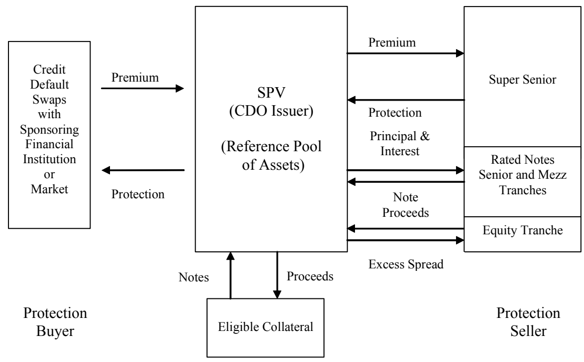
[2]*Eligible collateral mainly consists of investments in cash or government bonds or guaranteed investment contracts (GICs) issued by highly rated insurance companies.*

exhibit 4

How a Typical Synthetic CDO Works



Source: Morgan Stanley

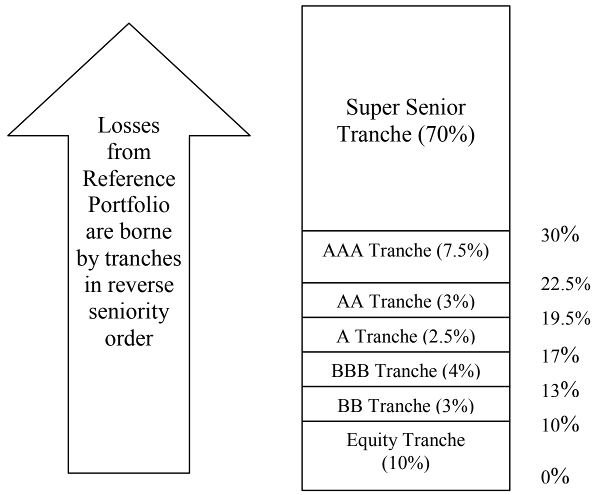
ATTACHMENT AND DETACHMENT POINTS

It is important to understand the terminology of attachment and detachment points to follow the mechanics of synthetic CDOs. An attachment point, expressed as a percentage or an absolute value, defines the amount of losses in the reference pool of assets that need to occur before a particular tranche starts to experience losses. A detachment point, also expressed as a percentage or an absolute value, defines an amount of losses in the reference pool of assets that need to occur for a complete loss of principal for that tranche. The size of each tranche (width) is the difference between the attachment and detachment points for that tranche and defines the maximum amount of losses that the tranche will experience.

Exhibit 5 illustrates a possible capital structure of a hypothetical synthetic CDO with high yield unsecured corporate credit risk exposure. The numbers in parentheses are tranche widths. The equity tranche has an attachment point of 0% and detachment point of 10%. The first 10% of the credit losses from the underlying portfolio are absorbed by the equity tranche. Similarly, the super senior tranche has an attachment point of 30% and detachment point of 100%. All portfolio credit losses exceeding 30% are borne by the super senior tranche. If the portfolio experiences losses equal to 15%, the equity and the BB tranches would be wiped out and the BBB tranche would lose half of its notional.

exhibit 5

Capital Structure of a Hypothetical Synthetic CDO



Note: The ratings and the capital structure shown above are merely for illustration purposes and do not represent an actual transaction.
Source: Morgan Stanley

WHY SYNTHETIC CDOs?

It is no coincidence that the surge in investor interest in synthetic CDOs has coincided with exploding trading volumes in credit default swaps and standardized index tranches. The application of credit derivatives technology has led investors with a wide range of interests to explore synthetic CDOs. In this section, we outline some of the key motivations for synthetic CDOs over their cash counterparts.

Funding Gap and the Super Senior Tranches

The larger the funding gap[3], the higher is the potential return to the equity tranches for a given level of leverage. Expressed differently, higher funding gap would enable a transaction to be structured with lower leverage for a given level of target return for the equity tranches. The larger funding gap of synthetic CDOs is primarily due to the existence of the so-called unfunded super senior tranches, which receive a spread lower than the spread paid to the Aaa/AAA note tranches of cash CDOs. This lowers the average funding cost for the CDO (the weighted average spread paid to non-equity tranches). In essence, synthetic CDOs enable investors to efficiently capture risk premiums resulting in a ratings arbitrage.

Increased Flexibility and Customization

Relative to cash CDOs, structuring synthetic CDOs provide increased flexibility. Synthetic technology makes it possible to customize risk exposures, with respect to currency, cash flow, tenor and size of exposure. Since there is no need for the SPV to identify and acquire a specific asset, the maturity of the transaction is not constrained by the maturity of the pool of assets. With the increased liquidity of credit default swaps across different maturities, it is possible to customize synthetic CDOs to shorter

[3]*We define funding gap of a synthetic CDO as the difference between the weighted average spread/premiums received by the SPV and paid to the different debt tranches of the CDO.*

maturities, an option typically unavailable with cash CDOs. It is also possible to structure the CDO liabilities such that the tranche coupon payment dates exactly match the premium receipt dates on the underlying CDS transactions. There is also significantly lower ramp-up period and therefore lower carry costs. The increased flexibility brings higher efficiencies and lower costs.

Wide Range of Permissible Assets
Synthetic CDOs enable managers to gain exposure to wide range of assets and strategies. For example, it is possible to structure CDOs to have long and short risk exposure whereas cash CDOs are typically long only.

Efficiencies of Unfunded Liabilities
Considering that there is not always a funded portion of a synthetic CDO, several sponsoring financial institutions find unfunded liabilities cheaper, easier and significantly faster to execute.

A TAXONOMY OF SYNTHETIC CDOs

The innate flexibility of synthetic structures implies a wide variety of synthetic CDO types depending upon the motivation, funding, underlying risk exposure, collateral management strategies and liability structure. In this section, we illustrate some of the major categories of synthetic CDOs and discuss the unique issues involved with each of them.

Balance Sheet Versus Arbitrage
Obtaining economic and/or regulatory capital relief was the original motivation for the development of synthetic CDOs. Transactions so motivated are balance sheet synthetic CDOs in which a financial institution, typically a bank, uses a credit default swap to remove credit exposure to a portfolio of credit risky assets from its balance sheet while retaining its ownership of such assets. This enables the sponsoring financial institution to maintain lending relationships with the entities issuing the credit risky assets and at the same time achieve capital relief and efficient credit risk management. The portfolios underlying such transactions are typically static with little substitution privileges.

In contrast, arbitrage synthetic CDOs, whose evolution followed that of the balance sheet genre, are designed to take advantage of the difference between the spread received from selling protection on individual reference assets/entities and the spread paid to investors to buy protection on a tranched basis. Unlike balance sheet CDOs, the credit risky assets are not on the sponsoring institution’s balance sheet. As with several cash CBOs, excess spread plays an important role in arbitrage synthetic CDOs, often used to offset losses or to hedge against future losses and in some cases returned to the investors of equity tranches.

Single tranche CDOs are an increasingly popular type of arbitrage CDO. The prevalence of bespoke portfolios looking for effective risk management vehicles is probably the major motivation behind these structures that allow the investor to customize the credit risk exposure to assume or lay off by picking the reference pool as well as the attachment and detachment points.

Static Versus Managed

The underlying portfolios in arbitrage synthetic CDOs can be either static or managed. In a static portfolio, the reference pool of entities is fixed at deal inception. In managed transactions, changes can be made to the reference portfolio by a designated collateral manager, within a broad framework of trading guidelines and restrictions. The trading guidelines and restrictions are designed to ensure that the collateral managers manage the risks and returns in the portfolio according a predetermined level of credit quality, diversification and risk management. There is a wide variation in the nature and scope of the trading guidelines. In some cases, the guidelines permit the manager to have long and short risk buckets allowing for the acquisition as well as hedging of credit risk subject to constraints.

In dealing with the trading guidelines, investors and rating agencies have to contend with a significant dilemma. In general, trading out of a deteriorating credit may be thought of as a prudent risk management measure. However, trading out of a deteriorating credit also usually implies having to make termination payments and incur losses because of trading. Some transactions treat such losses as subordination erosion without replenishing the notional amount of the underlying portfolio. However, some transactions allow for the replenishment of notional traded out which introduces the potential for adverse selection that misaligns the interests of debt and equity tranches. Rating agencies impose maximum spread per reference credit limits to address the potential for such adverse selection, which is not unlike the limits placed in cash CDOs on the purchase of deeply discounted securities.

An alternative approach to addressing this issue is through the excess spread mechanism. In many cases, the structure allows the excess spread to cushion the tranches from trading losses. Trading profits are used to supplement the excess spread. Trapping the excess spread until maturity or allow the leaking out of the excess spread only as long as the deal is performing satisfactorily are some other mechanisms used to address adverse selection issues. In many cases, trading ceases at some predefined point of the CDO life cycle or when trading losses reach a certain predefined level.

Rating agencies review trading guidelines by focusing on isolating trading losses such that losses to investors in rated tranches come from credit events or risk management of credit risk in the underlying portfolio and not because of discretionary trading. Typically, the portfolios in the single tranche CDOs are static.

Funded Versus Unfunded[4]

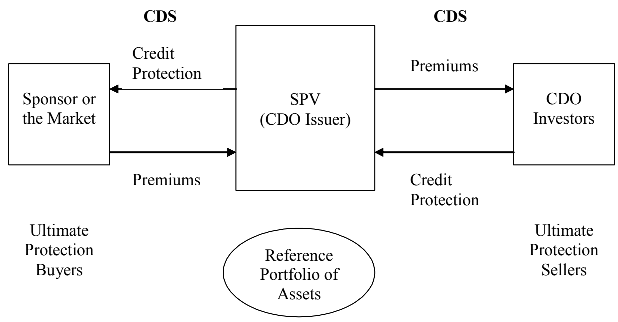
Unfunded portfolio credit default swaps are the most basic of all synthetic CDOs (Exhibit 6). The protection buyer enters into a CDS on a specific portfolio of reference entities with the SPV, which in turn obtains protection by entering into CDS on a tranched basis with the investors, the ultimate sellers of protection. The CDS with investor(s) in each tranche defines the attachment and detachment points and the credit events. As sellers of protection, each tranche receives a fixed spread applied to the tranche size. As losses occur, the sellers of protection make loss payments to the SPV in the reverse order of seniority, passed on to the protection buyer.

[4] *The diagrammatic representations used in this section have been adapted from "Moody's Approach to Rating Synthetic CDOs", Moody's Investor Service, July 29, 2003.*

The structure of the funded synthetic CDO is more complicated (Exhibit 7). In funded tranches, the CDO investor pays the notional amount of the tranche at deal inception and losses due to any credit events result in principal writedown. Throughout the life of the transaction, the investor receives LIBOR/EURIBOR plus a spread, which reflects the riskiness of the tranche. The amounts paid by tranche investors (the proceeds of issuance) are invested in eligible collateral; typically, either GICs issued by highly rated insurance companies or highly rated short-term securities. The maturity dates of the GICs are set to match the maturity dates of the funded notes. Premium income from the CDS written by the SPV and interest income received by investing the proceeds in eligible collateral form the source of income to the SPV used to pay interest to the funded note holders and premiums to the unfunded tranches.

exhibit 6

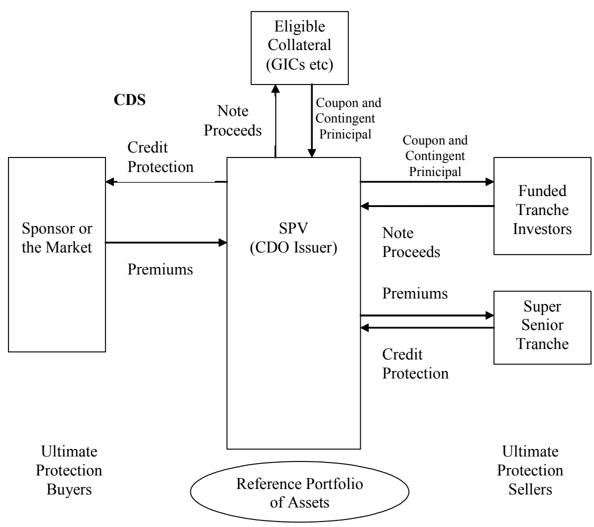
Structure of a Typical Unfunded Synthetic CDO



Source: Morgan Stanley

exhibit 7

Structure of a Typical Funded Synthetic CDO



Source: Morgan Stanley

In practice, most funded synthetic CDOs are actually partially funded, in that only parts of the CDO capital structure is represented by funded tranches. Super senior and equity tranches are typically unfunded.

RATING AGENCY APPROACHES TO SYNTHETIC CDOs

While not all synthetic CDO tranches are necessarily rated[5], ratings are important benchmarks for assessing investments in CDO tranches. In this section, we provide a broad overview of the rating methodologies used by the three major rating agencies. In general, the three approaches involve attributing default probabilities to each reference entity in the reference pool of assets and assumptions regarding the correlation of default probabilities and recovery rates. Incorporating correlation formally into rating agency models is a relatively recent phenomenon. The three major rating agencies have developed their own distinct methodologies for rating synthetic CDOs[6]. For each agency, the basic framework for cash and synthetic CDOs is similar. However, certain stress factors and haircuts are applied in analyzing synthetic CDOs to take several unique features[7] of credit default swaps into consideration. It is important to point out that analytical models are only a part of the rating agencies' analyses and each agency relies on other qualitative considerations such as deal documentation, legal assessment and evaluation of all parties involved in a transaction such as the collateral manager, hedge counterparty, servicer to arrive at a specific rating for each tranche.

Moody's

A Moody's rating represents an opinion on the expected loss of each tranche, expressed as the difference between the present values of the expected payments and the promised payments. For a long time, Moody's used variations of the widely known binomial expansion technique (BET), first developed in the context of cash CDOs, for rating synthetic CDOs. Recently, Moody's introduced a its new Monte Carlo simulation based models called CDOROM™ for rating synthetic CDOs marking a significant departure from its previous approach.

The BET approach maps the reference portfolio of assets into a hypothetical portfolio of N number of uncorrelated, homogeneous assets with identical default probabilities[8] and equal par values for calculating expected loss distributions. The number N in the hypothetical portfolio is the well known "diversity score", which is a measure of portfolio diversification – the higher the diversity score, the more diversified the reference portfolio. The formula for calculating the diversity score incorporates obligor and industry concentrations in the reference portfolio as well as default correlations across industries. The model calculates expected losses stemming from defaults in the hypothetical portfolio, going from zero defaults to N defaults and assigning a probability to each default scenario. Calculating probability-weighted losses for each CDO tranche results in the expected loss for that tranche, which is then mapped into a specific rating.

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[5] *Funded tranches of synthetic CDOs are generally rated. The "super senior" and the equity tranches are typically not rated.*

[6] *For complete discussion see "Moody's Approach to Rating Synthetic CDOs", Moody's Investors Service, July 29, 2003; "Criteria for Rating Synthetic CDO Transactions", Standard and Poor's, September 2003 and "Global Rating Criteria for Collateralized Debt Obligations", Fitch Ratings, September 13, 2004.*

[7] *Some of these unique features include the counterparty credit risk, soft credit event, and settlement mechanics.*

[8] *The identical default probabilities are assumed to equal the weighted average default probability of assets in the original reference portfolio of assets.*

Over time, Moody's has refined the BET approach by the use of the multiple binomial variation for rating synthetic CDOs which further divides the reference pool of assets into sub-pools and models the default behavior of each sub-pool with its own binomial analysis. CDOROM™ is a Monte Carlo simulation based model that models the default behavior of the assets in the reference portfolio and explicitly incorporates both intra and inter industry correlations. The model also simulates correlated recoveries to take into account systematic variation in recoveries.

Moody's addresses the soft credit events by applying a stress factor to the default probabilities used to model transactions. A stress factor of 12.5% is applied for transactions using the 1999 ISDA definitions and include restructuring credit event without any supplements. A stress factor of 5% is used for transactions that use the 2003 ISDA definitions or if all the supplements are applied to the 1999 definitions.

Recovery rate haircuts are applied to take into consideration the cheapest-to-delivery option embedded in the settlement of credit default swap upon a credit event. Moody's applies a haircut of 5% and 10%, respectively, for investment grade and below investment grade assets, if there is no restructuring credit event, or restructuring credit event with restructuring maturity limitation, or modified restructuring with restructuring maturity limitation. The haircuts applied increase to 10% and 15%, when transactions include restructuring credit event without restructuring maturity limitation or modified restructuring maturity limitation.

Standard and Poor's (S&P)
The S&P approach is based on the CDO Evaluator. Introduced in 2001, it was the first rating agency model to apply Monte Carlo simulation methods for rating CDOs. The S&P approach is different from the Moody's approach in that the rating addresses the first dollar loss for a given rating category as opposed to mapping expected losses into a specific rating category. The simulations take into account individual asset default probabilities based on its rating and pair-wise correlations between the assets in the reference portfolio. The model draws a large number of multivariate normally distributed numbers, which are then compared with a default threshold based on the asset's default probability and maturity to decide whether an asset defaults. The model produces a correlation adjusted probability distribution of potential, aggregate default rates for the collateral pool of assets. As such, it may be seen as an estimate of the distribution of aggregate defaults and losses at different probability levels.

Correlations in the Evaluator model are based on historically observed defaults, with asset correlation calibrated to default correlation. S&P classifies corporate industries at local, regional and global levels and gives an additional credit for geographically diverse portfolios. As we understand it, while explicitly incorporating intra-industry correlations, the S&P model currently treats inter-industry correlations as being zero.

To account for the unique features of CDS, S&P applies haircuts to the base-case recovery assumptions used in the CDO Evaluator. A hair cut of 5% is applied to the base-case recovery assumption to address the cheapest-to-deliver option. Likewise, a hair cut of 2.5% each is applied to account for the specified currency settlement feature, if consent required loans are deliverable and when the period between the credit event notification date and the valuation date is deemed too short (S&P prefers transactions to have the longest possible valuation period, with 45 days as the minimum). A haircut of 10% is applied when a transaction allows for the so-called old restructuring as a credit event (1999 ISDA definitions without any supplements). A 21% haircut is applied in transactions where the deliverable obligation is denominated in a currency other than the floating payment currency. All the haircuts discussed are mutually exclusive.

Fitch

Fitch's ratings are based on its Monte Carlo simulation platform, VECTOR, which was introduced in 2003. Like S&P, the Fitch approach also addresses the probability of a first dollar loss. The model CDO portfolio default distributions on the basis of Monte Carlo simulations using individual asset default rates and asset correlations as the key inputs. The default rates are derived from a matrix that provides default rates by rating and maturity based on historical realized defaults. Pair-wise correlations are based on estimates of intra and inter industry as well as geographical correlations of equity returns. The underlying statistical model for estimating correlations is a factor model that expresses the return of the equity security of a firm as a function of statistically determined factors and company specific idiosyncratic risk. Using this approach, average factor loadings and average idiosyncratic risk exposures are computed for each industry-geographic region grouping and used to derive asset correlations.

ANALYTICAL CHALLENGES IN MODELING SYNTHETIC CDOs

While synthetic CDOs are significantly simpler than their cash counterparts in terms of valuation because of a significantly simpler waterfall, cash flow diversion rules and optional redemption potential, they still pose significant analytical challenges. While this is true both under a risk neutral valuation framework as well as objective or historical probabilities, the challenges are best understood juxtaposed against the former. In this section, we explore some of these challenges.

The application of Gaussian copula models for analyzing correlated defaults in standardized credit index tranches has become an industry benchmark in much the same manner as the Black-Scholes model has been for equity option pricing (the technical details are explored in greater detail in Chapter 5).

In fact, standardized credit index tranches can be thought of as specialized cases of synthetic CDOs. The differences stem from mainly two sources, which we explore in this section. First, the underlying portfolios can be managed or static pools with the index and second, there is an additional layer of counterparty credit risk with synthetic CDOs.

Portfolios that allow trading pose several analytical challenges for valuation and risk management of synthetic CDOs. With static portfolios, knowledge of the credit quality of reference entities in the underlying portfolios, their correlation, the CDO capital structure and the cash flow waterfall structure of the transaction are sufficient to make a reasonable determination of the credit risk and returns for a given tranche. With managed portfolios, since the underlying reference entities might be changing, the problem is more complicated.

How does an analyst determine the credit quality of reference portfolios or calibrate the appropriate correlation levels when the constituents of the portfolios are unknown? One approach is to assume that the managers will always trade at the limit of the trading constraints. For example, if there is a maximum spread constraint, assume that the manager will always trade at that spread level. While some might consider this a prudent approach, it is not necessarily adequately reflective of the risks and returns an investor in a given tranche faces and has the effect of treating all managers with the same broad brush stroke. In a similar vein, correlations can be implied from observed prices of standardized index tranches. Estimating the same for non-standard synthetic CDO tranches with managed underlying portfolios imposes an additional layer of constraints.

There are two layers of counterparty credit risk with synthetic CDOs. The SPV enters into CDS with the sponsoring financial institution or the market in general and purchases credit protection from investors in funded and unfunded tranches. This introduces credit risk in transactions outside of the credit risk contained within the reference portfolio assets to the CDS counterparties. With funded tranches, there is also credit risk associated with the eligible collateral investments.

NEW DEVELOPMENTS IN SYNTHETIC CDOs

The original synthetic CDO market was a largely a bespoke one that certainly needed boosts in liquidity and transparency to make it more viable and mainstream. This benchmark liquidity was not only important for visibility purposes, but it also has helped the bespoke market in important ways. The resulting flood of structural innovation today is both interesting and rather complicated. The key question is how useful (or not) the innovation really is, and the answers largely depend on who (in the investment community) is asking. In many ways, the deluge of innovation reflects the diversity of credit investors in the market and their demand for sophistication, which we would argue is the important thematic shift in the market.

In Exhibit 8, we summarize some of the key innovative features that have either become well established recently, or have been just introduced and show (in our view) some promise. We would argue that in many cases, new features are actually a reaction to some type of risk that was exposed previously, such as excessive idiosyncratic risk during the last credit cycle or associated low recoveries. But others are strictly innovative, including things like interest rate hybrids and principal protection techniques borrowed from other markets.

exhibit 8 Key Innovations, or Those That Show Promise

Key Innovation	Our Thoughts
Hybrid CDO Squared (w/ABS)	Reaction to the over-levered CDO-squareds of several years ago. The large ABS portion serves to delever the structure
Pure CDO-Squared w/Thicker Tranches	Similar idea to yesterday's CDO-squareds, but thicker tranches serve to delever the structure
Large Collateral Pools w/Less Overlap	Investors have recognized the importance of overlap in CDO-squareds, particularly for subordinate tranches in the outer CDO. Lower levels of overlap are now common
Fixed Recoveries	A reaction to the low recoveries from fallen angel defaults in 2001-2002. Fixed recoveries reduce uncertainty, particularly in mezzanine tranches, but they are a double-edged sword as IG recoveries can be high as well
Dynamic Principal Protection (CPPI)	Application of an age-old technique to credit for investors seeking principal protection. Long/short tranche strategies or hedge fund investments seems to be the natural application
Cross-Subordination	An interesting concept that allows subordination within inner tranches of CDO-squareds to be shared
Interest Rate Hybrids	A natural progression as funded credit investors demand differing exposure to interest rate risk, beyond strict fixed or floating rate instruments
Adjustable Subordination (or Adjustable Coupon)	A viable technique for meeting investor demand for managed structures while allowing deal arrangers to hedge risks

Source: Morgan Stanley

CDO SQUARED

The so-called CDO squared structures are the arena where many of the recent innovation have come to light. A CDO squared transaction is a CDO backed mainly and some times only by other CDO tranches. In effect, they are really CDOs of CDOs (Exhibit 9). They have the benefit that they are insulated from a first loss exposure in the underlying portfolios and thus removed from idiosyncratic risk phenomenon. On the other hand, they have the potential for concentration risk across different portfolios that are hard to measure, control or hedge.

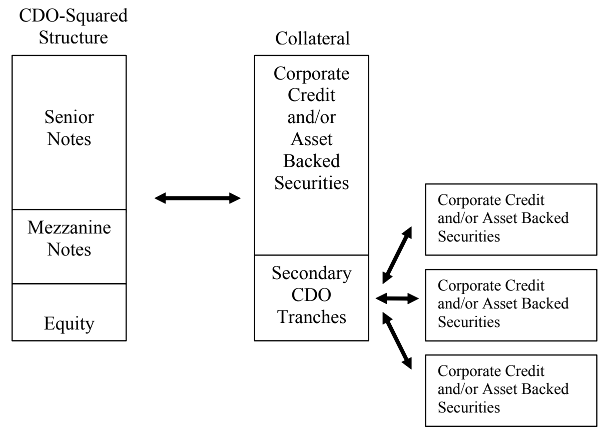
CDO SQUAREDS – A BRIEF HISTORY LESSON

Synthetic CDO-squared transactions have become popular in the market for a variety of reasons, and can play some interesting strategic roles in credit portfolios (for some of our earlier thoughts, see Chapters 11 and 35). From the perspective of innovation in the marketplace, they deserve special attention because of their relative size and the story behind them.

Early CDO-squared transactions were quite different from today's state-of-the art technology, demonstrating the learning process that market participants went through. The first deals were issued in 1999 and were generally managed cash flow structures comprised of a large number (80 or so) of already managed junior and senior mezzanine tranches of high yield CBOs, and to some degree CLOs. In retrospect, they were highly levered transactions with a fair amount of concentrated (overlapping) single-name exposure. Most performed poorly when the credit cycle turned and taught investors some important lessons.

exhibit 9

Anatomy of a CDO Squared



Source: Morgan Stanley

Today's CDO-squared structures are different along several dimensions. First, they are generally static synthetic structures. Second, the inner CDOs generally do not comprise 100% of the portfolio; there is often a significant portion of 'funding' in the structure, usually through the form of AAA-rated ABS collateral, which serves to delever the structure. As a result, 'first loss' tranches in the outer CDO generally can carry investment grade ratings. Third, the inner CDOs tend to be senior mezzanine or junior senior tranches of investment grade portfolios. Finally, the transactions are relatively transparent, meaning that investors have complete information on credit exposure and credit overlap (which may not have been the case in the past). It should be noted that CDO-squared transactions where the inner CDOs make up 100% of the collateral do still exist, but typically they include relatively thick tranches (e.g., 10% for investment grade portfolios). Also, in the cash CDO markets, pure CDO squared transactions are reemerging in new forms including those comprised of leveraged loan CLO tranches.

WHAT'S THE MOTIVATION? SYSTEMIC VS. IDIOSYNCRATIC RISK

Most investors who are attracted to CDO-squared structures are not looking to take on idiosyncratic risk, as there are better ways of doing that. Yet early transactions had plenty of idiosyncratic risk because inner CDO attachment points were low (on high yield portfolios) and overlap was relatively high. Today's structures reflect a flight from idiosyncratic exposure, but leverage is still an important part of the trade. While even the first-loss tranches of CDO-squareds are far from default, they are levered plays on systemic risk. Investors are effectively selling credit convexity, much like those who sell deep out-of-the-money options.

SURVIVAL OF THE FITTEST

Financial engineering in today's credit markets reflects Darwinian theories, in our view. The market will ultimately be able to distinguish good ideas from bad, and only the former will survive, but it will take some work to get there. We are strong supporters of continuing structural evolution, especially when it results from previous experience, but we advise investors to maintain a discerning approach.

chapter 3 A Tranched Indices Primer

While the market for outstanding synthetic CDOs is vast and quite diverse with respect to structural complexity, it remains fragmented, as we discussed in the introduction to this book. The emergence of standardized, tradable, and relatively diverse default swap indices in 2003 provided the opportunity for an on-the-run market for tranches to develop shortly thereafter. Today, the tranched index instruments are by far the largest liquidity point in the structured credit market, serve as an entry point for many investors and have been responsible for making the business mainstream.

Within the context of today's synthetic CDOs, the tranched indices are relatively simple instruments, and are effectively standardized static synthetic CDOs. Yet, they deserve special attention given the size of the market and the importance of understanding their subtleties.

In this chapter, we discuss the basic mechanics of the standardized indices of CDS and then go on to elaborate on details of tranched risk on these indices. We believe it is important to understand the nuances of these products before getting into an in-depth discussion of correlation and greeks of tranched structures, which we cover in Chapters 5 and 6. Our discussion in this chapter applies largely to corporate credit indices and their tranches. Some of the details for emerging markets indices may be significantly different.

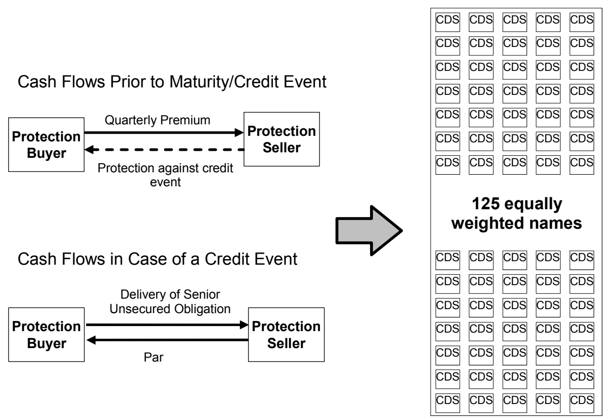
Credit Default Swap Indices

Credit default swap indices are simply portfolios of single name default swaps, serving both as trading vehicles and as barometers of the market activity. While intuitively very simple, the indices are responsible for increased liquidity and popularity of tranching of credit risk.

By buying protection on an index, an investor is protected against defaults in the underlying portfolio. In return, the buyer makes quarterly premium payments to the protection seller. If there is a default, the protection seller pays par in exchange of the reference obligation to the protection buyer. Exhibit 1 shows the cashflows in an index:

exhibit 1

DJ CDX Investment Grade Index



Source: Morgan Stanley

Several investment grade and high yield indices trade in the US, covering multiple maturities, sub-sectors, credit quality, etc. In addition, there are numerous similar indices for Europe, Pan Asia, and Emerging Markets. Pricing levels, descriptions, and calculators for these indices are available on the MSCD <GO> screen of Bloomberg.

IMPORTANT CHARACTERISTICS OF BENCHMARK INDICES

Static Underlying Portfolio

Once an index composition is fixed, no names can be added or deleted from the portfolio. It is also noteworthy that all names are typically equally weighted, as opposed to market weighted, which is common for benchmark bond indices.

Rolling Over of Indices

As time passes the maturity term of indices decreases, making them significantly shorter than the benchmark terms, so new indices are introduced periodically and the latest series of the index represents the current on-the-run index. Markets have continued to trade previous series of indices albeit with somewhat less liquidity.

Standardized Payment and Maturity Dates
Just like the single name default swaps, the cash flow dates of indices are also standardized – the 20th of March, June, September, and December of every year. Market participants have also standardized maturity dates to the four standard payment dates of the maturity year.

Deal Spread
The indices have a predetermined "Deal Spread", which is paid on a quarterly basis. Consequently, if the index is currently trading away from the deal spread, an upfront payment is required to reflect the difference between the current market spread level and the deal spread. Conceptually, it is equal to the present value of the difference between the two, adjusted for default probabilities.

It is also important to note that all the underlying single name contracts also have the same deal spread as the index. Just as a portfolio of bonds with different coupons has better convexity than a corresponding portfolio with the same coupon for each of the bonds (assuming both portfolios have the same average coupon and maturity), the convexity characteristics of the index are somewhat different from that of an equal-weighted portfolio of the underlying single name default swaps.

Payment of Accrued Premiums
If an investor enters an index transaction in between the payment dates, the protection seller would make a payment of accrued premium to the protection buyer, to reflect the fact that the protection buyer would pay premium for the full quarter on the next payment date but the protection is in effect only for part of the quarter.

Restructuring Definitions
The market standards regarding restructuring definitions for indices and underlying credit default swaps are not always the same. For example, while most of the underlying single names for DJ CDX NA IG index trade with a Modified Restructuring (Mod-R) definition, the index itself trades on a No-R basis. European indices, however, trade with the same restructuring definition as the underlying, Modified Modified Restructuring (Mod-Mod R). For further details on restructuring definitions, refer to *Credit Derivatives Insights – Single Name Instruments and Strategies*, February 2005.

DETERMINING THE UPFRONT PAYMENT

As we mentioned earlier, if the index is trading away from the deal spread, an upfront payment is required to reflect the difference between the current market spread level and the deal spread. Theoretically, the present value of the two premium streams should match when we take default probabilities and timing of cashflows into consideration.

The first step for calculating the upfront payment is to estimate default probabilities from the credit curve (for more details, refer to *Credit Derivative Insights - Single Name Instruments & Strategies*, February 2005). Using these probabilities, we calculate the present value of the current spread, by multiplying the spread with the probability of survival at the time of payment and then discounting back using risk-free zero rates. Now, this present value should equal the present value of upfront and running premiums (the Deal Spread), based on the same default probabilities. So if the deal spread is higher than the current par spread, the protection seller makes a payment to the protection buyer.

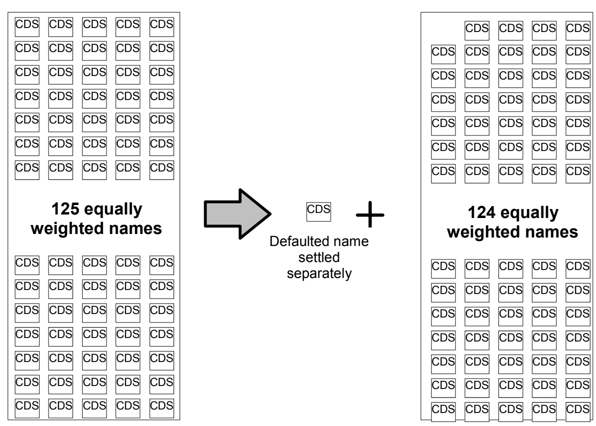
A convenient way to do this conversion is to use the CDSW function on Bloomberg. We simply put in the "Deal Spread" and value the contract using the current par spread. The "Market Value" represents the equivalent upfront payment. In addition to the upfront calculation, we can use this function to calculate mark-to-market, DV01 and cashflows. The DV01 is especially helpful in delta hedging of portfolio credit exposures using indices.

IMPACT OF DEFAULTS ON INDEX CASHFLOWS

When an underlying single name defaults, it is separated from the index and settled separately. For example, for DJ CDX NA IG index, which has 125 names, if one of the underlying names defaults, the remaining index would have 124 names and the same deal spread. The 1/125th of the notional would be separated and the protection seller would pay par to the protection buyer in exchange of a deliverable obligation.

After a default, the premium payments for the index would be (124/125)*Deal Spread, irrespective of which of the 125 names defaults (this methodology applies to CDX series 3, and may not hold for previous indices). This is due to the same deal spread for all underlying names in the index portfolio, as we mentioned earlier. It is important to note that an equal-weighted portfolio of underlying names could now have a different spread, given that the each of the underlying names has its own spread level and depending on which of the 125 names defaults, the average spread for the remaining 124 names could be different from 124/125 of the original spread.

exhibit 2
Impact of Default on Index



Source: Morgan Stanley

chapter 3

Tranches of Standard Default Swap Indices

Co-existence of synthetic CDOs and liquid benchmark indices resulted in the logical next step of applying the tranching techniques to the indices, which lead to standardized synthetic CDOs. In this section we will discuss the basic structure of these instruments, followed by a more detailed analysis of their characteristics.

THE BASIC MECHANICS

Borrowing the CDO technology, we can tranche the credit risk of an index into a number of slices, with different levels of subordination. The junior most tranches covers initial defaults, and once losses exceed the notional of the tranche they are passed on to the next senior tranche in the capital structure.

For example, the most liquid standardized IG DJ CDX NA index tranches are 0-3%, 3-7%, 7-10%, 10-15%, and 15-30% (see Exhibit 3). The first tranche, also referred to as the "equity" tranche, takes the first 3% of the losses on the portfolio. When the portfolio has accumulated large enough losses to exceed 3% of notional, the next tranche, 3-7%, will incur losses from any potential further defaults, and so on. The standardized tranches for the high yield index, DJ CDX NA HY, are 0-10%, 10-15%, 15-25%, 25-35%, and 35-100%.

How are the standardized tranches determined? The attachment and detachment points of standardized tranches are partly driven by the synthetic CDO market and expected ratings of the tranches.

It is important to note above that the IG equity tranche takes 3% of overall portfolio losses, not defaults. Assuming a 40% recovery, 5% of the portfolio would have to default in order to wipe out the entire equity tranche.

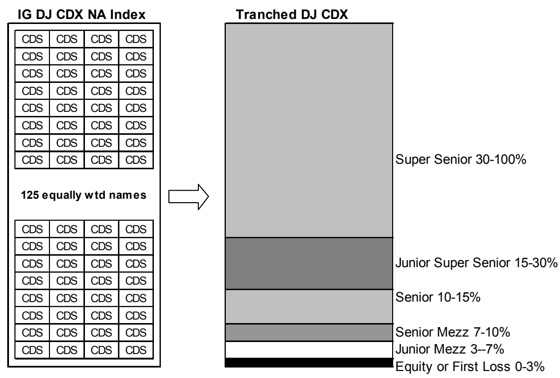
IMPORTANT CHARACTERISTICS OF BENCHMARK TRANCHES

Attachment and Detachment Points

The attachment point determines the subordination of a tranche. For example, a 3-7% tranche's attachment point of 3% implies that the tranche will incur losses only after the first 3% of the notional has been lost due to defaults over the term of the index. The detachment point determines the point beyond which the tranche has lost its complete notional. In other words, the 3-7% tranche is completely wiped out if portfolio losses exceed 7% of the index. The difference between the attachment and detachment points is referred to as "thickness" of tranche.

exhibit 3

Tranched DJ CDX NA IG



Source: Morgan Stanley

Market Quoting Convention

Tranches that are expected to incur significant default losses, i.e. the equity tranche and some other junior tranches, are typically quoted with a sizeable upfront payment and some running premium, while more senior tranches are typically quoted on a running premium basis. For investment grade (DJ CDX NA IG), the equity tranche is currently priced on an upfront plus 500 bps running, while all other tranches are priced on a running premium basis. However, in case of high yield (DJ CDX NA HY), the first two tranches are currently priced on an upfront basis with 0 bps running, while the more senior tranches are priced only on a running premium basis.

Typically, when a tranche is expected to face material losses, an upfront payment helps reduce the volatility of returns and sensitivity of the tranche to spread changes. The reason being that in case of high defaults the running premium would drop significantly along with the outstanding notional, implying lower expected premiums. Conversely the protection seller collects higher premiums in a low default case. For more details on this topic refer to Chapter 6.

Tranche "Delta"
The delta of a tranche reflects its sensitivity to changes in spreads of the underlying index portfolio. It is typically measured as a ratio of PV01 of the tranche to PV01 of the index. (PV01 is the change in the mark-to-market for a 1 basis point move in each of the underlying credits in the portfolio.) Typically, dealer quotes assume that the counterparty will also enter into a delta-neutral notional amount (i.e., delta x tranche notional) of the index simultaneously with a tranche transaction.

Broadly speaking, junior tranches have higher deltas than senior tranches, if both are quoted on a running premium basis. However, the presence of upfront payments for junior tranches (equity tranche for investment grade DJ CDX and the first two tranches for high yield DJ CDX) lowers tranche delta. We will discuss the intuition and further details on this topic in Chapter 6.

Rolling over of Indices
As time passes the maturity term of tranches and the underlying index decreases, making them significantly shorter than the benchmark terms. So, tranches on the new on-the-run indices are introduced, as the indices roll over.

Standardized Maturity Dates
Market participants have standardized maturity dates for tranches to the maturity dates of the underlying indices.

Standardized Payment Dates
Just like the underlying indices, the cash flow dates of index tranches are also standardized – the 20th of March, June, September and December of every year.

Payment of Accrued Premiums
If an investor enters an index tranche transaction in between the payment dates, the protection seller would make a payment of accrued premium to the protection buyer, to reflect the fact that the protection buyer would pay premium for the full quarter on the next payment date but the protection is in effect only for part of the quarter.

Restructuring Definitions
The restructuring definition market standards for index tranches matches the underlying index convention (No-R for US indices).

Hybrid Settlement in Case of Default

When one of the names in the index defaults, the loss is transferred to the relevant tranche (say, the equity tranche assuming that this is the first default in the portfolio). Determining the realized recovery on the defaulted name is very important, as it not only impacts the cashflows of affected tranches but also determines the erosion of subordination for other tranches.

To determine the recovery rates more accurately, the market has adopted a “hybrid settlement” for index tranches. The goal of hybrid settlement is to balance the protection seller's desire for a high valuation with the protection buyer's interest in keeping recoveries low. Hybrid settlement has two stages: partial physical settlement followed by a cash settlement valuation. The first phase consists of obligations being delivered up to the amount of the defaulted name’s delta in each tranche. The second phase involves an auction process, which determines the amount by which each tranche is written down.

chapter 4 A First-to-Default Basket Primer

While the lion's share of attention and liquidity in the tranched credit markets is focused on cash CDOs, synthetic CDOs and the tranched indices (see Chapters 1-3), first-to-default baskets, or more generally, Nth-to-default baskets are the simplest tranched credit instruments. First-to-default baskets are optically very similar to a credit default swap, but the uncertainty associated with whether a credit in the basket will trigger a credit event makes their risk and return profile intuitively more similar to CDO tranches. There are important differences, as well, which we address in this chapter.

OVERVIEW OF BASKET DEFAULT SWAP MECHANICS

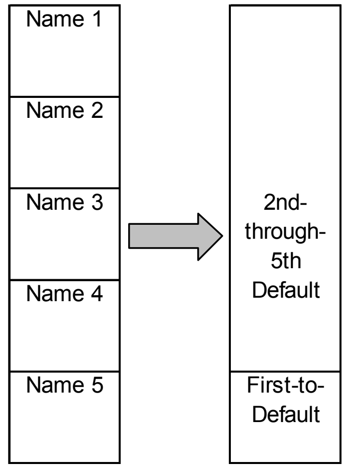
An Nth-to-default basket is a product with which the investor gains either long or short exposure to a relatively small basket of credits. The typical size of baskets ranges from 4 to 10 credits. The investor is either selling or buying protection on the Nth credit to default in the basket, as with a plain vanilla credit default swap, except that the reference credit is a basket instead of a single name. Five-name baskets are most common, and protection is typically bought or sold on either First-to-Default (FTD) or 2^{nd}-through-5^{th} default basis.

Suppose an investor sells FTD protection on a five-name basket of reference credits. The investor will receive a periodic payment (the "premium") in exchange for taking on the credit risk of the basket. If no credit events occur during the term of the basket default swap, the swap expires. If a credit event occurs during the term of the basket, the swap is terminated and the "buyer" of protection delivers the reference credit that experienced the credit event to the "seller" of protection in exchange for a par payment (equal to the notional amount of the swap). This process is analogous to a single name credit default swap.

The settlement in case of default can be done either through a cash settlement or physically, with a security that qualifies for delivery under the terms of the underlying default swap on the credit. A credit event is defined as it is in the single name market, with investors having the option of choosing the restructuring definition. When a credit event occurs, the seller of protection in the basket is effectively losing par minus the recovery value of the defaulted asset. For detailed definitions of credit events and deliverable obligations, refer to our publication, *Credit Derivatives Insights – Single Name Instruments and Strategies*, February 2005. The following exhibit shows an FTD swap with an underlying basket of five names:

exhibit 1

First-to-Default Swap



Source: Morgan Stanley

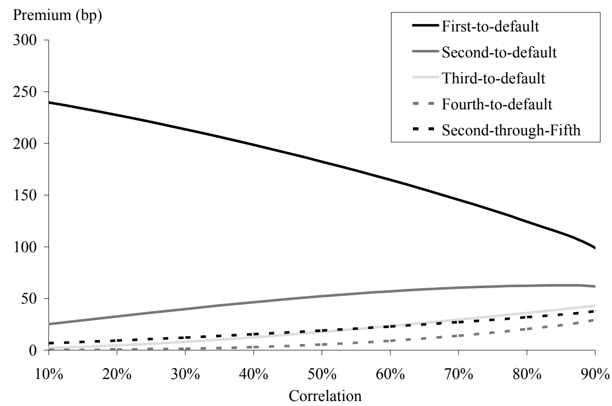
SELLING FIRST-TO-DEFAULT PROTECTION: LOOKS LIKE A DEFAULT SWAP, FEELS LIKE CDO EQUITY

Although basket default swaps resemble single-name credit default swaps optically, their risk/return and valuation profiles are much more like CDO tranches. FTD baskets are more similar to CDO equity, albeit with less leverage in that the investor receives a premium in exchange for taking on first-loss risk. Even if fully funded, the default swap basket can be thought of as a leveraged investment in a basket of credits, with the non-recourse leverage being provided by the counterparty. The seller of protection in an FTD, however, is only exposed to the first credit event, and the principal loss is directly related to the recovery value of the defaulted asset. This aspect is unlike CDO equity, where the CDO structure is still active after the first loss and continues to be active until it matures, is called or amortizes.

BASKET DEFAULT SWAPS ARE CORRELATION PRODUCTS

As in CDO tranches, correlation can have a dramatic effect on the pricing of basket default swaps. As an example, we consider a first-to-default swap on a basket of five credits, with each default swap trading at a premium of 50 bp. In the case of 0% correlation, a first-to-default swap would carry a premium of approximately 250 bp, the sum of the individual default swap premiums. In the case of 100% correlation, the first-to-default swap would have a premium of 50 bp, the maximum of the individual default swap premiums. A graph of the premiums on the first-, second-, third-, fourth- and second-through-fifth-to-default swaps as a function of correlation is shown in Exhibit 2.

exhibit 2
Basket Default Swap Premium Depends on Correlation



Source: Morgan Stanley

FIRST-TO-DEFAULT BASKETS: INVESTOR MOTIVATION

Why would an investor either sell or buy first-to-default protection on a basket of credits? Say an investor has a positive view on a basket of five credits and that each credit pays a premium of 50 bp in the 5-year default swap market, as in the previous example. By entering into five individual default swaps, the investor could gain $2 million notional exposure to each credit and effectively receive 50 bp of premium per annum on $10 million notional for five years if no credit events occur. If one or more credit events occur, then there will be a principal loss in each default swap (equal to par minus the recovery value of the default asset).

Alternatively, an investor can express a positive view on the same basket of credits by selling first-to-default protection on the basket with a notional amount of $10 million. From Exhibit 2, if we assume a correlation of 30%, the premium earned will be approximately 214 bp (86% of the portfolio spread); therefore, implementing this view via an FTD basket results in a higher-yielding investment for a given notional exposure. To get an equivalent yield from a single name, an investor would have to write protection on more than 4 times the notional. Therefore, an FTD is a much more levered way of expressing a positive view on credits, which is obviously a double-edged sword. For other examples, refer to Chapter 40, where we show how an investor can get a return profile of BBs with a risk exposure similar to BBBs.

Why would an investor buy protection on a basket of credits? It is effectively a way of shorting a basket of credits with less premium outlay than buying protection individually on each underlying credit. However, the swap gets terminated when the first credit event occurs, so the upside for the protection buyer is equal to par minus the recovery value of the defaulted credit only. This makes the basket a better hedge for default risk than spread risk.

Buying protection is also a way of hedging existing long exposure to credits, particularly for investors who want to reduce concentration risk but do not necessarily have an outright negative view on credits. For example, rather than buying protection individually on a portfolio of names, buying protection on the basket will be cheaper and more useful if the investor has a generally positive view on the credits but would like to reduce concentration risk. The buyer of protection is effectively short correlation.

exhibit 3 Investor Motivation for Basket Trading

Basket	Protection Seller	Protection Buyer
FTD	Receive higher yield for same notional by taking more levered exposure to basket	Avoid idiosyncratic risk on a basket
	Express credit views in levered form	Buy cheaper protection vs. individual swaps on all underlying names, but retain tail risk
	Position for rising correlation (for example as a result of mergers)	Express views of falling correlation between individual names or industries
2nd-through-5th	Express positive views on a basket, while avoiding idiosyncratic risk, but taking tail risk	Buy cheaper protection against the tail risk vs. buying protection on all underlying names
	Receive possibly higher yield than some of the low yielding names in the underlying basket	Manage risk for extreme scenarios
	Position for falling correlation (for example expressing views that expected mergers won't materialize)	Position for rising correlation (for example as a result of mergers)

Source: Morgan Stanley

MERGERS AND FTD BASKETS

The seller of protection on an FTD basket is long correlation, i.e., rising correlation among the names in the basket would result in a positive mark-to-market. This is also evident from Exhibit 2. This aspect of an FTD basket makes it an effective instrument for positioning for mergers and acquisitions activity among a set of names (assuming no replacement language, which we will elaborate on shortly).

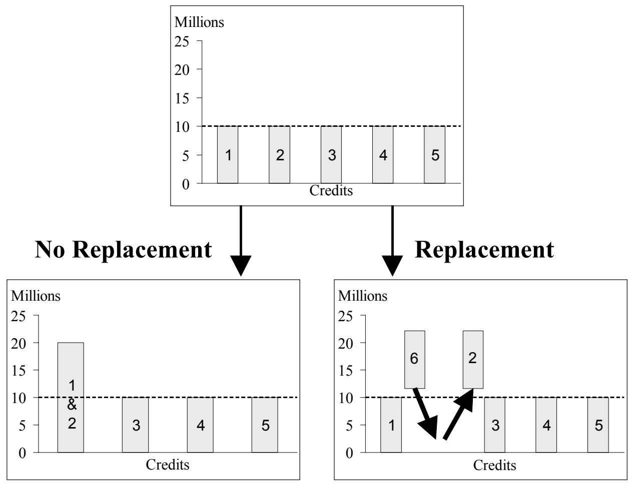
For example, if an investor expects M&A activity in a sector, he/she can write protection on an FTD basket, including names that are likely to be involved. If there is a merger, the correlation between the merged names will effectively go to 100%, resulting in an overall rise in basket correlation, benefiting the FTD protection seller. From another perspective, the FTD protection writer has to worry about only 4 credits after a merger, as opposed to 5 credits previously (assuming that the basket initially included 5 credits).

Replacement Language in FTD Baskets

What happens if two of the names in a basket merge? The mechanics behind merger treatment in baskets are important to understand, as there are two forms that trade in the market (see Exhibit 4). In the simplest form (i.e., without replacement language), a five-name, first-to-default basket where two reference entities merge effectively becomes a four-name basket once the merger closes.

exhibit 4

Replacement Language Matters – Impact of a Hypothetical Merger Between Credits 1 & 2



Note: Assumes $10 million notional of first-to-default exposure.
Source: Morgan Stanley

However, the "contractual" notional amount of the merged entity in the basket doubles to reflect that it was once two reference entities. Yet, this change in exposure size of the merged entity does not matter to the seller or buyer of first-to-default protection. A credit event in any of the four names (including the merged entity) would still trigger the contract. A credit event experienced by the merged entity, however, has a larger notional impact. Therefore, it would simultaneously trigger both a first-to-default and a second-to-default contract.

Replacement Language – Operationally Puzzling

The impact of a lack of replacement language seems intuitive to us, given either the correlation or leverage reduction analogies we described earlier. The seller of first-to-default protection sees a reduction in risk when there is a merger, so the seller of second-to-default protection must see an increase in risk, for which he or she must be compensated. Market clearing levels should take this into consideration, if the market is efficient about this. In fact, we would argue that the merger option is one factor that keeps implied correlation in small baskets higher than in large baskets.

First-to-default baskets trade with “replacement” language in the marketplace, as well (see Exhibit 3). Here, when a merger occurs, instead of dropping an entity from the basket, the buyer and seller of protection must mutually agree on a replacement credit, and often this replacement credit is one that trades at a similar spread level. Clearly, there is significant correlation risk in this exercise, and the buyer and seller of protection have opposite correlation views. Furthermore, the operational aspects of going through this process for each basket that experiences a merger can be tedious. We have much more experience with baskets that trade without replacement language, which, again, seems more intuitive to us. We thus recommend that both buyers and sellers of first-to-default protection avoid replacement language.

The Merger Impact – What Is It Worth?
In order to better understand the value of the merger options, we examine the pricing impact across credits with a variety of spreads and correlations. Generally, the merger impact becomes more valuable for riskier (e.g., higher spread) credits, as well as for baskets where implied correlation (before the merger announcement) is low. For example, the expected spread move in a basket with an average premium of 50 bp, at a correlation of 40% (which is typical for diversified industrial first-to-default baskets), would be 32 bp (see Exhibit 5). At 150 bp of average premium, it would be worth 80 bp. This assumes no movement in spread of the merged entity or other credits in the basket.

exhibit 5 What Is the Impact of a Merger Worth?

	Average Spread of Credits in Basket (bp)			
Correlation	**20**	**50**	**100**	**150**
20%	18	41	78	111
40%	15	32	57	80
60%	11	22	39	53
80%	6	13	22	29

Source: Morgan Stanley

To the extent that a merger drives the merged entity’s spread wider, the impact of the merger would be more muted than indicated in the table. As an example, for a basket with average spread of 50 bp, trading at 60% correlation, the gain on the merger of two entities (roughly 22 bp of first-to-default premium) would be fully offset by a 33 bp (66%) widening in spread for the merged entity.

SECOND-THROUGH-FIFTH DEFAULT BASKETS: ANALOGOUS TO SENIOR CDO TRANCHES

A second-through-fifth default basket (assuming five credits) is similar to a senior CDO tranche, and any credit events after the first default trigger the contract. Unlike FTD baskets, the swap remains in effect until maturity or until all the covered credits default. The risk/return profile is similar to that of a CDO senior tranche in that a protection seller is protected from idiosyncratic risk, but exposed to severe loss scenarios where multiple credits default (also known as “tail risk”). However, a key difference is that the return profile of the protection seller in a second-through-fifth default basket is independent of the severity of the first loss.

SECOND-THROUGH-FIFTH-TO-DEFAULT BASKETS: INVESTOR MOTIVATION

Why would an investor sell or buy protection on a second-through-fifth default basis? As with senior versus equity in a CDO, selling protection in a second-through-fifth default basket is potentially a safer or less volatile way to gain long exposure to a basket of credits. In exchange for a smaller premium, the protection seller has direct exposure to any defaults after the first credit event, but is protected from the first credit event. An investor with a positive view on the underlying credits can sell protection in this swap and potentially earn more premium than selling protection on some of the individual names. In contrast to first-to-default baskets, the seller of protection is short correlation (i.e., an increase in correlation among the underlying names would be bad).

Why would an investor buy protection on a second-through-fifth default basket? In general, it can be a significantly cheaper way of hedging existing long credit exposure when the investor is willing to take the risk of some losses on the first credit event, but wants to hedge against more severe default scenarios.

FUNDED BASKETS

Most basket default swaps are structured and executed in “unfunded” form and are not assigned credit ratings. However, it is possible to combine an FTD basket with a deposit to create a funded product. In that case, the protection writer would buy a note with spread over Libor coming from an FTD position. In case of a default in the underlying portfolio, the note holder would incur a loss of principal on the note, reflecting the payment of par minus recovery on the FTD basket.

EXAMPLE: EX-HIVOL FIRST-TO-DEFAULT BASKET

Among the more common types of first-to-default basket transactions we have witnessed in the marketplace are those involving high-quality credits from relatively unrelated industry groups. In such baskets, first-to-default protection sellers receive significantly higher premiums than the average for the basket because the low correlation among the credits effectively raises the probability that at least one credit will experience a credit event.

In Exhibit 6, we show the Ex-HiVol basket as an example, with five investment grade credits and individual default swap premiums averaging 37 bp. Investors confident that none of the credits will experience a credit event over a five-year term can implement this view by selling first-to-default protection on the basket. In exchange for taking on the risk that any one of the credits experiences a credit event, the investor receives a premium of 153 bp. This premium is 4.1 times the average of the five names and 84% of the total, assuming correlation of 38%.

The quoted prices can assume that the FTD protection seller/buyer would also buy/sell a delta-neutral amount of protection on the underlying credits. However, if the investor is not interested in entering into a delta-neutral transaction, the bid/ask would be wider, reflecting the transaction cost that the dealer has to incur for delta hedging.

exhibit 6 Ex HiVol Benchmark First-to-Default Basket

Names	CDS Level (bp)	Bid/Offer (bp)	Bid/Offer (% Total)	Imp Corr. Bid/ Offer (%)
DOW	22	153/164	84/90	38/25
SRAC	90			
DUK	25			
GECC	21			
VZ	25			
Total	183			

Source: Morgan Stanley

Clearly, the correlation assumption is an important input in valuation of FTD baskets. In the next chapter, we will spend considerable time on developing intuition for correlation. As we mentioned earlier, sensitivities of baskets to spread changes, correlation changes, time decay, etc. are intuitively similar to those of CDO tranches, which we discuss in Chapter 6.

chapter 5 What is Correlation?

"One man's delta is another man's correlation."

– Chris Boas

INTRODUCTION

Before we address what correlation is, it is worth a few words to address why correlation is of interest to credit investors. Portfolio structured credit products are generally based on portfolios of assets whose performance is interrelated. For example, default rates are economically cyclical and entire sectors can suffer from downturns, resulting in higher-than-expected default experience. These baskets of correlated assets behave differently from identical baskets of independent assets in several significant ways. Markets have long recognized these differences and prices have reflected the differing risks. Correlation is the missing link necessary to go from today's standard derivative pricing models to the prices we observe in credit markets, or vice versa.

WHAT EXACTLY DO WE MEAN BY CORRELATION?

We start with a definition from the American Heritage Dictionary:

"Correlation: n. A causal, complementary, parallel, or reciprocal relationship, especially a structural, functional, or qualitative correspondence between two comparable entities: a correlation between drug abuse and crime. {Statistics} The simultaneous change in value of two numerically valued random variables: the positive correlation between cigarette smoking and the incidence of lung cancer; the negative correlation between age and normal vision."

CORRELATION IN FINANCIAL MARKETS

In financial markets, correlation is best understood using the latter statistical definition. Most often, correlation in financial markets describes the relationship of the price changes (or returns) of two different assets. Consider the classic CAPM model, which implicitly uses the idea of correlation between the return of a given asset and the overall market in the definition of beta:

$$\text{Beta} = Cov(R_i,R_m) / \sigma^2(R_m)$$

$$= \rho(R_i,R_m)^* \sigma (R_i) / \sigma(R_m)$$

where

R_i and R_m are the return on asset i and the market, respectively

Cov is covariance, ρ is correlation, and σ is standard deviation

This is the type of correlation many investors and asset allocators are most accustomed to, and it has long been discussed in the financial literature.

Another example of this same type of correlation is in the world of equity index options where we can examine the correlation between securities, rather than the correlation between a security and the market. Consider the market for options on the Dow Jones Industrial Average and all of the components. Traded option markets tell us that the weighted average implied volatility for the portfolio was roughly 21% on March 23, 2005 while the observed implied volatility for options on the actual index was roughly 11%. The difference is explained by the correlation among the components.

In Exhibit 1, we summarize the implied index volatility as calculated under several correlation assumptions, as well as the observed index volatility from the options market. If the credits are 100% correlated then there are no diversification benefits and the volatility of the portfolio is simply the weighted average of the components, which is 21.3%. If the components are independent of one another, there are significant diversification benefits, with an implied index volatility of 4.3%. The reality is somewhere in between, and on this particular day, the correlation implied by market pricing was approximately 24.5%.

exhibit 1 Portfolio Volatility Affected by Correlation

Correlation	Index Volatility
0.0%	4.3%
50.0%	15.3%
100.0%	21.3%
24.5% (Index Option Implied)	11.0%

Source: Morgan Stanley, Bloomberg

In order to simplify the analysis above, we have used one common correlation variable for each pair of components and varied that number. In reality, this assumption of a single correlation between these assets is probably inadequate and the market pricing likely reflects the varying levels of correlation among the assets in the portfolio. While historical correlations among the returns of the index components are observable (because we have active equity markets for all the components), these are backward-looking estimates, like realized volatility.

CORRELATION IN STRUCTURED CREDIT MARKETS

Correlation in structured credit markets has a very different meaning than in most financial markets. We highlight the key differences below:[1]

First, the correlation quoted in structured credit markets is generally implied from the market price of a tranche, under a certain set of assumptions using a given model. Therefore it is usually an output, rather than an input, and it is generally forward-looking rather than historical. This may not have been the case in the early days of the market or in some of today's bespoke structures, but standardization in both models and contract terms has occurred almost organically, allowing market participants to

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[1]*This discussion focuses on the correlation measure used in standard copula implementations rather than rating agency approaches. For a discussion of rating agency approaches, please see Chapters 1 and 2.*

quote correlations to communicate price, given all the other market variables. Interpreting an implied correlation generated by one of today's standard copula models requires market data or assumptions regarding all of the variables listed in the Valuation section on Page 65.

Default Correlation Not Spread Correlation
Second, and probably most important, the correlation we are actually measuring is not the correlation of the change in prices (or spreads) but rather it is most closely related to the correlation of the timing of default events within the portfolio. In contrast to equity derivative models, structured credit models generate values based on default probabilities derived from today's market prices of the underlying instruments rather than the expected value based on the future market prices of the underlying instruments. This is a fundamental difference in the way credit derivatives are valued as compared to derivatives based on other asset classes.

The current generation of structured credit models rely on the distribution of aggregate default losses for the portfolio to derive the tranche price. Aggregate losses for the portfolio are generated by combining the likelihood of default for each credit with a measure of how correlated the default events are. The expected timing of default events for the individual credits are directly related to today's spreads for the portfolio components (but do not reflect the potential movement in spreads in the future).

Aggregate Correlation – If You Can Call It That
Third, the quoted correlation is a single number that represents the relationship between all the pairs of names in a given portfolio. Correlation is generally a concept that measures the relationship between any two assets. In structured credit markets, the same number is used to represent the relationship between every pair in the portfolio (as we have done in our Dow Jones Industrial Average example). When we say the price of the tranche has an implied correlation of 30%, we are essentially saying that the correlation for each distinct credit pair is implied by the market price to be 30%. While this definition does not allow us to vary correlation for each pair, it does provide a measure of the aggregate correlation in the portfolio.

As with the equity index example above, there are likely differing levels of correlation for the various pairs of names, but deriving correlations for all the pairs can be an exercise in futility. Unlike the equity index example, we cannot actually observe the historical default correlation for two given credits (if a name had a correlated default to observe, would it be in the portfolio?) so approximations of the pair-wise correlations add the risk of significant estimation errors. We can observe spread correlations, assuming spread markets are liquid, but these are imperfect proxies for default correlations (which we discuss below). Additionally, the sheer number of estimates required makes the process an unmanageable exercise fairly quickly. Consider a typical 100-name portfolio, which would require 4,950 distinct correlation estimates.

For all but the most junior tranches, the aggregate correlation of a portfolio is a more important driver of pricing than the correlation between any two credits. For the most subordinate tranches, the correlation between a single pair of credits can be an important driver, as well, given their exposure to idiosyncratic risk. For example, if the two widest trading names in a basket announced a merger for which the financing plan indicated increased leverage (and by implication, higher levels of default risk) for the joint entity, this would be doubly bad for the most junior tranches, while having only a marginal impact on the most senior tranches because of the idiosyncratic nature of the risk. Default propensity increased only for the two names and not for the broader universe, and correlation jumped between only these two entities, but their correlation to the rest of the portfolio likely dropped. Consider how muted the benefit would be to the same tranche if two of the most high-quality credits announced a credit-enhancing merger. Situations like this help, in part, explain the difference in implied correlations for actively traded tranches of the same portfolio.

OBSERVING DEFAULT CORRELATION

We like to say that implied correlation in structured credit is similar to implied volatility in equity options markets. It provides a way to communicate price, given all the other inputs, which are generally observable. Under this framework, observing different implied correlations for different tranches is like observing different implied volatilities in options markets: it measures the supply and demand dynamics in the market and, if persistent, can point to weaknesses in the assumptions or the model we are using.

There is one critical difference, however, between implied volatility and implied correlation. If we want to test implied volatility against realized volatility in markets, we can do so. We can observe the returns in the market during the period and compare realized return volatility against that implied by option prices. This type of comparison is not possible in structured credit markets, largely because defaults are generally low probability events and are hence infrequent, particularly in investment grade markets. What we really want to observe is the correlation between two events, each of which is itself fairly unlikely.

Users in today's market have turned to observable data to get a sense for default correlation as a proxy for a variable that is difficult to observe. This can be an exercise fraught with peril. To illustrate the point, we again turn to the equity markets. We examine two measures of correlation for the current components of the Dow Jones Industrial Average from January 1995 through March 2005. The first metric, which we will call "price correlation" is the average correlation of the daily percentage returns for each pair of index components. This measure is consistent with the correlation that is most frequently encountered in financial markets.

The second metric, on the other hand, is designed to be similar to the concept of the time to default correlation we use in today's structured credit models. It is defined as the average of the "timing correlations" for the components, where "timing correlation" is defined as the correlation of the number of "extreme return" days in a given month for each pair of index components. We define "extreme return" as a daily return greater than +/-5%. The idea is for this metric to capture the correlation of extreme daily moves only, assuming a month is a sufficient period to capture any lag among the components.

For the full period in question, we find that the average return correlation for the DJIA is roughly 16%, while the timing correlation is roughly 34%, or more than double the price correlation. We find similar (albeit flipped) results when we examine correlations in spread markets: the realized spread (price) correlation for the components of DJ CDX NA IG 3 was 56% for the year ending March 29, 2005 while the implied (timing) correlation in the 0-3% tranche on that date was 19%. The implication is that day-to-day equity price changes are only slightly correlated, while extreme events in equities are much more correlated. For credit spreads, the opposite is true: daily price changes are highly correlated, but default events are less so. The point here is really that when we talk about the correlation of extreme events like default, we need to be careful extrapolating from correlations that capture both large and small changes in valuation, such as the correlations of the prices of equities, assets or spreads.

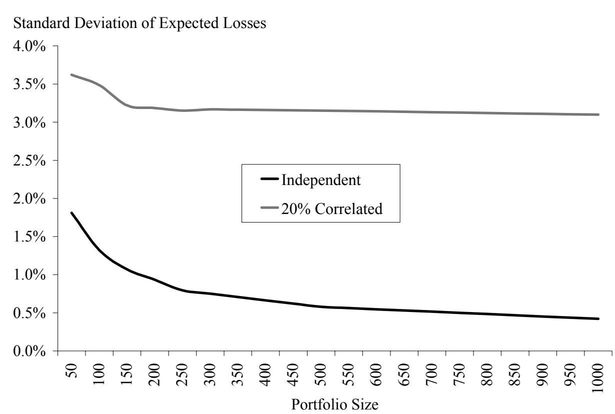
THE HIDDEN MEANING OF DEFAULT CORRELATION IN CREDIT MARKETS

After such a long-winded discussion of exactly what "correlation" is in structured credit markets, it is worthwhile to highlight what correlation does to the implied behavior of structured credit portfolios. Some work we have done in the portfolio optimization space, in which we focus on portfolio size, helps highlight the impact of correlation on credit portfolio performance.

In Exhibit 2, we show the volatility of expected losses of similar investment grade portfolios with different numbers of independent credits. As we increase portfolio size from 50 names to 1,000 (think of 1,000 as the investable universe), the uncertainty of expected losses of the portfolio declines to some minimum level (0.4% over five years for the largest portfolio). We then perform the same analysis for the same portfolio and superimpose 20% default correlation on the portfolio. The results in Exhibit 2 show that the absolute level of uncertainty declines much less than in the independent case. This points to the first impact of correlation on the credit portfolios, namely, that the absolute level of risk is greater than for an independent portfolio (this may sound obvious). Alternatively, the diversification impact of adding names to the portfolio is much less important for correlated names.

exhibit 2

Correlation Affects the Relationship Between Volatility and Portfolio Size (Expected Losses = 3.0%)



Source: Morgan Stanley

The real insight comes from examining these results against real world experience. We summarize the coefficients of variation (standard deviation divided by mean) of the simulation results in Exhibit 3 alongside the same for Moody's five-year cumulative default statistics for the 1970-1999 period. The most valid comparisons are the 1,000-

name portfolios against the Moody's results, because the 50-name portfolios have much more idiosyncratic risk. Most notable is that the volatility of expected losses for large portfolios is much greater for correlated portfolios and this is broadly consistent with actual default experience we see from Moody's. This is the hidden impact of correlation: to make the aggregate default experience inside our models more similar to what we actually experience, given the cyclical (correlated) and volatile nature of credit risk.

exhibit 3 Volatility – In the Models and in the Real World

	50 Credits 0% Correlation	1000 Credits 0% Correlation	50 Credits 20% Correlation	1000 Credits 20% Correlation	Moody's A	Moody's Baa	Moody's A & Baa
Coefficient of Variance	0.6x	0.1x	1.1x	1.0x	1.5x	0.7x	0.9x

Source: Morgan Stanley

VALUATION IN STRUCTURED CREDIT MARKETS

Valuation for the structured credit market has developed along several tracks. The most recent introduction is in the synthetic space and has been based largely on a derivative pricing framework not dissimilar to that used to price single-name credit derivatives. As with single-name credit derivatives, pricing for tranches or N-th to default baskets is a function of the single-name par spread levels, the spread at which the contract is struck, the risk-free interest rate and a recovery assumption, but we need to also add the following variables for tranches: attachment and detachment points (either in losses or in number of defaults) and the correlation of default events.

As with the single-name models, the spreads are converted into risk-neutral default probabilities, which is effectively the same as generating a loss distribution for the single-name credit. We can think of the single-name default probabilities as being represented by a very simple Bernoulli probability distribution, where default for a given single name is distributed in the following way:

1 if default with probability p
0 if no default with probability 1-p

Therefore, losses are distributed as follows, using a fixed recovery assumption:

(1-recovery rate)*notional amount if default with probability p
0 if no default with probability 1-p

The key to valuing tranches of a given portfolio is the ability to generate a distribution for the number of defaults in the entire portfolio over a given time horizon. This, in turn, gives us the ability to calculate the probability that losses in the portfolio exceed given thresholds (like the attachment and detachment points of tranches). Once we have these probabilities of various levels of default for the portfolio, we can generate expected losses, cashflows and value tranches accordingly.

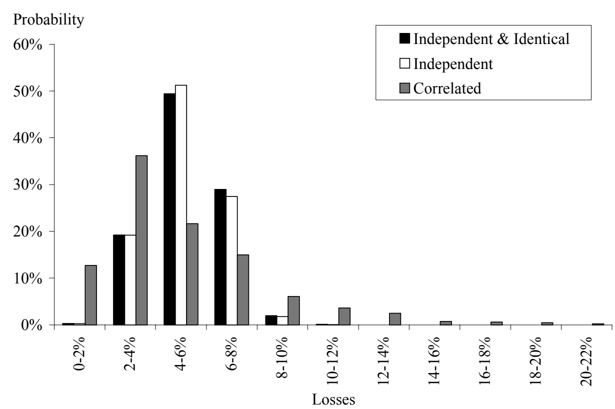
GETTING TO A PORTFOLIO LOSS DISTRIBUTION

In order to explore why copula models for structured credit products were developed, we begin with a simplified example and make it more complex to better fit reality. If we assume the default probability for each credit in a given portfolio (say, with 100 names) is the same and all the credits are independent of one another, generating the distribution of portfolio losses from the single name default probabilities is a simple matter. Going back to our statistics classes, if we are willing to assume that the single-name loss distributions look like Bernoulli trials, then the sum of 100 Bernoulli variables with the same probability of default has a binomial distribution (check with your local statistics expert if you don't believe us).

We then add the complication that the probabilities of default vary by credit and the problem becomes more complex. We no longer have a clean and simple closed form solution, but we can still solve the problem using simulation (or numerical approximations). The simulation process is fairly straightforward. We simulate 100 independent random numbers, check whether the random number for each credit generates a default for that credit and add up the individual losses caused by each default to generate a loss for the entire portfolio. We then repeat the process many times to generate a distribution for portfolio losses like those graphically illustrated in Exhibit 4.

exhibit 4

Correlation Creates Portfolio Loss Distributions with Fatter Tails



Source: Morgan Stanley

In Exhibit 4, we show the aggregate loss distributions for portfolios in which all the credits are independent and have the same default probability (5.5%) and a portfolio for which all the credits are again independent and have different default probabilities (although with an average default probability of 5.5%). Both were generated using simulation with 10,000 trials. The portfolios underlying these results are similar to the investment grade CDX index products in that the average spread is 66 bp and, in the second case, the distribution of spreads is similar to the CDX portfolios. What should immediately jump out is the similarity of the distributions but also the fact that the distribution of losses in both cases is very concentrated, with more than 50% of the scenarios inside the 4-6% range.

The third set of data in the exhibit reflects the idea that the individual credits are not independent but are positively correlated to one another. There a few key takeaways worth noting from the exhibit. First, the resulting portfolio loss distribution is much less concentrated with no single bucket accounting for more than 36% of the simulations. Additionally, the distribution has a much fatter tail. To illustrate the point, consider the likelihood of aggregate portfolio losses exceeding 10%, which is less than 0.1% for both scenarios in which defaults are independent. This compares to roughly 8% for the correlated scenario. The probabilities from the independent simulations would imply that the spread on tranches with attachment points above 10% are nearly zero, so positive correlation is a way to explain the pricing we observe in the marketplace. It is also consistent with the idea that credit risk is driven by cyclical changes in the underlying economy.

COPULA FUNCTIONS

In order to generate the results in the exhibit we applied a simulation-based approach, which reflected positive correlation among default events. In order to do this, we need some way to generate correlated random numbers from which to generate the default scenarios. This is where copula functions come into play. Copula functions are mathematical functions that allow us, in a simulation context, to transform independent random numbers into correlated random numbers.

While copula functions can be derived for several statistical distributions, the most common implementation (in structured credit markets) involves combining many normal distributions into a correlated multivariate normal distribution (also referred to as the Multivariate Gaussian Copula). These correlated normal variables are then mapped into default times based on the spreads (and implied default probabilities) for the underlying credits. These correlated single-name default times can be mapped into losses for a contract with a given maturity, which can, in turn, be aggregated into portfolio losses for the same given maturity. In a simulation context, we repeat this process many times to generate the portfolio loss distribution in Exhibit 4.

Why do we use the normal distribution? As with most other derivative models, the computation efficiency and theoretical attractiveness of the normal distribution were probably important drivers in selecting this as the basis for most structured credit pricing models. There are obviously alternatives to this, with the student T copula function being the most notable candidate.

CORRELATION AS A RELATIVE VALUE METRIC

The language of implied correlation has evolved to provide a useful relative value metric in the form of the often quoted base correlation. The first time we heard the term “implied correlation,” it was used to refer to what we now call “compound correlation” – that is, the correlation implied by the price of a tranche, given all the other market inputs. The problem with compound correlation is that it fails to give meaningful results in some of the mezzanine parts of the capital structure. In Exhibit 5, we summarize the implied compound and base correlation for one of the first liquid traded index products, Dow Jones TRAC-X[SM] Series 2. We find it notable that the implied correlation for the 3-7% tranche is so much different from the other observations.

chapter 5

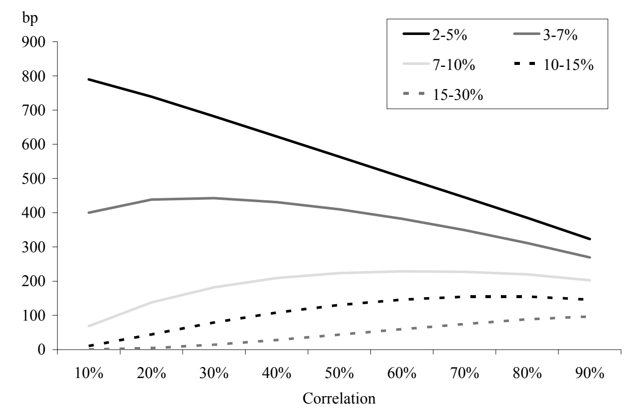
exhibit 5 Implied Compound and Base Correlation

	Bid	Ask	Compound Correlation	Base Correlation
Index	68	69		
0-3%*	43%	47%	21%	21%
3-7%	395	435	3%	25%
7-10%	138	158	17%	28%
10-15%	56	66	21%	34%

**Point upfront plus 500 bp running.*
Source: Morgan Stanley

In Exhibit 6, we show the spreads implied by compound correlation levels ranging from 10-90%. We find that there are actually two possible solutions for the 3-7% with a spread of 415 bp. This complicates the use of compound correlation as a relative value measure. Additionally, the idea of using compound correlation as a relative value metric is even further complicated by the fact that rising correlation is good for some tranches and bad for others, as the differing slope of the lines in Exhibit 6 illustrates.

exhibit 6 Correlation Sensitivity Varies with Seniority



Source: Morgan Stanley

Base correlation, which uses the implied correlations from a series of first loss tranches with detachment points equal to the detachment points of the actual tranches, does not suffer from either of the two issues above. It does not have tranches for which there are multiple solutions because all the correlations are implied from first loss tranches. We provide an example of one implementation of a base correlation approach in Exhibit 7. Base correlation provides a good relative value benchmark because it is fairly uniform in its meaning (i.e., rising base correlation means tighter spreads on that tranche, all else being equal), and it provides a unique price for a given base correlation. Additionally, it provides price sensitivities that are more in line with what we have observed in the marketplace when compared to compound correlation, which can imply unreasonable price sensitivity values for very high or very low implied correlation values.

exhibit 7 Tranche Equivalence – Long/Short Combinations

Benchmark Tranche	Replicating Portfolio: First Loss Tranche	Tranche Position	First Loss Imp. Correlation	First Loss Delta	Implied Benchmark Tranche Delta
3-7%	0-3%	Short	21.2%	12.2x	8.5x
	0-7%	Long	27.5%	10.1x	
7-10%	0-7%	Short	27.5%	10.1x	3.9x
	0-10%	Long	31.6%	8.3x	
10-15%	0-10%	Short	31.6%	8.3x	1.9x

Source: Morgan Stanley

WHAT IS CORRELATION MISSING?

In structured credit markets, it has never been the case (at least to our knowledge) that all the tranches of a given index/portfolio traded to the same correlation. There are several likely explanations for this (aside from liquidity), but most relate to assumptions in today's standard models. The use of a single correlation number fails to capture the fact that there are stronger relationships between specific companies and even entire sectors. These subtleties are more important for the more subordinate parts of capital structures and can move prices in ways that force our single implied correlation metric to move away from the correlation in other parts of the capital structure.

Today's copula models are risk-neutral in nature and therefore assume that investors are indifferent when faced with a choice between risky assets that can be hedged and risk-free assets. While single-name CDS are clearly a traded commodity, pricing in this market is far from continuous and investors in subordinate portions of capital structures have levered exposure to the risk that default swap prices in the underlying portfolio jump. Lower correlation for more subordinate portions of the capital structure can reflect the increasingly levered exposure to (and subsequent risk premium charged for) jumps in single-name prices or exposure to idiosyncratic risk.

Another factor in the relative pricing of tranches is the willingness of rating agencies to assign a rating to a particular tranche. The most severe dislocations in the pricing (and the largest implied correlation skew) in the market for liquid tranches occur at points between what are typically unrated portions of the capital structure and what are typically the most subordinate rated portion of the capital structure. In this case, the difference of correlation skew simply represents the different supply and demand dynamics for instruments with differing risk levels. The rating may add an institutionalized component, exacerbating these supply/demand dynamics and increasing the skew in correlation.

Finally, most of today's standard models use the normal distribution (or the Student T) to generate correlated defaults. It is very possible that the assumed distribution introduces error into the models simply because the distribution is not the best approximation of the real world.

chapter 6 Understanding Tranche Sensitivity

Having introduced the market standard correlation model in Chapter 5, we can now discuss how to calculate relative sensitivity measures based on this model, in the typical language of option greeks. The inclusion of tranches in portfolios has enabled investors to express credit views with very different risk and return profiles. For example, it is now possible to separate default risk from spread risk, and to take credit positions that become long when spreads are falling and short when spreads are rising. This precision, necessary for the implementation of such sophisticated strategies, emanates directly from the differences in sensitivities of tranches.

exhibit 1 Summary of Greeks

Greek	What does it measure?
Delta (δ)	Tranche price sensitivity to changes in underlying portfolio spreads, measured as a ratio of tranche PV01 to index PV01 (PV10% is also used sometimes)
M-Gamma (m-γ)	Tranche price sensitivity of a delta-neutral position to parallel shifts in spreads of underlying names. It represents a form of convexity (M = Market)
I-Gamma (i-γ)	Tranche price sensitivity of a delta-neutral position to jump-to-default risk or changes in spread distribution of the underlying portfolio. It represents a form of convexity to moves in a single credit while all others remain constant (I = Idiosyncratic risk)
Rho (ρ)	Change in tranche value due to changes in default correlation
Theta (θ)	Change in tranche value due to the passage of time

Source: Morgan Stanley

While we can borrow the basic concepts from the world of equity derivatives, where option sensitivities or "greeks" are well-documented and understood, the greeks for tranches of credit portfolios have a distinct flavor. Exhibit 1 shows the basic definitions of various greeks for structured credit. In this chapter, we start by exploring how tranches can be viewed as options on defaults and then delve deeper into the greeks. We have deliberately taken an intuitive approach in our explanations, as opposed to a mathematical one. Furthermore, while we focus largely on standardized tranches for simplicity, the arguments we make in this chapter hold for similar synthetic CDO tranches.

TRANCHES AS OPTIONS ON DEFAULT

One way of thinking about tranches is to view them as options on default losses on the underlying portfolio/index. This perspective helps us develop a feel for the sensitivity of tranches to various variables, such as time decay, spread changes, defaults exposure, etc. We can easily estimate expected losses for an index from its spread level, which serves as a benchmark for the tranches of the index.

For example, a spread level of 50 bp on the investment grade Dow Jones CDX five-year index implies losses of roughly 2.5% for five years on the portfolio (ignoring discounting and lost premiums in case of defaults), in a risk-neutral sense. Therefore, the 0-3% tranche is expected to lose some notional due to defaults and can be viewed as in-the-money. By the same argument, more senior tranches are out-of-the-money.

Interestingly, as the index spread widens, expected losses would increase and senior tranches could expect some notional loss, depending on the increase in spreads. Consequently, the subordination level that separates in-the-money and out-of-the-money tranches could change. For example, let us assume that the index widens to 100 bp, translating to roughly 5% losses. Now the mezzanine tranche, 3-7%, is also expected to lose some notional due to defaults. In other words, the tranche is now in-the-money. This implies that while the mezz tranche behaves more like senior tranches at low spread levels, it would act more like an equity tranche as spreads widen significantly.

Different index tranches have different capital structures, implying that the subordination level that separates in-the-money and out-of-the-money tranches may be different. For example, the 0-10% and 10-15% tranches in High Yield DJ CDX are in-the-money (i.e., the index level implies that defaults would penetrate these tranches), implying that they behave more like an equity tranche, while the next tranche, 15-25%, behaves more like the investment grade mezzanine tranche. Similarly, the mezzanine investment grade 3-7% five-year tranche is out-of-the-money, while it is in-the-money for the 10-year index, again implying markedly distinct sensitivities.

For the same reason, as time passes and spreads roll down the credit curve, tranches could move from in-the-money to out-of-the-money and their greeks would also change. Again, the intuition about how in-the-money and out-of-the-money tranches behave makes the process of projecting changes in tranche sensitivity more approachable.

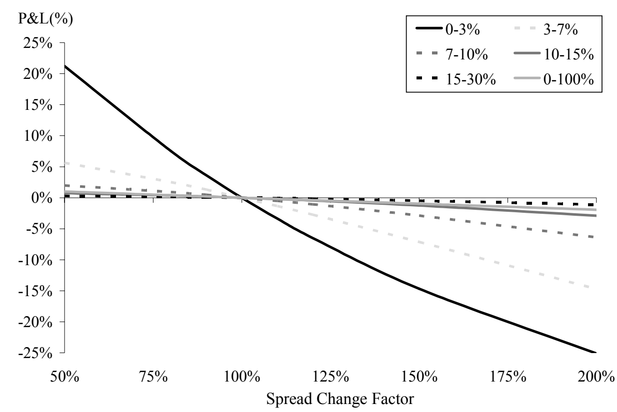
SENSITIVITY TO SPREAD CHANGES OR "DELTA"

As the spread of the underlying index changes, the impact on different tranches varies. Overall, it is consistent with the index directionally, i.e., as spreads widen, a short protection position in any of the tranches would lose money. Conversely, as spreads tighten, a short protection position would see a positive mark-to-market.

For small spread movements, one can estimate the impact using tranche delta, which is the ratio of change in the tranche value to change in the index for a given spread change. While it is usually calculated as the ratio of PV01s, some participants also use PV 10%. (PV01 is the change in the mark-to-market for a 1 bp move in each of the underlying credits in the portfolio. PV10% is the change in mark-to-market for a 10% increase.) Tranches with higher deltas would move more than tranches with lower deltas. Furthermore, tranches with deltas less than 1x would move less than the index, while tranches with deltas higher than 1x would move more than the index.

However, for bigger moves in spreads, the delta-based calculation is only approximate, as the impact of tranche convexity becomes more meaningful, which we will discuss later in this chapter.

exhibit 2
Spread Sensitivity



Source: Morgan Stanley

Broadly speaking, junior tranches have higher deltas than senior tranches, assuming both are quoted on a running premium basis. Given that junior tranches take losses before senior tranches, wider spreads make them proportionally more likely to be affected by the increased likelihood of defaults implied by wider spreads. In other words, the “default PV” (PV of expected default losses) rises faster than the index for junior tranches, but slower than the index for senior tranches, bringing the average default PV for tranches in-line with the index default PV. Additionally, as expected losses rise, the likelihood of lost premiums due to lower notional outstanding (as a result of defaults) also rises, which further accentuates the negative impact of rising spreads.

Impact of Upfront Payments

However, the presence of upfront payments for tranches lowers their deltas, compared to the same tranches without an upfront payment. Currently, the equity tranche for the investment grade DJ CDX index and the first two tranches for the high yield DJ CDX index trade with upfront payments (for more details, see Chapter 3).

Why does an upfront payment lower the delta of a tranche? The answer lies in understanding how rising spreads affect the present value of expected premiums (premium PV) and default PV. An upfront payment with no running coupon implies that as spreads widen, the tranche value is affected only by higher expected defaults, and not lower expected premiums, since the protection seller has already collected all of the premium. On the other hand, an all-running contract will have both negative impacts – higher expected defaults and lower expected premiums due to more defaults making it more sensitive.

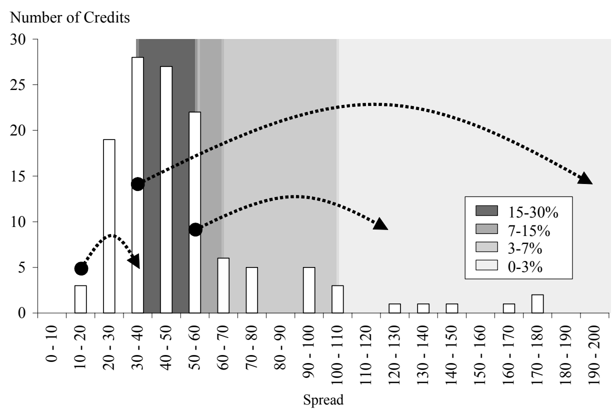
"I-GAMMA" OR SENSITIVITY TO SPREAD DISTRIBUTION CHANGES

While the impact of overall spread changes on tranches is more or less obvious, the effect of changes in distribution of the underlying spreads, especially when the overall portfolio average remains unchanged, is subtle and worth exploring further, as such moves are more common than big swings in the indices.

Tight trading names moving somewhat wider generally impact senior tranches, while wide or even average credits moving significantly wider impact junior mezzanine and first-loss tranches, depending on the size of the move. A good example of actual occurrence was the reshaping of the risk profile of investment grade in October 2004 due to stress in the insurance sector, especially with Marsh & McLennan (for details, see Chapter 26).

Thus, the shape of the risk distribution within the portfolio influences the pricing of tranches (see Exhibit 3). It should be fairly intuitive to recognize that the length and thickness of the right tail influences the pricing of subordinate tranches, meaning that the bigger the tail, the riskier the equity and mezzanine tranches. Similarly, the shape of the middle to left side of the distribution should influence the more-senior notes. As credit risk increases (shifts from left to right), senior tranches should become riskier.

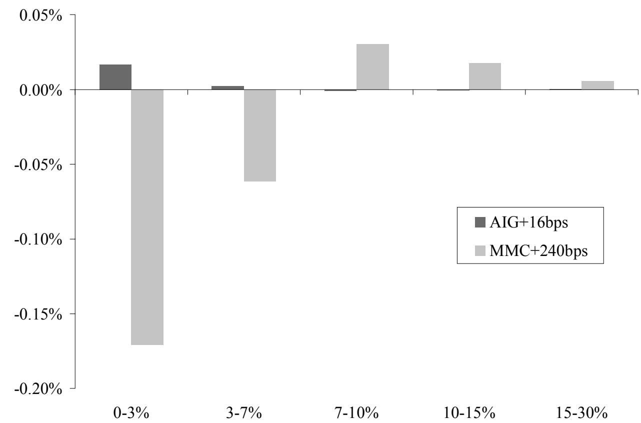
exhibit 3
Insurance Moves to the Right, Impacting Both Senior and Subordinate Tranches



Source: Morgan Stanley

Two credits in the insurance sector served as useful examples. The move in AIG's default swap premium (from 18 bp to 34 bp) increased risk in 15-30% type tranches, while reducing risk in super-seniors (30-100%). On the other hand, Marsh & McLennan (which widened from 30 bp to north of 250 bp) was clearly a right tail event, shifting risk from 15-30% type tranches to 0-3% (hypothetically, since MMC was not a part of the index). If we take this analysis one step forward, we can see the hypothetical pricing impact on tranches (see Exhibit 4).

exhibit 4
Tranche Pricing Impact: Two Opposite Examples



Source: Morgan Stanley

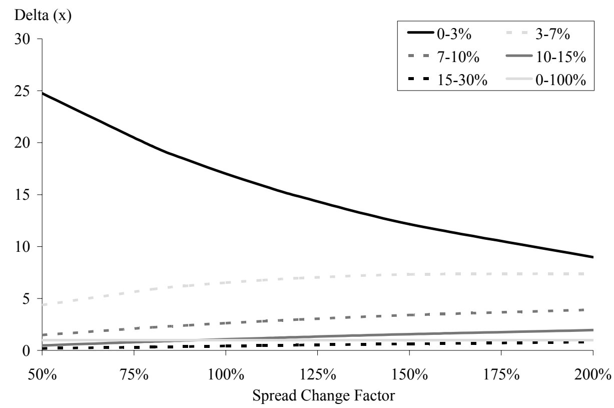
DELTA MIGRATION

In our past publications we have discussed the issue of instability of tranche deltas several times. Broadly speaking, tranche deltas change with movements in index spreads, passage of time, and changes in correlation. Consequently, trades that are delta neutral at inception can easily become delta positive or negative, depending on these factors.

Understanding these sensitivities can help us fine-tune investment strategies to achieve desired delta under different scenarios. For example, it is possible to construct trades that become delta positive when spreads tighten and delta negative when spreads widen, resulting in a more desirable payoff. Similarly, suppose an investor believes that the spreads are currently too tight and will widen in the near future but start tightening down the road, say next year. It is possible to implement a tranche combination that starts out delta negative but becomes more and more delta positive as time passes.

exhibit 5

Delta Sensitivity–
5 Year IG DJ CDX



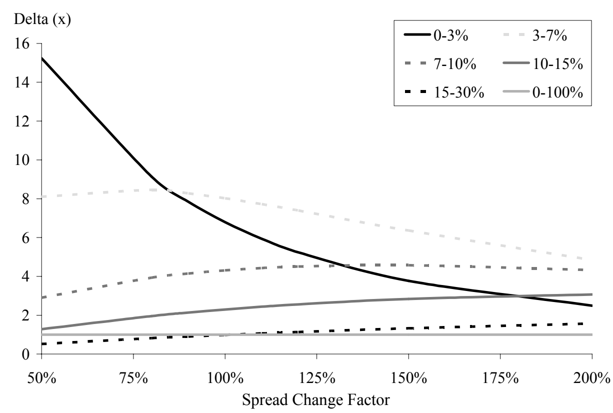
Source: Morgan Stanley

Let us first analyze how index level affects tranche deltas. Exhibit 5 shows how deltas change with spread movements. The intuitive way to think about delta sensitivity to spread changes is that the deltas for in-the-money tranches decrease with spread increases, while deltas for out-of-the-money tranches increase with spread increases.

Additionally, one has to bear in mind that more senior tranches start becoming in-the-money after a certain level of spread increase. This point is easier to see in the delta sensitivity pattern for 10-year investment grade DJ CDX tranches, as shown in Exhibit 6. Another point worth noting is that beyond a certain level of spread widening, the equity tranche delta declines rapidly. This is because expected losses far exceed the tranche notional, and the impact of any increase in expected losses is marginal.

exhibit 6

Delta Sensitivity –
10 Year IG DJ CDX



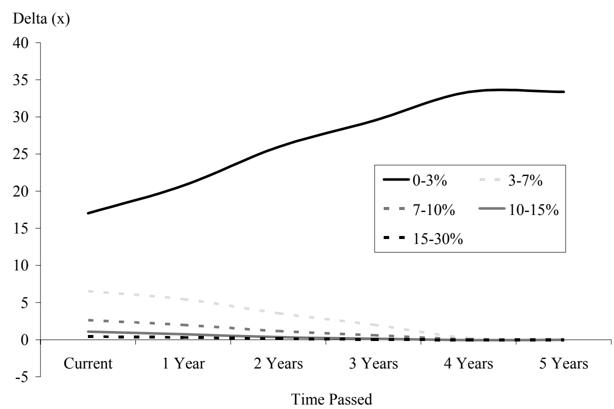
Source: Morgan Stanley

How do tranche deltas change as time elapses? Exhibit 7 shows how tranche deltas migrate as the index approaches maturity. For simplification, we have assumed that the credit curves for the underlying portfolio and tranche base correlations remain unchanged. Once again, it is more intuitive to think of the results in terms of tranches being options on defaults. Deltas for tranches that are in-the-money rise as time passes, while deltas for out-of-the-money tranches decline over time. Furthermore, since we have assumed that spreads roll down the curve, senior tranches get more and more out-of-the-money over time. (Note that we have assumed that there are no defaults.)

Another way to understand this delta migration pattern is to look at delta sensitivity to spread movements (Exhibit 5). As we roll down the curve index, spread declines resulting in rising delta for equity tranches and falling deltas for more senior tranches.

exhibit 7

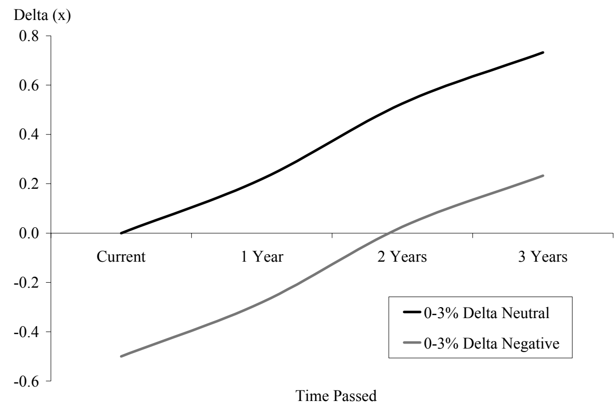
Delta Sensitivity Over Time – 5 Year IG DJ CDX



Source: Morgan Stanley

Now that we understand the delta migration pattern over time, it is possible to design strategies with desired spread sensitivities over time as we alluded earlier. For example, by combining delta-neutral notional amounts of equity and senior tranches we can put together a trade that becomes delta positive as spreads ride down the curve, resulting in a positive mark-to-market. Similarly, we can design positions with a delta mismatch initially, so that the position becomes delta negative or positive for an expected spread move or passage of time (see Exhibit 8, for example).

exhibit 8
Delta Migration Over Time

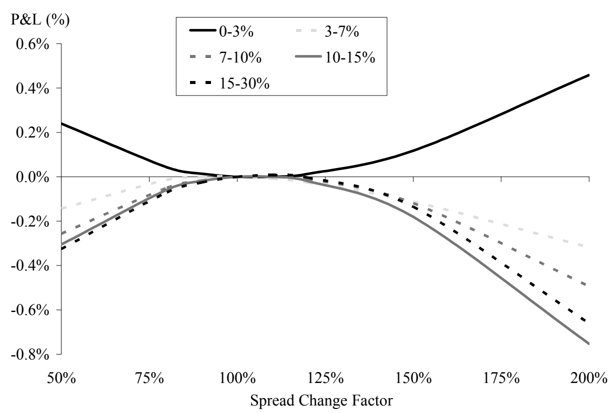


Source: Morgan Stanley

"M-GAMMA" OR CONVEXITY

As we discussed earlier in this chapter, for wide spread moves, the relationship between tranche value and index value does not remain linear. This difference between linear approximation (using deltas) and the actual movement in market value is captured by a tranche's convexity or gamma. We typically measure it as a ratio of PV100 to 100xPV01, i.e., the ratio of tranche mark-to-market for a 100 bp move in underlying spreads to 100 times PV01 of the tranche.

exhibit 9
5 Yr IG – Tranche Convexity (Delta Neutral)

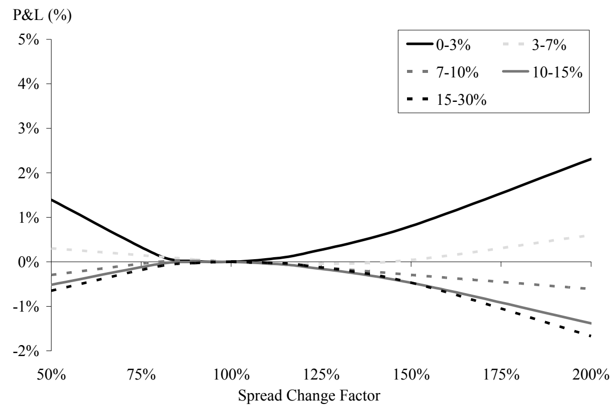


Source: Morgan Stanley

The easiest way to observe the materiality of convexity is to plot the P&L of a delta-neutral transaction of tranches, as we have done for the 5-year DJ CDX tranches in Exhibit 9. As mentioned earlier, tranches that are in-the-money are positively convex, while out-of-the-money tranches are typically negatively convex (from the perspective of the protection seller). In other words, a delta neutral short protection position in five-year IG equity tranche would have a positive mark-to-market for large changes in spreads, while a delta neutral 7-10% tranche of the same index would have negative mark-to-market.

exhibit 10

10 Yr IG - Tranche Convexity (Delta Neutral)

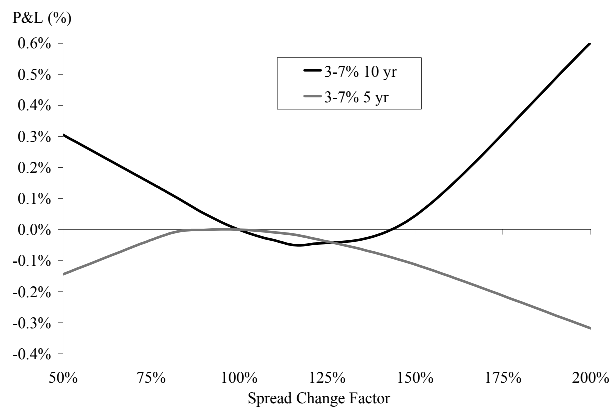


Source: Morgan Stanley

Exhibit 10 shows the convexity characteristics of 10-year IG tranches, where both 0-3% and 3-7% tranches are positively convex. To further illustrate this point, in Exhibit 11, we have shown the convexity attribute of the 3-7% 5-year and 10-year tranches. Clearly, the 3-7% tranche is negatively convex (and out-of-the-money, given current spread levels) for five-year DJ CDX, but it is positively convex (and in-the-money) for 10-year maturity.

exhibit 11

Mezzanine Tranche Sensitivity



Source: Morgan Stanley

While trading tranches of different underlying indices, for example 10-year tranches versus five-year tranches, convexity can be hard to measure, as the underlying indices are different and have convexity differences themselves. In addition, curve shape changes are also important to consider. For example, a steepening of the 5s-10s credit curve would affect 10-year tranches but not the five-year tranches.

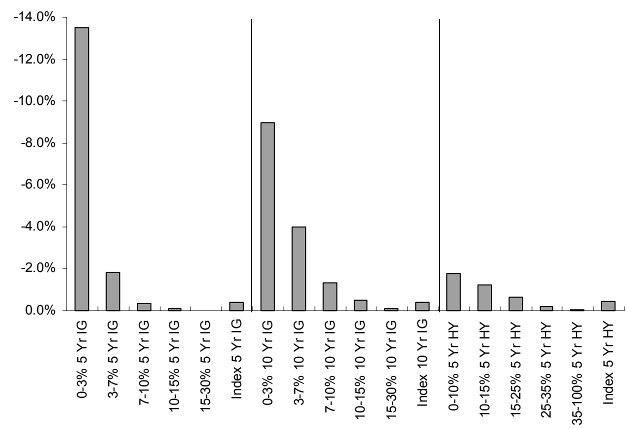
JUMP-TO-DEFAULT SENSITIVITY

While higher default sensitivity for junior tranches and lower for senior tranches is intuitive, given their relative positions in the capital structure, comparing sensitivities across different maturities and indices provides valuable insight into how defaults affect different tranches. For example, one default shaves off 14% value from a five-year investment grade equity tranche, but only 7% from a 10-year tranche and 2% from a five-year high yield equity tranche.

In Exhibit 12, we have summarized the average impact of one default on various tranches, assuming a 40% recovery for investment grade and a 35% recovery for high yield. Exhibit 13 shows the same impact on a delta neutral basis, i.e., assuming that we bought protection on the index to offset the tranche's spread sensitivity.

exhibit 12

Loss Due to 1 Default (% of Notional)



Note: Assuming 40% recovery for IG and 35% recovery for HY; Source: Morgan Stanley

Tranche thickness, expected number of defaults for the index, and presence of a upfront payment are important variables to watch in assessing default sensitivity. A thicker tranche, e.g., high yield equity versus investment grade equity, implies lower sensitivity to a default. Similarly, if the index is expected to have a large number of defaults, a single default has a smaller impact.

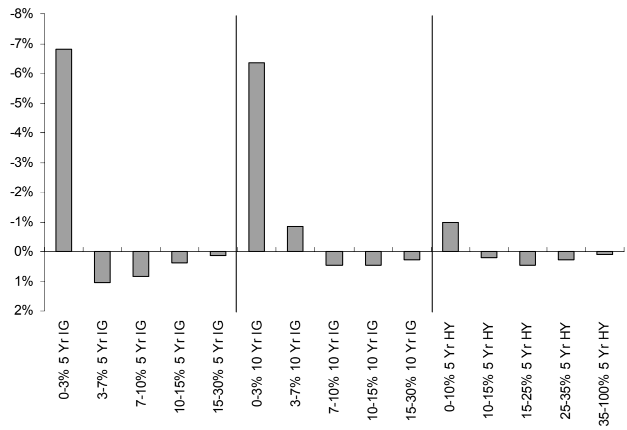
A tranche with upfront payment has lower default sensitivity, compared to the same tranche without an upfront payment, much like spread sensitivity. Again, the reason for lower sensitivity is that, due to an upfront payment, the protection writer does not lose premium due to a default, while in the absence of an upfront payment, the running premium would decline proportionally to the amount of tranche notional lost due to defaults.

Of the three equity tranches we mentioned, the five-year high yield equity tranche is the thickest, has the highest number of expected defaults (given that the high yield index trades much wider), and has all of its premium paid upfront. As a result, it has significantly lower sensitivity to defaults versus the investment grade equity tranches.

How do we determine if a tranche has more default risk or spread risk? Delta-neutral default sensitivity, as shown in Exhibit 13, helps us demarcate the subordination level in the capital structure where tranches transition from being net default sensitive to net spread sensitive. For example, the mezzanine tranche (3-7%) of five-year investment grade is net spread sensitive (i.e., the delta-neutral protection writer will have a positive mark-to-market in case of a default), while the 10-year mezzanine tranche is net default sensitive.

exhibit 13

Delta Neutral Loss Due to 1 Default (% of Notional)



Note: Assuming 40% recovery for IG and 35% recovery for HY; Source: Morgan Stanley

Utilizing the distinction between net default and spread sensitivities of tranches, we can construct trades that are more efficient in expressing our credit views. For example, a combination of long equity and short mezzanine in a delta neutral ratio effectively expresses a credit view that is constructive on default risk but not on spread levels.

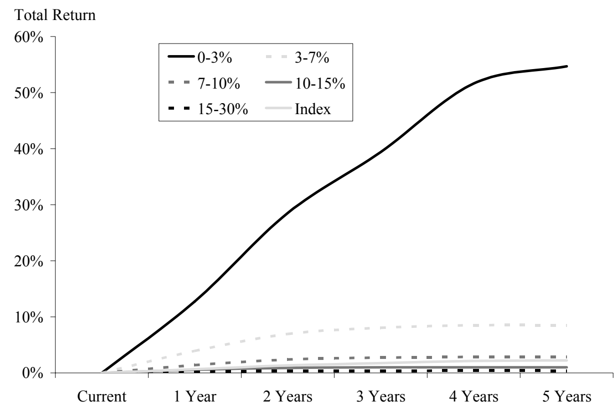
"THETA" OR TIME DECAY

As a credit default swap approaches maturity, the spread is bound to converge to zero, since credit protection provided by a CDS eventually becomes worthless if a default does not occur. Furthermore, the rate of decline in the value of protection is determined by the slope of the credit curve.

An upward sloping credit curve implies that a larger number of defaults are expected to occur towards the end of the index maturity. For example, the current high yield DJ CDX curve implies that about one-third of the total expected defaults in the coming five years are projected to occur during the fifth year. After one year, assuming no defaults occur during the year and spreads roll down the curve, essentially these defaults disappear, implying a substantial gain for the protection writer.

Since junior tranches are levered investments on defaults, their value (to protection buyer) declines much faster than the index. Exhibit 14 shows the total return of DJ CDX IG five-year tranches for different time horizons, from the perspective of the protection seller. The value of protection declines precipitously initially, assuming a static credit curve (i.e., spreads ride down the curve with the passage of time), and decelerates toward the maturity. On an absolute basis, tranches with higher than 1x delta lose value faster than index, while senior tranches with lower than 1x delta lose value slower than the index, as one would expect.

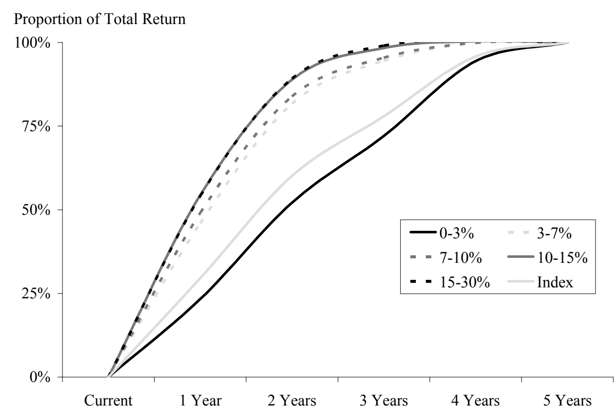
exhibit 14
Time Decay – 5 Yr IG



Source: Morgan Stanley

However, when we analyze a tranche's time decay relative to itself over time (i.e., how much of the total value is realized every year), we find that equity tranche value decays slower than the index while all other tranches decay faster than the index, in the case of investment grade five-year tranches. More importantly, about 50% of the total return is realized within the first year for tranches other than the equity tranche (assuming static base correlation and credit curves). For further details, refer to Exhibit 15.

exhibit 15
Speed of Time Decay – 5 Yr IG



Source: Morgan Stanley

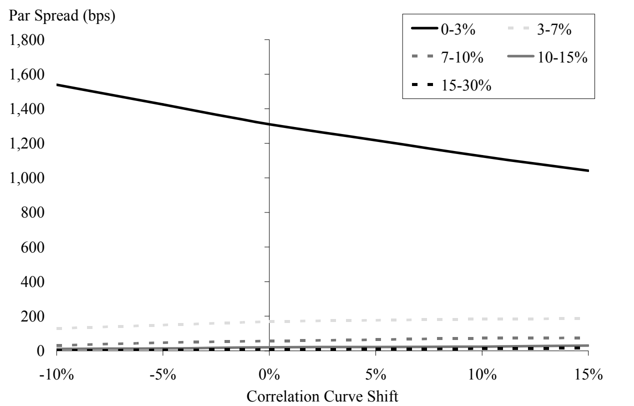
"RHO" OR SENSITIVITY TO CORRELATION CHANGES

As we discussed in Chapter 5, junior tranches are long correlation, while senior tranches are short correlation and mezzanine tranches are relatively insensitive. In other words, higher correlation is better for junior tranches and worse for senior tranches (from the perspective of protection sellers). Since premium is the compensation for taking default risk, the par premium for an equity tranche decreases with rising correlation while it falls for senior tranches.

Exhibit 16 shows the sensitivity of five-year investment grade tranches to parallel shifts in the base correlation curve. For example, for the +5% scenario, we assumed that the equity tranche's correlation increases 5% and the base correlation skew curve remains unchanged. Thus for all tranches, the attachment and detachment point correlations change by the same amount.

exhibit 16

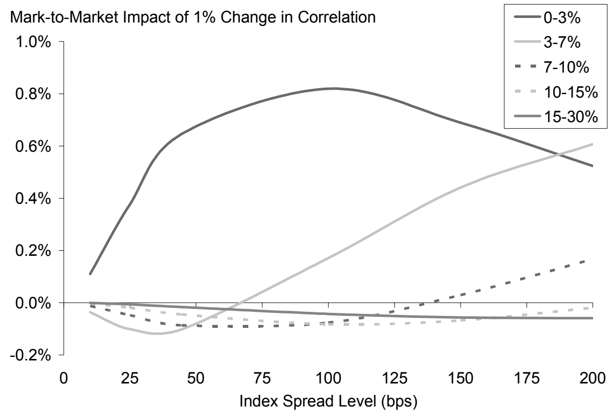
Impact of Correlation on Par Spreads – 5 Yr IG



Source: Morgan Stanley

Since base correlation considers all tranches as a portfolio of two equity tranches, as the skew (i.e., the difference between the implied correlations for attachment and detachment points) increases, the par spread decreases, just like the equity tranche.

exhibit 17
Correlation Sensitivity Changes with Changes in Spreads – 5 Yr IG



Source: Morgan Stanley

It is important to note that correlation sensitivity of tranches changes as the underlying index spread moves. In Exhibit 17, we analyze the mark-to-market impact of a 1% increase in correlation for five-year investment grade tranches at different spread levels for the index. As shown in the exhibit, senior tranches are relatively correlation insensitive for small changes in spread but become significantly more sensitive as the index widens materially. The converse is true for the equity tranche, i.e., it is rather sensitive for small changes to the index, but beyond a certain point of widening, correlation sensitivity starts to decline.

To isolate the impact of correlation changes, we have assumed that the base correlation skew remains unchanged. However, given a large number of ratings-based investors in very senior tranches, these tranches have a non-zero floor on price. In other words, when spreads fall to very low levels, the pricing on very senior tranches is more resilient. Consequently, base correlation skew tends to rise as spreads fall to very low levels and to flatten as spreads increase.

CONCLUSION

In this chapter, we discussed tranche greeks from a conceptual perspective. We find that thinking of tranches as options on defaults helps one develop intuition for the various sensitivities. Spread sensitivity (delta) declines as we go higher up in the capital structure; however, upfront payments tend to decrease this sensitivity. Furthermore, tranche deltas themselves are not constant, and change with changes in the index and the elapse of time. In-the-money tranches have favorable convexity for protection sellers, while convexity in out-of-the-money tranches favors protection buyers. Time decay for tranches is very rapid in the first few years and decelerates materially as they approach maturity. Finally, subordinate tranches benefit from rising correlation, while senior tranches lose value and mezzanine tranches are relatively insensitive.

Section B

Structured Credit Insights

Valuation and Sensitivity

Please see additional important disclosures at the end of this report.

chapter 7

A Framework for Secondary Market CDO Valuation

October 1, 2001

Sivan Mahadevan
David Schwartz

Introduction

As we watch the evolution of a secondary market in CDO notes and equity, we focus our research efforts on understanding how CDO valuations can be influenced by the multitude of factors that affect the value of these securities and their underlying collateral.

A collateralized debt obligation is effectively an investment in a leveraged portfolio of credit instruments. The risk of this portfolio is disproportionately redistributed into the various *tranches* issued by the special purpose vehicle administering the investment portfolio. The principal risks investors face are price volatility, liquidity and default risk, and there are many metrics that measure these characteristics.

Investors purchase CDO notes for a variety of reasons. The senior notes of a CDO offer good yield pickup over similarly rated instruments in the cash credit markets. These notes earn their high ratings because the CDO cash flow structure offers them substantial protection from defaults in the underlying collateral. The subordinated notes and residual components (equity) of CDOs offer investors unique risk and return characteristics not easily replicated in the cash or credit derivatives markets. Most CDOs are structured so that if default and recovery rates over their lifespan fall within a range that includes average historical rates, investors stand to benefit from the leverage of the structure and the resulting higher yields the CDO tranches offer relative to investments in the corporate bond markets.

Many traditional CDO note and equity holders have been buy and hold investors. The bulk of arbitrage CDOs are structured as cash flow CDOs, meaning that the collateral managers focus their efforts on meeting the cash flow liabilities while conforming to the structural guidelines of the various tranches. In cash flow deals, collateral managers' concerns about the market value or the price volatility of the underlying collateral is generally in the context of how such valuations can affect the credit quality of the collateral or the cost of transactions. This style is similar to asset/liability investment managers such as insurance companies. In arbitrage market value CDOs, the collateral managers focus on improving the market value of the underlying collateral, similar to how total-return oriented investment managers operate.

Independent of the structure and collateral management style of CDOs, buyers and sellers of CDO notes and equity in the secondary market are interested in determining a fair (and agreed upon) value for the expected cash flows, price volatility, liquidity, and default risk that a given CDO tranche represents. The goal of this chapter is to discuss objective ways for valuing CDO tranches in the secondary market, and to apply subjective considerations including market technical information.

In this chapter, we present several methodologies for secondary market CDO note and equity valuation with a focus on arbitrage cash flow CDO structures. The approaches differ in degrees of computational complexity and required market savvy, but ultimately they all help investors gauge the value of secondary market CDO investment opportunities.

CDO Valuation Framework

Before we describe a valuation framework for CDOs, we make some observations on how related financial instruments are valued in the secondary markets.

Investment grade corporate bonds are traditionally valued on a comparables basis. Liquid bonds from an issuer are compared to liquid bonds from other issuers with similar characteristics. The characteristics considered include credit quality, industrial sector, and maturity, and from these comparisons, spread levels are determined.[1] Bonds that have unique characteristics (such as optionality or special credit considerations) move away from their comparables, and spreads are adjusted accordingly, either independently, with respect to a new set of comparables, or with some sophisticated valuation techniques. For example, bonds with options can be valued in the Heath-Jarrow-Morton framework using a multi-path simulation.

Higher rated non-investment grade corporate bonds can be valued on a comparables basis as well, but reliance on these types of comparisons quickly disappears in favor of unique valuations derived from credit fundamentals and investor appetite.

Valuation techniques for asset backed securities vary given potential differences in security structure, but the comparables technique for securities with similar collateral and structure is common.

Valuation techniques for collateralized mortgage obligations (CMOs) are worth observing, given their conceptual similarity to CDOs. The least risky (i.e., most immune to prepayment risk) tranches of CMOs tend to be tested using various metrics and then compared to other similar lower-risk CMO tranches. The residual components of CMOs (known as Z-bonds, which carry the bulk of the collateral's prepayment risk) are often valued using modeling techniques that generate and discount cash flows over multiple input paths and average these results.

With this background in mind, we begin determining a framework for valuing CDO notes and equity by asking three fundamental questions:

- What common market practices exist today for valuing CDOs?
- What relevant input from the financial markets should influence CDO valuations?
- What financial valuation techniques can be applied to CDOs?

The answers to the above questions led us to organize our CDO valuation framework along three basic methodologies.

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[1] *Tracking and Outperforming Bond Indices: Morgan Stanley Fixed Income Research, July 9, 2000, R. Fuhrman, et. al.*

THREE VALUATION METHODOLOGIES

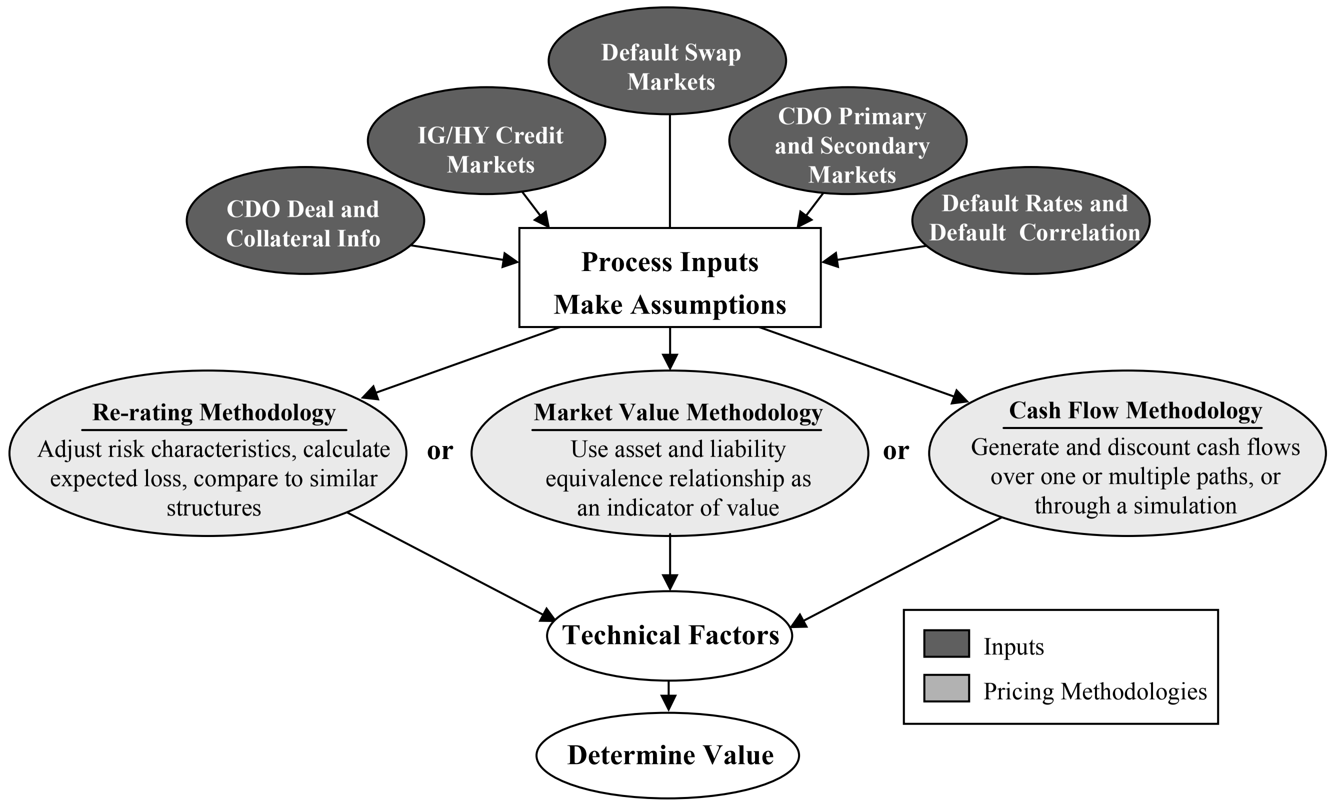
Market practices for determining secondary market CDO note and equity prices exhibit a range of required market savvy and computational complexity. The computationally simpler approaches involve generalizing collateral characteristics and comparing CDO tranches to similar structures with a common credit rating and collateral type. Computationally more complex approaches exist as well, ranging from valuing tranches over a handful of input paths to full-blown simulation models run over a large distribution of paths.

In this chapter, we describe three methodologies for valuing CDO notes and equity in the secondary market.

- ***Re-rating Methodology,*** an approach that is computationally relatively simple and involves inferring a rating for a CDO tranche through a single set of assumptions and comparing it to other similarly rated tranches to derive a value.
- ***Market Value Methodology,*** a technique that involves equating the market value of the assets of a CDO (the collateral) with the market value of the liabilities (debt, equity and management fees). Market value changes can be indicators of potential structural changes in a CDO as well.
- ***Cash Flow Methodology,*** a technique that is based on financial engineering fundamentals, namely generating and discounting tranche cash flows along input paths. Variants of this approach include a single assumption set, several assumption paths, and a simulation approach over a large distribution of events.

Exhibit 1 summarizes the spectrum of inputs and valuation methodologies for determining CDO tranche values.

exhibit 1
Secondary Market CDO Valuation Methodologies



Source: Morgan Stanley

The Re-rating Methodology

The re-rating methodology is based on a simple, quantitative approach to identifying a credit rating for a CDO note. Once a credit rating is identified, the note is compared to similar structures in the marketplace to determine a spread value. Comparability is usually based on CDO characteristics such as collateral type and cohort year of issuance. The approach is particularly valuable when an investor has newly updated information on a CDO, or would like to forecast changes to a CDO's structure. In such cases, the credit rating calculated by the re-rating methodology can be different from those assigned by ratings agencies, giving the investor insight into the current structure or evolution of the CDO. The approach is also useful in providing investors with a guide to how sensitive a tranche's credit rating is to changes in underlying assumptions.

The re-rating methodology is based on the well-known Moody's Binomial Expansion Method for determining a CDO tranche rating.[2] The Moody's approach is a simple method that involves generalizing a CDO's collateral pool, inferring a default rate for this portfolio and calculating expected losses for a given CDO tranche, which leads to a credit rating using Moody's association of default rates and ratings.

The re-rating methodology is described in the flow chart in Exhibit 3. The expected loss of a CDO tranche is computed based on two inputs: the binomial distribution of defaults and the loss distribution of a CDO tranche. From these two functions, we calculate the probability-weighted loss (the expected loss) for the tranche, which can then be mapped to a Moody's rating using the Moody's "Idealized" Cumulative Expected Loss Rates.[2]

GENERALIZING THE COLLATERAL – THE DIVERSITY SCORE

The re-rating methodology gains its simplicity from Moody's approach to generalizing the underlying CDO collateral. Moody's simplifies the collateral portfolio by breaking it down into a set of uncorrelated assets. Correlation is defined as default correlation (not correlation of asset returns or changes in spreads). Given a portfolio of correlated assets, the *diversity score* represents the equivalent number of uncorrelated assets. If a portfolio has 30 uncorrelated assets, then it has a diversity score of 30.

How does Moody's simplify a portfolio to a collection of uncorrelated assets? The basic assumption is that assets in different industry categories are uncorrelated. If a portfolio has 30 credits (each from a different Moody's industry category) then the portfolio has a diversity score of 30. Each of the 30 represented industry categories contributes 1.0 units to the total diversity. If more than one credit from the portfolio belongs to a given industry category, then that category's contribution to the total increases, following a sliding scale depicted in Exhibit 4. This relationship implies that credits in the same industry group have a positive default correlation. In Exhibit 5, we show that the implied default correlation between credits in the same industry falls from 33.3% to 16.7% as the number of credits in the industry increases from 2 to 10.

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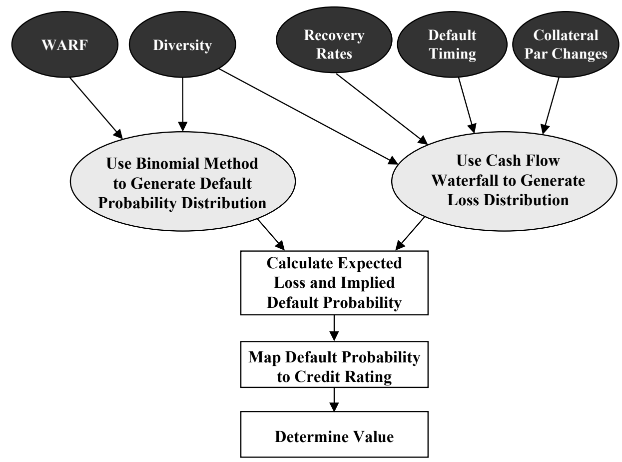
[2] *The Binomial Expansion Method Applied to CBO/CLO Analysis, Moody's Investors Services, Dec 13, 1996.*

exhibit 2 Moody's Industry Categories

Number	Industry
1	Aerospace & Defense
2	Automobile
3	Banking
4	Beverage, Food & Tobacco
5	Buildings and Real Estate
6	Chemicals, Plastics & Rubber
7	Containers, Packaging and Glass
8	Manufacturing
9	Diversified/Conglomerate Manufacturing
10	Diversified/Conglomerate Service
11	Metals & Minerals
12	Ecological
13	Electronics
14	Finance
15	Farming and Agriculture
16	Grocery
17	Healthcare, Education and Childcare
18	Home and Office Furnishings, Housewares and Durable Consumer Products
19	Hotels, Inns and Gaming
20	Insurance
21	Leisure, Amusement, Motion Picture, Entertainment
22	Machinery
23	Mining, Steel, Iron and Nonprecious Metals
24	Oil and Gas
25	Personal, Food and Miscellaneous Services
26	Printing and Publishing
27	Cargo Transport
28	Retail Stores
29	Telecommunications
30	Textiles and Leather
31	Personal Transportation
32	Utilities
33	Broadcasting

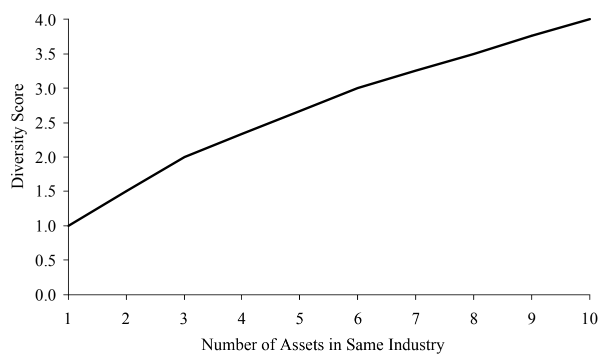
Source: Moody's

exhibit 3
The Re-rating Methodology



Source: Morgan Stanley

exhibit 4
Moody's Diversity Score Contribution for One Industry



Source: Moody's

exhibit 5
Implied Default Correlation

Source: Morgan Stanley, Moody's

The implied correlation calculation is based on moment-matching, with the assumptions that each credit has the same weight in the portfolio and that the default correlation between any two assets in the same industry are equal.

MODELING DEFAULTS AS A BINOMIAL DISTRIBUTION

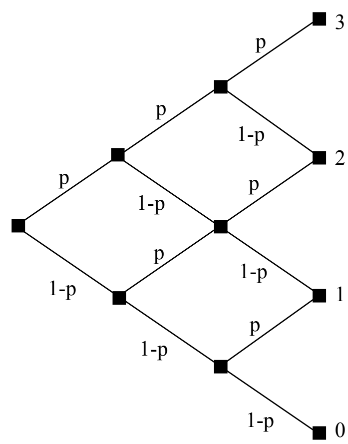
Moody's uses the diversity score of a CDO to model the default behavior of the collateral. The approach assumes that the number of defaults in a portfolio of *N* uncorrelated assets (i.e., diversity score = *N*) follows a binomial distribution. The binomial distribution is used as follows.

First, an event of default is considered to be a binary operation: an asset either experiences default, or it does not. The probability of an asset defaulting is represented by p. The probability of an asset not defaulting is equal to $1-p$. The Moody's method assumes that all assets in a portfolio have the same probability of default, derived from the WARF (numerical weighted-average ratings factor for the collateral).

Given these simplifications, we can model the default behavior of a portfolio using a binomial tree. Consider a portfolio of three assets. There are several possible default behaviors for this portfolio: the portfolio can experience zero defaults, one default, two defaults, or three defaults. The binomial tree in Exhibit 6 depicts all of the possible default outcomes.

exhibit 6

Binomial Tree of Defaults for a Three Asset Portfolio



Source: Morgan Stanley

There are eight possible paths in this binomial tree, and they are summarized in Exhibit 7.

exhibit 7

Distribution of Defaults for a Three Asset Portfolio

Number of Defaults	Frequency of Occurrence in Binomial Tree	Probability	Weighted Prob
0	1	$(1-p)^3$	$(1-p)^3$
1	3	$p(1-p)^2$	$3p(1-p)^2$
2	3	$P^2(1-p)$	$3p^2(1-p)$
3	1	p^3	p^3

Source: Morgan Stanley

Given this binomial distribution-based representation of portfolio default behavior, we can compute the portfolio's default probability distribution. The probability that a portfolio of *N* (uncorrelated) assets experiences j defaults is:

$$P_j = \binom{N}{j} p^j (1-p)^{(N-j)}$$

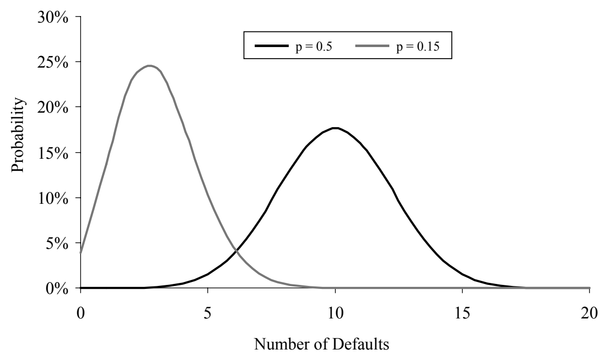
The first parenthetical part of this expression is a *combination*, or the number of groupings of j defaulted assets from a portfolio of N total assets ($j <= N$). This is mathematically equal to

$$\binom{N}{j} = \frac{N!}{j!(N-j)!}$$

The notation $N!$ (read "N factorial") is equivalent to $Nx(N-1)x(N-2)x...x1$ .The variable p is the generalized cumulative probability of default for any asset in the portfolio (derived from the portfolio WARF).

exhibit 8

Binomial Distribution of Defaults for a 20 Asset Portfolio



Source: Morgan Stanley

The graph in Exhibit 8 shows the binomial distribution of defaults for a hypothetical 20-asset portfolio. The two curves represent different default probabilities, *p=0.5* and *p=0.15*.

Does it make sense that the default behavior of a portfolio follows a bell-shaped curve? What the curve tells us is that for very risky credits with a cumulative default probability of 50% over the life of the structure, the probability of having zero defaults (out of 20) is close to 0%. The probability of having one default out of 20 is higher (but still very small), and the probability rises until you reach 10 defaults, after which it falls to near zero values as you approach a fully defaulted portfolio. In other words, the probability of experiencing only very few defaults is small, and the probability of experiencing a large number of defaults is also small – but the probability of having 10 defaults is the highest (17.6%) over the life of the structure.

In general, the binomial distribution is not a symmetric distribution, and the degree to which it is skewed is related to the probability of default of the individual assets and the number of assets. The distribution is symmetric if $p = 0.5$. For any p, the distribution becomes more symmetric as the number of assets increases.

COMPUTING A CDO TRANCHE'S EXPECTED LOSS

We can use the CDO's cash flow waterfall to determine the loss a CDO tranche will experience for a given number of defaults (see Chapter 1). In the example in Exhibit 9, the diversity score is 35 and $p = 21.5\%$. The bell-shaped graph and the left-hand scale show the binomial distribution. The columns and right-hand scale show the losses that the hypothetical CDO tranche will experience under different default scenarios.

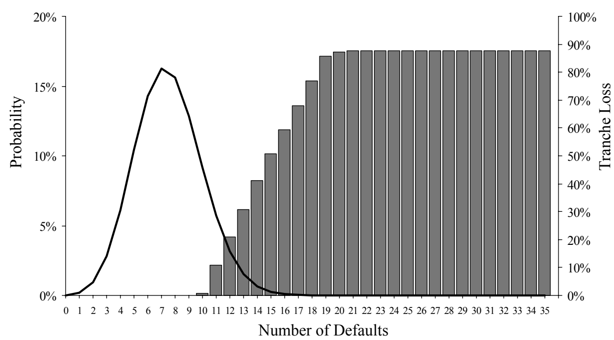
We can now combine this tranche loss distribution with the binomial distribution to calculate the probability-weighted loss, otherwise known as the expected loss.

$$Expected\ Loss = \sum_{j=0}^{N} P_j L_j$$

The variable P_j is the probability that the collateral portfolio experiences j defaults and the variable L_j represents tranche's loss when the collateral experiences j defaults.

exhibit 9

Binomial Distribution and Tranche Loss Distribution



Source: Morgan Stanley

INFERRING A MOODY'S CREDIT RATING

We can use the CDO tranche's expected loss to infer a Moody's credit rating. To do this, we must first assume a recovery rate for defaulted securities. Given this recovery rate, we can compute the implied default probability of the CDO tranche as follows:

Implied Def Prob = Expected Loss/(1-Recovery Rate)

We can map the implied default probability to a Moody's credit rating using the Moody's "Idealized" Cumulative Expected Loss Rates (see Exhibit 10). Note that this mapping is usually not done directly. Instead, implied default probabilities are multiplied by a stress factor (dependent on the target credit rating) before mapping a credit rating, adding some cushion to the inferred credit ratings. Finally, given this rating, a value for the CDO tranche can be determined from a comparables analysis as discussed at the beginning of this section.

exhibit 10 Moody's Idealized Cumulative Probability of Default by Rating and Number of Years

Rating	1 Year	2 Years	3 Years	4 Years.	5 Years	6 Years	7 Years	8 Years	9 Years	10 Years
Aaa	0.000	0.000	0.001	0.002	0.003	0.004	0.005	0.007	0.008	0.010
Aa1	0.001	0.003	0.010	0.021	0.031	0.042	0.054	0.067	0.082	0.100
Aa2	0.001	0.008	0.026	0.047	0.068	0.089	0.111	0.135	0.164	0.200
Aa3	0.003	0.019	0.059	0.101	0.142	0.183	0.227	0.272	0.327	0.400
A1	0.006	0.037	0.117	0.189	0.261	0.330	0.406	0.480	0.573	0.700
A2	0.011	0.070	0.222	0.345	0.467	0.583	0.710	0.829	0.982	1.200
A3	0.039	0.150	0.360	0.540	0.730	0.910	1.110	1.300	1.520	1.800
Baa1	0.090	0.280	0.560	0.830	1.100	1.370	1.670	1.970	2.270	2.600
Baa2	0.170	0.470	0.830	1.200	1.580	1.970	2.410	2.850	3.240	3.600
Baa3	0.420	1.050	1.710	2.380	3.050	3.700	4.330	4.970	5.570	6.100
Ba1	0.870	2.020	3.130	4.200	5.280	6.250	7.060	7.890	8.690	9.400
Ba2	1.560	3.470	5.180	6.800	8.410	9.770	10.700	11.660	12.650	13.500
Ba3	2.810	5.510	7.870	9.790	11.860	13.490	14.620	15.710	16.710	17.660
B1	4.680	8.380	11.580	13.850	16.120	17.890	19.130	20.230	21.240	22.200
B2	7.160	11.670	15.550	18.130	20.710	22.650	24.010	25.150	26.220	27.200
B3	11.620	16.610	21.030	24.040	27.050	29.200	31.000	32.580	33.780	34.900
Caa	26.000	32.500	39.000	43.880	48.750	52.000	55.250	58.500	61.750	65.000

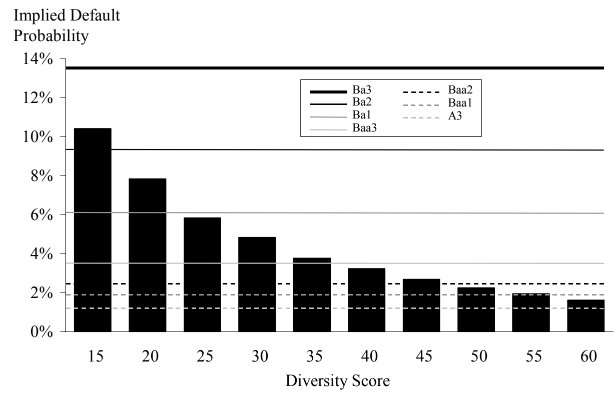
Source: Moody's

TRANCHE RATING SENSITIVITY

Through implied default probability mappings, the graphs in Exhibits 11-13 show the rating sensitivity of a hypothetical CDO tranche to changes in portfolio diversity score, WARF, and par loss (realized defaults). Such sensitivity analysis is an important use of the re-rating methodology as it gives investors insights into the stability of current or forecasted ratings. For example, a change in the collateral WARF from 1850 to 1950 will move the hypothetical tranche from an investment grade Baa3 rating one notch lower to Ba1. Similarly, an immediate par loss increase from 6% to 7% will lower the rating one notch from Ba1 to Ba2.

exhibit 11

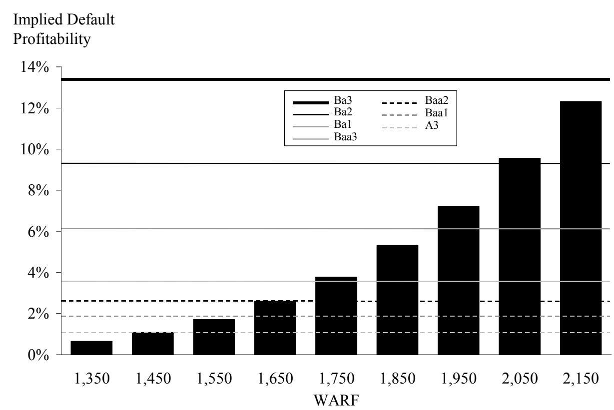
Tranche Ratings Sensitivity to Collateral Diversity Score



Source: Morgan Stanley

exhibit 12

Tranche Ratings Sensitivity to Collateral WARF

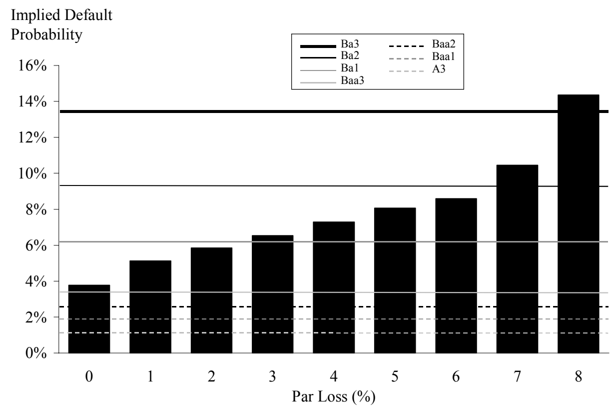


Source: Morgan Stanley

chapter 7

exhibit 13

Tranche Ratings Sensitivity to Immediate Collateral Par Losses



Source: Morgan Stanley

VALUING EQUITY AS THE RESIDUAL

The re-rating methodology, by definition, is useful only for determining value of CDO liabilities that carry a credit rating. How does one use this methodology to determine value for equity tranches that are not rated? The answer is that we can combine the valuations of rated CDO tranches in this approach with other methodologies (described in the following sections) to determine the residual value of the equity tranche.

The Market Value Methodology

One simple view of a CDO is to think of it as a portfolio with cash flows divided into many pieces. The sum of these parts must equal the whole portfolio. This equivalence property is the basis of the CDO valuation technique we call the market value methodology, the fundamental premise of which is:

Market Value of Assets = Market Value of Liabilities

The assets of a CDO are its collateral (adjusted for any hedges that may be in the structure). The liabilities of a CDO are the notes issued by the special purpose vehicle, the equity and any fees collected by collateral managers (over the life of a CDO) and by underwriters and administrators (at issuance). When CDOs are issued, this equivalence relationship between assets and liabilities exists (usually within a small band), but as CDOs age, we have found that the market value of assets does not always stay in line with the market value of liabilities. Absent are strong forces to drive equivalence, including:

- The difficulty of going long one side of the asset liability equation and short the other. Arbitrageurs are not easily able to drive the equivalence relationship.
- The buy and hold behavior of traditional CDO note and equity investors.

It should be noted that closed-end mutual funds experience similar behavior in the relationship between the NAV of the fund and the value of the fund's shares. Nevertheless, market value equivalence is a fundamental relationship that can be used as a relevant metric in valuing CDO liabilities. Furthermore, we find that many CDO market participants rely on the market value equivalence, and in this section we describe a market value based approach for valuing CDOs.

THE ROLE OF CHANGING MARKET VALUE

In theory, whenever we observe a change in the market value of the assets we should observe an *equivalent* change in the value of CDO liabilities. For example, a 10 bp widening in credit spreads of a CDO's underlying collateral should have a commensurate impact on the market value of the CDO's notes and equity. How can we measure this impact?

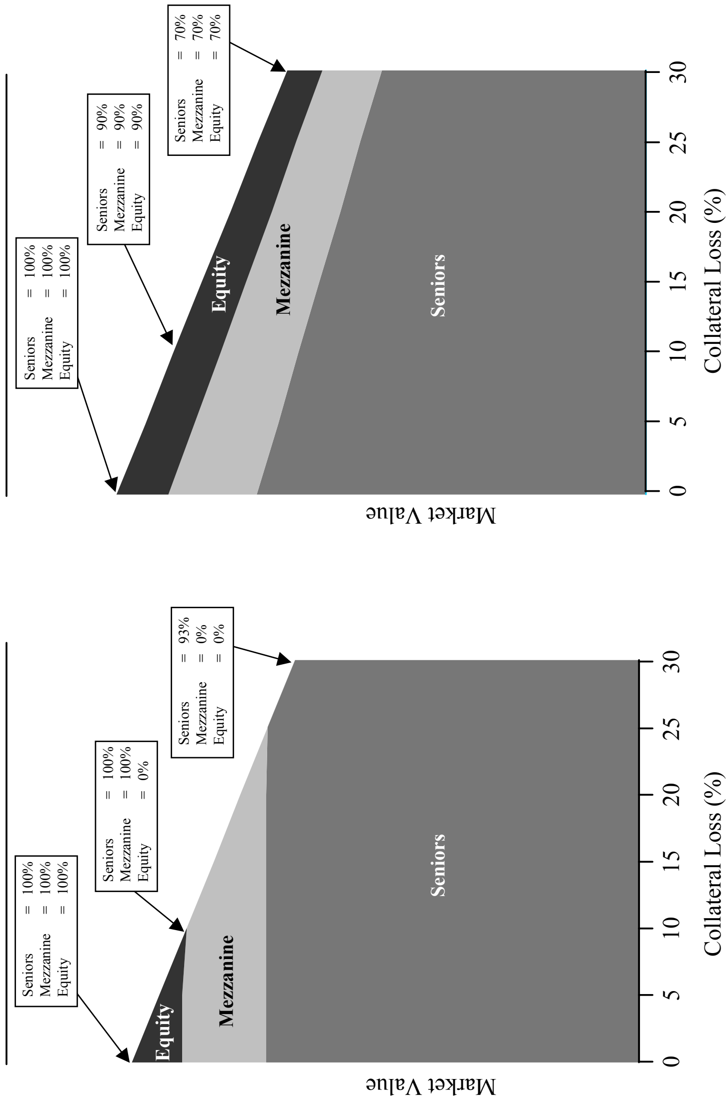
The market value approach tells us that a decrease in value due to a 10 bp widening in the credit spread of the underlying collateral should be distributed to the various CDO tranches such that:

- Each tranche is affected in a fair way.
- The market value of assets continues to equal the market value of liabilities.

How do we determine a fair way of distributing the change in market value to the various tranches? One extreme is for the tranches to absorb the losses sequentially. The most subordinated tranche (equity) would absorb losses until it lost its full par value, at which point the next subordinated tranche would begin to absorb losses. Another extreme is to distribute the loss in a pro-rata format to all tranches simultaneously (see Exhibit 14).

exhibit 14

Market Value Impact: Sequential and Pro-Rata Approaches



Source: Morgan Stanley

Consider a simple hypothetical example, a CDO with three tranches as depicted in Exhibit 15. If the collateral loses 10% of its value, under the sequential approach, the equity tranche will absorb the entire loss (its price would fall to 0% of par, as equity comprises 10% of the par value of the structure). The prices of the other more senior tranches would remain at 100% of par. Under the pro-rata approach, the loss would be distributed equally to each tranche (taking into consideration the tranche's weight within the CDO). The price of each tranche would therefore fall to 90% of par.

With a 30% loss of collateral market value, under the sequential approach, both subordinate tranches would lose all of their value (given that they make up 25% of the structure combined) and the remaining loss would be applied to the senior tranche, bringing its price as a percentage of par to 93.3. Under the pro-rata approach, each tranche would lose 30% of its value, so all tranches would be priced at 70% of par.

exhibit 15 Sequential and Pro-Rata Approaches: Examples

			10% Collateral Loss		30% Collateral Loss	
Tranche	Original Price	% of Par Value	Sequential Approach (Price)	Pro-Rata Approach (Price)	Sequential Approach (Price)	Pro-Rata Approach (Price)
Senior	100	75	100	90	93	70
Mezzanine	100	15	100	90	0	70
Equity	100	10	0	90	0	70

Source: Morgan Stanley

Is either extreme approach correct? Neither accurately reflects the risk of the various tranches, but the real values are likely bounded by these two approaches. For moderate declines in collateral value, the sequential approach where the subordinate tranche absorbs the entire loss is probably closer to what is practiced in the marketplace. In our view, to understand how the various tranches are affected, it is important to consider both the bounds and the nature of the market value changes.

A PRACTICAL APPROACH: CATEGORIZING MARKET VALUE CHANGES

As we mentioned in our introduction, collateral managers of cash flow CDOs are primarily concerned about meeting the cash flow liabilities of the CDO, while keeping the CDO in compliance with credit ratings, par coverage and interest coverage guidelines. Changes in market value of the underlying collateral are not necessarily of concern to collateral managers, unless these changes are large enough or specific enough in nature to have a structural impact on a cash flow CDO. Examples of changes in collateral that structurally affect a CDO include credit rating upgrades or downgrades, defaults, redemptions and reinvestment . From the perspective of cash flow CDOs, we can think of collateral market value changes as belonging to one of three categories:

- Small market value changes that will not lead to structural changes in cash flow CDOs. This includes small changes in the general level of interest rates and credit spreads.
- Large market value changes that may not lead to structural changes in cash flow CDOs, but are large enough to change assumptions about the general level of interest rates and credit spreads.
- Market value changes that are indicators of potential structural change in a CDO.

exhibit 16 A Practical Approach to Understanding the Impact of Collateral Market Value Changes

Nature of Market Value Change	Description	Likely Impact on Senior Notes	Likely Impact on Second Priority or Mezzanine Notes	Likely Impact on Equity
Small market value change with no structural CDO impact	Examples include changes in general level of interest rates or credit spreads	None	Market savvy required. Observe new issue comparables	Market savvy required, mark up or down on a price basis
Large market value change with no structural CDO impact	Large moves in the general level of interest rates or credit spreads	Market savvy required, but some of the impact should be absorbed here. Observe new issue comparables	Market savvy required, but the impact should be significant. Observe new issue comparables	Change discount rate assumptions (see cash flow methodology)
Market value changes that indicate structural changes in the CDO	Credit specific moves that are potential indicators of changes in ratings, defaults, or triggers that will force transactions or cash flow diversions	Value tranche using rating or cash flow methodologies, taking collateral indicators into consideration	Value tranche using re-rating or cash flow methodologies, taking collateral indicators into consideration	Value tranche using re-rating (residual) or cash flow methodologies, taking indicators into consideration

Source: Morgan Stanley

In Exhibit 16, we describe these three market value classifications along with the likely impact based on what we have observed in the market place. It is important to note, however, that the extent to which senior or mezzanine tranches are affected will depend on the amount of losses already incurred by the more subordinate tranches.

For small changes in market value that are not indicators of future structural changes in the CDO, we have observed that the senior notes are likely unaffected, while the equity and mezzanine notes typically absorb the bulk of the impact (if any). A guide to the magnitude of this impact can be the new issue CDO market, where investors observe the value of comparable CDO tranches.

If there are large changes in market value that are not indicators of future structural changes in the CDO, then we have observed all tranches of a CDO being impacted. Senior notes generally take their cue from comparables or the general level of high credit quality instruments in the cash markets. Market savvy is required for the second priority or mezzanine notes, just as we noted before. For equity, large changes in interest rates and credit spreads should influence fundamental assumptions like the yield (discount rate) required by investors (see the cash flow methodology).

MARKET VALUE AS AN INDICATOR OF STRUCTURAL CHANGE

The most insightful use of the market value approach is to use changes in market value as an indicator of potential structural change in a CDO. Examples of these indicators include:

- The market prices in a ratings upgrade or downgrade for a particular credit.
- The market expects a credit to default or perceives an increased probability of default.
- Collateral manager may be forced to sell a credit that falls below a ratings threshold (e.g., CCC).
- Collateral manager may change a view on a particular credit based on information that the market has already priced in which can trigger a sale.

Each of these examples gives the investor an indication of the potentially changing characteristics of a CDO as a whole or a specific tranche. Investors can then use other methodologies (i.e., the re-ratings or cash flow methodologies) to value the tranche. For example, if the market begins to price in an upgrade or downgrade for a particular credit, an investor could forecast a different WARF for the collateral, and use the re-rating methodology to value the tranche in question. If the market expects a credit to default (or if a credit falls to a ratings threshold that may force the collateral manager to sell it), then the investor can forecast a collateral sale and reinvestment and then revalue the tranche using the cash flow methodology.

The Cash Flow Methodology

The cash flow approach draws its support from one of the most fundamental valuation techniques for fixed income securities: generating cash flows and computing their present value using yield or a series of discount factors. Rated notes of CDOs have scheduled cash flows, so in theory, valuing rated notes by generating and discounting cash flows seems reasonable. CDO equity does not have contractually obligated cash flows, but for a given set of assumptions, there are definitive cash flows that can be valued as well.

VALUING CASH FLOWS OF RATED CDO NOTES

What factors influence the cash flows of a rated note? For cash flow CDOs, default and recovery assumptions for the underlying collateral are clearly important. The underlying collateral for most CDOs is not static, so investment and reinvestment strategies and guidelines are important as well. Furthermore, any reasonable cash flow valuation based on default, recovery and reinvestment assumptions would require some measure of sensitivity to changes in these assumptions (that is, investors rarely have one view on these assumptions, and would rather see how altering assumptions can affect the value).

In this section we describe two approaches to valuing a CDO tranche using cash flows. The first approach involves identifying a discount rate (yield) from comparable securities and testing its sensitivity to changes in input assumptions. The second approach involves projecting default-adjusted cash flows and discounting them at Libor over both a single path of assumptions and a distribution of assumptions.

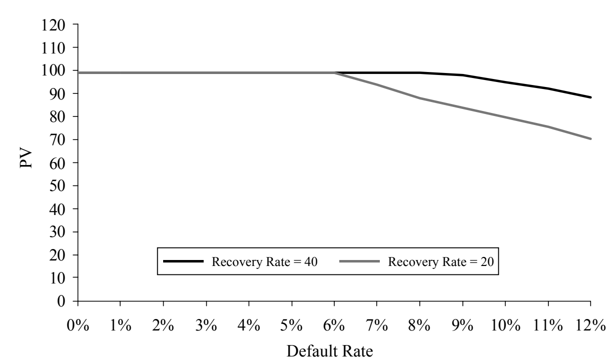
THE CASH FLOW APPROACH USING A COMPARABLE YIELD

From a corporate bond perspective, the discount rate we are most familiar with is yield. As we discussed earlier, corporate bond investors often value credits on a comparables basis, or making an educated guess at the right yield (based on comparable credits). In valuing CDO tranche cash flows, this comparables basis is used as well, along with tests of sensitivity to changes in input assumptions

A CDO note's spread is most likely based on spread levels for comparable notes (new issue or secondary market) and possibly includes other market knowledge about the specific structure. However, the heart of the approach lies in testing the sensitivity of the note's present value of cash flows (given a yield) to changes in underlying assumptions. Consider the example in Exhibit 17. If we assume that second priority notes on investment grade collateral CDOs of recent vintage have a yield of 8%, then we can hold this yield constant and test the sensitivity of the present value of cash flows of the tranche to a set of default and recovery rate assumptions.

exhibit 17

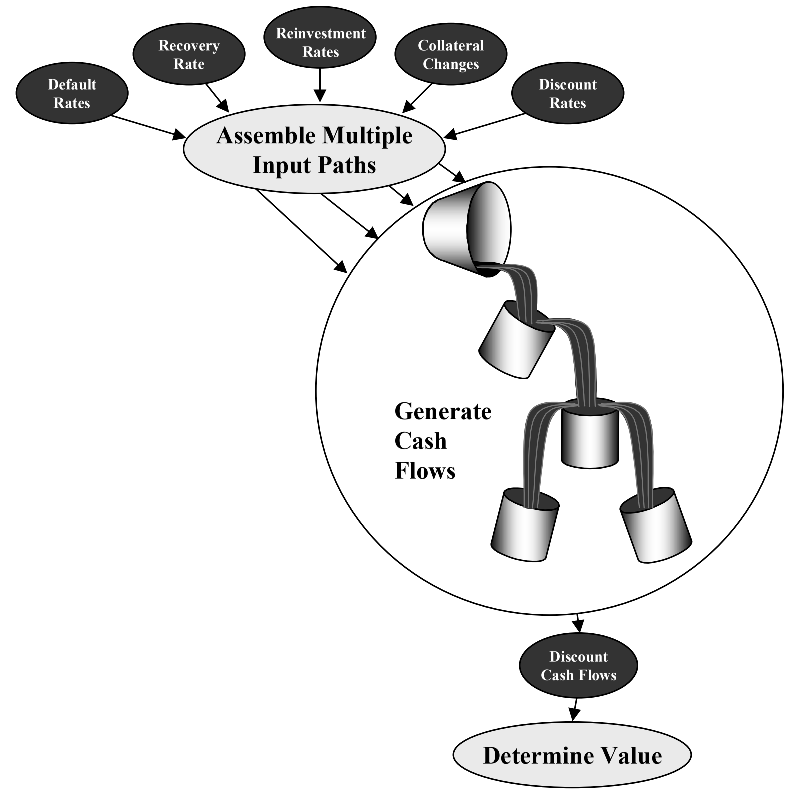
Mezzanine Note PV of Cash Flows Sensitivity



Source: Morgan Stanley

exhibit 18

Cash Flow Methodology



Source: Morgan Stanley

For a recovery rate assumption of 40%, the PV is very stable for annual collateral default rates of 0% to 8%. At a recovery rate of 20%, the stability holds until approximately 6% annual default rate. If these default and recovery rates are within ranges that cover collateral credit quality (with some degree of stressing), then we can say that the tranche's PV is stable at a yield level of 8%.

HOW DO WE DISCOUNT EQUITY CASH FLOWS?

As we described earlier, the equity tranche of most CDOs do not have contractually obligated cash flows, and most don't carry credit ratings either. However, for a given set of assumptions we can generate definitive cash flows for equity, so we can follow a similar cash flow discounting method as we do for rated notes.

We can consider deriving a yield for equity from comparable securities. However, it is hard to find comparables for equity tranches, as many secondary market equity tranches are unique. But referencing comparables is still an option, particularly for more recently issued deals (that could have similar collateral composition).

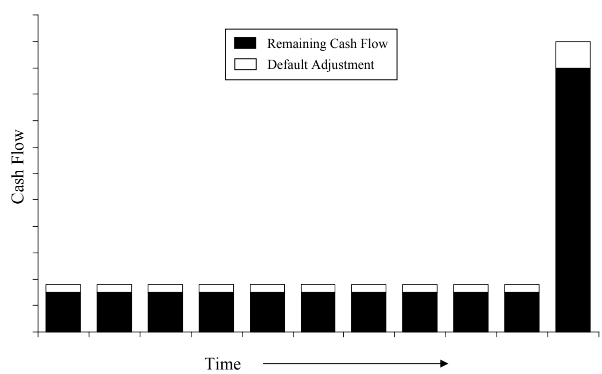
The more common approach, however, continues to be driven by what the market requires for the yield of CDO equity. Many deals are structured to have internal rates of return in the 15-20% range if default and recovery assumptions follow historical averages for a given collateral type. As such, after computing equity cash flows under typical collateral default rate assumptions, discount rates of 15-20% are commonly used to compute present values for equity cash flows.

PROJECTING DEFAULT-ADJUSTED CASH FLOWS

The first approach to using cash flows of a CDO note gives us a price only after we determine a value for the yield. How can we determine the price without assuming a yield?

A simplified approach to valuing a security is to assume that an investor receives the expected cash flows of a security (adjusted for the default probability – see Exhibit 19).

exhibit 19
Default-Adjusted Cash Flows



Source: Morgan Stanley

We can calculate the expected cash flows by adjusting the scheduled cash flows with the probability of default (see Exhibit 19). We then discount each adjusted cash flow by zero-coupon Libor to compute a present value.

$$PV = \sum \frac{DefaultProbCashFlow}{(1+L_i)^i}$$

We use zero-coupon Libor as the discount factor. In theory, the resulting present value is the price an investor would be willing to pay for a security with cash flows that have been adjusted for expected losses from defaults.

We can now use this resulting present value to solve for the appropriate spread (or yield) on the original security (with the original scheduled cash flows).

$$PV = \sum \frac{OrigCashFlow}{(1+(TsyYld + Spread))^i}$$

The above technique gives the default-probability-implied spread, based on an assumed probability of default. The probability of default can be inferred from the default swap market as well. When compared to historical default probabilities, the observed level in the default swap market probably more accurately reflects investors' views on a credit.

What do we do if there is there is no liquid default swap market to reference? To answer this question, we have to consider arbitrage forces. In corporate bond markets, investors can create a default-risk free credit instrument by financing a corporate bond (via an asset swap structure) and then buying default protection in the default swap market. In theory, such an investment structure can drive the relationship between the asset swap spread and default swap spread to near equivalence. In practice, there is a basis between the two values to explain differences due to supply and demand, counter party credit quality and other technical factors.

Default Swap Spread = Asset Swap Spread + Default Swap Basis.

Is the simple one-path approach to valuing a CDO note described above valid? The approach of default-adjusting cash flows and discounting by zero-coupon Libor is used, but generally in a multi-path context which we describe in the next section.

CASH FLOW SIMULATION METHODOLOGY

We have discussed above computing a default-probability-implied yield for a tranche, given one path of input assumptions. We can extend this to a formal simulation where a large distribution of assumptions are generated programmatically, where for each path, cash flows are generated, adjusted based on default and recovery rate assumptions and discounted using risk free rates. The average of these results can be considered a fair value for a CDO note.

CASH FLOW SIMULATION APPROACH

For each of thousands (or millions) of possible default scenarios, we repeat the following procedure:

- For each period, determine which individual bonds in the collateral pool default. Recovery and reinvestment assumptions need to be applied to defaulted bonds.

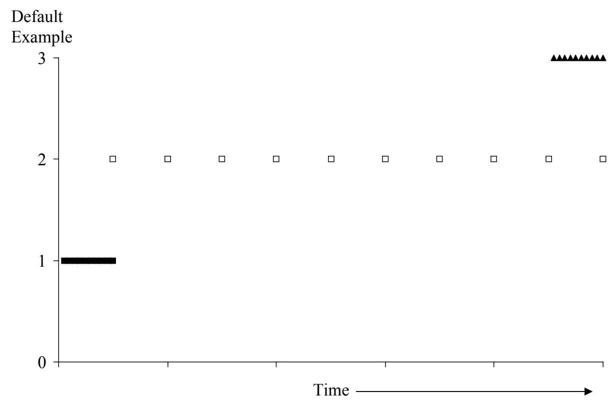
- Use the cash flow waterfall to determine what payments are made to each tranche in each period.
- Discount these cash flows at zero-coupon Libor.

Having repeated this process over many different default possibilities, we can average the results for each tranche to determine a fair value.

IMPLEMENTING THE SIMULATION: MODELING THE TIMING OF DEFAULTS

In theory this simulation is simple, but the implementation can be quite challenging. First, it can be computationally time consuming to simulate whether or not an individual bond defaults in each short interval of time. To overcome this computational burden, practitioners tend to directly model the amount of time it takes until a given bond defaults. The timing of defaults, not just the number of defaults, is critical for valuing CDOs. Consider the defaults that are graphically depicted in Exhibit 20.

exhibit 20
Default Clustering Examples



Source: Morgan Stanley

There are many ways a portfolio can experience 10 defaults. One extreme is that they are clustered early in the life of a CDO, while another extreme is that they are clustered late in the CDO life.

The timing of these defaults affects the cash flow stream available to the various CDO tranches. Many early defaults can trigger the delevering of the structure by senior note holders, resulting in reduced cash flows (or no cash flows at all) to the subordinated note or equity holders.

IMPLEMENTING THE SIMULATION: MODELING DEFAULT PROBABILITY AND DEFAULT CORRELATION

To correctly value a CDO, we need to use market-implied (or “risk neutral”) default probabilities. A term structure of default probabilities can be implied from default swap spreads or asset swap spreads. Practitioners tend to model default probabilities using a stochastic process, which can be calibrated to default swap spreads or asset swap spreads.

The correlation of defaults must be accounted for as well. Correlation is critical, since individual bonds are affected by a number of common factors (see discussion in the Extensions to Valuation Methodologies section).

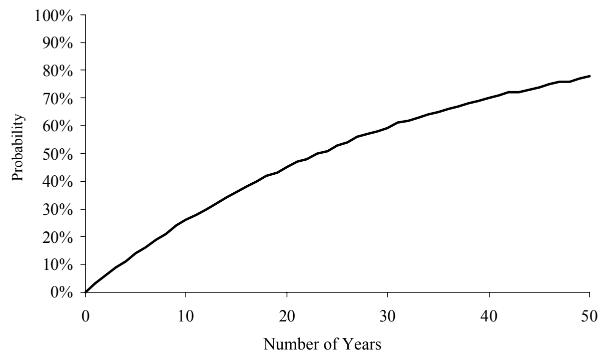
THE MATHEMATICS OF A SIMPLE SIMULATION

To give the reader a sense of how the occurrence of default can be modeled, we mathematically describe a simplified model of default for a single asset.

Suppose that, conditional on a bond surviving to a time t in the future (where time is measured in years), the probability of default over the next short time period Δt is $h\Delta t$, where h is constant. Under this assumption, the time to default follows an exponential distribution; i.e., the probability of the bond defaulting within the next t years is $1 - e^{-ht}$. For example, if $h=3\%$, the probability of the bond defaulting within the next two years is $1 - e^{-.03x2}$, or 5.82%. The parameter h is known as the hazard rate.

exhibit 21

Exponential Distribution: Cumulative Probability of Default



Source: Morgan Stanley

Under this model, the probability of the bond surviving for the next t years is e^{-ht}. Therefore, if we generated a uniform random variable U between 0 and 1, the relation $t=-log(U)/h$ would give us the default time for the bond. For example, using $h=3\%$ as above, if in our first path $U=0.757$, the corresponding time until default would be $-log(0.757)/.03 = 9.28$ *years.*

One aspect of this simplified simulation that is not realistic is that we have assumed that the hazard rate h is a constant. The hazard rate should be a stochastic function of time calibrated to current market levels. Moreover, to price a CDO tranche using this methodology, we would have one default process for each bond, and would have to combine them so as to account for the fact that defaults among bonds are correlated.

Extensions to the Valuation Methodologies

There are many natural extensions to the valuation methodologies that have been described in this report. In this section, we identify and summarize some of the extensions that are practiced in the marketplace.

MOODY'S DOUBLE BINOMIAL METHOD

Moody's applies the Double Binomial Method to CDOs that have collateral from two distinct pools (e.g., high yield bonds and emerging markets debt).[3] This technique allows each asset class to have a distinct default probability and diversity score. The two pools are assumed to be uncorrelated.

DISTRESSED CDO NOTES AND EQUITY: OPTION VALUE

Given the deep level of subordination that exists in many CDO structures, the marketplace has seen many subordinated tranches lose substantial value to a point where they trade like distressed securities. A distressed CDO does not imply that the entire CDO structure is in financial distress, it implies that the subordinated note of concern is in distress given its position in the cash flow waterfall. For distressed securities, the collateral has experienced par losses (defaults) to a point where the likelihood of receiving future interest and principal payments for a given subordinated note or equity is small.

It is difficult to value distressed CDO notes and equity using the valuation techniques we have described in this report. Any multi-path approach will be particularly sensitive to the underlying assumptions. Yet these distressed securities do have some value to those investors who are willing to take the risk, similar to out of the money options. In fact, a distressed CDO tranche could be valued as a series of out of the money options, with each potential cash flow modeled as a separate option. The value of the security is the sum of the option value series. From an investor's perspective, even if one cash flow (coupon payment) is received, the investment could have a positive return if the price of the security is low enough.

Consider a hypothetical equity tranche for a CBO. The graph in Exhibit 22 shows annual default rates versus yield for three different prices. At a price of 30, the equity has a yield of 7.4% at a future default rate of 0%, which is the best-case scenario for this residual tranche. However, the yield quickly falls to a value of 0% if annual default rates climb to 2.25%. At a price of 10, the tranche yields nearly 25% for a 0% default rate. The tranche yields about 5% if annual default rates climb to 5%.

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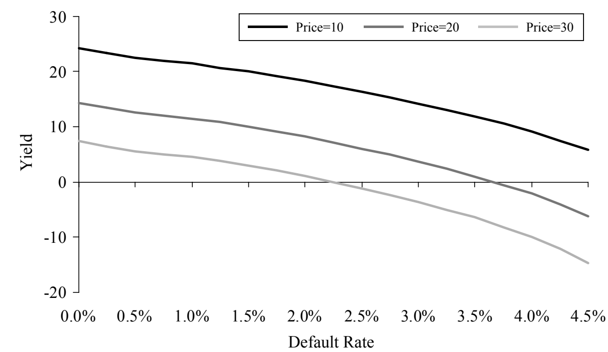
[3] *The Double Binomial Method and its Application to a Special Case of CBO Structures, Moody's Investor Services, March 1998.*

exhibit 22

Distressed Equity: Yield Sensitivity



Source: Morgan Stanley

NON-BINOMIAL DEFAULT DISTRIBUTIONS AND DEFAULT CORRELATION

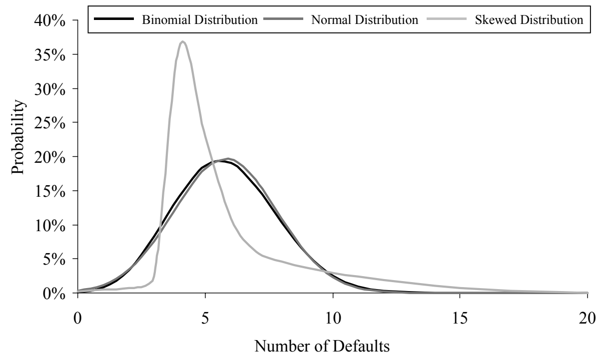
The re-rating methodology described earlier in this report is based on two generalizations about the default behavior of assets. First, the collateral is generalized to be an N-asset portfolio (N = diversity score) where each asset has the same probability of default (note that the double-binomial Moody's approach introduces two independent collateral pools). Second, the default correlation among the N assets is assumed to be zero (i.e., their default behavior is independent). This general treatment of the collateral leads to a computationally simple approach to calculating the expected loss of a CDO tranche.

However, a natural question to ask is: how different would our results be if we assumed that each credit had a unique probability of default and that the default correlation of assets were non-zero? In practice, computing an expected loss for a tranche in this manner is both data intensive and computationally complex, but it is practiced in the industry. There is commercially available software from at least one vendor (KMV L.L.C.) that provides default and correlation data and supports portfolio loss calculations based on this data.

The KMV approach[4] to modeling default risk is based on credit-specific expected default frequencies (EDFs) and a model for default correlation. The EDFs are calculated for each modeled credit and are based on the notion that an issuer will default if the market value of its assets falls below the market value of liabilities. The KMV model for default correlation is based the notion of a joint probability of default for two credits. KMV computes a default covariance matrix using a factor model that is based on diversifiable risk (such as those related to the industry an issuers belongs to) and systematic or non-diversifiable risk (such as those related to a country's economy and business cycle).

[4] *"Portfolio Management of Default Risk," KMV LLC, 31 May, 2001.*

exhibit 23
Comparing Distributions With Identical Mean and Variance



Source: Morgan Stanley

The resulting loss distributions from the KMV approach are in practice much more skewed than the normal distribution or the binomial distributions we described in the ratings methodology section of this report (see Exhibit 23). The skewed behavior comes from positive default correlation of issuers and industries.

What does a more skewed distribution imply? KMV's explanation is that:

- Most of the time, the loss is less than the average loss.
- The probability of large losses is higher with the skewed distribution (i.e., the skewed distribution has a fat tail). In a normal distribution, the chance of a 4 or greater standard deviation event occurring is very small. In the skewed distribution, it is much higher.

VALUING THE EQUITY OPTION

As we discussed in the market value approach, a change in the market value of the underlying collateral pool is useful in valuing cash flow CDOs in several ways. Related to the market value of underlying assets, there is one feature of CDO equity that has been overlooked so far in this report: the value of the option equity holders have to call the entire structure. This call option allows equity holders to delever the structure by forcing a call on all of the CDO's outstanding debt. Any remaining proceeds after the notes are retired (and after fees are paid) go to equity investors.

Equity holders may be motivated to call the structure for a variety of reasons including:

- Capturing market value gains.
- Limiting losses if the structure could lose more value.
- Reinvesting capital if equity returns look unattractive on a forward looking basis.

In theory, equity holders will exercise this option when the net present value of resulting proceeds (of calling the structure) is greater the net present value of the future (projected) cash flows. In practice, equity investors would consider the market risks of selling the (potentially illiquid) collateral as well.

In this report, we have not tried to model the value of this option, but if we were to, the model would be based on the asset price distribution of the underlying collateral (or a proxy to the underlying collateral such as a market index). An earlier research piece[5] discusses some of the technical conditions for calling high yield collateral CDO structures and concludes that calls are most likely after a CDO's reinvestment period ends.

For the burgeoning class of CDOs backed by higher quality collateral such as investment grade corporates and structured finance, the value of the call option is likely more significant for several reasons. First, the collateral is more liquid and therefore easier to sell in the event that equity holders decide to retire the structure. Second, it is simpler to project the future cash flows of the equity, given the narrower distribution of defaults for the collateral.

Summarizing the Valuation Methodologies

In this chapter, we have presented three basic methodologies for secondary market CDO note and equity valuation, namely the re-rating methodology, the market value methodology, and the cash flow methodology. We have presented variations and extensions for these methodologies as well, leaving CDO investors with a broad choice of valuation techniques. We summarize each of these variants in the table in Exhibit 24. In our view, all three basic methodologies, and all of their variants have their valid uses, but they differ in the degrees of computational complexity and required market savvy.

THE NEED FOR STANDARDIZATION

Which methodology should investors use? Investors and traders may never all agree on the best approach to value CDOs. In our view, a standardized approach to valuing CDOs would give investors a common language to speak and at the same time improve liquidity. As an analogy, in the mortgage-backed securities market, standardized prepayment assumptions and generalized collateral pools simplified the market tremendously, with sophisticated investors and traders relying on proprietary prepayment models to perform further valuations. One of the goals of this research report is to encourage more dialogue among industry participants on the topic of standardization.

COMPUTATIONAL COMPLEXITY VERSUS MARKET SAVVY

In the absence of standardization (or in addition to standardization when it exists), there are differences in the popularity of the various methodologies. We find the market value and re-rating approaches are currently more popular than cash flow approaches, due largely to their computational simplicity.

In the near term, we believe computational complexity will be a very important factor in determining the popularity of valuation methodologies. There are only a handful of commercially available or investment bank-provided CDO analytics tools today, so investors are naturally favoring the computationally simpler approaches that necessarily require a good deal of market savvy. The analytics Morgan Stanley provided are among the most sophisticated, allowing investors to value CDOs using the multi-path cash flow methodology. We expect the scale to tip in the other direction over time, with investors having many options to value CDOs both from commercial analytics providers and investment banks. In the interim, the choice of methodology will be a function of the tools available to an investor as well as the investor’s familiarity with CDO structures and the underlying collateral markets.

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[5] *"Call Me Later," Morgan Stanley Fixed Income Research, Oct 23, 2000.*

exhibit 24 CDO Valuation Methodologies

Valuation Methodology	Variant	Description	Advantages	Disadvantages	Computational Complexity	Required Market Savvy	Popularity Among CDO Investors
Re-rating	Binomial Distribution	• Generalize collateral by industry group • Industry groups are uncorrelated • Assume one default rate (two for double binomial) • Calculate expected loss under binomial distribution • Infer a credit rating, determine value by comparison	Simplest approach	Very general collateral and default assumptions No un-rated equity valuation	Low	High	High
	Non-Binomial Default Distribution (Can be variant of Cash Flow)	• Use credit-specific, model-generated default rates and correlation • Calculate expected loss under this unique distribution • Determine value by comparing expected loss	Default and correlation model with credit specific information	Lots of market data	High	High	Low
Market Value	Market Moves in Spreads and Interest Rates	• Observe market value change of collateral • For small changes, adjust subordinated note and equity values through market comparisons • For large changes, adjust all note values and fundamental equity assumptions (discount rate)	Simple asset and liability equivalence relationship	Difficult to assign market value changes to individual tranches	Medium	High	High
	Indicator of Structural CDO Change	• Use market value as an indicator of future CDO structural change such as ratings action, defaults, potential manager transactions • Forecast structural changes and value using Re-rating or Cash Flow methodology	Forecast CDO structural changes	Structural changes may not ultimately influence value and can be subjective	Medium	High	High
	Equity Option Value	• Value the option of equity holders to call entire structure	For low default rate assets, equity option can drive value of the equity tranche	Weak model support	High	High	Low

exhibit 24 (cont.) CDO Valuation Methodologies

Valuation Methodology	Variant	Description	Advantages	Disadvantages	Computational Complexity	Required Market Savvy	Popularity Among CDO Investors
Cash Flow	One Path	• Adjust tranche cash flows by default expectations • Discount cash flows by zero coupon Libor to determine value	Simple benchmark estimate	One path too restrictive, purely theoretical value	Medium	High	Low
	Multi Path with Sensitivity Analysis	• Select a discount rate (yield) by comparing tranche to similar structures in the market • Discount cash flows with this discount rate under a series of input assumptions • Observe price sensitivity to changes in assumptions	Comparables based with sensitivity testing	Difficulty in finding the right comparable	Medium	Medium	Medium
	Simulation	• Calibrate simulator to model arrival time of defaults over a large distribution • Generate cash flows over this distribution, discounting by zero coupon Libor • Average results to determine value	Fair market approach	Requires sophisticated model	High	Low	Low
	Distressed	• Model tranche like an out-of-the-money option • Determine option value	Fair value for the series of options	Weak model support	Medium	High	Low

Source: Morgan Stanley

chapter 8 Portfolio Sampling Risks

June 1, 2002

Sivan Mahadevan
David Schwartz

A common misconception in the analysis of CDOs is the assumption that the underlying collateral pool performs just like the "market" or just like an "index" for a given level or risk. Such generalizations make historical stress analyses easy, as all one has to do is observe the historical performance of the market or index. However, CDO collateral pools tend to have fewer securities than any broad measure of the market, and as such, there is a significant risk that the collateral pool behaves differently than the market, even if aggregate risk measures such as ratings are similar. Such portfolio sampling error is not necessarily a bad thing. In fact, investors who choose a collateral manager to actively manage a portfolio are effectively paying them a fee to deviate from the market with the hope that the deviation is beneficial to them. However, there is always the risk that the portfolio deviates from the market in a negative manner as well. We address this notion of portfolio sampling risk in this section.

TRACKING ERROR: TOTAL RETURN VERSUS DEFAULT RATES

There are many ways to measure the "risk" of a sample portfolio relative to a broad measure of the market. Index "tracking error" is perhaps the industry's most popular approach and involves observing the distribution of periodic total return differences between a portfolio (or portfolio strategy) and an index. The standard deviation of this difference is one measure of this tracking error.

For a cash flow CDO, rather than periodic return, the default rate is the variable whose distribution impacts the performance calculation. The risk that a particular tranche of a CDO misses its targeted return is directly related to the probability that the default rate exceeds a certain threshold (the probability of note impairment). From the mezzanine note investor's perspective, it is important to measure is the sensitivity of the probability of impairment to the size of the underlying collateral portfolio. To measure this sensitivity, we first need to generate the distribution of defaults for a given portfolio strategy. The traditional approach in the CDO market for doing this is to model portfolio default behavior using a binomial distribution. Our model generates what we consider to be a more realistic default distribution, by assuming positive default correlation between credits.

MEZZANINE NOTE IMPAIRMENT: SENSITIVITY TO PORTFOLIO SIZE

In Exhibit 1 we show the probability of impairment as a function of the size of a portfolio, for various mean default rates. The X-axis of the graph is the number of issuers in the portfolio. The Y-axis is the probability that the underlying collateral pool experiences enough defaults to impact the cash flow of the mezzanine notes. This analysis is based on a Baa2-rated mezzanine tranche of a typical 5-year synthetic investment grade CDO, whose underlying portfolio has an average rating of Baa1/Baa2.

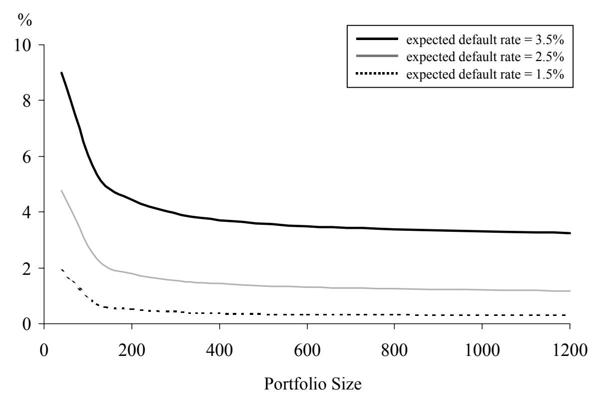
It is important to note that adding more and more credits to a portfolio does not reduce the probability of mezzanine note impairment to zero. This is true for two reasons. First, because the underlying credits are assumed to have positive default correlation, some of the risk is systematic and cannot be diversified away. Second, there are only a limited number of credits to choose from. We estimate that the global credit investor has access to approximately 1,200 investment grade credits, through the framework depicted in the Venn diagram in Exhibit 4.

To arrive at this estimation, we first considered the universe of credits available in the two largest corporate bond markets (the US dollar and Euro-currency markets, with credits from all over the world). We also considered the credit default swap markets in the US and Europe. While this methodology does not result in the comprehensive universe of issuers available, it is a reasonable measure of total available credit exposure. Adding corporate credits that trade only in selected domestic markets (such as the United Kingdom, Japan, and Australia) may add some credits to the total (say an additional 200 to 300) but accessing these credits can be difficult, even for the most global of investors. In our view, the 1,200 estimation should be considered the upper bound for the number of credits in a global investment grade credit portfolio that could realistically be included in a CDO.

In light of the fact that some of the risk that a mezzanine note becomes impaired cannot be diversified away, we find it useful to consider the "diversifiable risk" of impairment, shown in Exhibit 2. For this calculation, we take the probability of impairment and subtract the non-diversifiable risk, as measured by the probability of impairment for a 1,200 credit portfolio.

exhibit 1

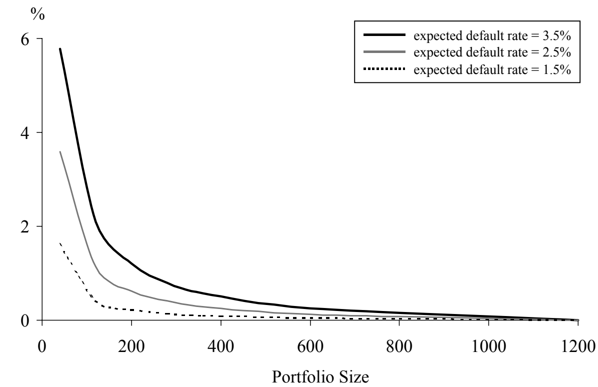
Probability of Mezzanine Note Impairment vs. Portfolio Size



Source: Morgan Stanley

exhibit 2

Diversifiable Risk: Probability vs. Portfolio Size



Source: Morgan Stanley

exhibit 3

Table of Inflection Points and Sweet Spots

5-Year Cumulative Default Rate	Inflection Point	Sweet Spot
1.5%	150	300
2.5%	190	400
3.5%	210	500

Source: Morgan Stanley

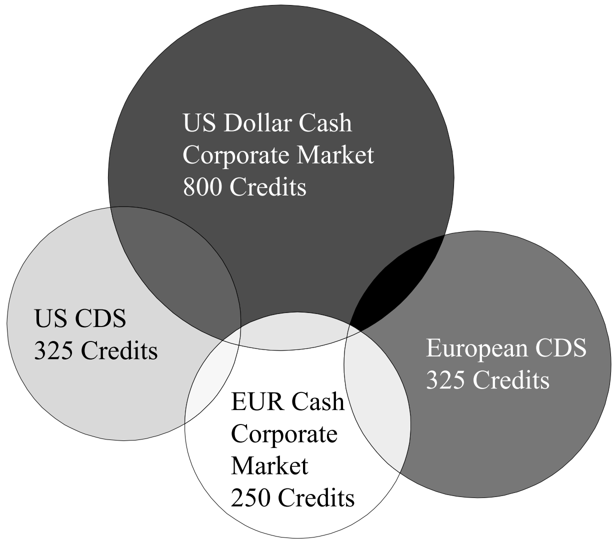
For a given mean default rate, we identify two points on this curve that we think are very important from the perspective of mezzanine note investors. The first is the "inflection point"[1]. We define the inflection point as the point at which a sufficient amount of the diversifiable risk has been removed. The second is the "sweet spot". We define the sweet spot as the point at which the marginal benefit of additional credit exposure is sufficiently small.

At a 1.5% default rate (which corresponds to the Moody's idealized 5-year cumulative probability of default for a Baa2-rated portfolio), the inflection point is approximately 150 credits while the sweet spot is approximately 300 credits. At a 2.5% default rate, the inflection point is approximately 190 credits and the sweet spot is approximately 400 credits. At a 3.5% default rate, the inflection point is approximately 210 credits with a sweet spot of 500 credits.

[1]*We are not referring to the mathematical definition; i.e. where the second derivative of the graph changes sign. Rather, we have in mind the colloquial definition of "a turning point, a point which marks significant change".*

exhibit 4

Global Cash and Credit Default Swap Markets



Source: Morgan Stanley

THE STATIC VERSUS MANAGED DEBATE

Any analysis of portfolio sampling risk within CDOs is usually at the heart of a broader discussion: the debate over investing in static deals versus hiring a manager to actively manage the collateral. Managers are generally favored in markets where credit skills and access to assets are limited, such as high yield bonds, leveraged loans, and emerging markets. However, in markets where such skills are broadly available and where access to assets is not as difficult, CDO investors truly have a choice between managed or static transactions. There are clear benefits and drawbacks for each approach. With a manager, investors hope that there is significant portfolio sampling error that leads to outperformance relative to the market. However, there is a cost for management, so any managed strategy has to be credible (in the minds of the investors) and should leave the manager with enough room to deviate from the market to earn the "alpha." In contrast, in a static transaction, investors are hoping that either initial credit selection will be adequate (with respect to default risk) for the life of the transaction, or that the collateral pool is large enough that the risk of tranche impairment is sufficiently low. The analysis provided in this chapter should aid investors in understanding the potential risks they have as mezzanine note investors, given the wide differences in CDO portfolio size in the marketplace.

CONCLUSION

As we have highlighted in this chapter, portfolio size is an important consideration for mezzanine note investors. If a CDO's underlying portfolio is larger than the inflection point (for a given default rate assumption), much of the diversifiable default risk can be significantly reduced. If the portfolio is larger than the "sweet spot" size, the marginal benefit of adding additional credits is small. It is important to note that such risks may be desirable in cases where investors intend to take name-specific credit risk in either static or managed transactions.

chapter 9 Streetwise Correlation

June 13, 2003

Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar

Correlation trading is the new new thing in credit markets. Over the past two years, CDO investors have become painfully aware of the correlation risks in their structures. As a result, investors are now focused on understanding the correlation of credits in portfolios backing synthetic and cash structures, although there is still healthy debate on what this actually means. As correlation relationships can be puzzling, our goal in this week's report is to help investors gain some intuition on the topic.

We have been writing about correlation risks in tranched investments for at least 18 months now, but a lot has occurred in the past 6 months.

- The Street has standardized a technique to price baskets, given correlation assumptions
- A market for first-to-default baskets has emerged, and we can observe implied correlation from these transactions
- A "trading" market for tranches of large baskets is developing, based on Synthetic TRACERS℠, and we can observe implied correlation from this market as well

STREET SPEAKING THE SAME LANGUAGE

We refer readers to previous research for a more detailed description of default correlation, and for a discussion on how to estimate it using structural models of default (Merton or Moody's KMV-like). Over the past several months, the Street has standardized a quantitative approach to pricing baskets. Without going into the details, we simply describe it as a way of taking a collection of independent default distributions (for each company) and combining them into correlated distributions for all of the companies in a basket. From this pricing process, an implied correlation can be observed. This pricing model can be thought of as the Black-Scholes for correlation products, although many have argued that other approaches should not be dismissed, including those that use a real correlation "matrix" instead of an average. Nevertheless, the beauty of this approach is that the Street now speaks a single language, and market participants can observe implied correlation, much like implied volatility in the options markets.

RULES OF THUMB

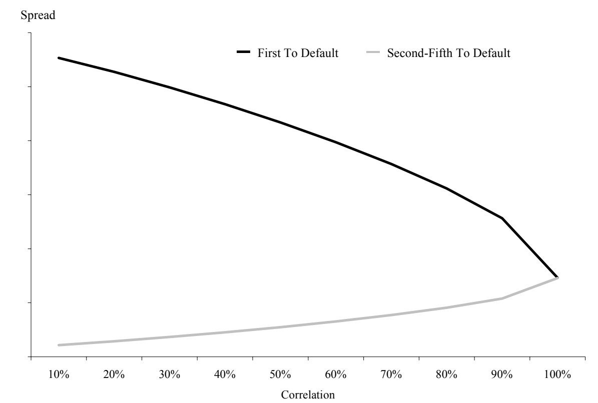
There is still a lot of correlation confusion among market participants. We argue that the rules of thumb are fairly simple.

- In "subordinate" tranches, risk and spread decrease as correlation rises
- In "senior" tranches, risk and spread increase as correlation rises

Investors in “subordinate” tranches are long correlation (spreads tighten when correlation rises). Investors in “senior” tranches are short correlation (spreads widen when correlation rises). In Exhibit 1, we illustrate these relationships for a simple five-name basket.

exhibit 1

Correlation Relationships – Small Baskets



Source: Morgan Stanley

THE “SUBORDINATE” VS. “SENIOR” DIVIDE

As we graduate from small baskets to large baskets, two things happen. First, the range of possible (or implied) correlation values narrows as large baskets are less sensitive to the idiosyncratic behavior of a small number of companies. Second, the tranche sizes that trade are typically much thinner than in small baskets, which makes their inter-relationship very interesting from a correlation perspective. As an example, dealers are now making markets in five tranches of synthetic TRACERS^{SM}, all within the bottom 30% of the capital structure. By comparison, in a five-name first-to-default basket, one can think of the implicit “tranche” size as being 0%-20%.

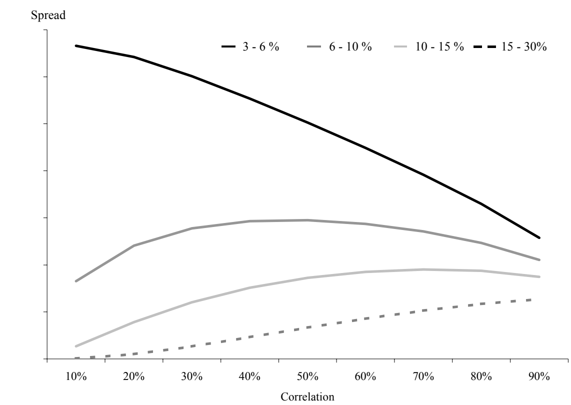
Given the number of tranches in the first 30% of the capital structure, we can think of each tranche as being somewhere on the spectrum from “subordinate” to “senior.” In Exhibit 2, we focus on the sensitivity of four tranches (ranging from 3% to 15% attachment points) of synthetic TRACERS^{SM} and make a few observations.

- The 3%-6% tranche has a downward sloping spread/correlation relationship (long correlation), suggesting that it is a “subordinate” tranche.
- The 6%-10% tranche has an odd convex shape; its spread first widens with rising correlation (like a senior tranche) but then tightens (like a subordinate tranche).
- The 10%-15% tranche is mostly upward sloping, with a curve that changes shape only at a high correlation, implying it is in the “senior” category.
- The 15%-30% tranche appears to be strictly upward sloping, suggesting it is a pure “senior” tranche under all reasonable correlation assumptions.

One point worth noting is the interaction between spreads and correlation. The average spread of the TRACERS[SM] portfolio in this analysis is approximately 70 basis points. If the spreads of the underlying portfolio widened dramatically, we can expect the 6-10% tranche to behave more and more like the current 3-6% tranche with respect to changes in correlation.

exhibit 2

Correlation Sensitivity – Tranched TRACERS[SM]



Source: Morgan Stanley

INTUITION

In a nutshell, our rules of thumb still apply for large baskets, but the definition of a "subordinate" tranche depends on the initial correlation assumption and portfolio spread levels. The intuition is that correlation measures how risk is distributed among the tranches. Low correlation implies that risk is concentrated in the most subordinate tranches. High correlation implies that risk is distributed among all tranches.

WHERE DOES CORRELATION TRADE? SMALL BASKETS

Based on market data from our benchmark first-to-default baskets, we can easily observe where correlation trades for small baskets. As an example, for the diversified industrials basket, mid-market implied correlation has been approximately 45%, while long-run average pair-wise equity correlation of the five companies is 31%. For the slightly more concentrated basic industrial basket, the average equity correlation is 42% while the basket trades at approximately 50%. Although not directly comparable (one could write a PhD thesis on why this is so), we do not consider this disconnection between equity and market-implied correlation to be significant. The concentrated and idiosyncratic nature of smaller baskets makes them less risky for sellers of protection on a first-to-default basis, which is why correlation trades higher.

WHERE DOES CORRELATION TRADE? LARGE BASKETS

In Exhibit 3, we show the new correlation information from the large basket market (100-name synthetic TRACERS^{SM}). We make two important observations. First, implied correlation is generally lower than historical equity correlation. We are seeing the opposite behavior of the small basket market, namely the larger basket size is putting downward pressure on correlation (the diversification impact). Second, in an arbitrage-free world, a given capital structure should trade at the same correlation, but we are clearly observing significant correlation differences among tranches. These differences demonstrate both the nascent nature of the market and the difficulty to arbitrage (transaction costs).

exhibit 3 Correlation Observations – Large Baskets

	Bid-Offer Spread (bp)	Implied Correlation
TRACERS^{SM} Tranches		
0%-3%	43/51 & 500 pa	24%
3%-6%	540/610	33%
7%-10%	145/185	19%
10%-15%	75/95	27%
15%-30%	14/23	31%
TRACERS^{SM} Equity Correlation		
1 Year Daily		33%
10 Year Monthly		38%

Note: TRACERS^{SM} equity correlation are historical observed values. 0%-3% tranche trades with points upfront.
Source: Morgan Stanley

chapter 10 Correlation Conversations, Convexity Ideas

August 1, 2003

Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar

With lower levels of volatility in the credit markets and a fairly stable spread environment over several weeks (except the past few days), correlation markets have further matured. We can point to increased participation in both the first-to-default basket and the larger single-tranche markets, as investors simultaneously reach for yield and discover tools to implement market views, either on the long or short side. In our recent travels, we have discussed the state of the correlation market with a number of institutions and have discovered quite a few sophisticated, cutting-edge correlation investors. That group would have been significantly smaller a year ago.

More importantly, there is a much larger class of investors who are just stepping into this market, and the resource allocation decisions they make over the next few months will be a key development for the market going forward. We focus this chapter on providing some insight into the recent correlation moves within the market's benchmark basket products and recommend a leveraged strategy for getting short credit that can take advantage of an interesting convexity relationship.

CORRELATION AND MINEFIELDS

Gaining intuition on correlation remains a challenge for many market participants. Our European strategy team has had success in using the following analogy: Consider a minefield, where an investor's goal is to make it across without blowing up. A subordinate tranche investor will blow up after he hits, say, two mines during his journey, while a senior tranche investor is safe until she hits ten mines. If the enemy places 20 mines throughout the field, where would the subordinate tranche investor like them to be placed? Clearly he would like them to be clustered in one small area, as this reduces the chance that he will hit one as he walks across. If they are dispersed evenly across the field, that is worse for him as the chance of him hitting one on any given path is actually higher. Remember, he is not concerned about hitting more than two. The senior note investor will think of it differently. If the mines are dispersed across the field, chances are that she will hit a few but the chance of hitting ten is unlikely. If they are clustered in one area, she may make it through safely on several paths, but if she hits the cluster, she will most likely blow up.

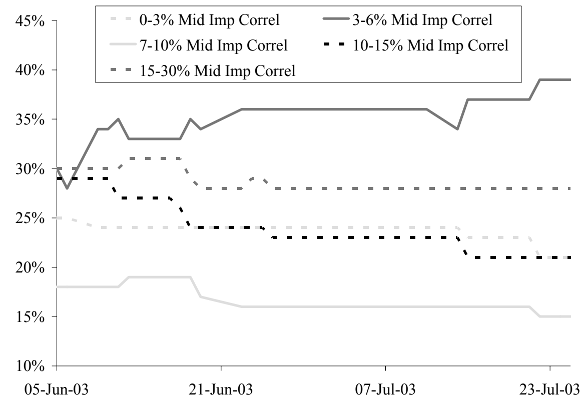
We can think of the correlation in this framework. A cluster of mines is high correlation (which the subordinate tranche investor likes), while mines dispersed more evenly throughout the field is low correlation (which the senior note investor prefers).

CORRELATION INSIGHTS

Since tranched TRAC-X (formerly called synthetic TRACERS) started trading in late May, we have collected some very interesting data on relative correlation moves of the various tranches during a period when the underlying portfolio has traded in a narrow range. The correlation disparities we discussed in an earlier report (see Chapter 9) have actually grown wider as flows have been tilted toward sellers of protection, particularly in “senior” tranches (see Exhibit 1).

exhibit 1

Diverging Implied Correlation – Tranched TRAC-X



Source: Morgan Stanley

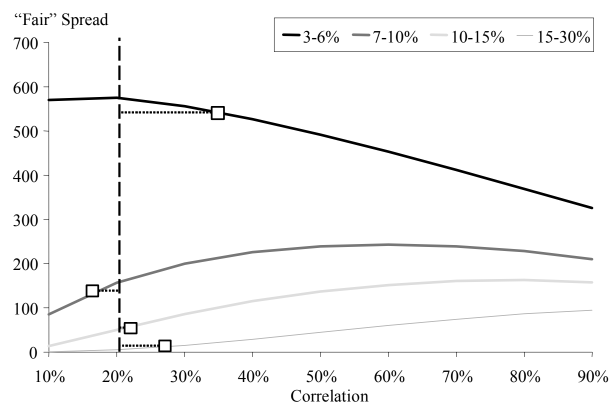
In early June, most tranches traded in a 24-33% implied correlation range, but today implied correlation values are significantly lower for “senior” tranches while being much higher for the “mezzanine” tranche (3-6%). These correlation moves are almost entirely attributed to flows. Therefore, a reach for yield among investors has driven both the 7-10% and 10-15% tranches tighter, moving correlation lower.

WHO IS RIGHT?

We illustrate in Exhibit 2 today’s implied mid-correlation for the various tranches (the squares) on curves that show the respective spread and correlation relationships. The dashed vertical line is at a 20% correlation, corresponding to where the 0-3% (equity) tranche is currently trading.

exhibit 2

Who Is Right? – Correlation Divergence



Source: Morgan Stanley

So what conclusions can we draw from this increasing correlation discrepancy? We have no strong recommendation at this point, but do have some insights. Long-run historical equity correlation is in the 30% range for the TRAC-X portfolio. The 0-3% tranche is trading far from that, but also has a large “error” term, given the tranche’s sensitivity to correlation and wider bid-offer compared to other tranches. Other correlation values are fairly scattered around this 20% level, so it is hard to draw any conclusions from this analysis alone, which leads us to focus on trading strategies as a way to think about opportunities.

AVOID THE ARBITRAGE TEMPTATION

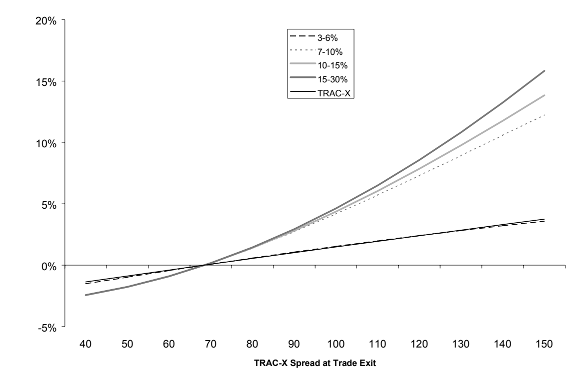
Although very tempting, given that bid-offer spreads have compressed, we do not recommend capital structure arbitrage trades in tranched TRAC-X. We do not see any reason why correlation values should converge in the near-term. The market is still new, pure correlation traders do not exist in large numbers and many investors are driven by yield and rating as opposed to “fair” pricing from derivative pricing models. We further add that, although the Street has standardized on a common pricing approach, there are numerous end investors who take a very different approach to modeling correlation, based on techniques that are more closely linked to the equity markets. For all these reasons, the correlation discrepancies are explainable and could remain in the near term. Tranche relative value trades based on expected spread changes or flows might be a better approach to exploiting these relationships, which we discuss next.

GETTING LONG CONVEXITY FROM THE SHORT SIDE

The trade that stands out as most appealing, in our opinion, comes from the view that we find a lot of comfort in getting short tight-trading names in today’s markets (see “Finding Comfort on the Short Side,” July 11, 2003). In particular, implementing a leveraged short credit view by buying protection on the 10-15% tranche appears attractively priced, considering spread levels and the convexity benefit.

exhibit 3

Convexity in Senior Notes for Short Sellers (Carry Neutral P/L as % of Notional)



Source: Morgan Stanley

With TRAC-X protection trading at about 72 bp on the offered side, investors can buy protection on the 10-15% tranche of TRAC-X for 62 bp (implied correlation of 20%). The 10-15% tranche will behave like a levered investment as spreads rise. This leverage will continue to increase as spreads widen (see Exhibit 3). As an example, consider the tranche’s theoretical value as TRAC-X rallied over 100 bp over the past

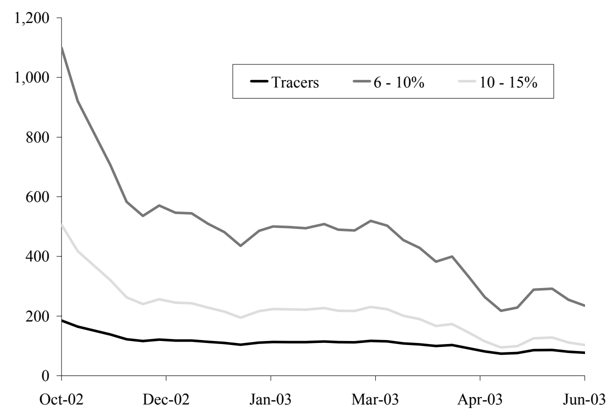
10 months (see Exhibit 4). The 10-15% tranche would have experienced a 400 bp move, representing on average approximately 5x price leverage. While we do not expect 100 bp of widening any time soon, the historical example simply illustrates that this tranche is indeed a levered play on credit on the downside.

Clearly, this type of leverage is interesting to investors who want to implement a short view, but the key benefit to this trade recommendation is the positive convexity the protection buyer gets when spreads tighten. The protection buyer in a 10-15% tranche will certainly feel pain as the market rallies, but the losses will be less severe than the gains on the other side (see Exhibit 3). Why is this so? In the most basic case, the tranche's value is floored at zero, so a big relative rally in spreads has limited downside for the buyer of protection. Furthermore, given this floor, the tranche's price movement may be much more muted as spreads rally. Our model tells us that a 30 bp tightening of TRAC-X (to a 40 bp level) would result in a "fair spread" of 14 bp on this tranche. If the tranche did trade at that level, it would represent less than 2x leverage, which we would argue is pretty good convexity for the buyer of protection. However, this is uncharted territory for TRAC-X, and we are not certain that the tranche would actually trade that tight, given practical market issues.

We can point to the European credit markets to gain a bit of insight on valuation. TRAC-X Europe (100 names) trades in the 40 bp range today. Pricing in tranches of TRAC-X suggest that a 10-15% tranche would trade at higher levels than the "fair" value, possibly in the 25-35 bp range. This results in even a better convexity story for the short-viewed investor who uses this tranche to implement his or her view.

exhibit 4

Tranche Fair Value Historically – Illustrating Leverage



Source: Morgan Stanley

chapter 11 How Many Sides in a CDO Squared? January 23, 2004

Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar

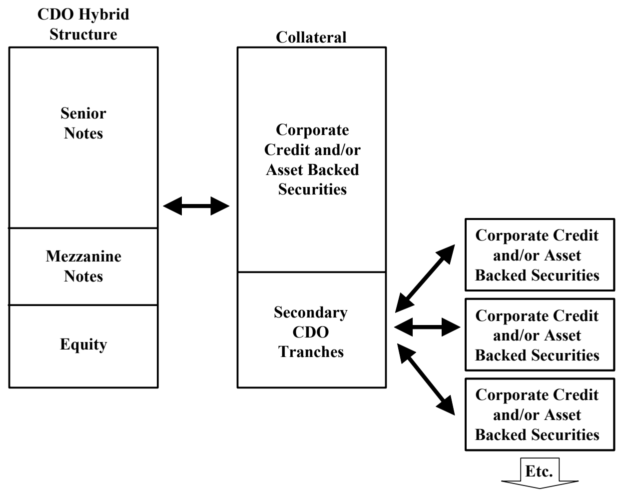
The market for CDO transactions backed purely by other CDOs never really blossomed, for a variety of reasons. Analyzing portfolios of CDO tranches using state-of-the-art models still remains a difficult and computationally intensive task. While such CDO squared transactions (as they are known colloquially) can benefit from a lack of first loss exposure in the underlying portfolio (thereby making them more immune to the dreaded idiosyncratic risk phenomenon), investors fear concentration risk across deals that is hard to either control or monitor.

Yet, CDO securities have become an increasingly common part of the collateral pool for both structured finance and synthetic CDOs. Secondary CDO "buckets" were typically small in the past, but today's spread levels in investment grade and ABS markets have pushed many transactions to hunt for yield in other ways. The newly established CDO secondary market has been the answer for many. In CDOs backed by asset-backed and commercial real estate securities, structures now allow secondary CDO exposure – up to 35% in some cases. "Synthetic" buckets can allow even more room for CDO exposure. Similarly, in synthetic CDOs, single-name credit default swaps are also combined with other synthetic CDO tranches to form the reference portfolio. What are the risks in these structures, and for whom are they best suited? We attempt to shed some light on the multi-dimensional puzzle in this week's report.

THE BASIC STRUCTURE AND MARKET

Despite all the fanfare several years ago, the process of resecuritizing portfolios of outstanding CDOs into a new CDO transaction remains a small part of the overall market. In 2003, there was only approximately $1 billion of CDO squared issuance, a small fraction of the $65 billion new issue market. Yet, we estimate that several billion dollars of secondary CDO paper found their way into both structured finance CDOs (where total new issuance was over $20 billion) and synthetic structures. In fact, such vehicles made up 15% of the CDO buyers in the secondary market in 2003, by our estimates. These structured finance and synthetic CDOs are really hybrids (see Exhibit 1).

exhibit 1
The Anatomy of a Hybrid CDO Structure



Source: Morgan Stanley

WHAT'S THE RATIONALE FOR THIS TRADE?

At the 10,000 foot level, the benefits of including secondary CDO paper in primary CDO transactions are fairly obvious. First, subordinate CDO tranches tend to be "cheap for the rating" because ratings are generally based on default risk, ignoring both the positive and negative mark-to-market implications of the leverage and convexity. Second, CDO tranches have less idiosyncratic risk than any single-name investment, given a lack of first loss exposure. In addition, the advocates will claim that even stressing historical default rates will still result in most structures avoiding losses. Third, CDO tranches can be a good means of diversifying into other types of collateral.

There is a lot of merit to the above argument if default risk (and associated ratings migration) is the only concern an investor has. Yet the leverage and convexity that is inherent in CDO tranches makes CDO squared (or hybrid) structures potentially more volatile than plain vanilla structures. Furthermore, what is missing from this argument is a dose of reality. There are many investors who do care about mark-to-market implications. Reduced idiosyncratic risk, while true in theory, becomes diluted when the various secondary CDO tranches reference portfolios that are "similar" (i.e., that have overlapping credit risk). Finally, we reiterate that secondary CDO tranches are not 100% of the collateral in today's typical transactions, so the relationship (correlation) between these secondary tranches and other credit risk is important.

SQUARES OR CUBES – HOW MANY SIDES TO THIS PUZZLE?

When analyzing CDO structures that include secondary CDO paper, there are three dimensions that warrant close attention, in our view. The first dimension is the accounting regime of the investor. As we mentioned above, the leverage and convexity of the tranches can lead to more volatile mark-to-market valuations, and investors should be comfortable with their exposure (if any) to these market swings. The second dimension is the seniority of the secondary CDO tranches included in the collateral, while the third dimension is the seniority of the CDO squared tranche in question, both of which again can have substantial valuation implications.

exhibit 2

The CDO Squared Puzzle – Senior or Mezzanine Exposure to Senior or Mezzanine Collateral?

CDO Squared Structure	Collateral: Senior	Collateral: Mezzanine
Senior	•Little idiosyncratic risk •Very little default risk •Ratings stability •Negative convexity (m-gamma) •Impact of overlapping credits is small	In between the two extremes
Mezzanine	In between the two extremes	•Leverage and yield •Lots of idiosyncratic risk (i-gamma) •Convexity is positive (m-gamma) •Overlapping credits can be disastrous

Source: Morgan Stanley

We highlight some benefits and risks in the second and third dimensions, from the perspective of an investor going long the tranches, in Exhibit 2. Of the four possible “squares” in the diagram, the two extremes are senior exposure to a portfolio of senior tranches (where idiosyncratic and ultimate default risk are low but convexity is negative) and mezzanine exposure to a portfolio of mezzanine tranches (where leverage and idiosyncratic risk are high, but yield and positive convexity are the benefits). As for the other squares, the benefits and risks get mixed a bit. For example, mezzanine exposure to a portfolio of senior tranches still has low idiosyncratic risk but is more levered and higher yielding than senior exposure to the same portfolio. The risk of overlapping reference credits is largest when mezzanine tranches are included in the collateral pool.

QUANTIFYING THE MTM IMPACT

The above “square” illustrates some of the pros and cons of CDO squared structures, but we have yet to shed any light on the first dimension: mark-to-market implications. Doing so requires making many assumptions, but here is one way to build up a framework.

Consider the following worst-case scenario: a CDO squared structure where all of the underlying CDO tranches are identical, meaning they have the same attachment and detachment points and reference identical underlying portfolios (say Dow Jones TRAC-X NA II). Such a structure is an unrealistic trade, but it gives us the basis for analyzing some of the risks.

As an example, if the Dow Jones TRAC-X portfolio moves 25 bp wider, a 7-10% tranche on this portfolio would widen 116 bp (based on the model) and a 10-15% tranche would widen 61 bp (see Exhibit 3). Now a 7-10% CDO squared tranche referencing a portfolio of identical 7-10% Dow Jones TRAC-X tranches would widen 906 bp, which we consider a worst-case scenario, owing to no diversification. But more realistically, if the CDO had 10% exposure to 7-10% tranches on TRAC-X-like portfolios, then it would widen by less than 91 bp, depending on the number of credits in the portfolio and the exact structure. This assumes that the remaining collateral portfolio is unchanged. The benefits of seniority are clear if we consider the same situation with 10-15%-type underlying tranches. The moves in the CDO tranches would be at most (but likely less for diversified structures) 35 bp and 18 bp, respectively, for 7-10% and 10-15% exposure to 10-15% tranches.

exhibit 3 25 bp Move Wider in Dow Jones TRAC-X NA II Results in…

	100% Exposure (No Diversification)		Upper Bound on 10% Exposure (More Typical)	
	7-10%	**10-15%**	**7-10%**	**10-15%**
Underlying Tranches (bp)	116	61		
CDO Squared Tranches				
7-10% (bp)	906	350	91	35
10-15% (bp)	496	182	50	18

Source: Morgan Stanley

OUR VIEW, IN A NUTSHELL

CDO squared structures are complicated business, but we have some concluding thoughts for investors who are considering getting long tranches in the large market of hybrid CDOs structures. For investors who are less sensitive to mark-to-market issues, such structures can offer a significant amount of protection from both idiosyncratic and market-wide defaults (depending on the nature of exposure). For investors who are sensitive to mark-to-market issues, it is important to get comfortable with the potential spread moves that we described (on the right hand side of Exhibit 3). In either case, we encourage market participants to form a view on what type of exposure and default protection make sense for the investment. Finally, be careful of overlapping credit risk in the secondary CDO tranches; this is the land mine that may be hard to spot.

chapter 12

Tailoring Baskets – One Size Doesn't Fit All

April 16, 2004

Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar

While default swap indices have introduced a good deal of uniformity for the market's liquid structured credit vehicles, the subtle differences both within and between on-the-run and off-the-run opportunities can have important investment implications. One example is in the correlation space, where tranches can have different or even opposite reactions to changes in the number of credits in the underlying baskets.

In the early days of the synthetic CDO market, there was a lot of experimentation with basket sizes, with deals ranging from 50 to over 250 credits. In today's markets, much of the liquidity is centered around 100-name-like portfolios, but customization allows investors to still do what they please. In the cash CDO world, leveraged loan CLOs typically include 50 to 100 credits. Should investors have a preference for larger or smaller portfolios? How much spread should they demand (or give up) to move from a smaller basket to a large one? How sensitive is valuation to different basket sizes?

Intuition tells us that long credit investors in senior tranches should prefer larger portfolios (the "diversity is good" argument), while those in subordinate tranches should prefer smaller portfolios (less credits to worry about). The popular correlation models agree with this logic in general, but may not capture market sentiment precisely. In particular, some of the correlation skew that we observe in the marketplace may be explained by views investors hold regarding the randomness associated with default events. Furthermore, the sensitivity of tranche valuation to basket sizes can change under different spread and correlation regimes.

SOME INTUITION BEHIND BASKET SIZES

Credit investors focus quite a bit on broad measures of the market such as popular corporate bond indices (800+ issuers) and the rating agency default studies that include an even larger number of companies. As such, comparing manageable-sized portfolios to the market involves a fair amount of sampling risk. Using this perspective, senior tranche investors should prefer larger baskets, because the sampling risk (relative to the market) is smaller. Such investors essentially take comfort in knowing their exposure is "similar" to the market when baskets sizes are large. Furthermore, they reduce exposure to "random" defaults, even if these baskets include more questionable credits.

First-loss tranche investors should have the opposite view. They prefer portfolios that will perform better than the broad market, but are very exposed to "random" idiosyncratic events. From their perspective, more credits translate into more headaches, even if the ultimate impact of a single credit event is smaller as the number of credits increases.

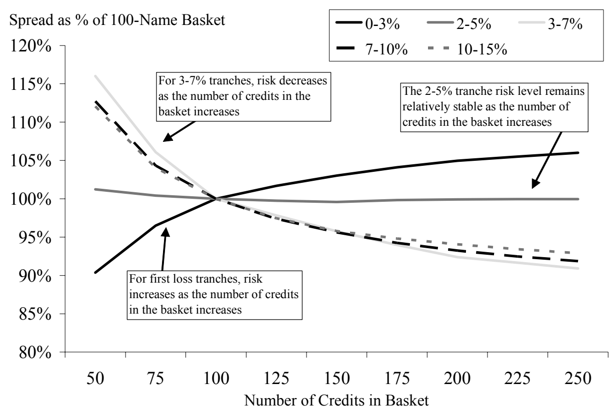
While the market has a lot of performance experience with baskets of varying sizes, the impact of the credit cycle overshadows these observations. For example, one 250-name static basket issued in 2000 (before the worst of the cycle) has experienced 13 credit events while another 250-name managed deal issued in 2002 (near the end of the cycle's worst part) experienced none.

WHAT IS IT WORTH? WHAT DO THE MODELS SAY?

One way to determine the impact basket sizes have on tranches is to see what the models say, since we do believe the models are grounded in some of the same theory we described above.

exhibit 1

Tranche Spread Sensitivity to Basket Sizes



Source: Morgan Stanley

At today's spread and correlation levels (62 bp for Dow Jones TRAC-X), the models tell us that the 0-3% tranche rises in spread by about 10% (174 bp) as a basket grows from 50 to 100 credits (see Exhibits 1 and 2). From 100 to 250 names, the rise in spread is only about 6% (107 bp) total.

exhibit 2

How Much Is It Worth? Tranche Spreads for "Similar" Baskets of Different Sizes

Tranche	50 Names	100 Names	125 Names	250 Names
0-3%	1,625	1,799	1,829	1,906
2-5%	654	647	645	646
3-7%	409	352	345	320
7-10%	132	117	114	108
10-15%	59	53	51	49

Source: Morgan Stanley

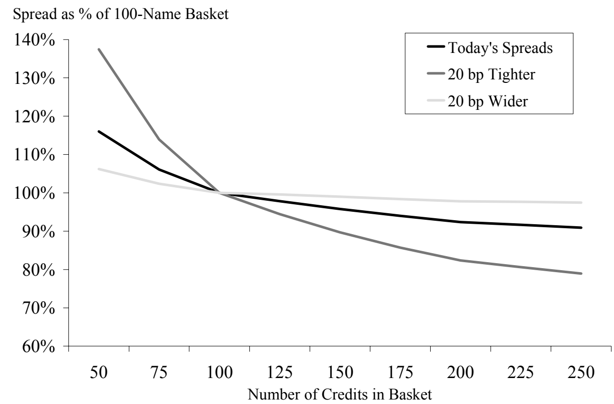
The 2-5% tranche is fairly invariant to basket sizes. The 3-7% tranche is the most sensitive, and has the opposite behavior to the first-loss tranche. Moving from 50 to 100 credits reduces spread by 15% (57 bp), and from 100 to 250 credits is worth about 32 bp. Clearly this junior mezzanine tranche benefits from an increase in the number of credits. The more senior tranches (7-10%, 10-15%) are shaped similarly to the 3-7% tranche, but are a bit less sensitive.

CORRELATION AND SPREAD SENSITIVITY

The above analysis assumes today's levels for both spread and correlation, but valuations are sensitive to changes in these assumptions as well. As a good example, in a wider spread environment, the 3-7% tranche sensitivity to basket sizes would decrease, with the opposite being true in a narrower spread regime (see Exhibit 3).

exhibit 3

3-7% Sensitivity to Basket Sizes Changes Under Different Spread Regimes



Source: Morgan Stanley

WHAT IS IT WORTH? WHAT DO THE MARKETS SAY?

If the markets believed entirely in what the models said, then the implied correlation levels for "similar" risk baskets of different sizes would be identical. Yet, based on some of our observations, implied correlation differences do exist for baskets of varying sizes, although we caution that comparing any two portfolios generally involves differences in credit risk as well.

We saw above that risk in first-loss tranches rises as the number of credits increase, according to the models. Investors, however, seem to demand even more premium. As an example, first-to-default baskets trade at high correlations (40-60%) relative to first-loss tranches of larger baskets (20%), implying that sellers of protection are paid less in first-to-default baskets than larger baskets. One justification for these higher correlations is that there is very little demand for selling second-to-default type protection, forcing dealers to hold this risk (or to hold first-to-default protection). But investors rarely feel sorry for dealers, so we don't give this argument too much weight. Rather, we believe long credit investors are willing to accept higher correlation (lower spreads) on first-to-default baskets because of smaller exposure to "random" defaults than in a 100-name basket.

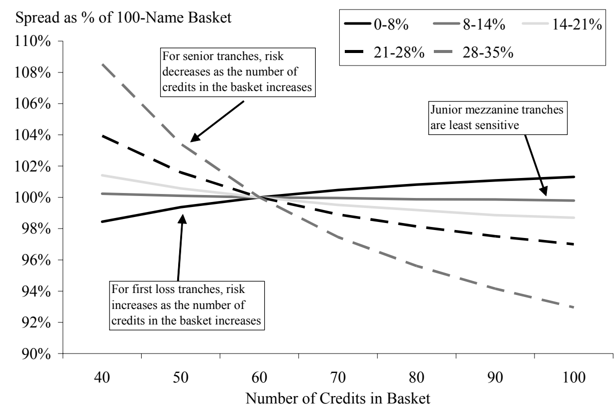
For the more common large basket liquidity points in the market, it may be harder to draw comparisons because portfolio differences can be significant. Yet, we do observe slightly lower implied correlations for first-loss tranches on the larger baskets. A reason for this correlation skew could be a desire by first-loss investors to be compensated for the additional "complexity" of dealing with a larger portfolio.

WHAT ABOUT CLOs?

Leveraged loan-backed CLOs tend to have underlying portfolios ranging from 50 to 100 issuers. The correlation models tell us that the absolute sensitivity to portfolio size is lower across the board (compared to synthetic investment grade). We attribute this lower sensitivity to the nature of leveraged loan credit risk (higher default likelihood, higher recovery given default) and the thicker tranches (again compared to synthetic investment grade). The patterns, though, are similar (see Exhibit 4).

exhibit 4

CLO Tranches – Similar Pattern but Less Sensitive



Source: Morgan Stanley

SOME PRACTICAL IMPLICATIONS

In our model-based analysis above, we took great care in keeping the spread distribution of credits consistent as we moved from small to large baskets. In practice, any two investment opportunities in different sized baskets will also carry differences in credit risk. Even if the average spreads of the portfolios are "comparable," the distributions of those spreads may not be, and can have a larger valuation impact than the basket size. As such, in many situations, basket sizes can be a second-order effect relative to actual credit differences.

For those looking at opportunities involving baskets of different sizes, our advice is to balance the general rules of thumb and the metrics we have described with the actual differences in portfolio credit risk. In particular, credits in the tails of the distribution that do not overlap can be an important driver of relative valuation.

chapter 13 Learning to Live in a Skewed World

April 30, 2004

Sivan Mahadevan
Peter Polanskyj
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In derivatives markets, the term "skew" is a polite way of saying someone (or something) is wrong. Volatility skew exists because options with different expirations and strikes trade at different implied volatilities. Some blame this on the markets not being efficient, while others claim that the models are not sufficient. In our view, there is truth to both statements, given that skew exists in every derivatives market we can think of.

The correlation markets should be no different, since tranches can be thought of as options on a portfolio experiencing losses. Although somewhat smaller than the market experienced late last year, we still see a significant amount of correlation skew in tranches on the benchmark products (see Exhibit 1). There are many drivers of this skew, stemming from both the models and the markets, and even perfect models and reasonably efficient markets will never remove it entirely, because not all investors think alike. In a sense, that's what makes markets.

In this chapter, we attempt to describe at least some of the factors that drive correlation skew today. From a market perspective, there are important technical differences among various investor communities that ultimately drive flows and pricing, and, thus, correlation skew. The models are continuing to evolve, as are ways market participants use them. Both can lead to opinions about model shortcomings, which, in turn, also drives pricing and correlation skew.

WHEN DO MARKETS AND MODELS DISAGREE?

There are many technical reasons why the markets can disagree with the models, causing a skew in correlation. Differences in credit analysis methodologies and performance metrics are key reasons. Not all investors live in the same accounting regime, and ratings are much more important to some than for others. For example, correlation skew between the 7-10% and 10-15% tranches can be explained by flows from ratings-based investors (more demand for the former, leading to higher correlation).

exhibit 1 Living with Correlation Skew – Implied Correlation Across Tranches and Benchmarks

	DJ TRAC-X NA 1	DJ TRAC-X NA 2	DJ CDX NA 2
0-3%	20.0	21.5	19.5
2-5%		33.0	
3-7%	15.0	4.0	3.5
7-10%	20.0	17.0	16.5
10-15%	24.0	23.0	22.0

Source: Morgan Stanley

Another big difference between markets and models is that investors do not necessarily have to agree with the risk-neutral approach (i.e., the risk of a credit is fully described by its spread). The lessons we learned in 2002 tell us that investment grade credit can be very asymmetric in nature, even if the ultimate default risk is low. Spreads do not necessarily reflect this phenomenon. Furthermore, risk-neutral models do not incorporate fundamental aspects of credit risk, unlike structural models like Moody's KMV[1]. Two credits that trade at 50 bp can have very different fundamentals, and can be valued very differently using other types of models.

Other factors can force markets and models to disagree as well, including the presence of "story" credits in portfolios, different maturities, or even the number of credits in a basket.

HOW ARE THE MODELS INSUFFICIENT? LISTEN TO THE "BUZZ"

A year ago, there was a lot of focus on "mainstreaming" the popular models to introduce a standard "language" in the market. We think these efforts were largely successful and introduced a lot of transparency and liquidity to a market that suffered from a lack of both. Yet, from a modeling perspective, more progress is necessary, and there is certainly a lot of "buzz" today regarding these issues. The two most important, in our view, are differences caused by assuming a single correlation instead of a correlation matrix, and the notion that mezzanine tranches can have more than one implied correlation value for the same price. The first issue is simple to explain but hard to calculate, while the second issue is a bit harder to explain, but much easier to calculate.

[1]*For a detailed study, see "Valuing Corporate Credit: Quantitative Approaches vs. Fundamental Analysis," October 2002.*

chapter 13

ONE NUMBER VS. A MATRIX – A REVOLUTION?

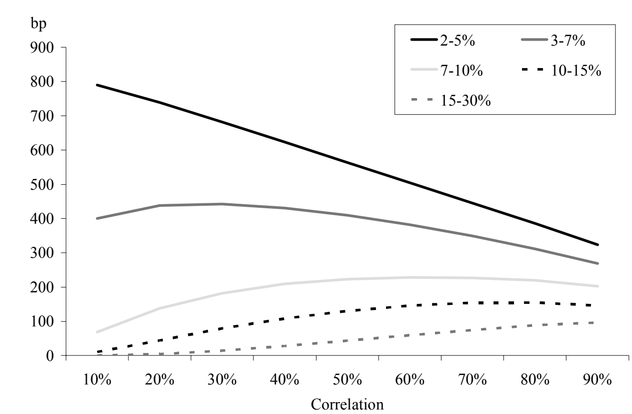
Simple forms of the standard model assume that the correlation (of default events) for various credits can be summarized by one number, when, in theory at least, an entire matrix is necessary. The practical problem is that it is mathematically very hard to imply a correlation matrix from a market price, especially for large underlying portfolios. However, computational short cuts are possible (sparse and/or partially specified matrices), and the market may begin to embrace this concept at some point.

Will the use of correlation matrices in models explain some of the skew we see in today's single-correlation models? Intuitively, it makes sense, but we do not claim to have all the answers yet. The biggest risk of using average correlation as a substitute for a correlation matrix is when the matrix is disperse (i.e., it has values that are very different from the average). This can be bad for long credit investors in equity tranches, albeit more beneficial to senior tranche investors. As an example, consider a "diverse" basket containing credits from multiple sectors, where credits in one sector are highly correlated to each other, but relatively uncorrelated to credits in other sectors. Relative to a basket in which all credits are equally correlated, the disperse matrix can be bad for equity (but good for seniors) because of the existence of a large region of the matrix with lower correlation values.

Using the standard models, equity tranches do trade at lower correlation levels than more senior tranches, so equity's relative attractiveness may simply be making up for the risk of a disperse correlation matrix.

exhibit 2

Correlation Sensitivity Varies with Seniority



Source: Morgan Stanley

Morgan Stanley

TRANCHE EQUIVALENCE: TWO LEGS INSTEAD OF ONE

One of the biggest limitations with the market-standard correlation models is that there is typically one tranche whose spread is insensitive to correlation (the term "correlation invariant" is popular). Such a situation is a correlation trader's nightmare (not to mention risk managers) because the models are not providing useful information. The problem benchmark tranche in today's spread and correlation environment is the 3-7% (see Exhibit 2). In different environments it would be other tranches (e.g., 7-10%, if correlation were higher or spreads wider).

In the press recently, a market participant introduced a solution to this problem, based on a notion borrowed from the equity markets[2]. Buying and selling options on the same stock or index but with different strikes and/or maturities is popularly termed a "call spread." When the implied volatilities on the two options are different, the strategy is quoted using both implied volatility measures. Essentially, the investor forms a relative value opinion on each leg of the trade, rather than on the combined position, which may be hard to evaluate because of its complexity. One can think of a mezzanine tranche in the same way. For example, a long credit position in 3-7% is economically equivalent to a short position in 0-3% and a long position in 0-7%.

WHY THE COMPLICATION? RELATIVE VALUE INFORMATION

Why is this unusually complicated way of describing a 3-7% tranche useful? It is because of the difficulty in implying a "reasonable" correlation level for this tranche. Breaking the tranche down into two legs (0-3% and 0-7%) that are not invariant to correlation is a way of getting around this problem. Effectively, investors can evaluate two meaningful implied correlation values instead of one meaningless value to form relative value opinions. This process can be "bootstrapped" for other mezzanine tranches, as well.

[2] *See Derivatives Week, April 12, 2004.*

chapter 13

exhibit 3 Tranche Equivalence – Long/Short Combinations

	Replicating Portfolio				
Benchmark Tranche	**First Loss Tranche**	**Tranche Position**	**First Loss Imp. Correlation**	**First Loss Delta**	**Implied Benchmark Tranche Delta**
3-7%	0-3%	Short	21.2%	12.2x	8.5x
	0-7%	Long	27.5%	10.1x	
7-10%	0-7%	Short	27.5%	10.1x	3.9x
	0-10%	Long	31.6%	8.3x	
10-15%	0-10%	Short	31.6%	8.3x	1.9x

Source: Morgan Stanley

As an example, a long credit position in 3-7% (Dow Jones TRAC-X) is economically equivalent to 21% correlation on a short credit position in 0-3% and 27% correlation on a long credit 0-7% position (see Exhibit 3). Since both tranches are first loss and, hence, long correlation, the higher correlation on 0-7% tells us that 3-7% is rich relative to the 0-3% tranche (which is at least partially explained above). While we may expect an upward sloping correlation curve, this methodology makes it clear how sloped the curve is for various tranches.

WHAT'S THE RIGHT DELTA?

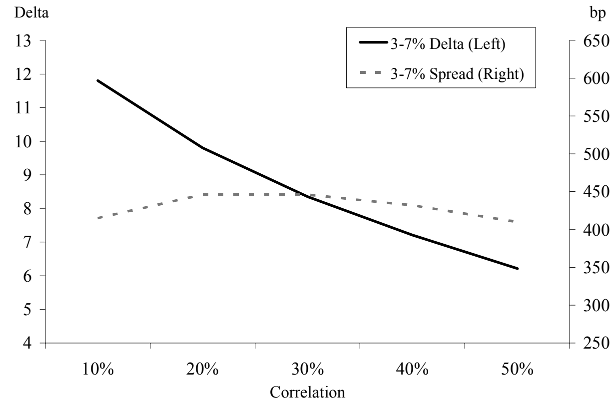
Another important application of this tranche equivalence method is to determine the right delta for a tranche. The delta of the currently correlation-invariant 3-7% tranche is actually very sensitive to correlation (see Exhibit 4). Active market participants concur that a delta of approximately 8 is assumed for this tranche today, which is close to what the tranche equivalence method implies (see Exhibit 5). A correlation level of 4% leads to a delta of 13, implying 36% more protection to be purchased as a hedge – quite a big difference for relative value investors.

WHERE DO WE GO FROM HERE?

Two things are clear to us: Models will continue to evolve, because there is still a lot of wood to chop with respect to understanding the behavior of correlated default risk. Correlation skew will persist, nevertheless, because investors think differently about credit risk and operate under different performance measurement regimes. That's what makes markets.

exhibit 4

3-7% Tranche – The Delta Is Sensitive to Correlation



Source: Morgan Stanley

exhibit 5

Picking the Right Delta

Tranche	Implied Correlation	Delta @ Implied Correlation	Delta Using Tranche Equivalence	Delta Difference	Delta Difference (%)
3-7%	4.0%	13.3x	8.5x	4.8x	36%
7-10%	17.0%	4.6x	3.9x	0.7x	15%
10-15%	23.0%	2.3x	1.9x	0.4x	17%

Source: Morgan Stanley

chapter 14 Correlation – The Delta Dawn

July 23, 2004

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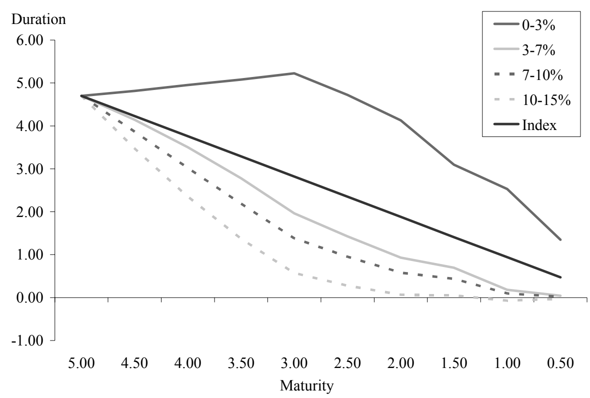
Peter Polanskyj
Anisha Ambardar
Angira Apte

It has been well over a year since the market for index tranches started trading, and in that time the correlation space has become one of the fastest growing areas of investor interest and participation within all of fixed income investing. Today's standardized tranches are an outgrowth of the original CDO market, even though many current investors never participated in this original market. In fact, we find it somewhat alarming that many market participants think of the tranche space as a new market, when in fact the first synthetic CDOs were issued in the late 1990s. If correlation was really a new market, we would be worried, because a good deal of growth has occurred over a short time period and in a relatively benign credit environment. As we have written in past research, we find it very comforting that the synthetic CDO market has been through a credit cycle, although many of today's "new" investors have not benefited from that experience.

The broadening and deepening of the market over the past year, though, is very significant and should certainly not be dismissed by any measure. There has been an explosion in liquidity and an associated boom in volumes, not to mention a whole new generation of investors. Two years ago, there was a limited number of investors using even basic models but today there is a fair amount of investing, trading, and hedging that is tied very closely to the output of correlation models. Further, more than a few investors use even more sophisticated models or approaches.

exhibit 1
Spread Duration Decays Over Time, But Not Uniformly



Source: Morgan Stanley

We are often asked by investors how the standard tranches have performed relative to both the market and models. In derivatives speak, this is equivalent to quantifying the performance of delta-neutral trading strategies. Some investors have expressed frustration that the deltas were in fact not optimal, causing some performance drag (or gain depending on the strategy), despite the relatively quiet spread environment. We are not surprised by these performance outcomes given the importance of the other significant factors and, fortunately, we now have some historical data to highlight this phenomenon.

Our simple performance studies over the past nine months show that delta-neutral positions (selling tranche protection, buying delta-equivalent of index protection) in the four most trafficked tranches resulted in positive performance. Yet, probably more important than the absolute numbers is quantifying the drivers of performance, which we attempt to attribute to the other factors including correlation, spread compression, time decay, and of course carry itself. And since hindsight is the only perfect science, we use some of our historical performance data to demonstrate what the best fit delta would have been.

DRIVERS OF PERFORMANCE

In derivatives markets, investors often implement delta-neutral trading strategies to hedge day-to-day market movements, allowing them to focus on other longer-term goals, such as volatility, convexity, or simply positive carry. Yet, deltas do not always explain all of the price movements, especially when moves are big. In the correlation space, other factors can play a significant role, for a variety of reasons.

- Implied correlation itself is probably the most important performance factor, especially when it moves around a lot, particularly for junior tranches (if this sounds obvious, that's because it is).
- As we have addressed in detail in previous research, the gamma or convexity of tranches can be significant on a relative basis. At today's spread levels, 7-10% and 10-15% tranches have a fair bit of negative convexity for wider moves in spread (for more details see Chapter 10).
- Spread compression (or decompression) can be a driver of performance because it changes the shape of the default distribution (i.e., size of tails). Tranches can be impacted by this in different ways (see Chapters 19 and 21).
- Even though this is a very model-centric phenomenon, the time decay of various tranches can be vastly different, as we highlight in Exhibit 1. In particular, long credit investors in relatively senior tranches benefit from a fall-off in risk more immediately (for more details, see Chapter 20).
- Lastly, picking the right delta is more of an art than a science. Deltas for small moves will be very different than deltas for big moves, and we see market participants using both, depending on what type of risk they are trying to hedge. Furthermore, the correlation invariance problem that the industry has focused on is pushing market participants toward using base correlations, which can result in somewhat different but hopefully more accurate deltas, especially for junior mezzanine tranches (see Chapter 13).

DELTA-NEUTRAL POSITIONS RESULT IN PERFORMANCE DIVERSION

In an attempt to illustrate practical investor behavior, we simulated performance of delta-neutral trading strategies in the standardized tranches using the following fairly simple method. We initially created delta-neutral positions (starting in October 2003) in each of the tranches (i.e., sell protection on the tranche and buy the delta-neutral equivalent protection in the index) and then rebalanced these positions on a monthly basis, updating hedges with the then-appropriate delta (assuming no bid-offer). We used the Dow Jones TRAC-X Series 2 index since it has the longest continuous tranche pricing history.

Despite the rather unexciting spread environment (DJ TRAC-X Series 2 widened from 59 bp to 66 bp during this period), delta-neutral strategies had relatively large performance outcomes, where conventional wisdom would have told us otherwise (see Exhibit 2). Interestingly, selling protection in the tranches versus delta hedging in the underlying index resulted in positive performance for almost all of the tranches, ranging from 10 bp for the 10-15% tranche to 420 bp for 0-3%.

exhibit 2 Delta-Neutral Paid Off

	Level		Delta Neutral P/L[1]		
Tranche	**Oct-03**	**Jul-04**	**Total**	**Carry**	**MTM**
Index	59	66	0.0%	0.0%	0.0%
0-3%	43%	41.30%	4.2%	-5.3%	9.4%
3-7%	380	365	3.3%	-5.5%	8.8%
7-10%	120	125	-0.1%	-2.3%	2.2%
10-15%	52	50	0.1%	-1.1%	1.2%

[1]*Percent of tranche notional.*
Source: Morgan Stanley

ATTRIBUTING PERFORMANCE – THE DELTA DAWN

There are clearly explanations for why delta-neutral trading strategies resulted in performance gains. As we highlighted above, several other factors can determine performance; we conducted a performance attribution study to determine what the most significant factors were over the last nine months. In Exhibit 3 we break down the total return of selling tranche protection (without delta hedging for simplicity purposes) into five components. For example, the 0-3% tranche had a total return of 5.5% during the time period, with positive or negative contributions from the five components. Among the positive contributions were 3.8% from premium (500 bp running for nine months), 3.9% from the correlation move (correlation rose from 18% to 22%, which is beneficial for this tranche), and another 3.0% from the time decay.

The negative contributors were spread widening of the index (-4.5%, which is approximately equivalent to the 7 bp of widening multiplied by the duration and the delta) and another 70 bp from the fact that the index decompressed marginally, which is bad for the 0-3% tranche.

The 3-7% tranche had directionally similar attributed performance relative to the 0-3% tranche, but the spread decompression was actually a marginally positive contributor, while the correlation move accounted for 190 bp. For the 7-10% tranche, premium was the biggest positive factor. The 10-15% tranche had an interesting attributed return profile, as the less-thought-about factors were the biggest contributors. The tranche earned 60 bp from the time decay (one can see the steep curve in Exhibit 1) and 40 bp from the spread decompression, implying that a lot of the index's risk moved into the tail that directly impacts the lowest tranches.

exhibit 3 Tranche Performance Attribution

Tranche	Premium	Correlation	Time	Average Spread	Spread Dispersion	Total
	Tranche Performance Attribution					
Index	0.8%	NA	NA	-0.5%	NA	0.2%
0-3%	3.8%	3.9%	3.0%	-4.5%	-0.7%	5.5%
3-7%	2.9%	1.9%	1.9%	-3.7%	0.5%	3.5%
7-10%	0.9%	0.0%	0.6%	-1.1%	0.3%	0.7%
10-15%	0.4%	0.1%	0.6%	-1.1%	0.4%	0.5%

Source: Morgan Stanley

HINDSIGHT IS THE ONLY PERFECT SCIENCE

If the above attribution analysis presents too many numbers to digest in one sitting, the key take-away is that the deltas on the tranches only explain part of the performance, even during a low-volatility credit environment. Did the models misguide us – were there in fact better deltas that we could have used?

To answer this question we ran a simple historical regression of index price movement to tranche price movement, and found that the "best-fit" deltas that came out of the analysis were quite similar to the "average" model generated deltas used in our simulation (except for 3-7%, see Exhibit 4). The R-squared numbers from the regressions were in the 60-70% range, suggesting that they are reasonably strong, but again highlighting that a meaningful portion of performance cannot be captured by index price changes.

exhibit 4 Historical and Model Deltas Say the Same Thing

Tranche	Regressed Delta	Average Rebalanced Delta
0-3%	11.9	12.0
3-7%	8.7	10.7
7-10%	4.0	4.2
10-15%	1.8	2.0

Source: Morgan Stanley

WHAT ARE WE MISSING?

Significant one-off idiosyncratic risk can be a big driver of performance as well. Spread compression/decompression captures this to some degree, but when there is a real decoupling, then it is all about single-name risk. Although we have not had much of this in the US credit markets over the past year, in previous research we have addressed the impact of the Parmalat default on tranches, which we felt was in line with model predicted behavior (see Chapter 32).

DAWN IN A WORLD WHERE THE SUN NEVER SETS

While correlation markets are big, global, and clearly here to stay, transparency continues to improve and we encourage market participants, seasoned or not, to use the opportunity to gain more investing insight. Absolute performance, good or bad, is not always the most meaningful result. How you got there is important as well.

chapter 15 Tranche Steps – One Back, Two Forward

September 24, 2004

Sivan Mahadevan
Peter Polanskyj
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While the notion that credit portfolio tranches are exposed to correlated default risk is as old as the CDO market itself, investment strategies based on this idea have really only formed over the past year or so, attributed mainly to the liquidity injection from tranche-trading in the benchmark indices. Today the term “correlation trading” is mentioned in many business planning meetings, but the reality is that investment strategies built around the leverage, convexity and liquidity of these instruments are the biggest benefit for most investors. Yet, with the flurry of new instruments across investment grade and high yield markets, this basic message gets a bit lost, in our view.

Why are tranche investment strategies interesting? The most important reason is that they allow investors to separate two important aspects of credit risk: default risk and spread risk. In a pure single-name portfolio, both components are closely linked together. With tranches, which are effectively options on the aggregate credit loss severity of a portfolio, it is possible to separate idiosyncratic default risk from market-wide spread movements. In the current credit environment, we are supportive of taking default risk but are not very excited about the actual level of credit spreads. Delta-neutral long/short trades involving subordinate and senior tranches can implement this view, but the details are essential.

For several reasons, we feel that it is important to take a step back and look over the usefulness of the correlation market today, from a strategic perspective. First, the market continues to grow daily with many new participants ready to manage credit risk in this new fashion. Second, with a fairly complicated menu of instruments trading, investment strategies abound, and these differ between investment grade and high yield. Third, the duration of an investment strategy is as important as the strategy itself, and today there are quite a few choices. Finally, from a relative value perspective, the concept of correlation has now become almost a purely technical term, with market participants focused on base correlation, which has a very different intuitive feel than real default correlation.

OPTIONS ON DEFAULT – 101

The basic idea behind tranching credit portfolios is to control the amount of idiosyncratic default exposure. Tranches that “feel” like they will have losses due to default over the maturity are effectively in-the-money options on default. Similarly, tranches where losses due to default over the term seem unlikely resemble out-of-the-money options. In market-standard correlation models, the factor that determines whether a tranche is in- or out-of-the-money is the level of spreads (along with spread distribution). From a bottom-up perspective, an investor’s actual opinion on defaults for a given portfolio is an important source of relative value, as it may differ from the risk-neutral model’s view.

TRANCHE CHARACTERISTICS

If one thinks of tranches as options on default, then understanding their sensitivity to spread movements (or defaults) becomes much easier. Images of convexity and hockey sticks should come to mind, and we highlight four of these characteristics in Exhibit 1 for today's benchmark instruments. In particular, we focus on tranche sensitivity to small market-wide spread moves (DV01 or delta), large market-wide spread moves (convexity or gamma), time decay (roll down or theta), and individual defaults (idiosyncratic risk). The numbers are tranche sensitivity measures relative to the underlying index.

exhibit 1 Tranche Sensitivity Menu

Index	Tranche	Delta	Time Decay[1]	Downside Convexity[2]	Avg. Default PV[3]
5Y IG	0-3%	14.0x	0.16%	0.5x	34.7x
5Y IG	3-7%	7.6x	0.17%	1.0x	5.6x
5Y IG	7-10%	3.3x	0.19%	1.3x	0.2x
5Y IG	10-15%	1.4x	0.22%	1.6x	0.4x
5Y IG	15-30%	0.5x	0.21%	1.8x	0.0x
10Y IG	0-3%	5.4x	-0.28%	0.4x	29.0x
10Y IG	3-7%	8.3x	0.06%	0.6x	11.3x
10Y IG	7-10%	5.3x	0.22%	0.9x	4.2x
10Y IG	10-15%	3.2x	0.25%	1.1x	1.1x
10Y IG	15-30%	1.3x	0.30%	1.5x	0.1x
HY	0-10%	2.0x	2.96%	0.6x	8.4x
HY	10-15%	2.9x	2.92%	0.8x	4.3x
HY	15-25%	2.7x	0.76%	1.0x	3.2x
HY	25-35%	1.4x	1.21%	1.2x	2.2x
HY	35-100%	0.0x	1.95%	1.7x	0.0x

[1] *1 year, delta adjusted*
[2] *DV100 / (100*DV01), index multiple*
[3] *Index multiple*
Source: Morgan Stanley

For example, from the perspective of a seller of protection, a 7-10% tranche on the 5 year investment grade CDX index has a DV01 or delta of 3.3x relative to the index and is negatively convex in that a 100 bp move in spread results in a price impact that is 1.3 times more convex than that for the index itself. The 7-10% does benefit from roll down/time-decay more so than a delta-neutral amount of the index (0.19% in price terms versus 0% for the index) and has less exposure than the index to the first default (by a factor of 0.2x, assuming the average default impact of the widest and tightest credits).

STRATEGIES FOR TODAY – SLICING AND DICING

In previous research, we have described in detail some of our basic strategies in the correlation space (see Chapters 18 and 20). Today, we summarize our core view on the market as being supportive of taking default risk but not very excited about the level of spreads. We find a handful of tranche strategies attractive today.

Long default risk, neutral to short spreads, positive carry. This strategy can be implemented by selling protection on any tranche with a large exposure to individual defaults (particularly discount priced first-loss tranches), combined with delta-neutral or net DV01 short hedges in the underlying index/portfolio or junior and senior mezzanine tranches. Protection in the mezzanine tranches is advantageous because they have more spread exposure than individual default exposure and will benefit from convexity when spreads widen. Some of the best tranches to use today include five-year investment grade 7-10% or 10-15% or 15-25% of HY CDX. The positive carry on the trade comes from the first-loss tranche's larger idiosyncratic risk relative to protection in the index or more senior tranches. We also recommend selective single-name hedging to either implement negative credit views or mitigate jump-to-default risks.

Long spread convexity. The simplest way to isolate spread convexity is to buy protection in tranches where convexity is relatively high (7-10% and 10-15% in five-year IG indices), and delta hedge with the underlying index. In today's markets, many of these strategies will be positive carry as well, but they may suffer from a time-decay or roll down phenomenon. Also, the long convexity trade does have increased idiosyncratic exposure through the delta hedge.

Playing economic cycles. Credit curves are now fairly steep out to 10 years, relative to when we first addressed the idea of mixing short and long maturities in correlation strategies. Nevertheless, selling protection in first-loss tranches versus buying protection in mezzanine tranches can be implemented with different maturities to express a cyclical view. In general, we favor selling first-loss tranches to shorter dates and buying more senior protection to longer maturities. Strategies that are DV01 neutral today can actually become negative DV01 over time, given the time decay phenomenon.

CORRELATION CAN BE CONFUSING

Since the liquidity infusion in the correlation market over a year ago, perhaps one of the biggest shifts in thinking has been about correlation itself. For pricing and relative value purposes, the Street has moved toward using base correlation instead of compound correlation because the standard models are better-behaved this way (for a full description, see Chapter 13). As we have mentioned in the past, we continue to view correlation from a fairly technical perspective, although the original sensitivity concepts do not change.

Base correlation for a given tranche is the implied correlation for a hypothetical tranche that attaches at 0% (the base) and detaches at the detachment point for the given tranche. For example, the base correlation for the 3-7% tranche is the implied correlation for a 0-7% tranche. However, since 0-7% does not really trade in the market, the price for the 0-7% tranche is computed by "adding" together the prices for 0-3% and 3-7%. In the base correlation framework, all tranches are equity style, meaning that they appreciate in price as correlation rises (i.e., long correlation). This makes relative value a bit simpler, and most focus on the skew (or curve) in correlation between the tranches.

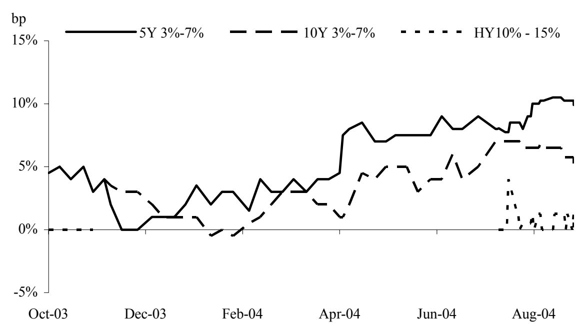
Before we delve into relative value, we would like to make one point very clear. Base correlation is clean and convenient, but it does confuse the true notion of default correlation. Tranches' sensitivity to realized default correlation does not change, i.e., the junior tranches tend to be long correlation (diversity is bad for them) and the senior tranches tend to be short correlation (diversity is good for them); see Chapter 9 for our early thoughts. From a day-to-day relative value perspective, base correlation is the cleanest metric, but in terms of intuition on the risks inherent in tranches, compound correlation remains a valuable tool.

CORRELATION RELATIVE VALUE

To help in relative value analysis, we have applied the base correlation calculations to about one year of benchmark tranche pricing history. One of the easiest ways to use this data is to focus on the shapes of the base correlation curves. The curve for the 3-7% tranche has steepened from near 0% at the end of the year to about 10 correlation points today (0-3% trades at 20% correlation and 3-7% trades at 30%, see Exhibit 2). We consider this a significant move and have discussed the relative richness of junior mezzanine notes recently (see Chapter 25). The 10-year 3-7% tranche followed a similar pattern, but does not appear to be as rich, from a base correlation perspective.

exhibit 2

Richening Mezzanine Notes – Base Correlation Curve for 3-7% Tranche



Source: Morgan Stanley

CONCLUSION

While we have spent a considerable amount of our research efforts over the past two years discussing the intuition behind and sensitivity of correlation instruments, we continue to view this space as novel from a credit portfolio management perspective. Furthermore, our market sense is that quite a few investors are on the verge of getting involved over the near term, as investments in analytical infrastructure come to fruition. Therefore, revisiting some of the basic steps should help to outline long-only and long/short investment strategies.

chapter 16 High Yield – Thinking Outside the Correlation Box

November 19, 2004

Sivan Mahadevan
Peter Polanskyj
Ajit Kumar, CFA

A key reason why we think the high yield structured credit opportunity is an interesting one revolves around the prospect of juxtaposing fundamental and quantitative approaches to valuing high yield credit risk. More so than in the investment grade markets, it is important for high yield structured credit players to think outside of the correlation box, and then to use market pricing and correlation intuition as a way to calibrate their views. We first argued for this approach in a previous report, where we described some of our fundamental views on the 100 names that make up the HY CDX portfolio (see Chapter 23). In a market where underlying cash bonds frequently trade on a dollar price basis, and investors often think about default and recovery risk separately, the opportunity to compare fundamental views with the results of risk-neutral models is compelling.

One way to better understand this phenomenon is to observe the apparent pricing "discrepancies" between investment grade and high yield equity tranches. While the tranches are far from being equivalent from a price or expected loss perspective, they trade at very different implied correlation levels in the market (19% for 0-3% investment grade tranche versus a much higher 39% for 0-10% high yield tranche). Furthermore, the correlation skew among all of the standard investment grade tranches is much steeper than in high yield.

From a protection seller's perspective, the lower base correlation on an equity tranche implies that the risk is cheaper while a lower skew implies the same for more senior tranches. Yet, in the still burgeoning market for synthetic high yield, it is hard to imagine that equity tranches can really be that rich relative to investment grade so quickly. Is there a better explanation? We do not claim to have all of the answers, but we do offer up several simple and fundamental explanations for why correlation levels are indeed much higher in high yield vs. investment grade tranches, in our view.

1. **Statistics favor high yield.** At 325 bp on HY CDX, the market implies a fair number of defaults (approximately 15% losses) over five years. There are clearly many bullish scenarios where the market (or a specific portfolio) could experience much fewer defaults, especially given high yield fundamentals. The existence of these scenarios favors high yield equity tranche investors, relative to investment grade. Furthermore, given liquidity, high yield equity tranche investors could feel more comfortable about getting out of their risk, especially compared to the much less liquid cash CDO world.

2. **Recovery outcomes may favor high yield, ironically.** In a market where investors differentiate default risk and recovery values, there is an argument that recovery values for HY CDX names could be higher than typical assumptions or market averages, given sector biases. Also, since it takes more defaults to cause pain in equity tranches, the likelihood is small that all of these defaults experience low recoveries. Furthermore, historical data show that when default rates are low, recoveries tend to be high, and vice versa. This makes equity tranches much more extreme plays on default risk than correlation models suggest.

3. **Defaults are more correlated in high yield.** High yield defaults have historically been more concentrated (in sectors) than investment grade, which is an argument for higher default correlation for equity tranches.

4. **Standardized terms favor high yield equity tranches.** Finally, given mechanics of equity tranches, the best and worst case scenarios for HY equity tranches are more positively skewed than for investment grade equity tranches.

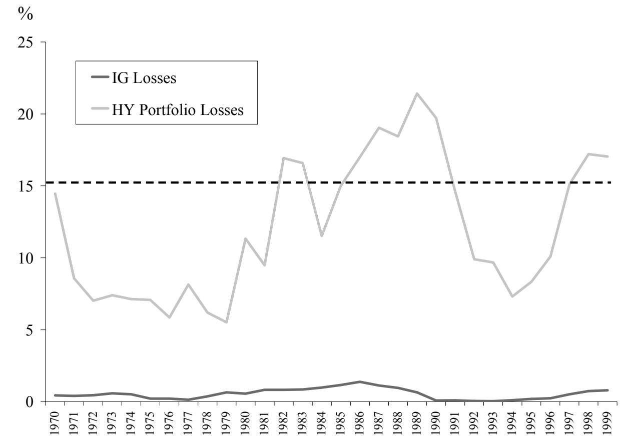
There is clearly a short story, if not a whole book, behind each of these themes, but we will attempt to shed a bit of light on them in a much more abbreviated form, with the goal of gaining a bit more intuition into high yield correlation.

1. STATISTICS FAVOR HIGH YIELD EQUITY TRANCHES

Our first point above is really about statistics. Exhibit 1 illustrates the inherent volatility in 5 year cumulative default experience for both the high yield (using a HY CDX-like ratings distribution, which is 50% BBs) and investment grade markets over time. The key takeaway is that high yield cumulative defaults are much more volatile over time than investment grade, both in an absolute sense and relative to the attachment points of the typical index tranches. Depending on the time period, a portfolio like HY CDX (in terms of ratings distribution) could generate losses only in the first tranche (0-10%) or could have sufficient losses to penetrate the bottom three tranches. For investment grade, losses generally are contained within the first tranche (0-3%). Additionally, the sampling risks inherent in a 100 or 125 name portfolio (relative to the broader market) should add to this volatility making more extreme results for portfolios possible.

exhibit 1

HY Default Rates Are Volatile – HY CDX-Like Ratings Distribution



Source: Morgan Stanley

At 325 bp on HY CDX, derivative models imply roughly 15% losses over five years, which is at the high end of historical five-year loss rate for a portfolio with similar ratings distribution to the index. Fundamentally, the default risk in the index feels better than this today (given cash on balance sheets, see Chapter 23). If we are headed for a trough in the HY default risk cycle, the statistical argument above favors the high yield equity tranche investor, since it has the most room to run in terms of absolute improvement in default experience.

Even if fundamentals worsen, the liquidity in the tranche market available to high yield equity tranche investors may be a relative advantage to playing the asset class directly and is an option that never existed in the cash CDO world.

2. RECOVERIES MAY BENEFIT HIGH YIELD EQUITY TRANCHES

On a very basic level, equity tranche investors in investment grade are exposed to more “random” event risk than high yield equity investors. This randomness comes both in the form of default events and uncertainty of recovery. Consider the maximum potential impact of varying recovery from 0% to 40% for a single default on the equity tranches. For the 0-3% tranche of a 125 name portfolio the impact of a single default ranges from 20% to 27% of notional while for the 0-10% tranche of a 100 name high yield portfolio this same percentage ranges from 6% to 10%. Additionally, the increased default risk in high yield relative to investment grade actually serves to further dampen the effect of any single recovery outcome on a high yield portfolio as it will be a smaller portion of the total expected losses. For investment grade, a single default event contributes more to the aggregate losses of the portfolio and hence individual recovery differences matter more.

Another relevant point about recoveries is that, based on historical data, low default rate environments tend to result in high recoveries on average, while high default rate environments tend to result in low recoveries. The economic argument for this is that asset values go down when lots of asset "supply" hits the market. This is particularly relevant in high yield where high default correlation in a particular sector (which we discuss below) could also drive lower recovery in that same sector. To the extent default experience is driven by company specific events rather than sector economics this is more beneficial for high yield.

3. DEFAULTS MAY BE MORE CORRELATED IN HIGH YIELD

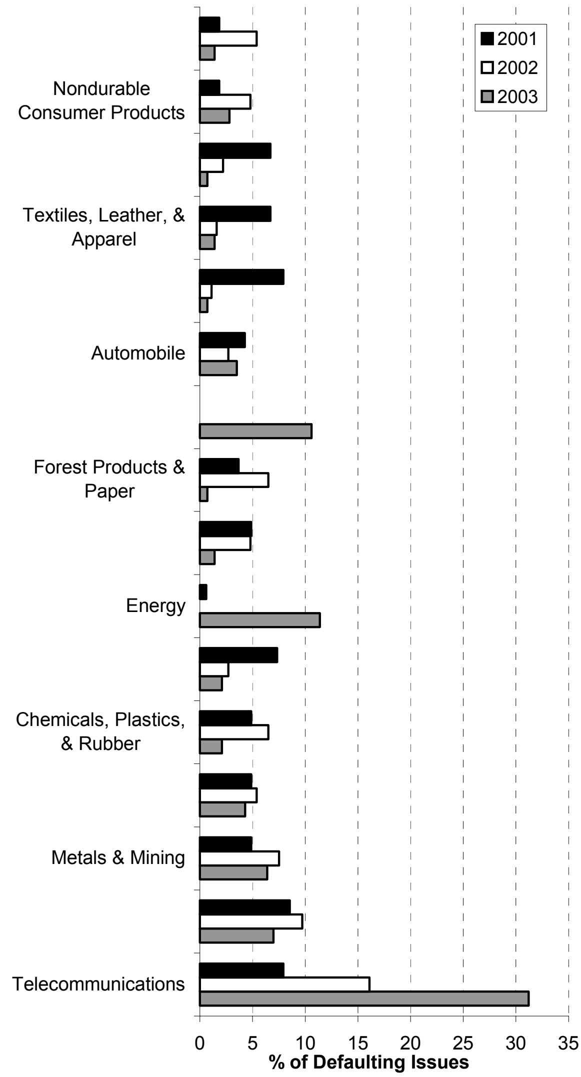
After discussing the notion of default correlation in a technical sense for so long, we finally get an opportunity to address it in a truly intuitive manner, thanks to the high yield opportunity. In investment grade, it is hard to argue that a given portfolio has high or low default correlation, because the credits themselves are so far from default, and historical experience suggests that investment grade defaults are not well correlated to sectors, which are big drivers of index/portfolio design.

In high yield, we have seen many sectors over time experience much higher defaults than the larger market, including Telecom during the last credit cycle (see Exhibit 2). In addition to the increased sector correlations in high yield, a structural argument can be made for higher correlation. If we consider that, generally speaking, high yield companies are closer to the default barrier than their investment grade brethren. And, if we are willing to accept the fact that macroeconomic factors affect asset values in both markets then the relative effect should be greater in high yield. This argues for higher absolute correlations in high yield.

chapter 16

exhibit 2

Defaults Have Sector Themes – Default Correlation Is Higher



Source: Morgan Stanley, Moody's

4. THE ASYMMETRY OF STANDARDIZED TERMS

The standard terms for equity tranches makes it very easy to determine the protection seller's best and worst case scenarios (see Exhibit 3, which is based on cash flows after protection is sold). For example, in the 0-10% HY tranche, where investors receive 75 points upfront for selling protection, the maximum downside is 25% of notional, while the maximum upside (zero defaults) would be 75% (seller of protection keeps the entire up front payment). For the 0-3% IG tranche, it is a similar example (investors receives 34 points up front), but since there is 500 bp of running premium the maximum upside is roughly 51% of notional while the downside is 66%.

exhibit 3 Max Upside/Downside Comparisons of Equity Tranches

	Max Upside	Max Downside	Upside/Downside Ratio
IG 5Y 0-3%	51%	66%	0.8x
IG 10Y 0-3%	74%	46%	1.6x
HY 5Y 0-10%	75%	25%	3.0x
HY5Y 10-15	39%	61%	0.6x

Source: Morgan Stanley

Both of these examples stand in stark contrast to what is typical for investment grade single-name investors who can face large (though unlikely) downside scenarios and small upside scenarios. Most notable on this front is the 0-10% tranche of HY which, because of large upfront payment, has 3 times the upside in a no default scenario. The leverage inherent in this structure is a product of the standardized terms of the traded instruments and presents an interesting upside/downside opportunity for some investors, even though the tranche is very much an in-the-money option on default based on market-implied (or "expected") losses.

Another effect is the implied subordination in the equity tranches generated by the size of the upfront payments. The seller of protection in the 0-10% tranche is only exposed to losses in excess of 7.5% (12 defaults at 35% recovery) of the index over 5 years (because he/she gets paid approximately 75 points upfront, and 0 bp running). In the case of investment grade the seller of equity protection is exposed to portfolio losses (based on the upfront payment) after just one or two defaults. Interestingly this is approximately the ratio of default rates implied by current investment grade and high yield spread levels.

chapter 17 Structural Evolution – Survival of the Fittest?

March 18, 2005

Sivan Mahadevan
Peter Polanskyj
Ajit Kumar, CFA

Over the past six months or so, there has been an important thematic shift in the structured credit market, in our view. No one will dispute the argument that the standardization and liquidity attributes of index tranches were largely responsible for bringing structured credit into the mainstream. We would argue that the tranche index market is now well established and serves as both the most visible part of the market as well a relatively easy entry point for many investors. In fact, with idiosyncratic events this week in General Motors, Liberty Media, IPG, and Viacom, it is easy to see the impact on leveraged tranches (see Exhibit 1).

exhibit 1 Tranche Transparency is Very Helpful – Impact of Recent Idiosyncratic Events

	Current Level (bp*)	1 Week Chg (bp*)	Delta-Implied Chg (bp*)	Change in Correlation Skew (%)	Richer or Cheaper?
DJ CDX 5 Yr	46.0	3.5			
0-3%	31.5	3.9	2.7	-0.65	Cheaper
3-7%	172.0	17.5	23.5	0.35	Richer
7-10%	58.0	5.5	8.8	-0.2	Cheaper
10-15%	20.4	4.1	3.3	-0.2	Cheaper
15-30%	8.3	1.1	1.4	-0.8	Cheaper

Note: For 0-3% tranche price and price changes are stated in points upfront.
Source: Morgan Stanley

As we addressed in an earlier report, the structured credit market was a largely a bespoke one that certainly needed boosts in liquidity and transparency to make it more viable and mainstream (see Chapter 28). This benchmark liquidity was not only important for visibility purposes, but it also has helped the bespoke market in important ways. The resulting flood of structural innovation today is both interesting and rather complicated. The key question is how useful (or not) the innovation really is, and the answers largely depend on who (in the investment community) is asking. In many ways, the deluge of innovation reflects the diversity of credit investors in the market and their demand for sophistication, which we would argue is the important thematic shift in the market.

In Exhibit 2, we summarize some of the key innovative features that have either become well established recently, or have been just introduced and show (in our view) some promise. We would argue that in many cases, new features are actually a reaction to some type of risk that was exposed previously, such as excessive idiosyncratic risk during the last credit cycle or associated low recoveries. But others are strictly innovative, including things like interest rate hybrids and principal protection techniques borrowed from other markets.

One of the innovations that caught our attention is the use of cross-subordination in CDO-squared structures, and we attempt to provide a bit of insight in this report into how valuable it can be. But for those who are not familiar with this new structural feature, a bit of a history lesson on the evolution of CDO-squared structures is necessary, which we happily provide, since we like telling stories anyway.

exhibit 2 Key Innovations, or Those That Show Promise

Key Innovation	**Our Thoughts**
Hybrid CDO Squared (w/ABS)	Reaction to the over-levered CDO-squareds of several years ago. The large ABS portion serves to delever the structure
Pure CDO-Squared w/Thicker Tranches	Similar idea to yesterday's CDO-squareds, but thicker tranches serve to delever the structure
Large Collateral Pools w/Less Overlap	Investors have recognized the importance of overlap in CDO-squareds, particularly for subordinate tranches in the outer CDO. Lower levels of overlap are now common
Fixed Recoveries	A reaction to the low recoveries from fallen angel defaults in 2001-2002. Fixed recoveries reduce uncertainty, particularly in mezzanine tranches, but they are a double-edged sword as IG recoveries can be high as well
Dynamic Principal Protection (CPPI)	Application of an age-old technique to credit for investors seeking principal protection. Long/short tranche strategies or hedge fund investments seems to be the natural application
Cross-Subordination	An interesting concept that allows subordination within inner tranches of CDO-squareds to be shared
Interest Rate Hybrids	A natural progression as funded credit investors demand differing exposure to interest rate risk, beyond strict fixed or floating rate instruments
Adjustable Subordination (or Adjustable Coupon)	A viable technique for meeting investor demand for managed structures while allowing deal arrangers to hedge risks

Source: Morgan Stanley

CDO-SQUAREDS – A BRIEF HISTORY LESSON

Synthetic CDO-squared transactions have become popular in the market for a variety of reasons, and can play some interesting strategic roles in credit portfolios (for some of our earlier thoughts, see Chapters 11 and 35 and "The Far Side of a CDO-Squared," June 10, 2004). From the perspective of innovation in the marketplace, they deserve special attention because of their relative size and the story behind them.

Early CDO-squared transactions were quite different from today's state-of-the art technology, demonstrating the learning process that market participants went through. The first deals were issued in 1999 and were generally managed cash flow structures comprised of a large number (80 or so) of already managed junior and senior mezzanine tranches of high yield CBOs, and to some degree CLOs. In retrospect, they were quite levered transactions with a fair amount of concentrated (overlapping) single-name exposure. Most performed poorly when the credit cycle turned and taught investors some important lessons.

Today's CDO-squared structures are different along several dimensions. First, they are generally static synthetic structures. Second, the inner CDOs generally do not comprise 100% of the portfolio; there is often a significant portion of 'funding' in the structure, usually through the form of AAA-rated ABS collateral, which serves to delever the structure. As a result, 'first loss' tranches in the outer CDO generally carry investment grade ratings. Third, the inner CDOs tend to be senior mezzanine or junior senior tranches of investment grade portfolios. Finally, the transactions are relatively transparent, meaning that investors have complete information on credit exposure and credit overlap (which may not have been the case in the past). It should be noted that CDO-squared transactions where the inner CDOs make up 100% of the collateral do still exist, but typically they include relatively thick tranches (e.g., 10% for investment grade portfolios). Also, in the cash CDO markets, we recently noticed the pricing of CDO comprised of leveraged loan CLO tranches crossing the tape.

WHAT'S THE MOTIVATION? SYSTEMIC VS. IDIOSYNCRATIC RISK

Most investors who are attracted to CDO-squared structures are not looking to take on idiosyncratic risk, as there are better ways of doing that. Yet early transactions had plenty of idiosyncratic risk because inner CDO attachment points were low (on HY portfolios) and overlap was relatively high. Today's structures reflect a flight from idiosyncratic exposure, but leverage is still an important part of the trade. While even the first-loss tranches of CDO-squareds are far from default, they are levered plays on systemic risk. Investors are effectively selling credit convexity, much like those who sell deep out-of-the-money options.

STILL MORE EVOLUTION – CROSS-SUBORDINATION

Today's highly engineered CDO-squared transactions are still evolving, as investor demand continues to get more sophisticated. The overlapping credit issue is transparent now, and we would argue that investors spend quite a bit of time focused on it. The other issue that has come up is the opposite of too much overlap, or too little overlap. In structures where there is not much overlap, the inner CDO tranches are somewhat independent of each other. As such, a natural scenario to consider is one where defaults are concentrated in a single inner tranche, to a point where it then triggers a loss in the outer CDO. The subordination in the other inner CDOs is effectively wasted in this scenario, so investors have wondered if this subordination can be moved over to the inner tranche that needs it. The technique is called cross subordination and implies that subordination of inner tranches can be shared and therefore must be fully exhausted before the outer CDO experiences a loss.

On the surface, cross-subordination sounds intuitively appealing, almost like there is nothing to lose by having it. But the real question centers on how valuable it is. The answer is that it depends on how much overlap there is in the portfolio, and the correlation regime we live in.

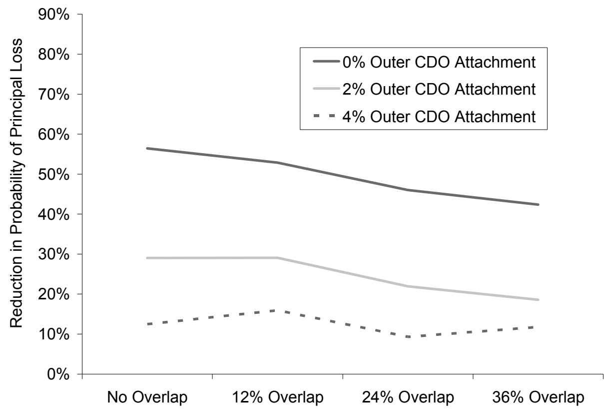
CROSS-SUBORDINATION – WHAT IS IT WORTH?

To get a sense for the value of cross-subordination we conducted a simple simulation (similar to market-standard correlation models) based on a hypothetical CDO-squared structure for which the inner CDO tranches were comprised of six 4-6% tranches of portfolios with spread distributions similar to the current Dow Jones CDX portfolio (average premium of 47 bp). These inner CDOs make up 12% of the notional amount for the outer CDO structure, with high-quality ABS assumed to make up the balance of the portfolio. We examine the impact of adding cross-subordination to the structure by measuring the probability of a principal loss on the first loss tranche of the CDO squared, assuming two default correlation scenarios (5% and 20%).

We compare the probabilities of a principal loss for structures with and without cross-subordination to arrive at an implied reduction in default probability derived from the cross-subordination. Exhibit 3 illustrates the results of the study for several different levels of overlap in the underlying six portfolios, where the overlap percentage is defined as the percentage pair-wise overlap between any two of the inner CDO portfolios.

exhibit 3

Cross Subordination Remains Valuable as Overlap Rises (20% Correlation)



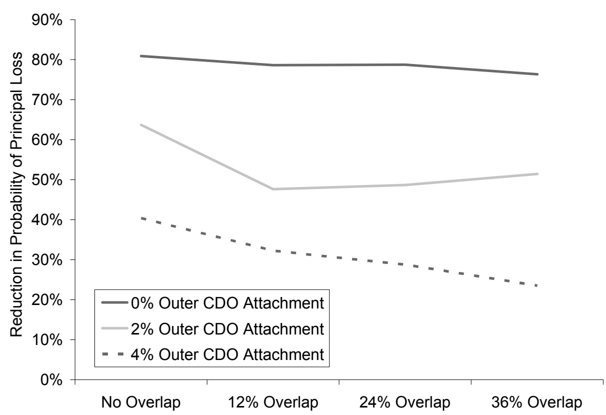
Source: Morgan Stanley

The results suggest that for first-loss CDO-squared tranches, there is significant value in cross-subordination structures with probabilities of principal loss reduced by 42% to 56% for the first loss tranche, depending on the amount of overlap (assuming 20% correlation, which we believe is a reasonable assumption). While overlap in the inner CDO portfolios slightly reduces the impact of the cross-subordination, the benefit is quite robust even for fairly extreme overlap scenarios. The value of the cross-subordination decreases as we go higher in the capital structure of the CDO squared.

In Exhibit 4 we extend the analysis for an underlying portfolio with default correlation of 5% and we find cross-subordination to be even more valuable, with the probability of principal loss reduced by 76% to 81% for the 0% attachment tranche, depending on the level of overlap.

exhibit 4

Cross Subordination is Even More Valuable in Low Correlation Scenarios (5%)



Source: Morgan Stanley

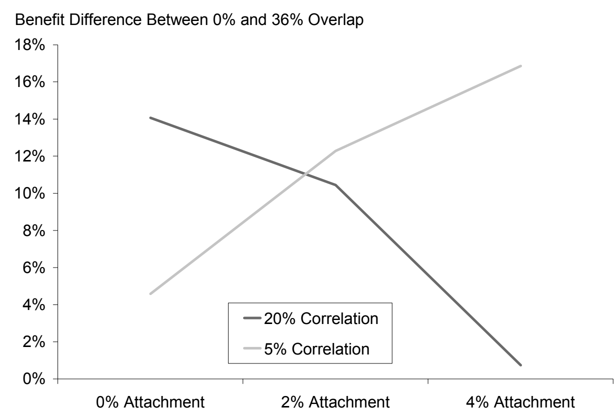
One point worth noting in the two correlation scenarios above is that the impact of overlap differs as we go up the capital structure of the CDO squared. In Exhibit 5, we show the difference in cross-subordination benefit between the no overlap scenario and the 36% overlap scenario under both correlation assumptions. For the 5% correlation scenario, the difference in the benefit of cross-subordination between the 0% and 36% overlap scenarios increases with subordination while for the 20% correlation scenario the difference in the benefit of cross-subordination decreases with subordination. The implication is that the impact of overlap on the value of the cross subordination is affected by the correlation regime we experience or, in plain English, the severity of the next credit cycle.

SURVIVAL OF THE FITTEST

Financial engineering in today's credit markets reflects Darwinian theories, in our view. The market will ultimately be able to distinguish good ideas from bad, and only the former will survive, but it will take some work to get there. We are strong supporters of continuing structural evolution, especially when it results from previous experience, but we advise investors to maintain a discerning approach.

exhibit 5

Cross Subordination Sensitivity to Overlap Differs by Correlation Regime



Source: Morgan Stanley

Section C

Structured Credit Insights

Investment Strategies

Please see additional important disclosures at the end of this report.

chapter 18 The Long and Short of It

August 22, 2003

Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar

We believe the credit market is near an inflection point from which spreads and volatility will move either higher or lower together. Based on that view of the credit world, we think scenarios where spreads slowly continue to grind in or jump out dramatically are both worthy of consideration.

Traditional trading strategies generally allow investors to benefit from one of these outcomes but not both. Investors who go long yieldy paper will benefit in a low volatility/spread regime but will be the ones who suffer most in a world of heightened volatility/spread levels. Ideally, we would like a position that generates positive carry in a low-volatility world while providing short credit spread exposure in a high-volatility world. How can investors get around this fundamental trade-off?

TRANCHING THE TRADE-OFF

CDO investors and other users of tranched credit have long understood the leverage inherent in tranched credit positions. This leverage also creates differing convexity characteristics depending on the level of subordination (see Chapter 10).

With the advent of a traded tranched TRAC-X market, investors have the ability to customize exposure to spreads and convexity. In Exhibit 1, we illustrate two sets of long/short combinations in tranched TRAC-X. Both strategies are structured to have offsetting price changes for very small moves in TRAC-X spreads and both have the same short notional position in the 10-15% tranche. Exhibit 2 illustrates the six-month forward P/L for both strategies, as generated in our fair value model.

The first strategy offers a moderate amount of leverage and convexity. While this strategy offers positive carry, the exposure is directionally equivalent to a short position in widening credit spread scenarios and a long position in tightening scenarios. The net carry of the combined positions is 65 bp.

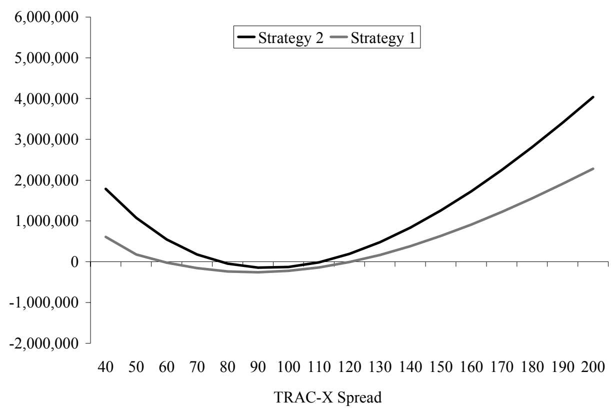
exhibit 1 Summary of Long/Short Tranched TRAC-X Strategies

	Long Position	Short Position
Strategy 1		
Tranche	TRAC-X	10-15%
Notional	100,000,000	50,000,000
Recent Spread (bp)	73	65
Net Carry (bp)*	65	
Strategy 2		
Tranche	0-3%	10-15%
Notional	11,000,000	50,000,000
Recent Spread (bp)	500 Plus 51.5% Upfront	65
Net Carry (bp)*	284	

**As a percentage of the long position notional amount, adjusted to reflect financing of any upfront payments.*
Source: Morgan Stanley

The second strategy offers a higher degree of leverage. This leverage also generates much greater convexity, resulting in a package with a higher overall sensitivity to spread levels, creating the more u-shaped profile. The net carry of the combined positions is 284 bp of the long position notional amount.

exhibit 2 Six-Month Forward P/L



Source: Morgan Stanley

NOT QUITE A FREE LUNCH

From Exhibit 2, one can see that these strategies perform well for most large widening and tightening moves in the underlying TRAC-X spread while resulting in only moderately negative results for minor changes in spread. The carry and spread sensitivity that is created may be attractive, but we have also created an exposure to correlation and modified the nature of the outright default risk.

IMPLIED CORRELATION MATTERS

The valuations in Exhibit 2 are performed using a constant correlation assumption and the value of these positions is clearly sensitive to that assumption. As we have written in the past (see Chapter 9), we view implied correlation as a measure of relative value in the pricing of the tranched credit market, akin to implied volatility in option markets. Therefore, these positions inherently introduce exposure to changes in the prevailing relative value regime in the market for tranched credit.

Simply put, both of these strategies are long correlation. More specifically, both strategies have exposure to declining correlation in the 10-15% tranche, which would imply that the tranche trades at tighter spreads, with all else being equal. The second strategy also has exposure to declining correlation in the 0-3% tranche, which would imply that the position trades at wider spreads, all else being equal.

Exhibits 3 and 4 illustrate the impact on both strategies of a shift in correlation to 15%, as well as 25%, for both tranches. Recent market implied correlations have been approximately 18% and 20% for the 0-3% and the 10-15% tranche, respectively. One can clearly see that the price paid for the levered exposure to spreads is a significant sensitivity to correlation as well.

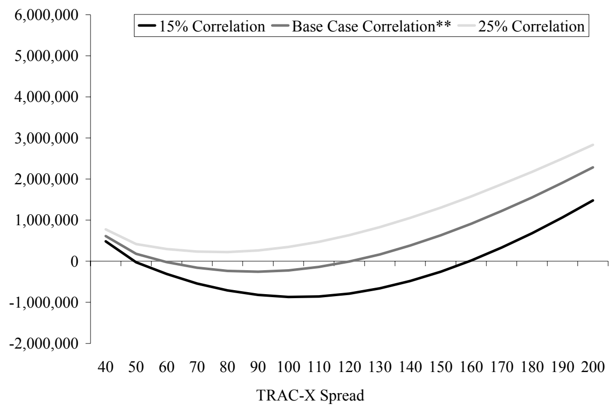
AND DON'T FORGET DEFAULT RISK

These strategies generally benefit from a widening in TRAC-X spreads but in the extreme scenario of default, they will suffer. In both strategies, investors have first loss exposure to the names in the portfolio, while the offsetting short position has a significant level of subordination. This subordination in the short position will result in a net loss for both strategies in the case of a default in one of the underlying credits.

In the first strategy, the nominal default exposure to each name in TRAC-X is approximately $1 million, while in the second strategy, the nominal exposure is approximately $3.7 million. The second strategy has roughly four times the default exposure to each credit, albeit with an identical short position. This increase in nominal default exposure is another aspect of the leverage built into the second strategy.

exhibit 3

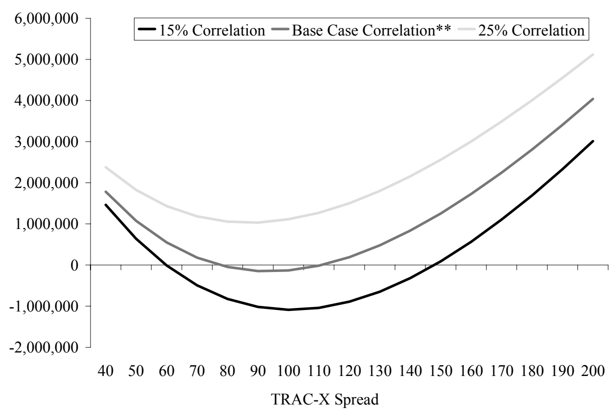
Strategy 1: P/L Sensitivity to Correlation



***Base Case Correlation is 20% for 10-15% tranche.*
Source: Morgan Stanley

exhibit 4

Strategy 2: P/L Sensitivity to Correlation



***Base Case Correlation is 18% for 0-3% and 20% for 10-15% tranche.*
Source: Morgan Stanley

CONCLUSION

While there are risks investors must bear in order to be involved in the market for tranched credit risk, our view is that the ability to customize exposure to spread movements and convexity may well be worth it. However, investors should carefully consider the correlation and default risk they assume with these strategies. We have provided two examples of trading strategies and encourage investors to explore the potential of this market further.

chapter 19 Getting Long Spread Decompression

October 24, 2003

Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar

We have written much about strategies to short the market using tranches, given the interesting convexity and carry opportunities in today's market environment. From an underlying credit perspective, the focus has largely been on relatively simple and standard portfolios (TRAC-X, for example). Yet, if we dig deeper into the investment grade market, we find even more interesting short credit/long convexity opportunities. It is easy to construct well diversified portfolios that are more compressed and thus trade significantly tighter than TRAC-X. We argue that such portfolios are good short positioning opportunities, in the context of a larger investment strategy.

Another factor that we have often glossed over is the inherent performance difference in shorting portfolios versus shorting tranches when markets do not move in tandem, as recent widening in Ford and GM has illustrated. In a straight credit portfolio, the impact of a decompression in spreads is fairly straightforward, and can be summarized by looking at spread averages. In a tranche, a decompression can have a very dramatic impact, given that portfolio losses are not distributed evenly. Our simple message is to hunt for such opportunities and get long the asymmetric performance.

A PORTFOLIO OF THE QUESTIONABLY TIGHT

A 60 handle on TRAC-X indices certainly raises lots of eyebrows and continues to get short sellers excited, but these benchmark indices may be too kind a measure of the relative richness of many credits in the market. There are at least 50 reasonably liquid US investment grade credits with default swap premiums 30 bp or tighter on the offer side.

As an illustrative and simple example, we built a diversified portfolio of 115 US credits, where protection on average is offered with a 40 handle. When comparing the portfolio to the TRAC-X series, we find that it is significantly more compressed (only 10 credits trade wider than 60 bp) and is higher rated with marginally higher diversity (see Exhibit 1). From an investment strategy perspective, the portfolio is both a cheaper short and a better opportunity to position for a decompression in spreads.

exhibit 1 Get Long Spread Decompression, at Cheaper Levels

	Example Portfolio	TRAC-X NA Series 2
No. of Credits (Total)	115	100
No. of Credits (Spread Buckets)		
0-30	25	22
31-60	80	41
61-90	10	18
91+	0	19
Average Spread	40	65
Moody's WARF	232	315
Moody's Div. Score	64	58

Source: Morgan Stanley

We work with this portfolio to illustrate some short credit/long convexity positions. Our main point is that, for credit pickers, this portfolio is one of numerous potential baskets that is well suited for this exercise. Liquidity is the key trade-off in using such customized portfolios for trading strategies versus market benchmarks like TRAC-X. However, for investors with a strong conviction about specific names or portfolios, we believe this is a worthy trade-off.

POSITIONING FOR SPREAD DECOMPRESSION

The average beta for all credits in the market must equal one, by definition. But not all credits have a beta equal to one, which is what makes credit markets interesting. Given the incredible amount of spread compression we have seen over the past year, the market is much more homogenous today. But it won't stay this homogenous forever. Credit- and sector-specific issues, along with general market moves, are catalysts for decompression.

How should one position for spread decompression? In a traditional credit portfolio, the simple trade is to underweight high-beta names, given that their incremental impact on performance is directly related to the size of the position. One can think of this relationship as being linear.

In tranched products, spread decompression is not a linear phenomenon. The widening of a handful of credits can have a dramatic impact on subordinate and/or "thin" tranches. Why is this so? It is the essence of a capital structure, where the distribution of losses is prioritized. As the likelihood of losses in a portfolio grows, the tranches with the greatest direct exposure to these losses will be impacted more. A short credit position in a reasonably subordinate tranche is a long spread decompression trade.

THREE TYPES OF TRANCHES, TWO TYPES OF DECOMPRESSION

Using the portfolio described in Exhibit 1, we focus on the performance characteristics of three tranches over two types of spread widening and decompression scenarios. The first scenario is a general market widening, where spreads widen equally on a percentage basis (i.e., if a 50 bp credit moves 5 bp, a 100 bp credit would move 10 bp). The second scenario is a sector blowup, where a handful of credits widen out dramatically relative to the rest of the market.

We propose three tranche strategies to position for a market widening and spread decompression (see Exhibit 2). The notional amounts are such that the net negative carry (from the purchase of protection) for the three positions is equivalent.

exhibit 2 Tranche Strategies

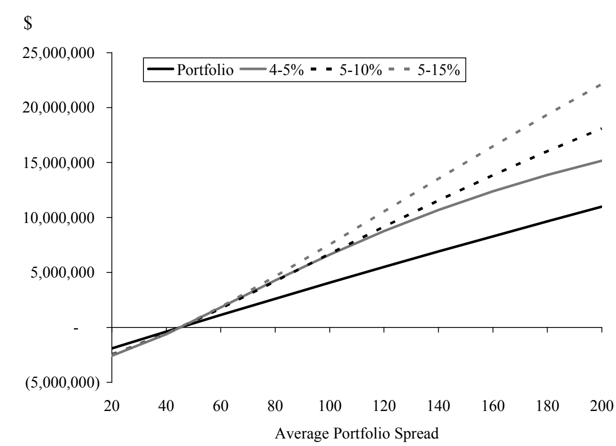
Tranche	Notional (MM)	Premium (Offer Side)	Net Carry (MM) (Notional x Prem)	Correlation
Portfolio	$163.3	45	$(0.75)	N/A
4-5%	$26.0	283	$(0.75)	18%
5-10%	$50.0	147	$(0.75)	30%
5-15%	$76.6	96	$(0.75)	30%

Source: Morgan Stanley

MARKET-WIDE DECOMPRESSION – 5-15% TRANCHE WINS

Under a market-wide spread decompression scenario, all of the short credit tranche positions outperform the underlying portfolio protection, assuming a fixed correlation (see Exhibit 3). The outperformance of tranche protection relative to the portfolio protection can be explained by the inherent leverage in these positions. The 5-15% tranche is the winner, though, when spreads widen in this fashion. This“thickest” tranche outperforms because, in this scenario, default risk is increasing in a uniform manner across the entire portfolio.

exhibit 3 Market-Wide Spread Decompression – “Thicker” Tranche Wins



Source: Morgan Stanley

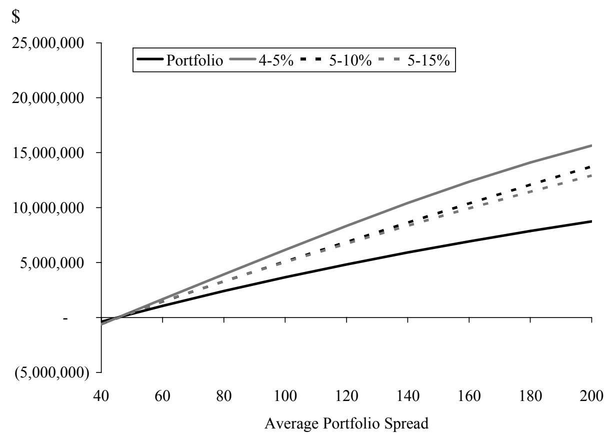
SECTOR-SPECIFIC DECOMPRESSION – 4-5% TRANCHE WINS

We simulate a sector specific blowup in spreads by widening out 15 credits in the 115-name portfolio (the performance is illustrated in Exhibit 4). The 4-5% tranche is the winner in this case, which seems intuitive given the relative “thinness” and lower attachment point of the tranche and resulting increased exposure to the 15 “risky” names.

In the context of a larger investment strategy, we continue to recommend short credit positions in tranches where convexity is attractive. For credit pickers, positioning for spread decompression is an added dimension to consider.

exhibit 4

Sector-Specific Spread Decompression – “Thinner” More Subordinate Tranche Wins



Source: Morgan Stanley

chapter 20 Throwing a Curve at Correlation

November 21, 2003

Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar

Correlation trading was certainly the new, new thing in credit markets during 2003, but as we approach the end of this innovative and historically significant year, credit curves are now getting a lot of the attention. Investors should be excited about the development of a "pure" term structure for credit, and the implication of this development goes beyond the single-name world.

In the context of correlation markets, the development of credit curves influences both valuation and trading strategies. Much of the initial focus in this area was on understanding valuations at an absolute level and then looking at relative value among tranches. Yet these are just two sides of the three-dimensional correlation puzzle. Considering both the shape of credit curves and the rationale of getting long or short to a particular term are critical tasks in managing a structured credit portfolio. We have argued that default rates and credit spreads are very economically cyclical. Credit curves do not fully reflect this behavior, in our view.

For investors who want to be outright long on a levered basis, shorter maturities seem attractive to us, given the typical length of economic expansionary cycles and current market pricing. In more balanced strategies (levered long with short positions), we favor getting short credit through longer-maturity tranches given pricing, the uncertainty associated with cycles turning and the natural spread duration decay in such a position.

exhibit 1 How Long Will It Last? US Expansionary Periods

Economic Cycles	Length of Expansionary Period
1854-2001 (32 Cycles)	3.2 Years
1945-2001 (Post WWII, 6 Cycles)	4.8 Years
Feb 1961 – Dec 1969	8.8 Years
Mar 1991 – Mar 2001	10.0 Years

Source: Morgan Stanley, National Bureau of Economic Research

SPREADS, DEFAULT RATES AND ECONOMIC CYCLES

Any levered long credit position today has an implicit view on the length of this expansionary period, given that default rates are very economically cyclical. The average length of expansionary periods over the past 150 years is 3.2 years, but since World War II the average length increased to 4.8 years (based on NBER data; see Exhibit 1). The expansionary periods in the 1960s and 1990s (which lasted 9 and 10 years, respectively) certainly skew this data. With the end of the last recession officially sanctioned as November 2001, we are now two years into the current expansionary period, so the natural question to ask is, how long will it last? Credit curves can give us some indication, and currently the market is telling us that incremental risk in the 3-5-year area is high (steep curve), but the risk between years 5 and 10 is low (flat curve). How relevant is this to levered investors?

A LEVERED LONG ONLY STRATEGY

In a perfect world, an investor would structure a levered long credit investment to coincide precisely with the expansionary period, and watch it expire before markets start pricing in trouble. But we do not live in a perfect world, and the risk of running over the cycle should not be ignored, as the resulting performance can be catastrophic.

Let's focus on an example. In Exhibit 2 we compare the pricing of three mezzanine positions: 2-5% and 3-7% tranches on the benchmark 5-year TRAC-X II index, and a 2-5% tranche of a hypothetical shorter version of TRAC-X II (3½ years).

exhibit 2 Three- and Five-Year Mezzanine Strategies – How Does the Pricing Compare?

Tranche	Maturity	Premium (Mid)	Implied Correlation	Spread DV01
2-5%	3.5	423	28%	38.1
2-5%	5.3	622	31%	52.2
3-7%	5.3	325	*	43.3

**This tranche is correlation invariant and trades roughly 110 bp rich to model valuation at 28% implied correlation.*
Source: Morgan Stanley

How can we compare the pricing differences between the tranches? Correlation is one component, and we see the 3½-year tranche is slightly cheaper on a correlation basis (28% vs. 31%). As a caveat, a 3½-year version of TRAC-X II is not standard, and therefore does not trade in the market, but tranches from older (original 5-year) synthetic CDOs do trade. Our 28% correlation assumption comes from the pricing we have seen for such tranches.

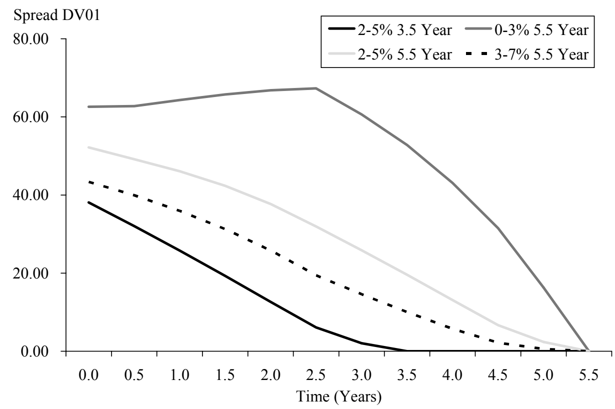
Apart from correlation, we attribute the bulk of the remaining pricing difference among the tranches to the cumulative effect of default risk and the shape of the credit curve, which is steep between 3 and 5 years (about 24 bp). Today, the 2-5% 3 ½-year tranche and the 3-7% 5-year tranche have similar DV01's and similar fair spreads (as valued with a flat correlation term structure). Yet, actual market pricing and forward exposures are quite different. What is the right trade? It depends, in part, on one's view of the economic cycles.

AVOID RUNNING OVER THE CYCLE

Going back to our fear of running over the cycle, suppose spreads start widening and default risk starts rising in three years. Intuitively, we are better off holding the 3½-year paper versus the 5-year investment under this circumstance, if the spread widening and default risk is much worse than implied by the credit curve. Furthermore, unlike bonds, the spread duration behavior of tranches is not necessarily linear over time. In fact, the DV01 of the shorter tranche decays at a faster pace than the longer-dated tranches (see Exhibit 3), which is helpful if the investment runs over the cycle.

exhibit 3

DV01 Decays at Different Speeds



Source: Morgan Stanley

As such, for investors who are looking to set up leveraged long positions (without downside protection), we favor less subordinated shorter-maturity opportunities, given the big differences in residual risk for an early end to the expansionary cycle. An investor's appetite for riskier underlying portfolios should be healthier in this scenario as well.

exhibit 4

Tranched Trading Strategies – Short-Dated Short or Long-Dated Short?

	Long Position	Short Position	Package
Package 1			
Tranche	2-5%	7-10%	
Maturity	3/20/2007	3/20/2009	
Notional	$30MM	$51MM	
DV01	38.1	22.5	0
Spread	423	115	228*
Package 2			
Tranche	2-5%	10-15%	
Maturity	3/20/2007	3/20/2014	
Notional	$30MM	$37MM	
DV01	38.1	31.1	0
Spread	423	115	282*

**Package net spread relative to long position notional amount.*
Source: Morgan Stanley

LONG/SHORT TRANCHE TRADING STRATEGIES

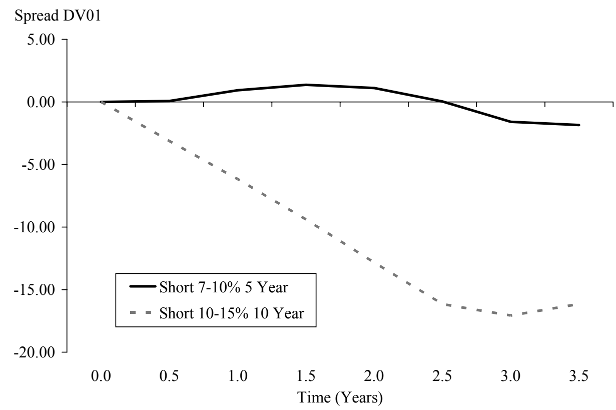
We have discussed in past research the benefits of balancing long credit positions in subordinate tranches with short positions in more senior tranches (see Chapter 18). These trading strategies have traditionally been implemented with similar maturities (usually on a delta-neutral basis). Yet, a short credit position in a longer-dated tranche may be a better hedge against an unexpected shift in economic cycles.

As an example, we take the levered long position described before (2-5%, 3½-year tranche) and delta hedge it by buying 5-year protection on the 7-10% or 10-year protection on the 10-15% tranche of TRAC-X II. Both trades are significantly positive carry (228 bp and 282 bp; see Exhibit 4) and are DV01 neutral at inception.

The two packages have different "residual" risks to spread movements over time, which we find interesting strategically. In the first package, the DV01 initially rises and then falls back to neutral over the 3½-year term. However, in the second package (with the 10-year tranche) the DV01 decays significantly over time. Effectively, this second package is a positive carry and DV01-neutral trade today, but becomes short DV01 over time, as the 3½-year tranche decays much more rapidly than the short 10-year position. Note that buying 10-year protection expresses a steepening view, but we find support for this fundamentally (see Chapter 18).

exhibit 5

Where Do You End Up? DV01 Decay of Long/Short Strategies



Source: Morgan Stanley

ALL ABOUT HEDGING ECONOMIC CYCLES

The rationale for putting on a DV01-neutral trade that decays over time is really all about hedging economic cycles. The largest risks to levered long strategies are defaults and rising spreads. Idiosyncratic or not, defaults are bad at any time during the trade, and the only way to protect against them is subordination (which 2-5% tranches have) and single-name delta hedging, which can be funded by the positive carry. Rising spreads, on the other hand, are only bad when spread duration is high. We have shown both long DV01 strategies that decay rapidly to zero and DV01-neutral strategies that become short DV01 over time.

Our fundamental message: use the developing term structure to position levered long or long/short tranches for the cyclical nature of our markets. Otherwise, unexpected economic cycles could ruin a great batting average.

chapter 21

Less Risk, but Longer Tails for Tranches

March 5, 2004

Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar

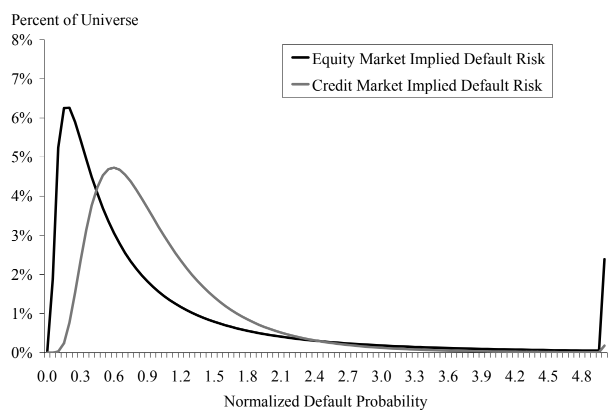
Recently, we argued that equity and credit markets have diverged fairly significantly this year. Implied equity volatility has fallen in a rallying stock market, while CDS premiums are wider. The Merton-type models are forecasting less default risk on average, but the dispersion of this equity-implied default risk is much greater than in the more homogenous world of credit spreads (see Exhibit 1).

If we think about default risk from this point of view, the resulting lower risk and longer tails can have a significant impact on correlation instruments. From the perspective of a seller of protection, lower default risk is a good thing at all levels of the capital structure, but very much so at the lower levels of subordination, given the leverage. While the longer tail negatively impacts subordinate tranches, at some point it actually benefits more senior tranches (because of diversity), depending on the length and thickness of this tail.

The devil, though, is in the details, because the valuation of just a few credits can materially impact the results. With a focus on Dow Jones TRAC-X II (and similar portfolios), we conclude that the risk distribution, combined with technical factors, argues for selling protection starting with 3% to 5% attachment points for 5-year maturities and 7% attachment points for 10-year maturities. In both cases, though, we recommend combining the long credit positions with single-name delta hedges and some market spread widening protection through more senior tranches.

exhibit 1

Equity Indicators – Less Risk, Longer Tails



Source: Morgan Stanley

THE TAILS OF THE DOW JONES TRAC-X PORTFOLIOS

From the perspective of what the credit markets went through in 2002, the long tails forecasted by today's equity indicators are quite benign. Yet these equity-forecasted tails are still much longer than those implied by the more homogenous credit markets. According to the Merton models, the riskiest credits in the Dow Jones TRAC-X II index are Viacom, EDS, Visteon, Sun Microsystems, Sears, Delphi, Toys R Us and Computer Associates, yet only three of these names are significantly wider than the index on a spread basis.

TODAY'S TAIL FAVORING 3% TO 5% ATTACHMENT POINTS

A portfolio with broader risk distribution than we initially expected would be effectively lower in correlation (or higher in diversity). This is good for "senior" tranches and bad for "subordinate" tranches (seller of protection point of view), all else being equal. To quantify the impact, we can think of this either in correlation or spread terms (see Exhibit 2). For example, the 7-10% tranche in Dow Jones TRAC-X II trades at 147 bp mid-market (18% correlation). If we then change the distribution of the spreads to match the equity-implied distribution in Exhibit 1 (keeping the average spread the same), we can get a sense of what the impact of the longer tails would be on valuation. The tranche would price at 105 bp (42 bp tighter, assuming the same correlation). Expressed in correlation terms, this is equivalent to a 6-point reduction to 12%, which is good for the seller of protection because the tranche is a short correlation position.

This behavior is true for all of the 5-year tranches above a 3% attachment point. The 3-7% tranche should price 50 bp tighter, for example. For tranches more subordinate than this, the opposite behavior is true. For example, the longer tail implies a 5-point reduction in correlation for the 0-3%, which is bad for the seller of protection. In spread terms, the tranche should price 149 bp wider to compensate for the longer tail (at current correlation levels). The 2-5% tranche should price 36 bp wider.

exhibit 2 Longer Tails Benefit 3% Attachment Points and Higher – 5-Year Tranched Dow Jones TRAC-X NA II

	Current Market		With Longer Tails (Equity)		Difference	
Tranche	Premium (bp)	Correlation	Premium (bp)	Correlation	Premium (bp)	Correlation
0-3%	1,849	20%	1,998	15%	149	-5%
2-5%	646	40%	682	33%	36	-7%
3-7%	420	5%	370	NA	(50)	**
7-10%	147	18%	105	12%	(42)	-6%
10-15%	63	22%	38	14%	(25)	-8%
15-30%	15	28%	7	20%	(8)	-8%

Note: 0-3% is quoted with points up front.
Source: Morgan Stanley

Intuitively, the impacts make sense, because the longer tail in the equity indicators is based on just a few credits (i.e., the tail is not thick), meaning that 0% to 2% attachment points are the most affected. If the tail were thicker, then the risk would begin to impact tranches with 3% attachment points, or higher.

In 10-year maturities, we find similar dynamics; however, the tipping point is higher in the capital structure. We therefore recommend shifting the minimum attachment higher because of the incremental risk associated with the extended maturity (see Exhibit 3). In particular, 7% attachment points appear attractive to us.

exhibit 3 Longer Tails Benefit 7% Attachment Points and Higher – 10-Year Tranched Dow Jones TRAC-X NA II

	Current Market		With Longer Tails (Equity)		Difference	
Tranche	Premium (bp)	Correlation	Premium (bp)	Correlation	Premium (bp)	Correlation
0-3%	1,946	22%	2,099	19%	153	-3%
2-5%	912	30%	940	28%	28	-2%
3-7%	677	30%	653	34%	(24)	4%
7-10%	383	4%	251		(133)	* *
10-15%	181	17%	112	6%	(69)	-11%
15-30%	61	30%	31	17%	(30)	-13%

Source: Morgan Stanley

LONGER TAILS WITH TIGHTER SPREADS

The longer tails, though, are only half the story if we want to use equity market indicators to make better relative value decisions. Credit risk, on average, is lower when measured by these equity market indicators. In fact, for the Dow Jones TRAC-X II index, the indicators imply that spreads should be 22 bp tighter, given the year-end relationship of the two markets. However unrealistic this may seem, if it actually happened, it would have a substantial effect on many tranches and is obviously net positive for all of the tranches (again, from the perspective of the seller of protection). We show the combined effects of spread tightening and long tails in Exhibit 4, ranging from 12 bp for the 15-30% tranche to 476 bp for the 0-3% tranche.

exhibit 4	Less Risk and Longer Tails — 5-Year Tranched DJ TRAC-X NA II

Tranche	Current Market Premium (bp)	Current Market Correlation	With Longer Tails (Equity) Premium (bp)	With Longer Tails (Equity) Correlation	Difference Premium (bp)	Difference Correlation
0-3%	1,849	20%	1,372	(476)	0-3%	1,849
2-5%	646	40%	425	(221)	2-5%	646
3-7%	420	5%	128	(292)	3-7%	420
7-10%	147	18%	39	(108)	7-10%	147
10-15%	63	22%	14	(49)	10-15%	63
15-30%	15	28%	2	(12)	15-30%	15

Source: Morgan Stanley

MODELS VS. REALITY – WHAT ARE THE TRADES TO DO?

Before we formulate ideas to implement some of the equity/credit divergence, we need to consider technical factors, as well as base-case market views.

- One danger in formulating investment strategies based on the shape of distributions is that these distributions can change rapidly (more sectors or credits become stressed). We argue that investors should keep this "tail length volatility" in mind when weighing the risks of tranched trading strategies. A significantly thickening tail, however, is not our base-case scenario.

- We are comfortable with the notion that default risk is more dispersed than implied by spreads. This distribution, combined with current market pricing, argues for selling protection on tranches with attachment points at 3% to 5% (5-year maturities). We favor this strategy with selected single-name delta hedges (to hedge thickening tails), and out-of-the-money style protection via more senior tranches or spread options (to hedge market-wide spread widening).

- While the combination of tighter spreads and long tails is supportive of selling protection on more senior tranches, a dose of reality tells us to stick to our guns in regard to favoring buying protection, particularly for the 10-15% tranches. The models tell us that the longer tail would force this tranche to trade in the 30 bp range, and the equity-implied spread tightening would move the tranche to trade below 20 bp. We do not believe the market would allow either of these outcomes, particularly because AAA paper from competing assets (ABS and cash CDOs) would become significantly more attractive.

In a nutshell, for portfolios with characteristics similar to Dow Jones TRAC-X II, we recommend attaching long credit positions at 3% to 5% levels (for five years), given current market pricing and our views on the tail risks. We further recommend complementing this long position with selected single-name hedges and out-of-the-money protection (senior tranches or options) to hedge against significant market spread widening.

chapter 22 Streetwise Correlation – Taking the High Road

September 10, 2004

Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar

During the summer of 2003, the investment grade structured credit market experienced a significant secular shift. The market moved from the fairly active, yet disparate, world of synthetic CDOs to an explosion of liquidity in benchmark index tranches. With liquidity came transparency, the correlation buzzword, and a host of new investors (see Chapter 9 for our early thoughts). One year later, many credit investors associate the term "structured credit" directly with "correlation" or CDX tranches, even though the real market is much broader than that.

This summer was not as earth-shattering, but during the quiet that marks the end of the season, a very similar market starting emerging in the high yield space. Coincidently, if we turn the clock back exactly a year, our first weekly report after Labor Day 2003 was on the topic of high yield structured credit (see Chapter 36). At that time, we noted the advances in investment grade, and questioned whether high yield was next, given the maturity of the CDO and CLO markets. A year ago, we had more questions than answers, and more issues than strategic advice.

One year later, we argue that a liquid and mature high yield structured credit market is closer to a reality, for many reasons. First, there has been a fair improvement in liquidity in the underlying high yield single-name derivatives markets, along with a deeper investor base. Second, while it has taken some time, we do have one standard high yield index today. Third, trading of synthetic high yield tranches has become active, taking a cue from the very successful experience in the investment grade markets. Finally, the cash CDO markets are flush with liquidity today, more so even than during the heyday of the late 1990s.

At this point, we could write a book on the importance of a well-developed synthetic structured credit market in high yield, to complement the already mature cash CDO market. As we address this topic over time, we may have enough for a book, but for now, we will focus on three points that seem most relevant to us. First, it is important to understand the characteristics of this nascent market, from pricing to the investor base. Second, the sensitivity of the benchmark high yield tranches to changes in spread and correlation is not necessarily equivalent to the standard investment grade tranches, because the tranches themselves are not necessarily similar. Finally, there is an important link between the new high yield tranches and the much more mature cash CDO market, which can aid in valuation and eventually bridge the gap.

THE NATURE OF THE MARKET – A FIRST GLANCE

Volumes are still thin and bid-offers have not reached the levels of investment grade tranches, but there is a reasonable amount of liquidity in the tranches of high yield CDX today, with more than a handful of dealers making markets. Market participants have picked standard tranches that are similar, in terms of attachment/detachment, to those in the cash CLO and older high yield CBO worlds. However, the 0-10% and 10-15% tranches trade with points up front and 0 bp on a running basis, mainly because a zero coupon reduces the effect of the single-name default swap curve shape, which is in general harder to infer in the high yield market.

exhibit 1 Trading the High Yield Tranches

Tranche	Level	Delta	Base Correlation
High Yield CDX (5 Yr)	**360**		
0-10%	75/78[1]	1.4	41.50
10-15%	46/49[1]	2.9	42.75
15-25%	645/695	3.1	46.25
25-35%	240/275	1.7	56.25
35-100%	35/45	0.3	
Investment Grade CDX (5 Yr)	**56.5**		
0-3%	38.5/39.25[2]	13.3	20.50
3-7%	262/269	7.4	31.00
7-10%	104/108	3.7	35.40
10-15%	37/40	1.6	44.00
15-30%	11/12	0.5	66.50

[1]Quoted with points up front and zero bp running.
[2]Quoted with points up front and 500 bp running.
Source: Morgan Stanley

The implied base correlation curve across tranches is relatively flat (compared to investment grade), which can have some interesting relative value implications. For example, the 15-25% tranche trades just a few (3 to 4) correlation points higher than the equity tranches, but in investment grade, the 3-7% tranche is a full 10 correlation points higher. On a relative basis, this would indicate that selling 15-25% protection in high yield is more attractive than selling 3-7% protection in investment grade, based on the models.

The early flows seem to be tilted toward sellers of protection in the lower tranches (0-10%, 10-15%), with some establishing shorts higher up by buying protection on the 15-25% tranche, which could explain the relative value we mentioned above. From what we see, hedge funds are the early players, although press reports point to participation by CLO managers who are struggling to find collateral in the loan markets.

GETTING A HANDLE ON DEFAULT RISK

With the goal of better understanding pricing and price sensitivity of the high yield tranches, an important first insight is to quantify differences in default risk. From a historical perspective, five-year high yield default rates are on average about seven times that of investment grade (assuming a A/BBB portfolio and Moody's data), although differences could be much smaller or larger during certain points in the credit cycle. Given that expected losses are directly related to spreads in today's standard correlation models, we often look to relative spread levels as another indicator of default risk. Today's spread levels on the indices imply six times the expected loss for the high yield index, compared to investment grade.

LOOKS SIMILAR, FEELS DIFFERENT

Why is comparing the default risk between investment grade and high yield important? For those who are accustomed to trading the investment grade CDX tranches, the standard high yield tranches may look familiar, but they will feel very different, as they were designed to be closely aligned with common tranches in the high yield and leveraged loan CDO market, rather than to mirror the risk of the investment grade tranches.

From a default risk perspective, the 0-3% investment grade tranche is more like a hypothetical 0-18% high yield tranche, given today's spread levels. But we caution that there is a lot more complexity necessary to make a direct comparison with investment grade.

First, the term structure of default risk or spreads is an important factor in tranche valuation (especially junior tranches). While we have a reasonably well developed credit spread curve in investment grade, the same is not true in high yield. Thinking in terms of default rates, investment grade default risk generally increases over time, as we have shown in prior research (see Chapter 18). A similar analysis for high yield would indicate default risk that is concentrated in the early years and can actually decrease with time.

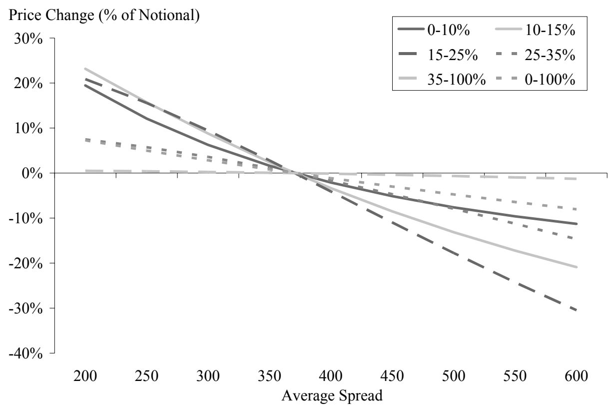
Second, from a statistical perspective, the spreads of the investment grade and high yield indices act as the means of the aggregate default distributions, but the distributions can, in fact, be shaped very differently, given the disparity in the level of individual credit risk. Moreover, the shape of the aggregate default distribution is an important driver in determining pricing on tranches.

HIGH YIELD TRANCHE SENSITIVITY

Beyond comparisons to investment grade, the next important step is to better understand the sensitivity of the high yield tranches to changes in index spreads and correlation. We note that the range of deltas for the quoted high yield tranches is much smaller than for investment grade (see Exhibit 1). Therefore, the price sensitivity of the tranches to changes in average index spread is more clustered (see Exhibit 2). Several other points stand out to us, as well, which we characterize from the seller of protection's perspective.

exhibit 2

High Yield Tranches – Price Sensitivity

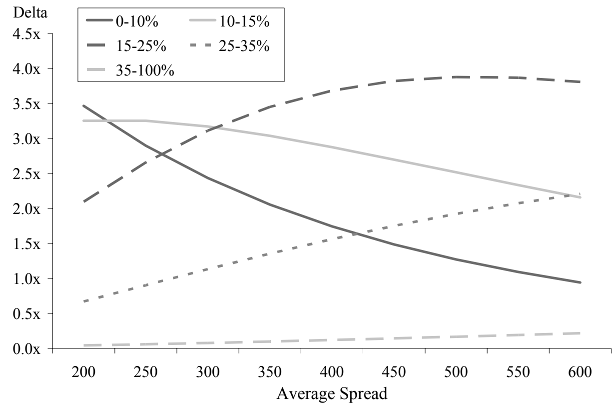


Source: Morgan Stanley

- The 25-35% tranche (and all tranches more junior) are more sensitive to broad spread moves than the index itself, implying that they are levered. The 35-100% tranche has very little price sensitivity, which corresponds to the more conservative AAA-rated attachment points in the CLO market.
- The 15-25% tranche appears to be the most negatively convex, implying that losses for a given spread move wider are more than gains for the same spread move tighter. The 0-10% tranche appears to be the most positively convex, which we would attribute to the low implied dollar price associated with the large upfront premium.

chapter 22

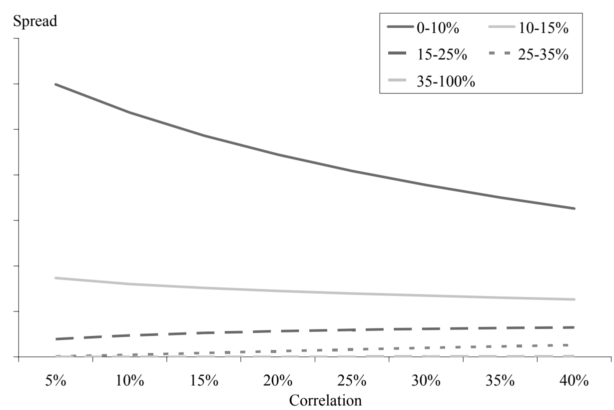
exhibit 3
High Yield Tranches – Delta Sensitivity



Source: Morgan Stanley

- Another way to observe convexity is to simply see the changes in delta (based on 10 bp spread move, see Exhibit 3). At today's spread levels, the 15-25% tranche's delta increases quite a bit for wider moves (i.e., negative convexity or gamma), although it does eventually flatten at the 500 bp range. The 25-35% tranche is also negatively convex, while the 0-10% tranche is positively convex across all spread ranges.
- The 0-10% tranche is a long correlation tranche, as one would expect (i.e., spreads tighten as correlation increases, see Exhibit 4). The inflection point is the 15-25% tranche, which is upward sloping (short correlation). At current spread levels, none of the standard mezzanine tranches are correlation invariant (or non-monotonic).

exhibit 4
High Yield Tranches – Correlation Sensitivity



Source: Morgan Stanley

BRIDGING THE HIGH YIELD GAP

Finally, beyond the look and feel of the new high yield correlation instruments, the emergence of this market is an important secular trend within all of the high yield space, in our view. In our own research, we have been trying to bridge the valuation gap between the structured credit and cash CDO worlds for some time (see Chapters 37 and 38). Correlation and spread data from the high yield tranche market brings the correlation-based valuation of cash CDOs one step closer to a reality, although we caution that there are still material differences between the simple high yield tranches and the more structurally elaborate cash CLO/CBO securities. Cash structures have valuable triggers that are difficult to explicitly price, and the nature of the underlying collateral (maturity, spread distribution and recovery rates) can be significantly different than the more liquid high yield CDX index, particularly for older CDO transactions. Nevertheless, the gap is beginning to narrow, and we expect market participants to push it even further ahead.

chapter 23 A Shot at High Yield Tranches – Bottom-Up

October 1, 2004

Sivan Mahadevan
Brian Arsenault
Peter Polanskyj
Ajit Kumar, CFA
Andrew Sheets

Many market participants approach the correlation space in a top down manner, given the ease in doing so with all of the liquidity in the benchmark instruments. Today, there is quite a bit of focus on trading patterns, long/short tranche ideas, and relative value in correlation skew. In the investment grade markets, this approach is certainly acceptable, given compressed spread levels and healthy corporate balance sheets, although we continue to encourage investors to consider default and spread risk in the companies that make up the tails of the indices.

The structured credit opportunity in high yield, on the other hand, requires a much different approach, in our view. The mistake most made in the original high yield CBO market was to apply average market factors to very specific portfolios. As we passed through the trough of the credit cycle, many painfully discovered how different these portfolios were from the so-called market averages. The peak 10% default rate during 2001 matched the worst period during the previous recession (1991), so it should not have surprised investors, but CBO portfolios were much more high-beta in nature. As such, the collateral in most deals underperformed the "market" by large factors, although the subsequent recovery was stronger as well.

High yield is very much a bottom-up market, and we feel that any structured credit investment strategy within the space needs to follow suit, however tedious that may be. In our first steps of adhering to this philosophy, we find that a large percentage of companies in the 100-name CDX universe are both free cash flow positive and have enough cash on hand to meet debt payments over the medium term. In a nutshell, the portfolio appears like more of a low-beta trade, relative to the broader market (half the portfolio is rated BB). As such, we are constructive on taking levered default risk on the index over the medium term, although we caution that there are credits in the index that concern us, fundamentally.

Additionally, as we have written about recently, long/short strategies in tranches allow investors to separate default risk from spread risk, which is an intriguing concept to apply to the high yield market (see Chapter 15). From an investment strategy perspective, we identify some interesting long/short ideas that allow investors to implement relatively bullish default risk scenarios without taking too much spread risk.

THE BOTTOM UP VIEW – CDX VS. THE MARKET

Despite conventional wisdom, when you invest in HY CDX you are not buying the "market," but are essentially getting exposure to a static pool of 100 names, with a higher quality profile relative to the market. CCC risk is almost equivalent, but the BB basket is 12% greater, mainly at the expense of B rated credits. This resulting decrease in portfolio default risk is significant, at least based on historical data. The 20-year average annual default rate for a mid-BB credit is 0.67%, but an order of magnitude higher 7.65% for a mid-B. Industry sector weightings are fairly consistent with the market.

exhibit 1 HY CDX – Lower Beta, or Higher Quality vs. the Market

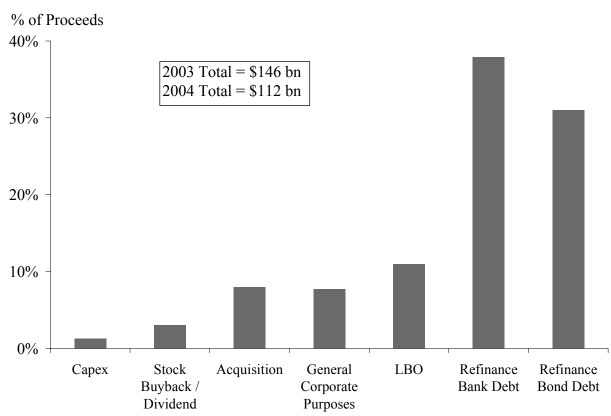
Rating Distribution*	HY Index % Market Weight	HY CDX % Market Weight
BB	39%	51%
B	47%	36%
CCC	14%	13%

**Ratings exclude MCIA, Using S&P ratings*
Source: Morgan Stanley

REFINANCING DEBT – THE TERM OUT STORY

Despite cautious tones regarding our high yield overweight recommendation (see "Bumps in the Road," September 10, 2004), default risk should remain muted for some time. Since 2003, high yield issuers have taken advantage of investor enthusiasm to tap the market for over $250 billion in new issuance. Although the quality has decreased recently, over two-thirds of issuance since the beginning of 2003 has been used to refinance loans and bonds (see Exhibit 2).

exhibit 2 2003-2004 HY Use of Proceeds, YTD



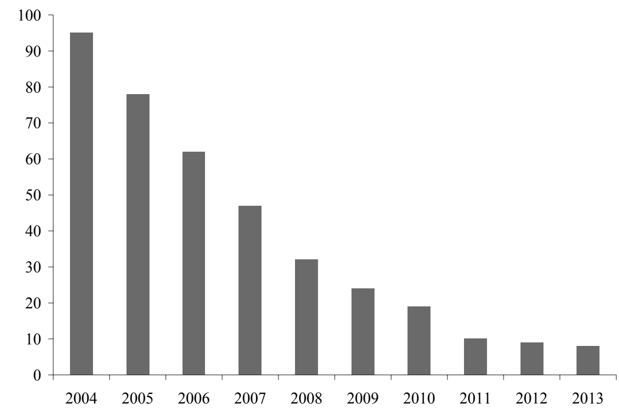
Source: Morgan Stanley

HOW MUCH DEFAULT RISK?

We have mentioned in previous research that high yield issuers are sitting on hoards of cash. In fact, almost 16% of the total debt for the 100 companies in HY CDX is covered entirely by cash today. In fact, since so many companies have pushed amortizations into the future, 62% of the issuers in HY CDX have debt covered by cash on the balance sheet up to the end of 2006. This stands in contrast to the issuance boom of the late 1990's, when proceeds were primarily applied toward capex and expansion. Cash as a percentage of debt for the high yield index stood at 9% in Q1 1999, half of what it is now. In addition, 77% of the names in the HY CDX index are free cash flow positive.

exhibit 3

Healthy Balance Sheets – % of HY CDX Companies with Debt Covered by Cash**



***Debt amounts include straight debt, converts and term loans*
Source: Morgan Stanley

THE TAILS OF THE HY CDX INDEX

Despite the market's strong liquidity profile, at least a few defaults are inevitable, especially within the CCC space, as the historical annual default rate for CCC issuers is in the 25% area. However, to blindly hedge all CCC credits would be a waste of carry, in our view. Issuers such as Huntsman and Crown Castle are in the process of being rewarded for operational improvement. For names such as Calpine, Six Flags, Charter, AMR, and Level 3 (to name a few), their operational challenges are reflected in year-to-date equity returns (see Exhibit 4).

exhibit 4 HY CDX – CCC Issuers

Name	Moodys	S&P	S&P Outlook	Years Covered	YTD Equity Return
Huntsman Intl Llc	Caa1	CCC /*+	POS	1	N/A
El Paso Corporation	Caa1 /*-	CCC+	NEG	2	6%
Calpine Corp	Caa1	CCC+	NEG	3	-37%
Meristar Hospitality Crp	B2	CCC+	NEG	3	-17%
Six Flags Inc	B3	CCC+	NEG	5	-27%
Dynegy Holdings Inc	Caa2	CCC+	NEG	6	8%
Crown Castle Intl Corp	B3 /*+	CCC /*+	POS	3	32%
Chrtr Comm Hlds/Chrt Cap	Ca	CCC-	POS	1	-34%
Levi Strauss & Co	Ca	CCC	DEVELOP	2	7%
American Tower Corp	Caa1	CCC	POS	4	35%
AMR Corp	Caa2	CCC	STABLE	NA	-44%
Triton PCS Inc	B3 /*-	CCC	NEG	7	-53%
Level 3 Communications	Caa2	CC	DEVELOP	4	-54%
Qwest Capital Funding	Caa2	B	DEVELOP	1	-28%
Rite Aid Corp	Caa1	B-	STABLE	2	-43%
Owens-Illinois Inc	Caa1	B	NEG	1	29%

Source: Morgan Stanley

Away from the CCC credits, there are a handful of other names that warrant caution as well. For example, in Exhibit 5 we examine issuers whose amortizations are not covered by cash over the next 2 ½ years and have lagging equity performance YTD. To overstate the obvious, limited liquidity and plummeting market caps are not a recipe for success in high yield investing.

exhibit 5 Early Amortizations and Lagging Equity Performance

Name	Moodys	S&P	S&P Outlook	Years Covered	YTD Equity Return
Dura Operating Corp	B2	B /*-	NEG	1	-44%
Allied Waste North Amer	B2	B+	STABLE	1	-37%
Mediacom Llc/Cap Corp	B2 /*-	B+ /*-	NEG	2	-26%
Navistar International	Ba3	BB-	STABLE	1	-24%
Abitibi-Consolidated Inc	Ba2	BB	NEG	1	-21%
HCA Inc	Ba1	BBB-	STABLE	1	-10%
Collins & Aikman Prodcts	B2	B-	NEG	2	-3%

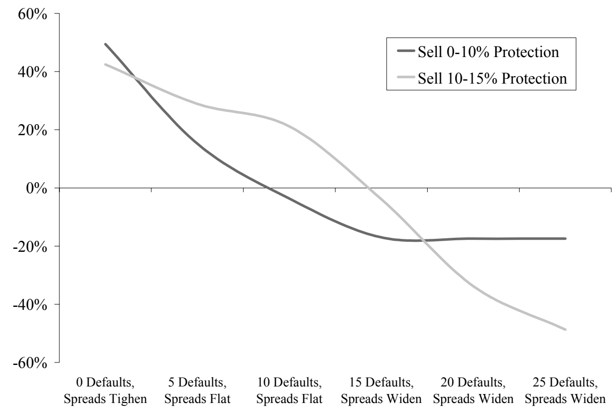
Source: Morgan Stanley

FROM FUNDAMENTALS TO STRATEGIES

One of the biggest sources of opportunities in the high yield structured credit space is that fundamental views like what we described above are not fully reflected in tranche pricing, for several reasons. First, default risk is not the only factor that drives spreads in the high yield market, even though risk-neutral (i.e., correlation) models are built upon this premise. Second, default swap credit curves are still not that well developed today for the full 100 names in the index, so the positive near-term nature of default risk implied by today's fundamentals will not necessarily translate into curve shape and model-based valuations.

exhibit 6

Levered Long Total Returns – 3 Year Holding Period



Source: Morgan Stanley

DEVELOPING LONG/SHORT STRATEGIES

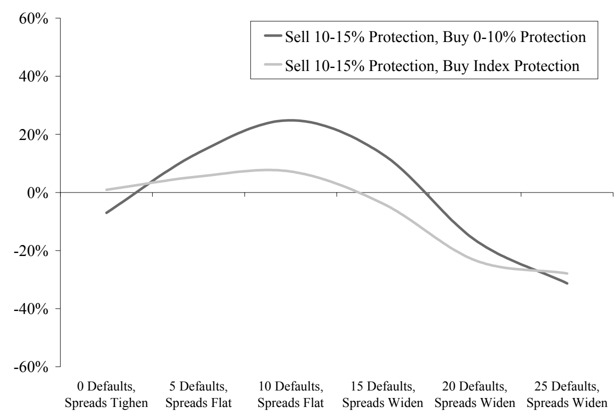
In developing long/short investment strategies using the benchmark tranches, the first step is understanding the total return profile for levered long side of the trade. The 10-15% has positive return for up to 15 defaults (versus 9 defaults for 0-10%), but it also has a larger potential negative return for high numbers of defaults (see Exhibit 6). Because of the upfront nature of payments, the 0-10% position would benefit from further rising short rates and back-ended defaults (because the larger upfront payment would earn more interest).

In Exhibit 7, we illustrate the total returns of two long/short strategies under the same scenarios. The first strategy is to sell protection in the 10-15% tranche and buy an equal-notional amount of protection in the 0-10% tranche. This package does well in scenarios where HY CDX experiences 10 to 15 defaults, but despite being a long/short strategy, it is not delta hedged (which would be difficult, see below) and remains exposed to near term spread moves. Furthermore, it requires a large net upfront payment and would suffer if short rates continued to rise.

Another long/short strategy is to pair the sale of protection in the 10-15% tranche with the purchase of protection in the index, on a delta-neutral basis. This package has its best performance in the 5 to 10 defaults scenarios and has much less exposure to small spread moves and positive convexity for large spread rallies. For investors looking to hedge both early default risk and market-wide spread moves, this long/short strategy may be preferable. Further, the strategy would benefit from rising short rates, because there is a net positive upfront payment. The deltas, though, require close attention, because the upfront nature of payments implies that deltas can increase substantially even while the duration of the underlying index drops (see Exhibit 8).

exhibit 7

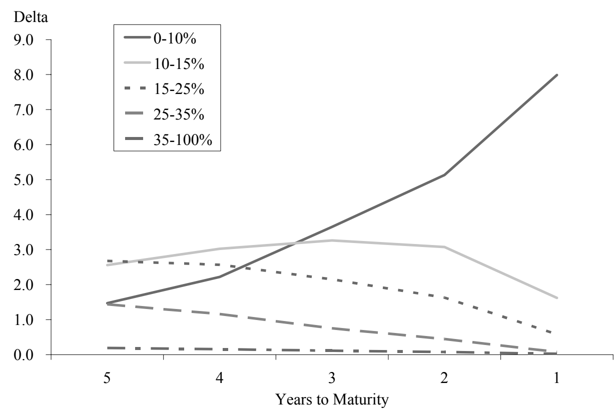
Long/Short Total Returns - 3 Year Holding Period



Source: Morgan Stanley

exhibit 8

Watch Out for Rising Deltas



Source: Morgan Stanley

CONCLUDING THOUGHTS – DEFAULT RISK VS. SPREAD RISK

While we have presented readers with quite a bit of fundamental and strategic food for thought, a key-take away is that we are fundamentally supportive of taking default risk on the 100-name HY CDX index. There are clearly many ways investors can implement this view, but we chose to focus on long/short strategies that minimize the impact of small spread moves because this a new and relatively interesting way to approach the high yield market.

Section D

Structured Credit Insights

Market Themes

Please see additional important disclosures at the end of this report.

chapter 24 Swinging a Double-Hedged Sword

June 20, 2003

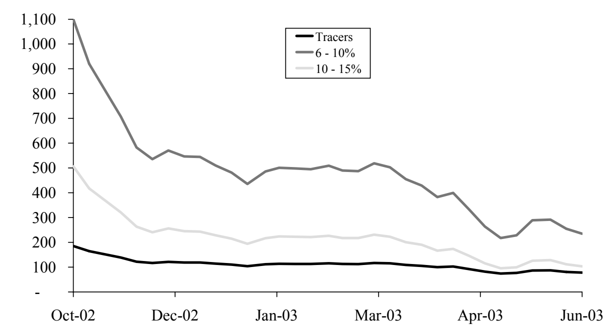
Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar

In Chapter 9 we wrote about the important correlation and spread relationship in synthetic tranches that we can observe in the market. We received quite a bit of feedback on this topic, generally tilted toward questions about the relationship and where the market is headed. In this chapter, we are focusing on the price sensitivity of synthetic tranches, which we believe is critical to understand before market participants jump into this market sector or otherwise "trade correlation." In particular, we illustrate the inherent leverage of subordinate tranches, and focus on one important application, namely, the use of tranches to offset the volatility of single-name credit default swaps. This hedging of volatility is an issue for any institution required to mark-to-market their credit derivatives but not their cash exposures (e.g., banks and insurance companies).

OBSERVING LEVERAGE

In Exhibit 1 we compare the implied spread sensitivity of two TRACERS[SM] tranches to the (untranched) TRACERS[SM] basket over an eight-month time period. The spread values of the tranches are derived from our expected loss model (using a fixed correlation assumption), as we only have recent market prices for TRACERS[SM] tranches.

exhibit 1
The Inherent Leverage in Subordinate Tranches



Source: Morgan Stanley

The key observation in this analysis is the leverage. The TRACERS[SM] basket rallied approximately 108 bp over this period, while the 6-10% and 10-15% tranches rallied 865 bp and 404 bp, respectively. Based on these relative moves, the inherent price leverage in the two tranches is 7x and 5x, respectively.

DON'T GET FOOLED BY THE RATING

There is one more point that we believe is critical to understand. The ultimate default risk of a tranche (when issued as a funded note) may be low enough to get a high rating, but one should realize that agencies are rating the risk of default and the severity afterwards. The price volatility of an instrument may not be a concern in assigning or maintaining a rating. While one could argue that traditional credit investors should be used to this phenomenon in the single-name credit markets, given the cyclical nature of many credits, the leverage in tranches may introduce a higher level of price volatility compared to economic cycles. In short, investors in synthetic tranches must be aware of these differences in price sensitivity and of the fact that credit rating alone can be a misleading measure of price sensitivity.

VOLATILITY OF A HEDGED POSITION

Banks and insurance companies who are credit derivatives users suffer from income statement/earnings volatility because of FAS 133 issues. In particular, many of their cash credit investments are not marked-to-market, while their derivative investments or hedges require mark-to-market treatment. Ironically, this situation creates a disincentive for those seeking to hedge credit exposures, based purely on accounting rules, assuming they are unable to meet the requirements for hedge accounting.

We consider banks as a specific example. Many banks have been buyers of protection to partially hedge their corporate credit exposure in loans. As their loans are not marked to market, the credit default swaps positions can add earnings volatility although, in fact, they are simply hedges for concentrated credit exposures. Additionally, banks must contend with the fact that credit default swaps are higher beta instruments (because of higher volatility and a propensity to reinforce trends) and may indeed move more dramatically than cash instruments in a credit improving environment. This implies that there would still be a mark-to-market impact, even if the cash instruments were marked.

Banks, for the most part, have to live with these problems unless they are willing to offset their long protection positions with long credit positions (via credit derivatives to get the same accounting treatment). One simple solution is to offset the purchase of protection on some names with the sale of protection on others, but this process adds credit risk to portfolios, and requires banks to take name-specific (or idiosyncratic) risk. This risk is precisely what banks are trying to shed in the first place, so this long protection/short protection strategy on single names does not necessarily help.

GETTING LONG DIVERSIFIED CREDIT RISK

Another method banks can use to get long credit risk through derivatives is to consider diversified credit portfolios. Clearly, getting long credit through a liquid basket (such as synthetic TRACERS^{SM}) is one way to gain diversified long credit exposure, but there may not be enough spread in the basket to offset the premium paid out on the long protection positions (although full premium offset may not be a goal). Further, there is no first-loss protection in such a diversified basket, which can result in additional (or unexpected) idiosyncratic risk in the bank credit portfolio.

A second approach is to consider selling protection on synthetic tranches, which can have a similar impact from a carry perspective, but with differing sensitivity to moves in credit spreads depending on the exact tranche. Yet, the inherent leverage in these tranches could be the second blade of a double-“hedged” sword used to hedge both idiosyncratic credit exposure and financial statement volatility.

WHAT IS A GOOD HEDGE?

We construct a hypothetical example. Using the benefit of hindsight, suppose a bank (in April 2002) wanted to hedge what turned out to be the 10 largest tightening and 10 largest widening names in the 100-name TRACERS^{SM} for a volatile one-year period (until April 2003). If we assume the purchase of \$10 million of protection on each name, the first data column of Exhibit 2 describes this portfolio (\$200 million notional with an average premium outlay of 144 bp).

exhibit 2 Hypothetical Portfolio and Hedges (April 2002)

	Original Portfolio	Untranched	7-10%	10-15%
Protection	Buy	Sell	Sell	Sell
Notional	200,000,000	194,000,000	38,000,000	50,000,000
Initial Premium	(144)	91	339	174
Net Premium	(144)	(56)	(80)	(101)

Source: Morgan Stanley

We then construct three packages, meant to serve as hedges for this portfolio of protection. The first hedge is simply selling protection on the full TRACERS^{SM} basket, using a risk (or spread PV01) neutral notional amount. The second package is to sell protection on the 7-10% TRACERS^{SM} tranche, and the third package includes the sale of protection on the 10-15% tranche (in both cases with a PV01-neutral notional amount). The net premium on all of these packages is negative (but still better than just buying protection on the 20 names).

exhibit 3 Performance and Volatility Comparison – Which Hedge Is Best?

	Original Portfolio Alone	Original Portfolio with TRACERS^{SM} Hedge	Original Portfolio with 7-10% Tranche Hedge	Original Portfolio with 10-15% Tranche Hedge
07/01/02	0.49%	-0.91%	-1.73%	-0.83%
10/01/02	3.60%	-0.22%	-1.82%	0.06%
01/02/03	1.45%	0.26%	-0.06%	0.63%
04/01/03	1.19%	0.83%	1.33%	0.52%
Std Dev	1.34%	0.74%	1.50%	0.66%

Source: Morgan Stanley

As the bank's goal is to reduce mark-to-market volatility, we analyze the performance of the protection purchase with the three packages we described above (see Exhibit 3). Over the subsequent four quarters, the estimated P/L (excluding the impact of carry) on the 20-name portfolio of protection is shown with values ranging from 0.49% to 3.60%. The standard deviation of these four quarterly values is 1.34%. The first package reduces the volatility of the P/L to 0.74% and moves the quarterly P/L percentage closer to zero in three of the four quarters. The second package (with 7-10% tranches) does a worse job by increasing the overall volatility and moving the P/L percentage further away from zero in two of the four quarters. The last hedge performs the best, with the overall volatility at 0.66% and P/L percentage changes closer to zero in three of the four quarters.

WHAT IS THE RIGHT ANSWER?

The hedge that will perform the best (i.e., near zero P/L volatility) is well correlated to the original portfolio of protection, but does not introduce idiosyncratic risk into the whole process.

An untranched basket has the advantage of simplicity and liquidity, but can introduce idiosyncratic risk because of the lack of first-loss protection. Tranches can be used to solve this problem (and can be higher yielding), but the inherent leverage and carry impact must be managed carefully. We point out that if we examine the results in Exhibit 3 for hedges weighted to be carry neutral rather than PV01 neutral, the volatility of the P/L is markedly increased for both the tranched and untranched hedges.

Both approaches can reduce overall P/L volatility and premium outlay, so we encourage institutions with mark-to-market accounting issues on hedges to think about the idea of "hedging" their mark-to-market volatility. Tranches, more specifically, can be structured to provide exposure to aggregate credit losses in a portfolio with subordination providing a buffer against idiosyncratic default risk.

chapter 25 Mezzing with the Markets

September 17, 2004

Sivan Mahadevan
Peter Polanskyj
Viktor Hjort

An age-old battle in financial markets involves the seesaw between technicals and fundamentals, which is very much front and center in today's credit markets, on both sides of the Atlantic. Fundamentals appear strong currently, given the nature of most corporate balance sheets, but the warning flags have been raised as many companies look to execute shareholder-friendly activities rather than keep leverage at suboptimal levels. Spreads seemed like they were priced to perfection just a few weeks ago, but the ominous structured credit bid has almost driven us into a new regime, making the battle even more acute.

As we see it, the structured credit bid seems to have some strong legs in the current environment. With rates remaining low and equity markets showing uninteresting returns, the reach-for-yield phenomenon is naturally pushing investors toward products that offer higher yields. The current fundamentals in the credit markets make levered credit a natural choice because default risk seems to be low, independent of the current level of spreads.

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While investors do not need to look beyond the single name markets to get a sense of how much impact the structured credit bid is having on valuations, the relative pricing of benchmark tranches is in fact much more enlightening. At current spread levels, junior mezzanine tranches feel like out-of-the-money options on default, and that phenomenon, combined with the demand for yield, has pushed them significantly tighter. Implied correlation values reveal some of this recent richening as well, but there are other, more subtle factors helping to drive spreads tighter.

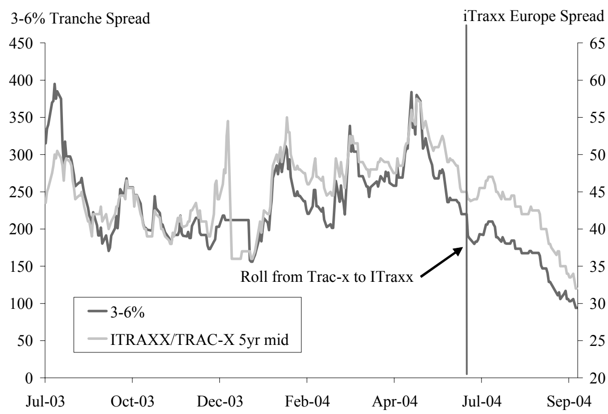
Has the market gone too far? From a default risk perspective, taking credit risk continues to feel fairly attractive, given the healthy state of corporate balance sheets today. Those who go long equity and mezzanine tranches are, in effect, expressing this view, so it may be difficult to argue with that logic. However, there is a price for everything, and we explore the potential sensitivity of some tranche positions to events that are not priced into the market, such as a spread-widening environment or a random credit event.

THE STRUCTURED CREDIT BID

The impact of the structured credit bid has been felt by everyone in the investment grade markets over the past few weeks, with already tight default swap premiums tightening 12 bp in the US and 11 bp in Europe. Benchmark mezzanine tranches are an even better indicator, with rallies of 100 bp and 75 bp for the US and Europe, respectively, using 3% attachment points since the middle of August. Models aside for the moment, from an optical perspective, junior mezzanine notes feel quite rich, particularly an 85 bp spread on 3-6% in Europe.

exhibit 1

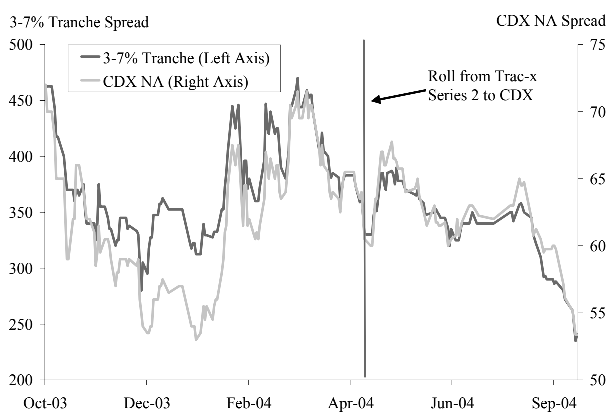
Mezzanine Tranches vs. the Market – Europe



Source: Morgan Stanley

exhibit 2

Mezzanine Tranches vs. the Market – US



Source: Morgan Stanley

How deep is this bid? In the old days, the CDO bid had reasonable impacts on investment grade and high yield markets, but the size and scope of the current bid is quite a bit more substantial, in our view. It certainly involves traditional buyers of structured credit products, including European and US institutions, but what is new this time around are both retail investors in Europe and institutional investors in Asia (outside of Japan).

Perhaps one reason why the flows are occurring when they are is the general frustration with the alternatives, including the equity markets and interest rates that are not rising as much as many had hoped. Effectively, investors are expressing the view that economic growth will be unexciting but still positive, while defaults remain low.

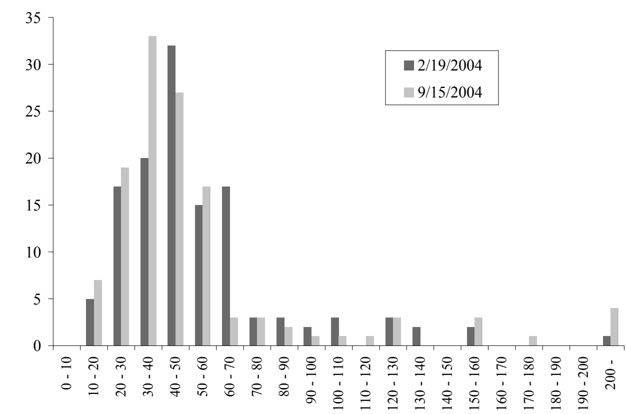
Is anyone leaning against the wind? We have seen some minimal amount of structured credit unwinding in the face of very tight spreads, but that flow is much smaller. Most who locked in the bigger coupons from years past appear to be quite happy continuing to clip the coupons, even if there is some mark-to-market risk going forward. However, we do note that there has been structured credit-related net selling of credit risk in the past that has impacted the markets (the 3-100% tranche trades, for example; see "Equity Indicators – Is the Tail Wagging the Dog?" February 27, 2004).

YOU CAN SEE IT IN MEZZ PRICES

If we dig deeper into the junior mezzanine activity, we can attribute the tightening to three factors: the move in the underlying market, the technical flow (i.e., correlation), and a change in the shape of the distribution of the index. The first two factors are both substantial (as shown in Exhibits 1 and 2) and obviously somewhat interrelated. The base correlation move was approximately 3 points (over the past five weeks), making the base correlation curve now worth nearly 11 points between the junior mezzanine and equity tranches in the US.

exhibit 3

Redistribution of Credit Spreads Makes Junior Mezzanine Less Risky



Source: Morgan Stanley

The market and correlation moves clearly overshadow more subtle impacts, but investors can gain some insight if they focus on these effects as well. Model-based valuation of mezzanine and equity tranches can be very sensitive to the size and shape of the tails of the credit distribution because this tail is, in effect, what increases the probability of an out-of-the-money option becoming in-the-money. Six months ago, we took the somewhat wider tails that we saw in equity indicators (Moody's KMV) and considered the impact they would have on the benchmark tranches. At that point, we found that the longer tails of the equity market were beneficial to attachment points of 3% and above, if in fact the equity indicators eventually wound up influencing credit spread distributions (see Chapter 21). The distribution of credit spreads within CDX has indeed reshaped since then, in a way that is beneficial to 3-7% type tranches (see Exhibit 3). We note, however, that the European indices and tranches did not experience a similar change.

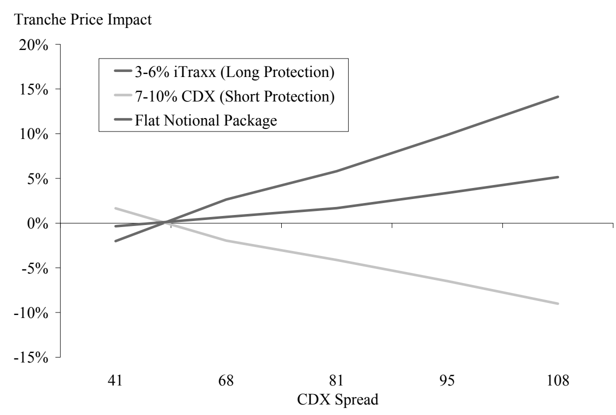
3-6% EUROPE VS. 7-10% US

A trade idea we find interesting is one that plays against the absolute level of spreads that influence tranche pricing so much. Clearly, a random default can come from anywhere, but the cost of buying this random default option in Europe is much less expensive than in the US. As such, a long protection position in the 3-6% European tranche versus a short protection position in the US 7-10% tranche would benefit from the random default in Europe while not being penalized as much by a similar event in the US. Additionally, this is a flat carry trade. We approximate the spread move caused by a loss in subordination resulting from a default of the widest credit in the 3-6% iTraxx tranche to be roughly 2.5 times that of the 7-10 CDX tranche (55 bp versus 22 bp).

Additionally, the trade has some interesting spread convexity and roll-down or time decay behavior. In Exhibit 4, we have shown the performance of both tranches for a variety of spread scenarios. To normalize the spread movement in Europe versus the US, we assume the iTraxx/CDX basis will widen with spreads subject to a maximum of 25 bp. Under these assumptions, the package benefits from generic spread widening, with potential further upside for scenarios where the basis tightens or simply widens less.

exhibit 4

Buy 3-6% Protection in Europe, Sell 7-10% in the US



Source: Morgan Stanley

WHICH WAY DO WE GO?

For all of the reasons cited, we feel that the structured credit bid is strong and not necessarily going away any time soon. Furthermore, near-term default risk continues to seem attractive to us, even if spread levels do not. For those investors who are inclined to position against the technicals, the 3-6% vs. 7-10% idea takes advantage of the hurricane force winds blowing across the Atlantic today.

chapter 26 Insurance Reshapes the Risk Profile

October 22, 2004

Sivan Mahadevan
Peter Polanskyj
Ajit Kumar, CFA

In a market dominated by technicals of late, the fundamental repricing of credit risk in the insurance sector serves as an important wake-up call for credit investors. It is not common to see a significant increase in credit volatility overnight among tight trading names in any credit environment, and the resulting spread move in the insurance sector has effectively reshaped the investment grade risk profile. This action, in turn, has some interesting implications for the structured credit market, as tranches with varying seniority have exposure to different parts of this reshaped risk distribution.

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Tight trading names moving somewhat wider generally impact senior tranches, while tight or even average credits moving significantly wider impact junior mezzanine and first-loss tranches, depending on the size of the move. The net effect of the insurance repricing in the structured credit market to date has been a bit of both, although for portfolios including the most stressed insurance credits, the thickening of the right-hand tail (risky credits) has had the biggest pricing impact on subordinate tranches. The tranched CDX market avoided the extreme scenario, as the two most stressed names (Marsh & McLennan and Aon) were not part of the index's 10-name insurance sector.

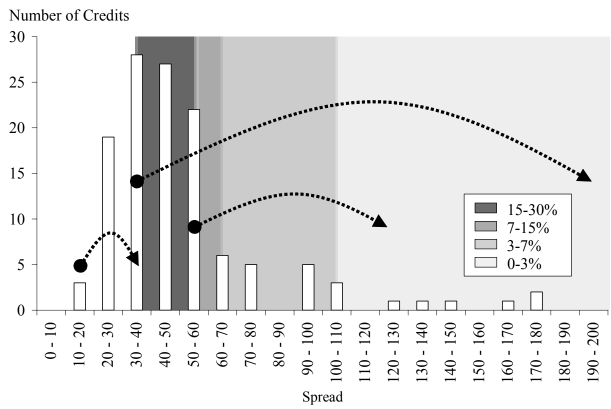
Interestingly, the blossoming of the CDO-squared market this year reflects the desire of investors to hedge exactly this type of risk, even though it was an "unexpected" event by most measures.

RESHAPING THE DISTRIBUTION: IMPACT ON TRANCHES

The point of most structured credit investment strategies is to redistribute credit losses. The process of doing this results in the tranches behaving like options on a portfolio experiencing a specific amount of losses due to default. As such, the shape of the risk distribution within the portfolio influences the pricing of tranches (see Exhibit 1). It should be fairly intuitive to recognize that the length and thickness of the right tail influences the pricing of subordinate tranches, meaning that the bigger the tail, the riskier the equity and mezzanine tranches. Similarly, the shape of the middle to left side of the distribution should influence the more senior notes. As credit risk increases (shifts from left to right), senior notes should become riskier.

exhibit 1

Insurance Moves to the Right, Impacting Both Senior and Subordinate Tranches



Source: Morgan Stanley

Two credits in the insurance sector serve as useful examples. The move in AIG's default swap premium (from 18 bp to 34 bp) increases risk in 15-30% type tranches, while reducing risk in super-seniors (30-100%). On the other hand, Marsh & McLennan (which widened from 30 bp to north of 250 bp) is clearly a right tail event, shifting risk from 15-30% type tranches to 0-3%.

exhibit 2

Change in Single-Name Deltas Shows Risk Redistribution

Tranche	AIG+16 bp	MMC+240 bp
0-3%	12.4%	61.9%
3-7%	8.0%	14.7%
7-10%	0.6%	-27.7%
10-15%	3.1%	-36.3%
15-30%	43.2%	-45.4%

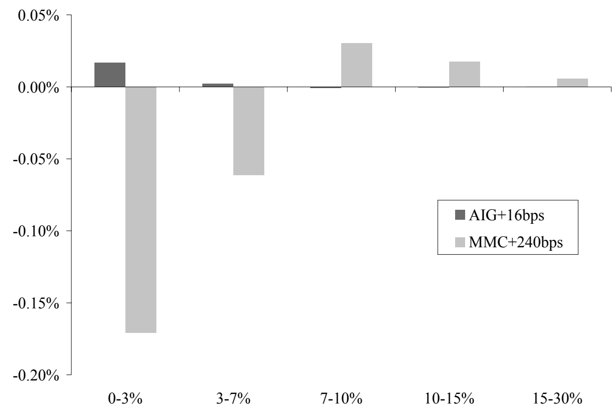
Source: Morgan Stanley

For investors who like to think of single-name risk in tranches on a delta basis, the resulting changes in these deltas tell the same story, but more numerically (see Exhibit 2). The AIG delta to the 15-30% tranche rose 43.2% (from a very small number), due solely to AIG's widening. Hypothetically, if Marsh & McLennan (MMC) were part of CDX, its delta in the 15-30% tranche would have dropped 45% and would have risen 61.9% in the 0-3% tranche.

If we take this analysis one step forward, we can see the actual pricing impact on tranches (see Exhibit 3). The move in AIG (alone) had a marginally positive impact on the 0-3% tranche, approximately 0.28% in price terms, or about 0.02% on a delta-neutral (to the index) basis. AIG's impact on the other tranches is even more negligible. The Marsh & McLennan move (alone, if it were part of the index) would have caused a 2.24% drop in the 0-3% tranche (0.16% on a delta-neutral basis). The impact on the 3-7% tranche would have been negative as well, but for the remaining tranches, it would have been a positive event.

exhibit 3

Tranche Pricing Impact: Two Opposite Examples



Source: Morgan Stanley

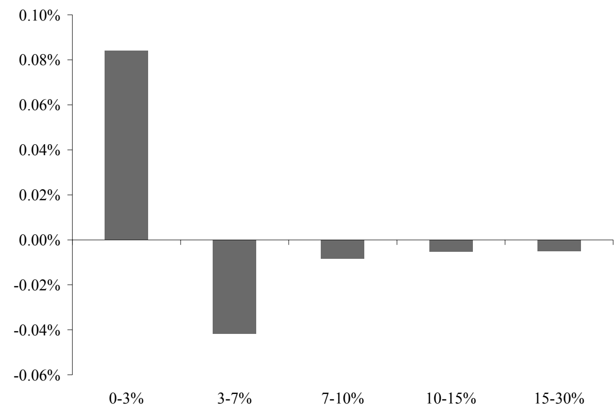
THE IMPACT ON THE LIQUID TRANCHES

While it is likely that almost every insurance name with single-name liquidity would appear in at least a handful of bespoke tranches throughout the market, it is also important to focus on the names that appear in CDX, to get a sense of the impact on benchmark liquidity. There are 10 insurance names in the 125-company index, which experienced an average widening of 29 bp since October 14. Two names (Ace Limited and Aetna) moved from average levels to the right tail, with spread levels above 100 bp. Three others moved from the 40-50 bp zip code to the 70-80 bp neighborhood (XL, Cigna, Hartford), while others moved from fairly tight spreads (30 bp and below) to the 40-50 bp range.

As CDX does not include the two most stressed insurance credits (currently), the net impact of the insurance move on the index tranches is somewhat different than it would have been otherwise (see Exhibit 4). Relative to a delta-neutral amount of index protection, the 0-3% tranche outperformed, as the moves in Ace and Aetna into the right tail were more than offset by the risk distribution at lower spread levels. The remaining tranches all underperformed the index, as the net effect was to move risk from the far left tail of the distribution into the middle. If Marsh & McLennan and Aon were part of the CDX index, the net performance would have been flipped, with subordinate tranches underperforming the seniors.

exhibit 4

Tranche Index Effect Was More Muted – Given Index Composition



Source: Morgan Stanley

HOW DID THE MARKET REACT? WATCH THE TECHNICALS

Our analyses above show the impact on the various tranches given the insurance sector spread move, alone. Yet there were some technically driven correlation moves, as well, which provide a sense of market direction. The increase in idiosyncratic risk is not supportive of selling protection on very subordinate tranches. Consequently, early this week, we did see correlation levels fall even further. But we should emphasize that falling correlation levels have been a trend even prior to the insurance news and may be related to hedging in the marketplace ahead of the expected structured credit pipeline of issuance. There was a modest rise in 0-3% correlation over the past two days, reflecting the fact that sellers of protection re-emerged, but, again, we emphasize that this could be related to hedge unwinding. It is also important to note that structured credit exposure to the insurance industry is largely a synthetic phenomenon; the cash CDO market has little insurance exposure, given the focus on high yield debt.

THE ARGUMENT FOR SUBORDINATION GAINS SOME TRACTION

There are clearly many ways to lever credit today, but when tranches are involved, there are essentially two types of resulting risk: idiosyncratic and systemic. Selling protection on subordinate tranches (junior mezzanine and equity) is a form of leverage that contains both types of risk, while the risk in senior mezzanine (and more-senior tranches) is less idiosyncratic in nature, albeit systemic. Long/short combinations of the two can isolate idiosyncratic risks and have been a popular trade in the market place.

The move in the insurance sector highlights the risk in taking a lot of idiosyncratic exposure, though the tranched index market was spared from the most volatile credits. Subordinate tranche positions in portfolios containing the big movers in insurance would not have performed as well as senior tranches. Interestingly, the CDO-squared market exists exactly for this reason, and is effectively a way of taking levered exposure to tranches that have less idiosyncratic risk themselves. An insurance sector type move is one that would not negatively impact the typical senior mezzanine tranche, provided it is contained to a reasonably small number of credits.

chapter 27 Challenging Correlation Cynicism

December 3, 2004

Sivan Mahadevan
Peter Polanskyj
Ajit Kumar, CFA

Much of the derivatives skepticism across the credit markets from a couple of years ago has subsided, given the tests, cycles and general growth that default swaps have experienced. However, a healthy bout of cynicism has developed in the correlation space today, especially given the enormous impact structured credit is having on credit spreads. This sentiment is especially acute in the high yield community for a variety of reasons including the relative novelty of derivatives in this space and the pain (however distant it may now seem) associated with the high yield CBO experience.

We continue to view structured credit instruments as being important credit portfolio management tools that allow investors to isolate, hedge, or even amplify certain characteristics of credit risk. The vast improvements in liquidity, transparency, and standardization have been a key driver of our views, as we have watched these markets evolve since the late 1990s. Correlation cynicism, nevertheless, needs to be addressed.

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Among investors who are less involved in the structured credit markets, the most common question we are asked center on what concerns us most in this space. When risks, flows, and technicals are well balanced, we are generally comforted; when they are not, we begin to get worried. The long/short nature of the correlation market today results in a fair amount of balance and is one of our biggest reasons for comfort. We are also reassured by the transparency in the market, and the alternatives that pricing models provide to a pure ratings-based approach. We are most concerned with the impact an "unexpected" default or stressed sector can have on the levered money in this space. We also worry about the imbalance caused by differences in mark-to-market treatment among investors, and the resulting flows that could occur.

A TWO-SIDED MARKET

The original CDO market was a long-only business, where risk was effectively taken out of the market and then repackaged and redistributed into the hands of different investors. The disparate and fragmented nature of the market made it relatively illiquid as well. When the credit cycle turned, most investors in these products were effectively positioned the same way, and the bid for paper was thin, to say the least. Ratings downgrades brought forced sellers to the market, and mark-to-market valuations began to suffer in a truly negatively convex manner.

We draw quite a bit of comfort in realizing that today's structured credit market is a two-way market, which, simply put, means that there is a winner and a loser for almost any event that impacts these structures. For example, as we have written about repeatedly, investors have used mezzanine and senior tranches as ways of implementing long and short views. However, a derivatives market does not have to be well balanced, and we do worry a bit about crowded trades and accounting differences among investors, which can tilt the balance.

THE UNEXPECTED DEFAULT

We continue to be supportive of taking default risk in investment grade and high yield markets, given the generally healthy state of corporate balance sheets. The levered default-risk (long first-loss tranches) trades have become very popular in the hedge fund and banking community. The good news is that most of the positions are hedged to some degree, either for spreads moves (via short mezzanine or index protection) or for defaults in riskier credits, or both. But the risk that most investors have in this trade is a quick jump to default from an unexpected name, or a sudden reshaping of the risk distribution for an entire sector (like we saw in the insurance space, but on a bigger scale). At least based on the few examples of this in history, this risk is largely random, as it has involved events that were difficult to predict, including fraud and litigation. So today's generally healthy balance sheets do not necessarily reduce this risk factor, given its randomness, although the focus on corporate governance in the US since 2002 may help to mitigate it.

exhibit 1 The Impact of Stress – 0-3% CDX Tranche

Scenario	Unhedged	Delta Hedged
Widest credit moves up 1000 bps	-6.3%	0.4%
Tightest credit moves up 1000 bps	-6.6%	-2.1%
10 Wide credits up 100 bps	-6.0%	1.0%
10 Tight credits up 100 bps	-5.7%	0.7%
All credits move 8 bps each	-5.3%	0.8%
Widest credit defaults with 40% recovery	-12.8%	-1.0%
Tightest credit defaults with 40% recovery	-14.9%	-8.5%
Widest credit defaults with 0% recovery	-22.4%	-2.7%
Tightest credit defaults with 0% recovery	-24.2%	-13.5%

Source: Morgan Stanley

To demonstrate the jump risk, we calculated model-based losses that can occur in both equity and mezzanine tranches of the 125-name CDX index (see Exhibits 1 and 2). A tight or wide trading name moving 1,000 bp wider would result in a loss in excess of 6% for a 0-3% tranche if the credit were unhedged. If the credit were delta-hedged, there would be a slight gain if it were the widest trading name in the portfolio (because more protection would have been purchased) but still a significant loss (of 2.1%) if it were a tight trading name. If the jump risk were more sector related (10 names moving 100 bp wider each), the losses would still be significant in the unhedged case, but slightly less than in the one credit case.

If jumping directly to default, the losses get quite a bit bigger for the equity tranches, as one would expect. At 40% recovery, the losses are 12.8% and 14.9%, respectively, for the widest and tightest names. The tightest name defaulting results in a higher loss because the tail of the portfolio does not shrink, as it would if the widest name defaulted. Even in the hedge case, losses occur because the deltas would not be precise enough for the jump risk. A more extreme case occurs with a 0% recovery, where a delta-hedged position on a tight trading name would result in a 13.5% loss on the 0-3% tranche, quite significant for a name that was delta hedged. If it were the widest name, the loss would have been only 2.7%.

exhibit 2 The Impact of Stress – 3-7% CDX Tranche

Scenario	Unhedged	Delta Hedged
Widest credit moves up 1000 bps	-1.3%	0.5%
Tightest credit moves up 1000 bps	-1.9%	0.1%
10 Wide credits up 100 bps	-2.8%	0.1%
10 Tight credits up 100 bps	-2.8%	0.0%
All credits move 8 bps each	-2.7%	-0.1%
Widest credit defaults with 40% recovery	-1.5%	1.6%
Tightest credit defaults with 40% recovery	-2.5%	0.4%
Widest credit defaults with 0% recovery	-3.5%	1.8%
Tightest credit defaults with 0% recovery	-4.6%	0.3%

Source: Morgan Stanley

For a junior mezzanine tranche (3-7%), the decision to delta hedge individual credits does protect the tranche from relatively large losses. However, delta hedging specific credits is very uncommon among mezzanine tranche investors, unless it is part of a larger correlation book. As such, losses as much as 4.6% can occur from a single default on a tight trading name (with 0% recovery) despite the fact that there is 3% subordination in the tranche.

CREDIT CYCLE EXPERIENCE

A common criticism and fear inherent in the structured credit markets revolves around the relative lack of market experience among players in this "youthful" business. Although the majority of today's users of correlation instruments have entered this market over the past 18 months, there is still a sizeable amount of users on both the dealer and investing side of the business who lived through the 2001-2002 credit cycle in seats where they had to manage structured credit risk, which we do find comforting. Yet, the experience gap in the marketplace is a risk, and will cause some dislocation when idiosyncratic risk rises.

BIG ENOUGH TO BLAME

While it has become quite common in the credit markets to blame structured credit activity on the rapid tightening and spread compression that has occurred, it should be noted that for anyone comfortable with today's spread levels, a disappearing structured credit bid can have an equal but opposite impact on the market. Will this draw even more cynicism from the larger credit community? The answer is probably yes.

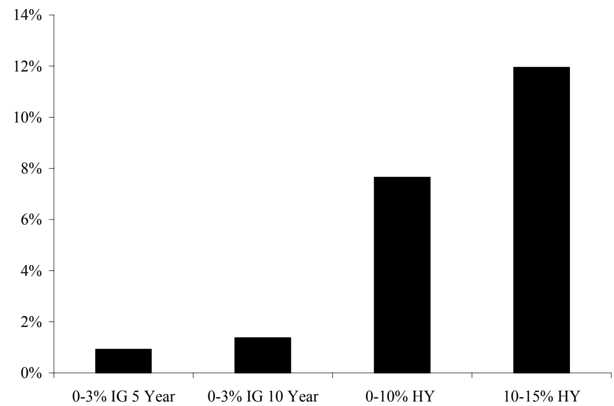
We do not see the structured credit bid fading away in the near-term, but over the medium-term the risk is certainly there. The key message is that there is dislocation risk in the credit markets that can be caused by "unexpected" flows. An unforeseen unwind from a hedge fund is another example, which could be related to issues at the fund, or even a flow triggered by the increasingly large community of fund of funds. We should note, though, that quite a few investors are waiting on the sidelines for an attractive invitation to get involved in this space, and such a flow-related dislocation might serve to be their calling.

UPFRONT PAYMENTS ARE PRE-FUNDED LOSSES

While the unfunded nature of most of the activity in the correlation space can lead to quite a bit of leverage deployment, we are comforted by the fact that the riskiest tranches require sizeable upfront payments to the seller of protection. The upfront payments are typically "posted" back to the counterparty, and effectively serve as a collateralization of the default exposure inherent in the first loss positions (see Exhibit 3).

exhibit 3

Pre-Funded Losses – Upfront Coverage from Defaults



Source: Morgan Stanley

In the case of investment grade CDX, the 5-year upfront is sufficient to cover the first 1% of losses in the index (2 defaults with 40% recovery) while for the 10-year index, the upfront can cover roughly the first 1.4% of losses (3 defaults at 40% recovery). In high yield, today's typical upfront on the first-loss tranche covers the first 7.6% losses in the 100-name index (12 defaults at 35% recovery), while the 10-15% tranche's upfront covers 12% of losses (18 defaults at 35% recovery).

MODELS, TRANSPARENCY AND THE POWER OF BLOOMBERG

Ironically, skepticism is increasing at a time when structured credit is more transparent than it has ever been. The transparency is actually demonstrating the option-like behavior of many of the instruments, which is a dramatic improvement from years ago when these risks were less well understood. We find this comforting. However, ratings have always been and will continue to be important guidelines for investors, but ratings are based purely on expectations of default, not on pricing movements, so pricing shocks can exist, which is a concern. So are the differences between the various agencies, especially when they are exploited.

Market standard correlation models have existed for the past nearly two years, and today the introduction of a correlation model on Bloomberg will undoubtedly have a long-lasting impact on the market, much like the role Bloomberg functionality has played in many other corners of the fixed income markets. Yet, as we have discussed on numerous occasions, models will evolve over time, which can result in risk being repriced, like the move to a base correlation standard did earlier this year. We do worry about investors who have been too "married to the models" in their approach.

ACCOUNTING IMBALANCES

As we alluded to earlier, one of the imbalances in the market that concerns us is related to differences in accounting practices within the investment community. A good portion of the sellers of mezzanine and senior protection in the correlation space are investors who can carry the risk on an accrual basis, thereby mitigating much of the mark-to-market risk. In a moderately negative credit environment, they are unlikely to be forced sellers. So why are we concerned? We are concerned partially because those who have bought protection on the same tranches are generally mark-to-market investors, and may be forced to unwind this protection (as a hedge against something else that is falling in price) before its full hedging potential is realized.

CORRELATION CYNICISM

Skepticism will always exist when the structure of markets change. We are by no means preaching that all is perfect in this new world, but we feel confident in challenging some of the correlation cynicism, given the progress that has been made in the structured credit space. But we do expect higher volatility, market dislocations, and a bit of frustration going forward, as investors manage credit portfolios along this new landscape.

chapter 28 Balancing Liquidity and Creativity

January 28, 2005

Sivan Mahadevan
Peter Polanskyj
Ajit Kumar, CFA

The index tranche market continues to dominate liquidity, flows, and investor participation within the structured credit space. In fact, many newer investors associate the term 'structured credit' directly with the index tranches, even though the market is much broader than that. We do not deny that the hyper-growth in popularity of index tranches has opened up the market to many new investors and created much needed transparency and standardization, not to mention important valuation benchmarks and a two-way market. Clearly, there is more liquidity today in the index tranches that anyone could have ever imagined.

Yet, the ease with which one can use index tranches has forced many investors into the same trades, both thematically and credit wise. For investors with reasonable amounts of structured credit exposure, but little diversity in terms of underlying portfolios and instruments, the resulting concentration risk can be harmful, triggered by both technical themes associated with activity in the liquid instruments as well as significant credit-specific events. Both of these triggers are very relevant in today's market.

From an opportunity set perspective, the structured credit market remains largely a bespoke one, where creativity, and the effort it requires, are the only barriers to entry. We encourage structured credit investors to keep this thought in mind as they hunt for value, as less trafficked routes may in fact be more scenic.

THE VALUE OF LIQUIDITY

An age-old battle in the fixed income markets centers on the value of liquidity. Unlike in the equity markets, investors have many instruments to choose from, and one must constantly judge the importance of liquidity on the margin, given pricing and market opportunities. There is a tendency to seek out liquid opportunities, even though most investors will not require the liquidity most of the time. There have been studies done in the interest rate markets, for example, which show that off-the-run instruments outperform on-the-runs over long periods of time.

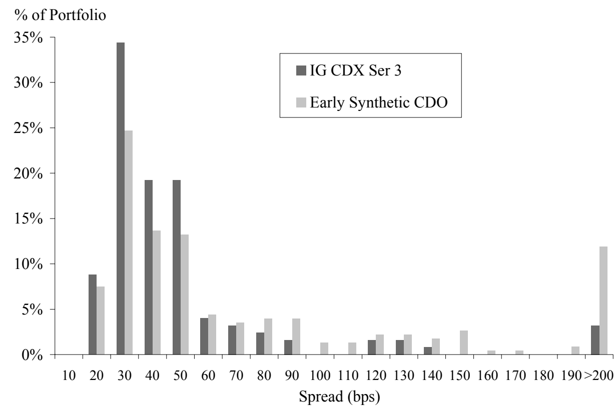
CREATIVITY HAS ITS BENEFITS, EVEN IF IT'S MORE WORK

Getting back closer to home, our main point here is to encourage credit investors generally and structured credit users in particular to re-consider the importance of liquidity on the margin, as their exposures grow in absolute size. There can be some price advantages for seeking out less liquid opportunities, but more importantly, the diversity in credit exposure and risk profile is a key consideration.

With respect to balancing liquidity and creativity, there are three points we would like to make. First, the argument that a pure liquidity focus results in lots of credit overlap is an easy one to make. If every long, short, or long/short combination is exposed to largely the same sets of credits, then bolts from the blue will have an even more magnified impact.

exhibit 1

Not Much in Common – Spread Distribution of CDX and a Seasoned Synthetic CDO



Note: Synthetic CDO used for descriptive purposes is EPOCH 2000-1, issued 12/2000 with 3 years left to maturity from today.
Source: Morgan Stanley

Second, the shapes of credit distributions can be vastly different. The index, which is frequently rebalanced and has a generally compressed distribution today, may look very different from a seasoned synthetic CDO tranche that was constructed during a different part of the credit cycle (see Exhibit 1). Given the distribution shape differences, tranches on these two portfolios would likely have fairly different risk and return characteristics as they may be driven more by credits in the portfolio than market-wide moves (i.e., they could be relatively uncorrelated, no pun intended).

Third, we live in a very technical market today, and the technicals associated with CDX (because it is a traded instrument) have been somewhat frustrating for anyone who uses indices as a reflection of market activity. We argue that the most liquid tranches can also be very technical in nature. As such, we encourage investors to have some diversity in the exposure they have to any one technical theme.

THE IMPACT OF SINGLE-NAME EXPOSURE – INVESTMENT GRADE

We take forward the first point, as it has a tremendous amount of relevance today. Despite all of the spread compression in the market, there is still a decent number of story credits in the investment-grade and cross-over space, from General Motors and Bombardier to the M&A risk associated with both wide and tight trading names. In fact, given where we are in the cycle and the generally healthy state of corporate balance sheets, it is this credit-specific risk that is likely the biggest issue for structured credit investors today, rather than big swings in market-wide average spreads.

We highlight the P&L associated with some severe credit-specific events (involving one or two credits at the most) in Exhibit 2 for the standard investment grade index tranches (protection seller's perspective). We highlight a few points for anyone with large amounts of unhedged exposure to market standard portfolios.

- If the widest trading name in CDX tightened significantly (to 100 bp) the equity and 3-7% 5-year tranches would outperform the index tremendously, while performance of the other tranches would be more in line with the index. In the 10-year tranches, the outperformance would extend to the 7-10% tranche as well.
- A tight name becoming distressed or defaulting immediately would result in a 12% to 15% loss for the investment grade 5 year equity tranche but a lower 7% to 10% loss for the 10-year 0-3% tranche. This is related to the much higher upfront payment for the latter, which also reduces the tranche's sensitivity to spread changes. The opposite is true for the mezzanine tranches, where the impacts are much worse for 10-year versus 5-year.
- Two names defaulting, however unlikely that may seem in investment grade today, can cause P&L outcomes many times that of the index in equity and mezzanine tranches, especially for 10-year tranches.

The key message is that most large investment grade credit portfolios tend to contain exposure to more than 125 names (the number in CDX) and also tend to be debt-market capitalization-weighted instead of being equally-weighted. While intentional single-name concentration is certainly a subordinate tranche investment strategy, for those who have been forced into this state because it is easy, we encourage some credit selection exercises.

exhibit 2

Investment Grade Tranches – The Impact of Severe Single-Name Events (Seller of Protection Perspective)

	Widest Credit Tightens Significantly	Tightest Credit Widens 1000 bps	Tightest Credit Defaults with 40% Recovery	2 Tightest Credits Default with 40% Recovery	Widest Credit Defaults with 40% Recovery	2 Widest Credits Default with 40% Recovery
IG 5 Yr Series 3 CDX						
Tranche P&L						
0-3%	2.7%	-12.6%	-15.0%	-28.9%	-12.1%	-25.5%
3-7%	0.8%	-4.1%	-2.4%	-5.5%	-1.2%	-3.3%
7-10%	0.2%	-1.1%	-0.5%	-1.2%	-0.2%	-0.5%
10-15%	0.1%	-0.4%	-0.2%	-0.4%	0.0%	-0.1%
15-30%	0.0%	-0.1%	0.0%	-0.1%	0.0%	0.0%
Index	0.1%	-0.6%	-0.5%	-1.0%	-0.3%	-0.8%
Tranche P&L (Delta Hedged)						
0-3%	0.7%	-3.3%	-7.0%	-12.9%	-6.6%	-13.2%
3-7%	0.0%	-0.1%	0.9%	1.3%	1.1%	1.9%
7-10%	-0.1%	0.6%	0.9%	1.6%	0.8%	1.7%
10-15%	-0.1%	0.3%	0.4%	0.8%	0.4%	0.8%
15-30%	0.0%	0.1%	0.2%	0.3%	0.1%	0.3%
IG 10 Yr Series 3 CDX						
Tranche P&L						
0-3%	1.7%	-7.1%	-9.8%	-18.6%	-8.1%	-16.7%
3-7%	2.0%	-8.5%	-5.3%	-10.9%	-2.7%	-6.9%
7-10%	0.9%	-3.6%	-1.9%	-4.0%	-0.7%	-1.9%
10-15%	0.4%	-1.6%	-0.8%	-1.6%	-0.2%	-0.6%
15-30%	0.1%	-0.4%	-0.2%	-0.4%	0.0%	-0.1%
Index	0.2%	-0.7%	-0.5%	-1.0%	-0.3%	-0.7%
Tranche P&L (Delta Hedged)						
0-3%	0.6%	-2.4%	-6.4%	-11.9%	-6.3%	-12.4%
3-7%	0.6%	-2.8%	-1.2%	-2.8%	-0.5%	-1.7%
7-10%	0.1%	-0.4%	0.3%	0.5%	0.5%	1.0%
10-15%	0.0%	0.1%	0.4%	0.8%	0.5%	0.9%
15-30%	-0.1%	0.3%	0.3%	0.6%	0.3%	0.5%

Source: Morgan Stanley

exhibit 3 High Yield Tranches – The Impact of Severe Single-Name Events (Seller of Protection Perspective)

	Widest Credit Tightens Significantly	Tightest Credit Widens 1000 bps	Tightest Credit Defaults with 35% Recovery	4 Tightest Credits Default with 35% Recovery	Widest Credit Defaults with 35% Recovery	4 Widest Credits Default with 35% Recovery
			HY 5 Yr Series 3 CDX			
Tranche P&L						
0-10%	2.2%	-0.9%	-2.9%	-10.5%	-0.7%	-3.7%
10-15%	1.8%	-1.5%	-2.5%	-10.5%	0.0%	-0.6%
15-25%	0.8%	-0.9%	-1.3%	-5.5%	0.0%	-0.2%
25-35%	0.2%	-0.4%	-0.4%	-1.8%	0.0%	0.0%
35-100%	0.0%	-0.1%	-0.1%	-0.3%	0.0%	0.0%
Index	0.5%	-0.4%	-0.8%	-3.0%	-0.1%	-0.8%
Tranche P&L (Delta Hedged)						
0-10%	1.3%	-0.3%	-1.6%	-5.1%	-0.4%	-2.4%
10-15%	0.3%	-0.3%	0.0%	-0.9%	0.4%	1.9%
15-25%	-0.3%	-0.1%	0.6%	1.8%	0.3%	1.7%
25-35%	-0.3%	0.0%	0.4%	1.4%	0.2%	0.8%
35-100%	-0.1%	0.1%	0.2%	0.7%	0.0%	0.3%

Source: Morgan Stanley

THE IMPACT OF SINGLE-NAME EXPOSURE – HIGH YIELD

The high yield situation is somewhat different though, given how the standard tranches are structured, the smaller number of names that trade in the market, and the limited number of off-the-run synthetic structured credit opportunities available (although there are plenty of seasoned cash CBOs and CLOs, see Chapter 39).

From a sensitivity perspective, since many more defaults are priced in based on the industry standard risk-neutral models, the impacts are less extreme on relative basis. For example, if the HY CDX index experienced 4 near-term defaults, the models show that the 0-10% tranche losses would vary from 3.7% to 10.5%, while the 10-15% tranche (which is equity-tranche-like in risk) would vary from 0.6% to 10.5% (see Exhibit 3, from a protection seller's perspective). With 4 near-term defaults on wide trading names, based on model valuations and no change in correlation, the 10-15% tranche would experience positive moves on a delta neutral basis, although we caution that 4 quick defaults would likely cause spread widening and adverse correlation moves that could more than offset these model based figures.

CREDIT SELECTION

In case the numbers cloud the key points, we reiterate that in today's market environment, much of the risk in structured credit strategies will be driven by credit selection and market technicals, and less so by the generic scenarios like the market moving 50 bp wider or tighter. For investors who have been forced into the credit exposure by liquidity, we encourage balancing liquidity with credit selection creativity.

chapter 29 Correlation and Credit Cycles

February 4, 2005

Sivan Mahadevan
Peter Polanskyj
Ajit Kumar, CFA

As we progress deeper into this part of the credit cycle, valuations continue to compress for the most part, and investors are getting comfortable with taking on more, and in many cases different kinds of credit risks, particularly in the structured credit space. We have devoted quite a bit of our research efforts over the past several months to the high yield opportunity in structured credit, given the secular changes that are occurring in the high yield space with respect to derivatives, juxtaposed with the prominence of the cash CDO market. We continue to view this as an interesting opportunity, especially for fundamentally minded investors, but we also see opportunity across the term structure of tranches.

Within the investment grade structured credit space, a change that is likely more cyclical than secular in nature is the addition of liquidity and investor interest into maturities beyond 5 years. There is quite a bit of bespoke deal flow in longer maturities today, particularly in 7 years, in part because of the steepness of credit curves. Many long-term credit investors are establishing structured credit positions in longer-dated credit, particularly at the mezzanine and senior levels. However, since the bespoke market is somewhat fragmented, the most transparent part of the market beyond five years is the market for standardized 10-year index tranches, which today is perhaps seeing more flows than the benchmark 5-year tranches. Yet, we caution that the 10-year index tranche market appears very technical, with flows dominated by the dealer community (hedging risk coming from the bespoke market) and hedge funds, which is not unlike the early days of 5-year index tranche trading.

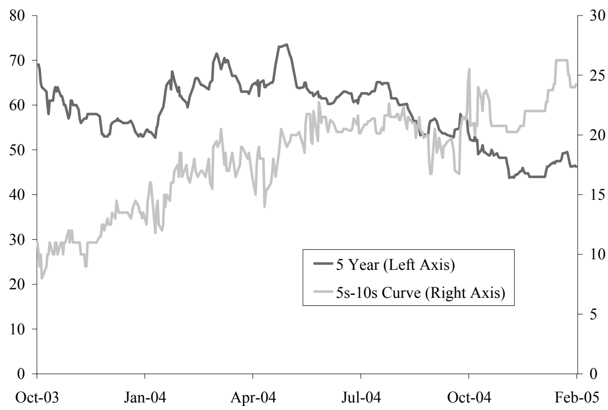
Given this newfound activity in longer maturities, we provide our readers with a few thoughts on how to compare the various opportunities. Although they are optically similar, the risk and return profiles of 5- and 10-year index tranches are quite different, with the 10-year standard tranches being more similar to the high yield tranches, calibrated for expected loss differences. The steep credit curve dominates relative valuation, and for anyone with strong credit cyclical views that disagree with curve steepness, the 10-year liquidity point provides ways of implementing these views.

A STEEPER CREDIT CURVE

One of the key motivators for taking longer-dated credit risk in structured form has been a fairly sharp steepening of the 5s-10s credit curve over the past 15 months, in an otherwise tightening market environment. When we first argued that the credit curve should be steep (see "Getting Short the Long End," October 10, 2003), the 5-year premium on the index was 67 bp, and there was approximately 10 bp of steepness from 5 to10 years (a 15% premium to 5-year risk). Today, the 5s-10s curve is 25 bp steep, on a much lower base (45 bp for 5 years), which makes 10-year risk trade at a 56% premium to 5-year risk.

exhibit 1

CDX 5s-10s – Curve Steepens While Spreads Tighten



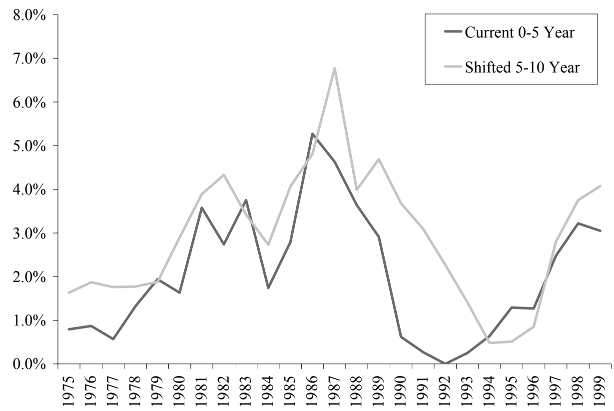
Source: Morgan Stanley

What is the right level of steepness for credit curves, given where we are in the economic cycle? History tells us that, for 10-year investment grade credits, there is generally more default risk in the back 5-years than in the front 5-years (50% more on average, see Exhibit 2 for BBBs). Yet, previous studies suggest that the difference can be even greater if we are in the early part of the credit cycle recovery, although we would argue that at this point the credit recovery cycle is more mature than that (see "Getting Short the Long End," October 10, 2003, for our early cycle views).

chapter 29

exhibit 2

BBB Default Experience, First 5 Years vs. Back 5 Years



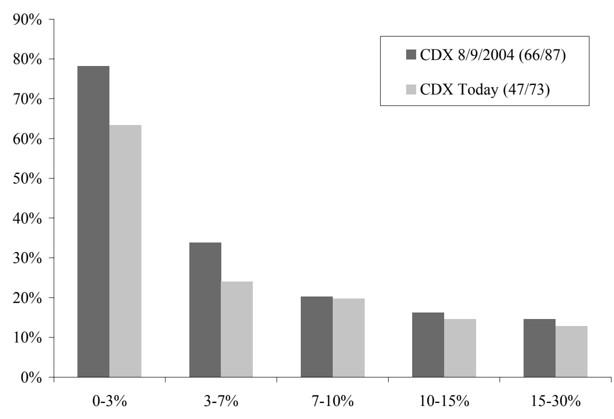
Source: Morgan Stanley, Moody's

TIME, TRANCHES AND CREDIT CYCLES

Today's steep curves indicate significant increases in credit risk 5 years forward. This difference between 5- and 10-year risk has dramatic impacts on risk-neutral correlation models used for pricing tranched risk, and can result in relative value opportunities for those willing to trade credit cycle views against the models. In Exhibit 3, we illustrate the proportion of 10-year expected losses priced into the first 5 years for each tranche of CDX, both today and in August 2004, when 5-year spreads were wider (at 66 bp) and curves flatter.

exhibit 3

How Much of 10-Year Risk is in the First 5 Years?



Source: Morgan Stanley

The results are intuitive; the majority of risk for the 0-3% tranche is associated with near-term default risk, while the majority of losses for the other tranches are associated with back-end risk. The 0-3% tranche is already in the money (or underwater, see below) for 5-year risk at today's spread levels, and therefore the incremental risk in the 5-10 year period is relatively small. At the same time the allocation of risk for the more senior tranches is much more stable and biased toward the back 5 years because these tranches remain out of the money (above water) for both 5- and 10-year risk.

Today's tight spread environment results in an increased proportion of the risk in the 3-7% tranche being priced in the back five years when compared to what we saw in August. For those looking to play the timing of default risk views, this part of the capital structure offers opportunity because it prices like out-of-the-money protection for 5-year risk and in-the-money protection for 10-year risk.

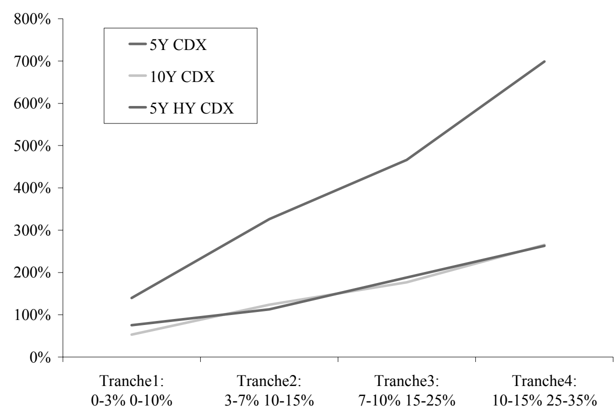
COMPARING CAPITAL STRUCTURES – HOW FAR ABOVE WATER?

With a plethora of liquid index tranches that trade in the market today (6 families between the US and Europe), there can be quite a bit of confusion for anyone who simply attempts to compare them. We find a simple, yet still useful method is to think of the tranches as being above or underwater, from the perspective of portfolio expected losses (which are implied from spreads). For example, with 5-year CDX in the US at 45 bp, the expected losses over 5 years are approximately 2.2% and the most subordinate tranche has a 3% detachment point. Our simple 'below or above water' metric is the ratio of the two or 140% (see Exhibit 4).

The standard equity tranches for the 10-yr CDX (0-3%) and the HY CDX (0-10%) are completely underwater, and have scores below 100%. A simple glance of the 3 tranche families in the US, based on this metric, shows how different 5- and 10-year tranches are from each other, with the 10-year IG and 5-year HY having surprising similarities. To be clear, this is a function of how the market chose to standardize tranches, not a statement about risk similarities between investment grade and high yield.

exhibit 4

How Far Above Water – Tranches vs. Expected Losses



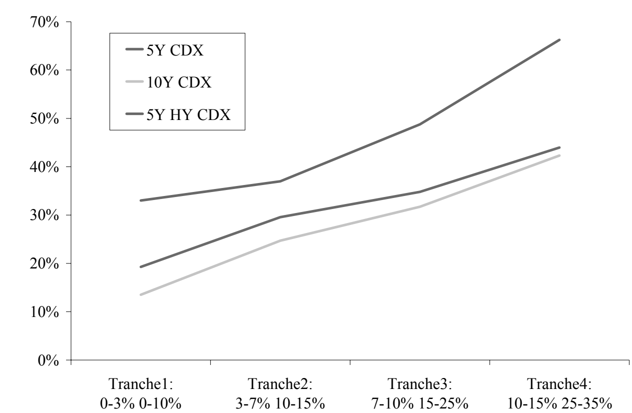
Source: Morgan Stanley

CORRELATION REGIMES

While, from an expected loss perspective, the standard 10-year investment grade CDX tranches resemble their HY CDX cousins, from an implied correlation perspective, the 5-year and 10-year investment grade tranches are much more in line (see Exhibit 5). We have discussed, in previous research, a variety of reasons why correlation means something very different in the high yield space (see Chapter 16).

Under some reasonable assumptions, spreads in the high yield index imply roughly 12.5% losses over 5 years. Based on Moody's data, we approximate historical 5 year loss experience for a comparably rated index has ranged from 6% to 23%. Meanwhile, even for the 10-year maturity in investment grade, we estimate the index losses have ranged from 0.4% to 3.0%. While a result marginally worse than expectations in high yield could easily generate losses in excess of the 10-15% tranche detachment point, even the worst case scenario (historically) in investment grade barely touches the 10-year 3-7% tranche (assuming a market portfolio), despite the fact that these tranches are reasonably comparable based on the analysis in Exhibit 4. This exposure to default rate volatility in likely one reason why the 10-15% tranche in high yield prices cheap (based on correlation skew) relative to the closest investment grade tranches.

exhibit 5
Implied Base Correlation



Source: Morgan Stanley

Additionally, expected losses do not capture the jump-to-default risk, as the models give this a very low probability of occurring. For such an event, the 5- and 10-year CDX 0-3% tranches have roughly the same absolute default exposure (27% of their notional), while the 0-10% HY tranche has only 10% of its notional exposed to a sudden jump to default. This is an argument for investment grade equity tranches trading cheaper on a correlation basis (lower correlation).

CORRELATION AND CREDIT CYCLES

We have touched upon curve ideas within the tranche space very early on in previous research (see Chapter 20). Yet, with a rather large liquidity injection in the 10-year part of the index tranche market today, and quite a bit of activity in longer-dated bespoke portfolio tranches as well, investors have much more choice in implementing structured credit ideas along the curve. Given where we are in the credit cycle, we continue to like taking shorter maturity default exposure through subordinate tranches, and hedging some of market risk of those positions with longer-dated tranche protection. For long-only strategies, one cannot ignore the steepness of credit curves, but understanding which tranches will behave like in- or out-of-the-money options across various maturities and asset classes is an invaluable addition to the structured credit toolbox.

chapter 30

How Big Is the Structured Credit Market?

April 8, 2005

Sivan Mahadevan
Peter Polanskyj
Vishwanath Tirupattur
Ajit Kumar, CFA

One of the common sources of curiosity among credit investors today involves understanding the scope of the structured credit market. The structured credit bid is clearly a supporter of spreads, and whether or not credit investors are involved, there seems to be a good understanding of the reasons to gain exposure to credit via these vehicles. But many unanswered questions remain about how large the appetite for credit via these structures really is or has been. Most studies of the size of the markets result in a few numbers in the multi-trillion dollar range that include both long and short gross positions, but with very little detail behind them.

While we do not claim to have the most comprehensive profile of the market, we think one third-party institution has done a fairly good job of tracking the market. Using data from Creditflux, a UK-based provider of news and analysis for the credit derivatives and structured credit market, we have been able to get a reasonable estimation for the amount of credit risk that has been distributed via bespoke structured credit products to end investors. We acknowledge that even this data is likely only 60% of a market that is difficult to track, given the private nature of many transactions.

In this chapter, we provide a detailed profile of the structured credit market using this data, focusing on what we consider to be the most relevant angle, namely the size and nature of credit risk that has been distributed to end investors via bespoke products. Our key takeaways are as follows:

- At least $465 billion notional of synthetic tranches have been distributed to end investors since the beginning of 2002. 27% ($125 billion) was distributed in funded form.
- $131 billion (28%) of this tranche notional has been distributed largely in bespoke form since the beginning of 2004, although the effect on first quarter 2005 numbers is not yet fully reflected.
- We estimate that on a delta-adjusted basis (i.e., taking leverage into consideration), the $131 billion tranche notional translates into $350 billion of actual credit risk.
- This transfer of credit risk is large by any measure, particularly relative to other metrics. In 2004, net new issuance in US investment grade markets was $341 billion, high yield was $40 billion, and cash CLO issuance was $30 billion.

- Of the delta-adjusted $350 billion distributed since the beginning of 2004, 51% is in mezzanine tranches, 24% is in equity tranches and 17% is in senior tranches. Only 8% is in super-senior tranches.
- Since 2002, 51% of the tranche notional amounts are specified in euros, while 40% are in US dollars, giving an indication of the domicile of end investors.

exhibit 1 Distributed Bespoke Structured Credit Tranches ($ Millions)

Vintage	Funded	Unfunded	Total Distributed
2002	30,520	128,775	159,295
2003*	52,802	122,434	175,236
2004	39,545	80,923	120,468
2005 Preliminary	2,415	8,444	10,859
Total	**125,282**	**340,576**	**465,858**

Note: 2003 numbers include index tranches; other years are mostly bespoke tranches.
Source: Morgan Stanley, Creditflux

exhibit 2 A Big Market – 2004 Issuance Comparisons

	2004 Issuance ($ Billions)
Synthetic Structured Credit (Delta-Adjusted)	338
Cash CLOs	30
Net US Investment Grade Issuance	341
Net US High Yield Issuance	40

Source: Morgan Stanley, Creditflux

METHODOLOGY AND DATA

The issuance data we use is based on information Creditflux gathers regularly directly from the dealer community and the rating agencies (although the rated portion of this market is actually quite small – $38.9 billion, according to S&P). Since Creditflux also calculates league tables, there is some motivation for dealers to provide the data, in the event that market transparency is not a good enough reason. Nevertheless, Creditflux does acknowledge missing parts of the market from certain dealers; however, we feel it remains the most comprehensive source. For the bespoke transactions that Creditflux tracks, there is quite a bit of information specific to leverage, which is obviously a key factor. CDO-squared transactions are included, which is an important part of the market. The collateral for all of these structures is largely investment grade corporate credit risk from the US and Europe (structured finance collateral is about 20% of the total).

END INVESTORS – FOCUSING ON BUY-AND-HOLD

The day-to-day transaction volumes in structured credit are dominated by trades in the index tranches, which are often between dealers and a medium-sized community of large hedge funds and proprietary trading desks that specialize in structured credit. In this study, we are by no means minimizing the importance of these market participants, but we feel that the more interesting point to most credit investors is the quantity and nature of credit risk that is removed from the market by bespoke structures and put away in portfolios where it is unlikely to come out, unless forced by cyclical changes in credit risk and the like.

Without knowing the profile of each investor in the market, we are forced to make some generalizations, given the structures. Tranches issued in funded form, in our view, are more likely to wind up in buy-and-hold type portfolios, given the costs involved in actually funding structures and potentially getting ratings. The $125 billion of credit issued in funded form over the past 3+ years is quite substantial if we consider that it represents approximately $330 billion of credit risk on a delta-adjusted basis. This far outpaces the cash CLO markets ($85 billion of issuance in the same time period), a popular alternative for investors who must hold funded assets.

exhibit 3 Funded Issuance ($ Millions)

	Since 2002	2004
Synthetic Tranches (Delta Adjusted)	338,260	106,772
Cash CLOs	85,142	29,808

Source: Morgan Stanley, Creditflux

Another buy-and-hold indicator is activity in CDO-squared structures, where investors' expectations for liquidity are lower. Over the past year, nearly 14% of the bespoke transactions completed (funded and unfunded) were in CDO-squared structures, amounting to about $18 billion of tranche notional, which could translate into several times more of actual credit risk (it is difficult to determine leverage levels).

The unfunded portions of bespoke transactions remain the largest part of the market (accounting for 73%) and can quite easily go into the hands of investors who are less likely to flip out of it; however, it is harder for us to make generalizations in this regard.

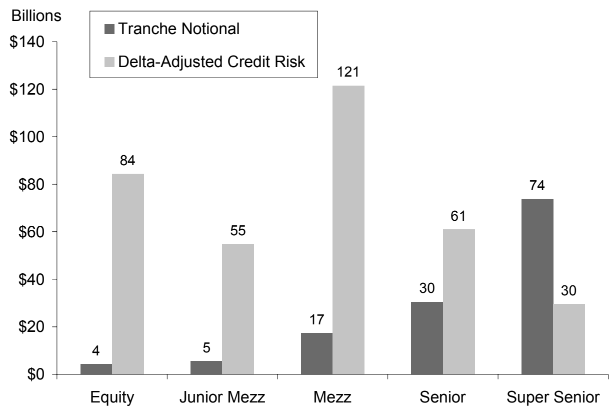
TRANCHE DETAILS – ACTUAL RISK AND LEVERAGE

The typical structured credit transaction today is by no means fully distributed. Some portion of the total credit risk is held by the arrangers, either on a hedged or proprietary basis. This contrasts with the cash CDO market, which remains a fully distributed market. But credit risk in the synthetic market is not evenly distributed among the tranches, so we must adjust tranche notionals by the amount of real credit risk behind them. We have chosen to classify the various distributed tranches into categories of seniority and have then delta-adjusted their notionals to get a sense of the amount of credit risk behind the trades.

exhibit 4	Tranche and Leverage Analysis (2004 Forward)					
	Equity	Junior Mezz	Senior Mezz	Senior	Super Senior	Total
Tranche Notional	4,213	5,480	17,356	30,495	73,861	131,405
Average Attachment Point	0.0%	2.4%	5.0%	7.4%	12.8%	
Average Detachment Point	2.4%	3.8%	6.7%	9.7%	87.9%	
Estimated Delta	20.0x	10.0x	7.0x	2.0x	0.4x	
Delta-Adjusted Credit Risk	**84,255**	**54,802**	**121,490**	**60,990**	**29,545**	**351,081**

Source: Morgan Stanley, Creditflux

exhibit 5
Credit Risk Distribution – Notional vs. Adjusted



Source: Morgan Stanley, Creditflux

We are only able to break the market up in this manner since the beginning of 2004, but the distribution gives us a good sense of the profile of the risk. On a delta-adjusted basis, about 50% of the distributed risk has been in mezzanine notes (both junior and senior mezzanine). Equity tranches account for 24% of the risk, while senior notes account for 17%. Super-senior tranches account for only 8% of the risk.

These delta-adjusted numbers are much different than the raw notional amounts for the tranches (Exhibit 5). This highlights that structured credit investors, as many have suspected, could have a fairly levered exposure to credit spread widening. There are two factors that at least partially serve to offset our concerns on this front: the buy-and-hold nature of many investors and the low absolute notional exposure to the most levered tranches (less than $10bn for equity and junior mezzanine). Investors may have taken $140bn worth of spread risk in the equity and junior mezzanine tranches but at the end of the day their losses are capped at the $10bn number (whether losses are generated by defaults or spread widening). This amounts to about 160 bp of spread widening in the underlying portfolios assuming an average duration of 4.5.

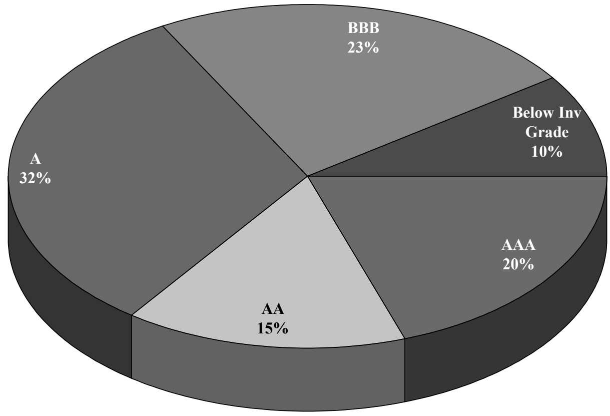
chapter 30

RATINGS ANALYSIS

While officially rated tranches remain a small part of the market ($70 billion on a delta-adjusted basis, or 20% of the distributed credit risk), they are indeed very visible and are a key motivator for many investors. On a delta-adjusted basis, the bulk of issuance (65%) is in mezzanine tranches rated A, BBB, and below investment grade.

exhibit 6

Ratings Distribution (Delta-Adjusted, 2004 Forward)



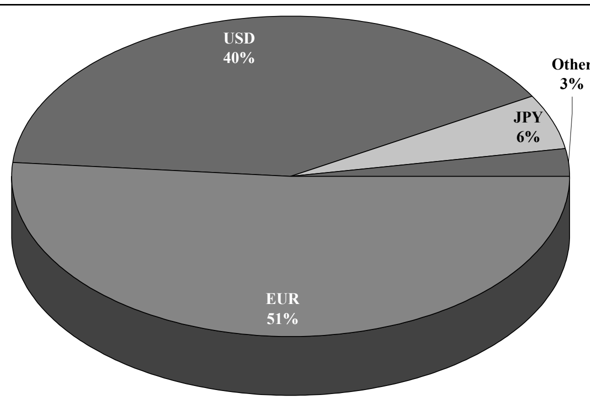
Source: Morgan Stanley, Creditflux

INVESTOR DOMICILE

The specified currency of notionals gives us some indication of the domicile of investors, and the results are not at all surprising. About one-half of the credit risk (which is global in nature) is specified in euros, with 40% being in US dollars. In a distant third is Japanese yen, with the remaining scattered through 11 other European and Asian currencies.

exhibit 7

Specified Currency of Notional



Source: Morgan Stanley, Creditflux

WHAT CAN WE GLEAN FROM THIS ANALYSIS?

As most market participants have suspected, there is a substantial amount of credit risk that has been transferred into synthetic structures and distributed to end investors. At $350 billion of credit risk (delta-adjusted and comprised of global credits) over the past year, this volume dwarfs cash CDO issuance and is on par with net issuance in the US corporate bond markets. Furthermore, the market is likely larger than these estimates, given that our data set only represents a subset of the market.

Yet, credit market participants should give importance to two points. First, we believe that quite a bit of levered credit risk has been placed in the hands of investors who are less likely to sell the risk unless there is a sharp deterioration in the underlying portfolios. Second, in the event of a sharp deterioration in these portfolios, the CDO technology employed leaves the end investors with limited ultimate losses, given the non-recourse leverage in the structures.

Section E

Structured Credit Insights

Performance

Please see additional important disclosures at the end of this report.

chapter 31 CDO Performance – Unplugged

November 14, 2003

Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar

The significant transformation of the $400 billion CDO secondary market this year has, among other things, given structured credit investors an important source of performance information. In a market plagued for years by a lack of transparency, the liquidation of one of the world's largest CDO senior note portfolios gave birth to secondary market liquidity, which has subsequently moved well beyond this one flow. From the moment we started researching the CDO market, we have been asked to estimate performance for the market. Without an active secondary market, hypothetical performance calculation was the only alternative. The results of hypothetical calculations tended to be somewhat amplified and far from pure (which we thankfully avoided).

A SIMPLE SENIOR NOTE STUDY

Today, we feel confident enough to take a first look at CDO performance, although pricing information in the market is still somewhat fragmented. We therefore focus on a universe of over 100 floating rate senior notes for which we have monthly pricing information since inception (deals originating from 1995-2002). So how does it look? In a nutshell:

- Senior notes have lost 1.3% on average per year, in excess of Libor. If the Libor component is included, the average performance would have been positive, but the focus in this study is on excess returns rather than on total returns.
- Senior notes backed by leveraged loans have been the best performers (down less than 0.1% annually), while deals backed by high yield bonds were down 2.4% and investment grade cash bonds (synthetic not included) lost 3.0% on average.
- Leveraged loan and emerging markets senior notes have exhibited the least return volatility (within the universe), while similar tranches from investment grade cash and high yield bond deals have experienced significantly more volatility.
- 2003 returns (year-to-date) have been dramatic: up 7.6% for the universe and 15.5% for high yield bond backed senior notes.
- AAA senior notes have significantly outperformed AAs (-0.2% vs. -2.9%). Leveraged loan AAAs are the best performing at 0.5% annually.
- Wrapped AAAs returned 0.2% on average. With high yield bond collateral, wrapped AAAs outperformed unwrapped AAAs (0.4% vs. -0.8%), but the opposite was true with leveraged loan collateral (0.2% vs. 0.5%).
- 1999 was the worst cohort for both AA- and AAA-rated senior notes from high yield deals. 1996 and 1997 were the best.
- For the AAA-senior notes of leveraged loan transactions, 2000 was the worst cohort, while 2002 was the best. For AAs, 2001 was the worst and 1999 was the best.

exhibit 1	A First Look at CDO Performance – Senior Notes: Excess Returns over Libor				
Collateral	**Since Inception**	**2001**	**2002**	**2003 YTD**	**Std Dev of Returns**
Emerging Markets	-0.2%	-0.4%	-1.6%	3.3%	0.5%
High Yield Bonds	-2.4%	-3.6%	-16.2%	15.4%	4.5%
US Leveraged Loans	-0.1%	0.1%	-3.6%	2.9%	1.7%
European Leveraged Loans	0.0%	0.1%	-1.1%	-1.7%	1.1%
Investment Grade (Cash)	-3.0%	-0.2%	-13.8%	5.2%	5.1%
Total (Senior Notes)	-1.3%	-1.9%	-10.6%	7.6%	3.6%

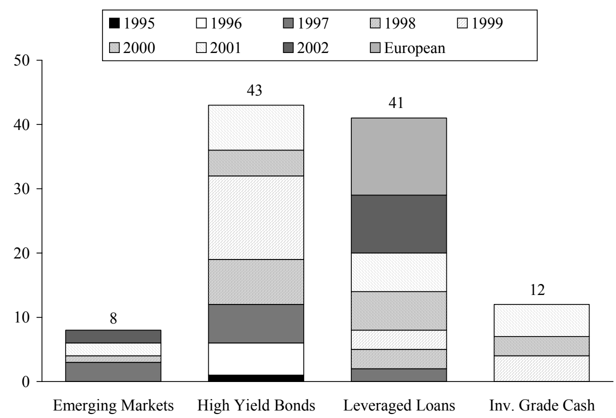
Source: Morgan Stanley

THE UNIVERSE AND METHODOLOGY

For this study, we included a total of 108 senior notes from deals that originated during the 1995 to 2002 period, where we have consistent monthly pricing information (see Exhibit 2). We included 43 high yield bond senior notes, 41 senior notes from leveraged loan transactions (including 12 from Europe), 12 investment grade cash senior notes, and eight from emerging markets. We excluded synthetic deals because the senior part of the capital structure is generally issued as a default swap, not a funded security.

exhibit 2

Profile of Our Senior Note Sample



Note: Four deals in the universe were categorized as "Other."
Source: Morgan Stanley

We calculated performance as excess return over Libor. Therefore, the return of each instrument during a month was based on percentage change of the flat price of the security, taking into consideration accrued interest from the excess coupon (above Libor) on the instrument. For example, a floating rate note with a Libor + 50 bp coupon priced at 99.0 with zero accrued at the end of month one and 99.5 at the end of month two would have an excess return of 0.55% for month two (equal to ((99.5 + (0.50/12))/99.0 -1). Aggregate returns are simple averages of individual tranche returns. Prices are mid-market.

THE PERFORMANCE BOOMERANG: 2002 VS. 2003

The sharp rally and compression of spreads in underlying credit markets during 2003 has had a resounding impact on CDO performance. Many floating rate senior notes trade at or near par (the median price in our universe is $97), which was simply unthinkable a year ago. Senior notes backed by high yield bonds had the most room to run, returning 15.5% this year, compared to being down 16.2% during 2002. The range of returns was from close to 0% to nearly 64% for these notes. Investment grade cash deals also had some room to run, and rallied over 5% in excess of Libor this year. Our limited universe in this sector was down nearly 14% in 2002, so the relative retracement has not been as strong as in high yield. Emerging markets senior notes (which are dominated by AA-rated securities) have rallied 3.3% above Libor this year, which is far less than high yield, even though the underlying markets have had a terrific run, but this can be explained by ratings (see below). In leveraged loans, 2003 returns are nearly 3%, while last year the universe was down 3.5%. European leveraged loan senior notes are the only sub-sector that has generated negative returns during 2003, which we attribute to weaker secondary market liquidity, compared to US-originated transactions.

As a matter of comparison, excess returns (above Treasuries) in investment grade corporate bonds this year have been close to 5%; in high yield, excess returns have been over 20%.

AAAS OUTPERFORM AAS – WERE WRAPS NECESSARY?

The most important insight we gather from looking at the performance of senior notes across ratings is that the numbers reflect the fact that these structures are not necessarily free of impairment or stress. AA performance has lagged AAAs across the board since inception (-2.9% vs. -0.2%, based on original ratings). Within US leveraged loan deals, AAAs are up 0.5%, while AAs are down 0.4%. In both investment grade and high yield transactions, AAA notes are down about 0.8%. But the performance of AAs is uglier, with investment grade deals down 12.2% and high yield bond deals down 4.3%.

Were wrapped securities necessary? Wrapped leveraged loan senior notes underperformed unwrapped AAAs (0.2% vs. 0.5%), but significantly outperformed in the high yield bond space (0.4% vs. -0.8%).

exhibit 3 AAAs Outperform AAs; Wraps Help High Yield But Not Leveraged Loans

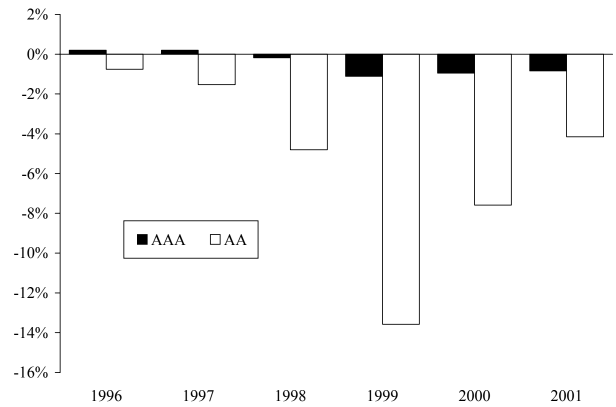
	AAA Wrapped	AAA	AA
Emerging Markets	-0.2%		-0.4%
High Yield Bonds	0.4%	-0.8%	-4.3%
US Leveraged Loans	0.2%	0.5%	-0.4%
European Leveraged Loans		0.1%	-0.9%
Investment Grade (Cash)	-0.1%	-0.8%	-12.2%
Total	0.2%	-0.2%	-2.9%

Source: Morgan Stanley

CREDIT CYCLICALITY: A LOOK AT COHORTS

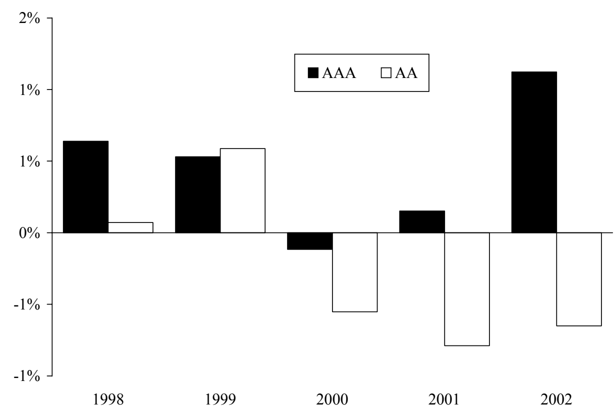
The cohort effect was most dramatic in high yield bond transactions, as one would expect, given the incredibly cyclical nature of default rates and the tendency for such deals to include new issuance. AAA and AA performance was in sync for high yield deals: 1999 was the worst year, while 1996 and 1997 were the best.

exhibit 4
High Yield – Cohort Performance (Since Inception) Highlights Credit Cycles



Source: Morgan Stanley

exhibit 5
Leveraged Loans Cohorts



Source: Morgan Stanley

In the much more stable leveraged loan space, AAAs had positive performance since inception for all cohorts except 2000, while the performance of AAs reflects the credit cycle, albeit in a more muted way than in high yield.

CONCLUSION – WHAT'S THE VALUE OF (NEGATIVE) CONVEXITY?

What are the trades to do? We argue that AAA- and AA-rated notes in most CDOs (backed by corporate credit) are negatively convex. Yet, that negative convexity may not be worth much to investors who are bullish on the credit markets over the medium term. We feel there is still value in many AA-rated senior notes for bullish investors. However, getting short the AAA notes is a worthwhile strategy (which can implemented via total return swaps) for bearish investors. The package, positive carry trade is to get long AAs and short the AAAs, which performs well if markets remain healthy and mitigates the downside if markets sell off.

chapter 32 Leverage and Long-Lasting Milk

January 16, 2004

Sivan Mahadevan
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One of the biggest risks in levered long-structured credit strategies is idiosyncratic defaults, particularly when they happen quickly. Anyone involved in the synthetic CDO market during 2001 and 2002 has experience with this phenomenon. Two years forward, the character of this market has changed dramatically, but there is still idiosyncratic default risk out there. Given the dramatic improvements in pricing transparency, the impact of the Parmalat bankruptcy offers a lot of insight into the risks of structured credit investing in today's markets.

Parmalat is an idiosyncratic or "low correlation" event, meaning its credit issues had virtually no impact on the rest of the market. Protecting against such events is difficult unless the credits in question are individually hedged. Parmalat was in the Dow Jones Euro TRAC-X Index and was a common name in synthetic CDOs as well. Any investor who is long subordinate tranches is exposed to this idiosyncratic default risk to a fairly significant degree. Conventional wisdom dictates hedging some of this idiosyncratic risk, but hedging only a fraction of the risk is economically possible, and even then dynamic hedging strategies may not always work.

We focus this chapter on describing both the ratings and mark-to-market impact of the Parmalat bankruptcy (as it unfolded) on structured credit, comparing actual pricing with what the models would have predicted. We also review how dynamic delta hedging strategies would have played out and offer some ideas to investors who seek to distinguish idiosyncratic default risk from market-wide risks.

THE PARMALAT IMPACT ON BENCHMARK PRICING

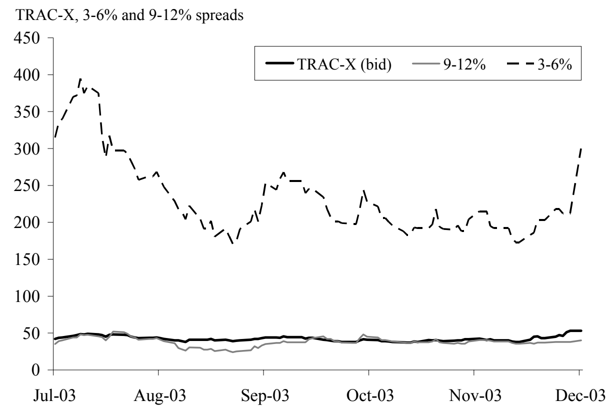
Parmalat was a name that traded wide (200 bp) relative to the rest of the European investment grade market (40 bp) for most of 2003. In early November 2003, Parmalat spreads marched higher and stayed in the 500-600 bp range for two weeks before blowing out much further in mid-December. Parmalat filed for bankruptcy on December 24th.

The initial 400 bp move in Parmalat had a 4 bp impact on the Dow Jones Euro TRAC-X portfolio (given its 1% contribution, although other credits tightened). The 0-3% tranche of the Dow Jones Euro TRAC-X moved 10 points (on an upfront basis) as a result of the initial move wider in Parmalat (see Exhibit 1). The 3-6% tranche widened 20 bp. The impact Parmalat had on more senior tranches was smaller than on the portfolio directly, reflecting the pivot point of leverage. The 9-12% tranche widened less than the 4 bp widening caused by Parmalat.

Once Parmalat filed for bankruptcy, the 3-6% tranche widened an additional 80 bp (for a total of 100 bp) while the 9-12% tranche moved out an additional 2 bp, still outperforming the Dow Jones Euro TRAC-X portfolio. The overall loss on the 0-3% tranche is approximately 28.7%, with 26.7% attributed to the Parmalat default payments, and 2% attributed to repricing the (now thinner) equity tranche on the 99-name portfolio.

exhibit 1

The Parmalat Effect – Subordinate Tranches Feeling the Impact



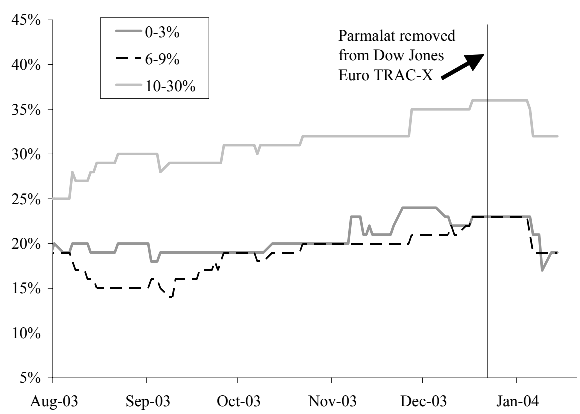
Note: Shows the spreads of Dow Jones TRAC-X Europe and tranches.
Source: Morgan Stanley

In our view, the correlation moves on all tranches were not significant, which suggests that market behavior was consistent with the notion that it was an idiosyncratic event, with little impact on risk appetite going forward (see Exhibit 2). This effectively means that market pricing and expected pricing from the models should have been consistent. We discuss this further below.

Yet, since the Parmalat bankruptcy, the implied correlation on the new 99-name European portfolio has been somewhat lower (for all tranches, see Exhibit 2). We attribute this to less demand for selling protection on subordinate tranches (which are long correlation trades) and more demand for selling protection on senior tranches (which are short correlation trades). This translates into greater demand for higher levels of subordination, which makes sense given increased fears of idiosyncratic default risk.

exhibit 2

Correlation Falls After Parmalat



Note: Shows the spreads of the Dow Jones TRAC-X Europe and implied correlation of tranches.
Source: Morgan Stanley Research

TRADING STRATEGIES – TESTING THE MODELS

A risk in many of today's structured credit strategies is that their performance deviates dramatically from model-predicted levels under adverse conditions. Risk managers and investors can lose a lot of sleep worrying about this. While there is no guarantee that the models will always work, model-based valuations were definitely in the right ballpark with respect to the Parmalat move and eventual default. As we noted above, we did not see big or unexplainable moves in correlation, which would generally be harbingers of modeling problems. Nevertheless, it is interesting to observe model-predicted values (see Exhibit 3) and compare them to actual pricing.

exhibit 3 Tranche Price Moves Relative to Underlying Portfolio

Tranche	1 Credit Goes to 500 bp	1 Credit Goes to 1,500 bp	1 Credit Defaults (20% Recovery)
0-3%	22.5x	22.1x	35.3x
3-6%	5.8x	4.3x	3.7x
6-9%	1.4x	0.9x	0.2x
9-12%	0.6x	0.3x	0.4x
12-22%	0.1x	0.1x	0.1x

Source: Morgan Stanley

As an example, the pricing model tells us that if a wide credit in a 40 bp portfolio widens to 500 bp, the 0-3% tranche should move 22.5 times the underlying portfolio. The move we observed in the 0-3% tranche was certainly of this magnitude: 7 bp on the portfolio times a spread duration of 4.5 equals a 0.31 price move on the Dow Jones Euro TRAC-X, which, if we multiply by 22.5 equals approximately 7 points. This is reasonably close to the initial move on the 0-3% tranche given that Parmalat actually widened beyond 500 bp in the period.

For the 3-6% mezzanine note, the price move for a similar change in one credit is roughly 6 times the underlying portfolio, which again matches the initial move we saw as a result of Parmalat (4 bp * 6 = 24 bp). As a result of the default with recovery at 20%, the 3-6% should move approximately 4 times the underlying, according to the model. The 20 bp move on Dow Jones Euro TRAC-X (if the defaulted Parmalat is included) was a factor of 5 smaller than the 100 bp move on the 3-6% tranche.

DYNAMIC DELTA HEDGING

For those who protected their subordinate tranches (and many did) against a Parmalat default, the deltas that come out of these models are fairly important, as they provide guidance regarding how much single-name protection to purchase. We show the approximate single-name deltas for an average credit in Dow Jones TRAC-X NA in Exhibit 4. Assuming a $30 million 0-3% tranche exposure, it is interesting to observe that an average credit has a delta of $4.2 million (14%). The delta rises to $8.7 million (29%) if the credit becomes distressed. The maximum exposure to a single name is $10 million (33%).

For mezzanine and more senior tranches, the deltas tend to fall as a single credit becomes distressed (indicating a low i-gamma) because of the increased probability of that credit defaulting and impacting only the most subordinate tranche (which has a high i-gamma), leaving the mezzanine and senior tranches with less subordination to a lower yielding portfolio.

exhibit 4 Deltas to an Average Credit Getting Wider

	Initial Delta	Delta with Credit at 500 bp	Delta with Credit at 1000 bp
0-3%	14%	23%	29%
3-7%	6%	5%	4%
7-10%	1%	1%	0%

Source: Morgan Stanley

FUNDED NOTES – WATCH OUT FOR RATINGS ACTIONS

Parmalat is a common credit in synthetic CDOs. Fitch estimates that EUR 700 million of Parmalat exposure is included in the 69 deals it has rated. Moody's has rated 65 CDOs with approximately EUR 600 million of Parmalat exposure in total (there is overlap in these two universes). On December 24, Fitch put 29 securities from 11 public CDOs and an additional 24 tranches from 22 private CDOs on ratings watch negative. Parmalat exposure in these transactions ranged from 0.20% of the underlying collateral to an astonishing 5%. Moody's has found portfolio exposure to be between 0.13% and 1.33% for synthetic CDOs, and between 1.2% and an even more astonishing 6.3% for four cash flow CDOs it has rated. Fitch's actions, at that time, were based on expectations of a 40% recovery rate, but with bonds trading closer to 20% now, there could be more severe ratings actions by that agency. To date, Fitch has downgraded one CDO transaction; Moody's has downgraded several. We expect many more downgrades as the agencies plow through all of the deals in their respective universes.

Synthetic CDO equity tranches, which are generally not rated even if they are issued as funded securities, were largely held by the dealer community and prop desks, based on our experiences. Given that Parmalat was always a wide-trading credit, we believe that most dealers dynamically delta hedged Parmalat prior to the events, and certainly during the march toward bankruptcy. Dynamic delta hedging does not guarantee the avoidance of loss though, as such a strategy is highly dependent on recovery rate views and the cost of protection purchased. Given expectations for a low recovery, we do believe that there will be losses in broker-dealer correlation books, but those losses may not be significant. As for hedge funds, we would not be surprised to see a significant loss somewhere, owing to equity or levered mezzanine tranches.

POSITIONING FOR IDIOSYNCRATIC DEFAULTS?

The recent spread widening of Adecco (a name in the Dow Jones Euro TRAC-X Index which recently announced that it expects the audit of its financial statements for 2003 to be delayed) is a reminder that more idiosyncratic credit risk exists in the markets. How can investors position for such events? We have recommended buying protection on senior tranches (10-15% for example) as a hedge against market-wide moves in spreads. But, as the Parmalat episode has shown, such tranches move less than the underlying market when single-name events occur. Individual "bolts from the blue" have a much bigger impact on more subordinate tranches. For investors looking to play such events, buying protection on mezzanine-type tranches is one way to implement the view, but we caution that such trades have large negative carry and can suffer significantly if spreads tighten. The trade only makes sense for those with a conviction that more idiosyncratic events are to come.

chapter 33

Understanding Asymmetry in CDO Ratings Migration

February 11, 2005

Vishwanath Tirupattur
Sivan Mahadevan

One concern we hear from CDO investors pertains to the ratings stability of the debt tranches. In theory, typical CDO structures have built-in features that should facilitate relative stability of the ratings of debt tranches. In practice, this expected ratings stability has not materialized to the extent many investors had hoped for. Indeed, some CDOs have experienced drastic downgrades[1], unheard of in other asset classes, in terms of frequency, severity and the relatively short time over which such downgrades have happened. Notwithstanding the recent pickup in the upgrade-downgrade ratio in CDOs backed by corporate credit, the negative experiences from the last downturn in the credit cycle seem to linger in the minds of some CDO debt investors.

On the other hand, we are also cognizant of the general criticism about structured credit ratings that rating agency actions are not necessarily reflective of "true" credit quality observed in market prices of credit-sensitive instruments. Proponents of this school of thought point to methodological biases, lack of timeliness and the subjectivity associated with rating actions. We are not unsympathetic to the analytical underpinnings of such criticism. Still, it seems to us that until another all-encompassing metric for CDO tranche credit quality emerges and becomes as universally used, rating actions will continue to matter to CDO market participants. Consequently, we surmise that an analysis of rating actions history is a useful step in understanding CDO performance.

In this report, we analyze a large database[2] of Moody's CDO rating actions during the period 1992-2004 to provide a historical perspective over a reasonably large time frame covering the troughs and peaks of a full credit cycle. While there is a clear asymmetry in CDO rating actions in terms of the number of upgrades to downgrades (a lot more tranches have been downgraded than upgraded), we find a substantial degree of variability in ratings actions over time and across different vintages and CDO types. Rating actions are clearly reflective of developments in the underlying collateral sectors; yet, there are time lags and substantive differences between rating actions in the underlying sectors and in CDO tranches. We discuss some reasons why much of this asymmetry is not entirely unsurprising and provide our views on what to expect in terms of rating actions going forward.

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[1] *For example see "Russian Doll," The Economist, September 23, 2004.*
[2] *Monthly updates of "CDO Rating Changes Excel Data Supplement" obtained from Moody's Investors Service website.*

DATA

The data we used encompassed more than 1,800 CDO rating actions by Moody's covering more than 800 CDO tranches. The database predominantly covers US deals, which clearly dominate the outstanding universe of rated CDO tranches. We have treated *pari passu* tranches as one tranche to avoid manifold counting of rating actions in CDOs with multiple tranches with the same rating. Further, we did not consider insured tranches. It must be noted that our dataset did not include withdrawn ratings. Moody's generally considers withdrawn ratings to be an indicator of a strong credit performance since most withdrawn ratings are for tranches that have received full payment of principal and all accrued interest.

In sum, we had 1,528 rating actions in the dataset – 1,467 downgrades and 61 upgrades. We used the rating prevalent immediately preceding the rating action to determine if it is a downgrade or an upgrade action, as opposed to using the rating at the beginning of the year like in some other comparable studies. Where there have been multiple rating actions in a given year in one tranche, we have counted each such action separately and have *not* treated them as one, as in some rating agency studies. Finally, while the results reported here are in terms of the number of tranches, the same analysis was also performed in terms of initial dollar par volume. The results are qualitatively similar to those reported here and available to interested readers.

CDO DOWNGRADES: IS THERE A PATTERN?

Rating agency studies[3] indicate that when evaluated as a single sector, CDO downgrade rates are similar to those of corporate securities. Based on average one-year transition rates, downgrades in CDO tranches were similar to those in corporate securities in general. However, significant variations may be noted across different vintages, CDO types and initial ratings when rating actions are examined over a relatively longer time frame.

The figures in Exhibits 1 through 4 are percentages of total downgrades or upgrades in our sample of rating actions. It is worth pointing out that the outstanding number of CDOs has risen dramatically over the years. The universe of CDO tranches that could have experienced a rating action in 2004 is about 35% larger than the same in 2002, the year of the largest number of downgrade actions. In this context, we find it noteworthy that downgrades in 2004 accounted for merely 11.1% of all downgrades. The most significant observation regarding upgrades is that there were only 61 of them in our dataset out of a total of over 1,800 rating actions.

[3] *See for example, "Credit Migration of CDO Notes, 1996-2003, for US and European Transactions," Moody's Investor Service, March 4, 2004.*

chapter 33

exhibit 1 Moody's CDO Rating Actions by Vintage

(% of Total Downgrades)

Vintage Year	Year of Rating Action 1992	1998	1999	2000	2001	2002	2003	2004	Grand Total
1990	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1995	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2
1996	0.0	0.1	0.3	0.1	0.5	2.3	0.5	0.1	4.0
1997	0.0	0.9	0.8	1.8	2.3	4.5	1.4	0.6	12.2
1998	0.0	0.2	0.6	1.2	3.6	8.7	2.0	0.7	16.9
1999	0.0	0.0	0.0	0.0	2.0	17.8	6.5	1.1	27.5
2000	0.0	0.0	0.0	0.0	0.8	5.4	11.3	4.7	22.2
2001	0.0	0.0	0.0	0.0	0.1	5.5	5.9	3.0	14.5
2002	0.0	0.0	0.0	0.0	0.0	0.3	1.2	0.8	2.3
2003	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
Grand Total	0.1	1.2	1.6	3.1	9.4	44.6	28.9	11.1	100.0

(% of Total Upgrades)

Vintage Year	Year of Rating Action 1997	1999	2000	2001	2002	2003	2004	Grand Total
1996	1.7	0.0	0.0	0.0	1.7	1.7	0.0	5.1
1997	0.0	1.7	3.4	5.1	8.5	1.7	1.7	22.0
1998	0.0	0.0	0.0	0.0	3.4	1.7	8.5	13.6
1999	0.0	0.0	0.0	1.7	3.4	1.7	8.5	15.3
2000	0.0	0.0	0.0	0.0	0.0	10.2	3.4	13.6
2001	0.0	0.0	0.0	0.0	0.0	20.3	3.4	23.7
2002	0.0	0.0	0.0	0.0	0.0	1.7	0.0	1.7
2003	0.0	0.0	0.0	0.0	0.0	3.4	0.0	3.4
2004	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.7
Grand	1.7	1.7	3.4	6.8	16.9	42.4	27.1	100.0

Source: Moody's and Morgan Stanley Calculations

CDO RATINGS ACTIONS LAG

Nearly three-quarters of CDO downgrades took place during 2002 and 2003 when corporate credit was the predominant underlying collateral in the outstanding CDO universe. Out of 1,466 downgrade actions in our sample data, 1,077 downgrades took place in 2002 and 2003. Recall that during the last credit cycle, the corporate bond default rate peaked in 2001 and continued at a relatively high level in 2002 before declining in 2003 and continuing to do so in 2004. Average recovery rates, both for senior secured and unsecured credits bottomed in 2001 and continued at low levels during 2002 before picking up in 2003. In other words, corporate credit loss rates reached their peak levels in 2001-02, while the CDO downgrade activity peaked in 2002-03. This suggests that there is a clear lag between the timing of losses in the underlying sector and their reflection in the ratings of CDO tranches. Further, the effects of substantial improvements in the corporate credit environment through 2004 are still in the process of being reflected in rating actions of corporate credit-backed CDOs. As such, it seems reasonable to expect continuing upgrade activity in corporate credit CDOs.

Similar lags in rating actions are also evident in the case of ABS CDOs and their underlying sectors (see “The Usual Suspects,” December 17, 2004). The nature of the underlying collateral and delays inherent in compiling data necessary to take rating action create a double lag effect in structured finance deals.

IS THERE A VINTAGE EFFECT?

There is a noticeable vintage effect in CDO downgrades – 1998, 1999 and 2000 vintage deals contributed to over two-thirds of all downgrades. Arbitrage CBOs with high yield bonds as underlying collateral were the source of a vast majority of the downgrades observed in the 1998-2000 vintage years of issuance. While we do not have data that precisely match CDO rating actions with CDO issuance by vintage and collateral type, from the issuance data we have, it appears that as many as three-quarters of CBOs with high yield bonds as collateral issued during 1998-2000 may have experienced at least one downgrade action.

Even though 1997 and 2001 deals constitute the majority of upgrades, given the relative paucity of upgrades, we hesitate to posit an obvious vintage effect in CDO upgrades.

CLOs VERSUS CBOs: DIVERGENT PERFORMANCE

Arbitrage CBOs with high yield bonds as underlying collateral accounted for nearly two-thirds of all CDO downgrades. In stark contrast, the share of CLOs was only 5.7%, which was also smaller than the share of CBOs with investment grade corporate credit as underlying collateral. Note that outstanding CLO notes are more than 30% higher than outstanding high yield CBO notes.

The explanation for this superior performance of CLOs relative to all shades of CBOs lies in the performance of the leveraged loan sector. Default frequency and severity in high yield loans have historically been significantly lower than that of high yield bonds. A recent report from Moody’s points out that three-year cumulative credit loss rates on similarly rated loans and bonds have been 1.5 to 2.0 times as great in corporate bonds as in corporate loans[4]. We posit that the differences in realized loss experience between high yield loans and bonds have not been adequately reflected in Moody's rating methodology, which might be an explanation for the stark differences in the proportion of downgrades between CDOs with high yield bonds and loans as underlying collateral.

exhibit 2 Moody's CDO Rating Actions by CDO Type

(% of Total Downgrades)

CDO Type	Year of Rating Action 1992	1998	1999	2000	2001	2002	2003	2004	Grand Total
HY Bond CBO	0.0	0.4	1.1	2.5	6.1	32.7	15.2	3.2	61.1
IG Bond CBO	0.0	0.0	0.0	0.0	0.0	1.8	3.9	0.2	5.9
EM Bond CBO	0.0	0.8	0.0	0.2	0.3	0.3	0.0	0.1	1.7
Leveraged Loan CLO	0.1	0.0	0.3	0.3	0.5	1.8	2.5	0.1	5.7
Synthetic CDO	0.0	0.0	0.0	0.0	0.1	2.9	2.3	0.1	5.3
ABS CDO	0.0	0.0	0.0	0.0	0.0	0.3	3.0	6.8	10.1
Balance Sheet CDO	0.0	0.1	0.3	0.1	2.4	3.9	1.3	0.4	8.4
Other CDO	0.0	0.0	0.0	0.1	0.1	1.0	0.7	0.0	1.8
Grand Total	0.1	1.2	1.6	3.1	9.4	44.6	28.9	11.1	100.0

(% of Total Upgrades)

CDO Type	Year of Rating Action 1997	1999	2000	2001	2002	2003	2004	Grand Total
Balance Sheet CDO	0.0	0.0	0.0	0.0	5.1	11.9	0.0	17.0
HY Bond CBO	1.7	0.0	0.0	0.0	1.7	6.8	20.3	30.5
EM Bond CBO	0.0	0.0	3.4	5.1	10.2	1.7	0.0	20.3
Leveraged Loan CLO	0.0	1.7	0.0	0.0	0.0	13.6	5.1	20.4
ABS CDO	0.0	0.0	0.0	1.7	0.0	3.4	0.0	5.1
SYNTHETIC CDO	0.0	0.0	0.0	0.0	0.0	5.1	1.7	6.8

Source: Moody's and Morgan Stanley Calculations

Synthetic CDOs, both of the arbitrage and balance sheet variety and structured finance CDOs combined the bulk of the rest of the downgrades. It may be noted that while downgrades were down significantly in 2004 generally and across different CDO types, reflecting the recovery in the credit cycle, structured finance CDOs have shown an uptick. Structured finance CDOs accounted for 100 of the 162 downgrades in 2004. Continuing deterioration in manufactured housing, aircraft and franchise loan sectors is the underlying cause of downgrades in structured finance deals. We expect this trend to continue in 2005.

[4]*See "Credit Loss Rates on Similarly Rated Loans and Bonds," Moody's Investor Service, December 2004.*

exhibit 3 Moody's CDO Rating Actions by Initial Rating

(% of Total Downgrades)

Initial Rating	Year of Rating Action 1992	1998	1999	2000	2001	2002	2003	2004	Grand Total
Aaa	0.0	0.0	0.0	0.0	0.4	4.7	3.7	2.0	10.8
Aa1	0.0	0.0	0.0	0.1	0.1	1.0	0.4	0.1	1.8
Aa2	0.1	0.2	0.3	0.7	1.3	5.9	3.9	2.1	14.5
Aa3	0.0	0.1	0.0	0.1	0.1	2.5	0.9	0.3	4.0
A1	0.1	0.0	0.0	0.0	0.1	0.3	0.1	0.1	0.7
A2	0.0	0.2	0.1	0.0	0.3	1.4	1.2	0.3	3.5
A3	0.0	0.0	0.0	0.1	0.2	2.2	3.3	1.1	6.8
Baa1	0.0	0.0	0.1	0.0	0.1	0.8	0.1	0.1	1.2
Baa2	0.0	0.0	0.0	0.2	1.2	9.1	8.0	3.1	21.8
Baa3	0.0	0.5	0.9	1.2	2.3	7.1	2.2	0.9	15.1
Ba1	0.0	0.0	0.0	0.0	0.1	0.3	0.1	0.0	0.5
Ba2	0.0	0.0	0.1	0.3	1.1	3.9	2.5	0.5	8.3
Ba3	0.0	0.0	0.1	0.0	0.4	2.5	2.1	0.5	5.6
B1	0.0	0.1	0.1	0.3	1.1	2.0	0.2	0.0	4.0
B2	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.3
B3	0.0	0.0	0.0	0.1	0.3	0.8	0.1	0.0	1.3
Grand Total	0.1	1.2	1.6	3.1	9.4	44.6	28.9	11.1	100

(% of Total Upgrades)

Initial Rating	Year of Rating Action 1997	1999	2000	2001	2002	2003	2004	Grand Total
Aaa	0.0	0.0	0.0	0.0	0.0	3.4	5.1	Aaa
Aa2	1.7	0.0	1.7	1.7	6.8	5.1	8.5	Aa2
Aa3	0.0	0.0	0.0	0.0	0.0	1.7	1.7	Aa3
A1	0.0	0.0	0.0	0.0	0.0	3.4	0.0	A1
A2	0.0	0.0	0.0	1.7	6.8	1.7	1.7	A2
A3	0.0	0.0	0.0	0.0	0.0	5.1	3.4	A3
Baa1	0.0	0.0	0.0	0.0	0.0	3.4	1.7	Baa1
Baa2	0.0	0.0	0.0	0.0	1.7	5.1	3.4	Baa2
Baa3	0.0	0.0	1.7	1.7	1.7	5.1	1.7	Baa3
Ba1	0.0	0.0	0.0	0.0	0.0	6.8	0.0	Ba1
Ba2	0.0	0.0	0.0	1.7	0.0	1.7	0.0	Ba2
Ba3	0.0	1.7	0.0	0.0	0.0	0.0	0.0	Ba3
Grand	1.7	1.7	3.4	6.8	16.9	42.4	27.1	100

Source: Moody's and Morgan Stanley Calculations

Exhibit 3 summarizes ratings actions based on the initial ratings of the CDO tranches. *A priori*, one might have hypothesized that tranches rated towards the lower end of the ratings spectrum would experience a relatively large proportion of downgrades. However, CDO tranches with an initial rating of Baa2/Baa3 have experienced the most downgrades in our study, accounting for 37% of total downgrades. The relative paucity of tranches with an initial below-investment grade rating probably explains this difference, reflective of typical CDO capital structures at issuance. While a similar explanation may be advanced for CDO tranches with an initial rating of Aa (20.3%) accounting for a higher proportion of downgrades than tranches with an initial rating of A (11%), we are not convinced. That tranches with an initial Aaa rating account for 10.8% of total downgrades, about the same as those with an initial A rating, is also surprising.

Exhibit 4 shows the average number of notches a tranche has been downgraded across CDO types given its initial rating – a measure of downgrade severity. Within the investment grade range of ratings (based on initial rating), we note that average downgrade severity has been relatively modest in arbitrage CLO transactions and most severe within structured finance CDO transactions.

exhibit 4 Average Number of Notches Downgraded

Initial Rating	CDO TYPE						
	RESEC	CBO-ACF	CLO-ACF	IG CBO-ACF	CDO-EM	SYNTHETIC-ARBIT	BS-SYNTHETIC
Aaa	2.8	2.5		2.0		1.7	1.6
Aa1		2.6		3.0		1.0	1.0
Aa2	3.6	2.8	1.4	3.4	2.0	2.0	2.9
Aa3	2.6	2.6	1.3		2.0	3.0	2.9
A1	4.0		2.0	6.0		3.0	2.2
A2	4.8	3.7		4.0	2.3	1.8	2.9
A3	4.1	2.7	2.8	3.5		2.5	1.0
Baa1		2.8		3.3			3.0
Baa2	4.4	3.1	2.5	4.1	4.5	2.8	2.7
Baa3	4.2	3.1	2.9	2.5	2.8	3.8	
Ba1		2.0		8.0			3.8
Ba2	4.3	3.8	2.9	1.0	3.0		2.7
Ba3	6.2	4.0	4.0	3.6			3.0

Source: Moody's and Morgan Stanley Calculations

DOWNGRADE/UPGRADE RATIO: WHY SO HIGH?

On the face of it, the ratio of downgrades to upgrades seems extremely lopsided in favor of downgrades. Based on that, one might be tempted to conclude that the CDO ratings performance is much worse than other competing asset classes. One may also wonder why the recovery in the macro economic environment over the last few years and the substantial improvement in the credit cycle, reflected in spread tightening across all asset classes including CDO tranches, is not similarly reflected in their ratings performance. While we will not dispute that this ratio is somewhat higher in CDO tranches relative to other asset classes, at least based on the time period covered by sample data, we argue that jumping to conclusions about the CDO sector relative to other asset classes based on this data alone may be misleading. Compared to several other asset classes, the ratings history of CDO tranches is relatively short. Secondary trading activity, a clear impetus for investors to demand timely rating agency actions, is limited compared to other fixed income instruments. With the expected pick-up in secondary trading of CDO tranches, we expect greater demands on rating agencies by market participants. We further maintain that there are structural and implied leverage reasons that explain why the relatively high downgrade/upgrade ratio in CDO tranches is not entirely surprising.

The main reasons for downgrades of CDO tranches are: defaults in the underlying collateral resulting in erosion of subordination, deterioration in the credit quality of the underlying collateral (as measured by negative ratings migration), failure of excess collateralization tests and to a lesser extent, violation of covenants.

Transactions that have experienced defaults and have had par losses are unlikely to receive rating upgrades as credit quality of the remaining collateral improves. When coupled with worse than average recovery levels, as has been the case since the 2001-02 downturn in the credit cycle, the effect is further magnified. High yield CBOs of 1998, 1999 and 2000 vintages not only had negative migration of ratings in their underlying collateral but also experienced a high degree of defaults in the underlying collateral with lower than average recoveries. These are unlikely to get upgraded significantly relative to their initial ratings even if the remaining collateral experiences a positive ratings migration until significant de-levering takes place. We are beginning to see some upgrade activity as a consequence of such de-levering, which we expect to continue going forward.

CDOs are levered financial instruments and, as such, are likely to experience a disproportionate impact from rating changes. Every default and every negative rating action in the underlying collateral affects multiple tranches of a deal. As such, measured in raw counts of downgrades, this is bound to have a magnified impact. If a lot of downgrades and defaults occur at the same time, as they did in 2000 and 2001, multiple tranches of a CDO will be affected and a disproportionately large number of CDO tranches will therefore be downgraded.

An improvement in credit quality reflected in narrowing credit spreads in assets, as observed over the last year and half, may actually have a perverse effect on CDOs that are in the reinvestment mode. Given the duration mismatch between CDO assets and liabilities, particularly in CDOs with corporate credit as underlying collateral, cash from maturing assets needs to be reinvested in assets at spreads much lower than they were when the liabilities of the CDO were locked up. The problem is further confounded due to the low interest rates that have prevailed in the last few years. As interest rates have declined, refinancing activity has picked up, leaving CDOs overflowing with higher than expected cash balances. As a consequence, some CLOs might be in breach of weighted average spread (WAS) covenants. Anecdotally, we hear of CDO managers attempting covenant amendments to lower the WAS requirements.

Further, declining interest rates also hurt the carrying value of the interest rate hedges and might result in downgrades. Improving credit fundamentals readily reflected in the prices of the underlying collateral do not affect coverage tests in many cases since they are par based tests and as such are unaffected by the market value of the underlying collateral. In our view, rating agency models do not adequately reflect these inter-relationships between reinvestment risk, transitions in credit quality and changes in interest rate levels. How these considerations are modeled have significant implications for the credit quality of CDO tranches. The technology in this regard is still evolving.

The typical CDO capital structure implies that a CDO has at least one Aaa tranche. Compared to corporate securities in general, there is a much larger universe of Aaa rated CDO tranches. Obviously, any improvement in credit quality does not benefit the rating of a tranche already at the top of the ratings spectrum, but any deterioration can certainly hurt it.

As we pointed out earlier, our dataset did not include withdrawn ratings. Moody’s generally considers withdrawn ratings to be an indicator of a strong credit performance since most withdrawn ratings are for tranches that have received full payment of principal and all accrued interest. In 2003, there were 130 tranches with withdrawn ratings and about 30 during 2002. Treating withdrawn ratings as upgrades considerably improves the ratio.

Ultimately, the conflict of interest between the debt and equity tranches is the major source of CDO performance. We attribute the poor ratings performance of vintage high yield CBOs to tight collateral spreads that lured CDO managers into investing in poor-quality assets to achieve targeted equity returns. Lack of balance between the conflicting interests of the two competing parts of the capital structure is a common theme that haunts the CDOs which have experienced downgrade activity.

NEAR-TERM EXPECTATIONS FOR CDO RATING ACTIONS

The lag between the performance of the underlying sectors and their translation into the ratings of CDO tranches enables us to predict CDO rating actions to come in the near term. The extremely benign corporate credit environment we have witnessed over the last year, across the rating spectrum, leads us to be reasonably confident in expecting a continued up-tick in upgrades relative to downgrades in vintage CDOs with corporate credit as the underlying collateral. To a lesser extent, this is also likely to be true in the case of vintage emerging market CDOs.

On the other hand, recent downgrades and defaults in troubled ABS asset classes such as manufactured housing, franchise loans and aircraft securitization suggest that the trend towards increasing downgrades in vintage ABS CDOs is likely to accelerate (see "The Usual Suspects," December 17, 2004). The poor ratings performance of multi-sector ABS CDOs may have contributed to the current dominance of the RMBS collateral class in ABS CDOs of 2004 vintage.

chapter 34 Interest Rates – Rising Tides Lift CDO Boats?

March 4, 2005

Vishwanath Tirupattur
Sivan Mahadevan

INTEREST RATE WORRIES

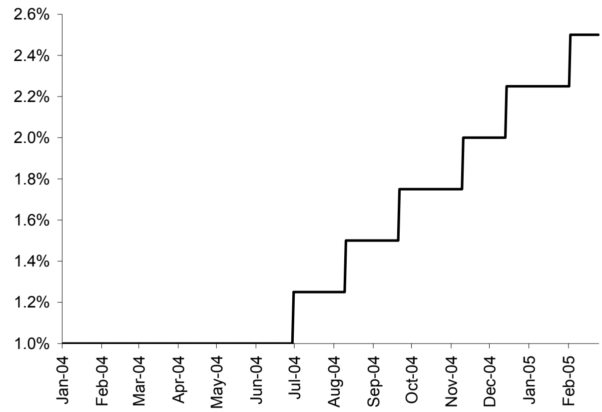
US Treasury markets in the past few weeks have been roiled by remarks from Federal Reserve officials, conflicting signals from a flurry of economic statistics and growing concerns about foreign central bank appetite for USD assets. The Treasury yield curve has experienced significant flattening. Ten-year Treasury rates have been down by more than 30 bp and have come back up more than 40 bp since the beginning of the year. No less authority than the Chairman of Federal Reserve, Alan Greenspan, characterized the recent rally in Treasury bonds as a “conundrum.” The surprising jump in the producer price index certainly rekindled inflation fears, which were never entirely dormant. Crude oil prices, which had dipped to below $42 per barrel toward the end of December 2004, have roared back to above $53 per barrel and have continued to stoke inflation fears.

Morgan Stanley economist Richard Berner points to the dwindling slack in the economy, rising costs combined with slower productivity growth and a still-accommodative monetary policy as the three factors contributing to upside risks to future inflation. He suggests that the Fed requires a significantly tighter monetary policy in order to realize its forecasts of stable core inflation through 2006. (See “The Next Inflation Surprise,” February 22, 2005.)

Since June 2004, the Fed has already raised the target Fed Funds rate six times, 25 bp each time, for a sum of 1.50% (Exhibit 1). The Morgan Stanley economics team expects another 25 bp increase in each of the next two upcoming Fed meetings. Fed Funds futures and Eurodollar contracts seem to be expecting another 150 bp hike by June 2006. While there are differences of opinion regarding the amount of monetary tightening to come over the next year, it seems beyond question that the short-term interest rates are headed higher.

exhibit 1

Federal Funds Target Rate



Source: Morgan Stanley

Given the specter of rising short-term interest rates, what are the implications for CDO performance? Prima facie, it would seem that since CDO debt is predominantly of floating rate nature, rising interest rates are of little consequence. However, we suggest that interest rates do affect the performance of certain types and have an even more prominent impact in certain vintages of CDOs. Depending upon the extent of monetary tightening, the impact can be meaningful in some cases. An examination of the effect of interest rate movements on CDO performance is the focus of this report.

MINIMAL IMPACT ON CLO PERFORMANCE

CDOs whose assets are also largely floating rate instruments are mostly unaffected by interest rate movements except for the indirect macro economic effects such movements may have on default probabilities of the underlying assets and their recoveries upon default. The level of interest rates also may have other indirect effects through refinancing and prepayments within the CDO collateral. At current interest rate levels and taking into consideration the range of expected changes, it seems to us that this is a second order effect and likely to have minimal impact on CDOs with predominantly floating rate collateral. CLOs largely fall into this category and, as such, are relatively insulated from interest rate changes.

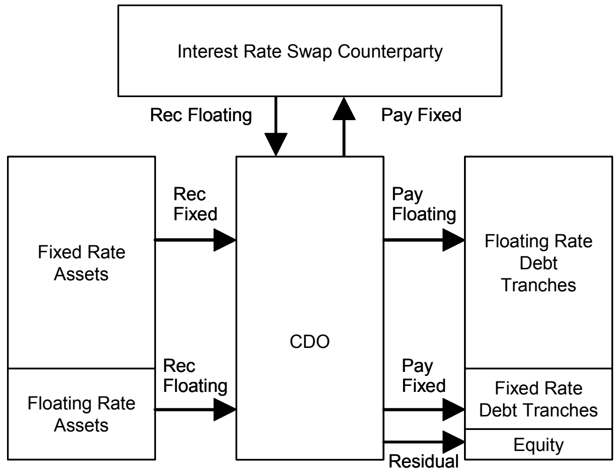
POTENTIAL EFFECTS ON CBOs AND ABS CDOs

However, in the case of high yield or investment grade CBOs and ABS CDOs, the underlying collateral is dominated by fixed rate instruments, and the liabilities have a substantial floating rate component. The potential interest rate mismatch is addressed through interest rate hedges at deal inception, in the form of interest rate swaps and/or interest rate caps. Of these two hedging instruments, interest rate swaps are the most significant component of the hedge in the vast majority of CDOs with a hedge in place at deal inception. The swaps are generally structured as amortizing swaps – swaps whose notional balance declines according to a predetermined schedule. The amortization schedule is determined at deal inception to match the expected amortization schedules of the CDO's debt tranches. Coupons from the fixed rate bonds pay the fixed rate leg of the swap and the floating rate receipts from the swap offset the coupons on the floating rate debt tranches. Exhibit 2 demonstrates how such an interest rate swap hedge works in a typical CDO.

chapter 34

exhibit 2

Typical Interest Rate Swap Hedge



Source: Morgan Stanley

In a small number of cases, balance-guaranteed swaps are used with the amortization of the swap notional explicitly linked to that of the CDO's debt tranches. In other words, the swap notional amortizes as a function of the outstanding notional of the CDO's floating rate debt tranches, rather than according to a predetermined schedule. Since such swaps are significantly more expensive than the plain-vanilla interest rate swaps with pre-determined fixed amortization schedules, the latter have been the hedge instruments in the vast majority of CDOs. Interest caps, when employed as hedges, are structured to be deep-out-of-the-money protection against rising interest rates. Typically, they are structured at deal inception to be forward starting. It is important to note that payments to hedge counterparty are usually at the top of the cash flow waterfall for most CDOs, ahead of payments to the senior-most debt tranches.

HEDGE AS A SOURCE OF RISK?

During the life of a CDO, a deal can become over-hedged or under-hedged depending upon the realized performance of CDO assets and/or liabilities relative to the expectations at deal inception. As fixed rate assets default, the source of cash flow for the fixed rate payments to the hedge counterparty diminishes. Thus, when interest rates decline under an over-hedge scenario, the deal experiences a drag on its cash flows, having to pay a higher fixed rate to the hedge counterparty while receiving lower floating rates. Failure of performance tests in terms of over-collateralization, coverage ratios and collateral credit quality can result in the diversion of available cash flows towards faster-than-scheduled amortization of the senior debt tranches, which results in realizing a liability payoff schedule different from that envisaged at deal inception, based on which swap amortization schedules would have been determined.

The extent of this hedge mismatch determines a CDO's sensitivity to interest rate movements. The higher a CDO's actual performance deviates from its expected performance, the higher the potential for a hedge mismatch, and consequently, the higher the sensitivity to interest rate movements.

DEFINING HEDGE MISMATCHES

It is important to remember that if the realized deal performance is close to the expected performance at deal inception, there will be little hedge mismatch; thus, interest rate movements will not have a direct impact on CDO performance. Our understanding of how rating agencies estimate the over-hedge amount is the following: Subtract the sum of the performing floating rate assets from the sum of the current par amount of the floating rate debt tranches of the CDO to compute the required amount of the hedge notional. The notional amount of the swap available in the deal in excess of the required hedge notional is the amount by which a deal is considered currently over-hedged.

We illustrate using the example of PPM America High Yield CBO I Limited, a high yield bond CBO that closed in March 1999. Fitch downgraded the A-1 notes from BBB- to BB on February 23, 2005, citing, among other reasons, the over-hedged nature of the deal. Based on data reported by Intex, the current par amount of the outstanding floating rate tranches is about $147 million. The collateral portfolio has $140 million of assets, of which about 99% are fixed rate assets and 1% floating rate assets. The transaction has a current outstanding swap notional of $244 million.[1] This results in an over-hedged notional amount of about $98.6 million and constitutes the source of the deal's sensitivity to interest rate movements.

It must be noted that this measure of the hedge mismatch does not take into account the amortization of the swap. A more refined approach would incorporate not only the amortization schedule of the swap but also current expectations of the CDO's asset defaults and pay downs of the CDO's debt tranches.

AS RATES RISE, OVER-HEDGE HELPS

Exhibit 3 shows the 3-month LIBOR rates over the last several years. During 2002-03 when interest rates declined, transactions that originated during 1998-2000 experienced significant drag on their performance. Poor collateral credit performance in terms of defaults was further exacerbated in those deals by the drag on the deal cash flows from the underlying hedges.

As interest rates rise, this effect is reversed. Over-hedged deals stand to benefit in terms of cash flow and the mark-to-market value of the hedges. With rising short-term rates, the spread between the fixed rate payments to and the floating rate receipts from the hedge counterparty declines, cushioning the deal cash flow. The mark-to-market value of the hedge also improves, thus improving the market value and liquidation over-collateralization ratios, deal parameters of significance in the secondary markets for CDO tranches. The higher the short-term rates are, the more pronounced their beneficial impact on over-hedged CDOs. It is precisely the over-hedged deals of this vintage (1998-2000) that bore the brunt of the effect of falling short-term rates that stand to benefit from rising rates. The longer the remaining term to maturity of the swap, the higher the sensitivity of deals with hedge mismatches to interest rate changes.

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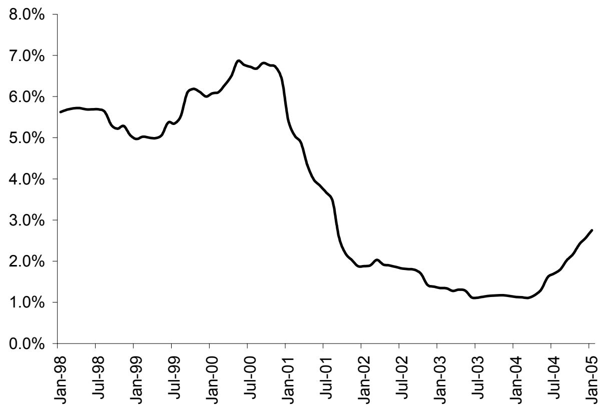
[1] *The swap starts to amortize in June 2005 based on a predetermined schedule, declining to a zero balance by December 2008 (Source: Intex).*

exhibit 3

Three-Month LIBOR (1998-present)



Source: Morgan Stanley

We illustrate the potential mark-to-market impact of the hedge mismatch with an example using the PPM America High Yield CBO I referred to earlier. As a part of the hedge, the deal pays a fixed interest rate of 5.45% and receives 6-month LIBOR. The current outstanding swap notional is $244 million, which amortizes to zero by the end of 2008. Exhibit 4 shows the mark-to-market impact of interest rate movements on this interest rate swap by shifting the forward curve by 50 bp, 100 bp, 150 bp and 200 bp.

exhibit 4 Interest Rate Sensitivity of Typical Hedges in CBOs

	Mark-to-Market Value
Current	($9,029,633)
Forward curve + 50 bp	($6,694,595)
Forward curve + 100 bp	($4,358,827)
Forward curve + 150 bp	($2,023,059)
Forward curve + 200 bp	$312,708

Source: Morgan Stanley, Company Reports

The mark-to-market value of the hedge is currently negative to the tune of about $9 million. As rates rise, the drag on the deal from the hedge declines. An upward shift of 200 bp in the forward curve moves the hedge into positive territory. The shape of the curve also matters. In a bear flattener scenario (short-term rates rising more than long-term rates), the mark-to-market value of an over-hedge improves even more.

We do not want to overstate the effect of rising short-term interest rates on CDO performance and valuation. All we are suggesting is that CDOs that suffered because of the over-hedge problem when short-term rates declined are likely to benefit when short-term rates rise. The beneficial impact depends upon the extent of the hedge mismatch and remaining term to maturity of the swap.

RATING ACTIONS FROM OVER-HEDGE

It is worth emphasizing that exposure to interest rate movements through a hedge mismatch is secondary to the credit quality of the collateral and realized default rates in determining CDO performance. Still, the drag on the deal cash flows arising out of hedge mismatches was one reason cited as rationale for the many CDO downgrades experienced during that period. Exhibit 5 shows a list of CDO rating actions in which hedge mismatches were cited as contributing factors for downgrade actions. While by no means meant to be comprehensive, this list of 64 unique CDO tranches illustrates that hedge mismatch is a significant issue considered by rating agencies. This list can also serve as a starting point for identifying transactions that would most benefit from rising short-term interest rates.

exhibit 5 Select CDO Downgrade Actions Due to Over-Hedge Exposure

Date	Deal	CDO Type	Deal Closing Date	Class	Original Principal ($MM)	Currency	Original Rating	Previous Rating	Revised Rating	Current Rating	Agency
9/21/2001	Summit CBO I Ltd	ACF HY Bond	04/23/1999	B	37		AA-	AA-	BB	C	Fitch
9/21/2001	Summit CBO I Ltd	ACF HY Bond	04/23/1999	C	36		BBB	BBB	CC	C	Fitch
9/21/2001	Summit CBO I Ltd	ACF HY Bond	04/23/1999	D-1	6		BB	BB	CC	C	Fitch
3/13/2002	ML CBO VI 1996-C-2	ACF HY Bond	10/31/1996	A	154		AA	BBB-	CCC+	D	S&P
3/13/2002	ML CBO VII 1997-C-3	ACF HY Bond	03/13/1997	A	170		AA	BBB	CCC+	CC	S&P
3/13/2002	ML CBO III 1996-C-1	ACF HY Bond	08/29/1996	A	184		AA-	A-	BB	BB	S&P
10/25/2002	Summit CBO I Ltd	ACF HY Bond	04/23/1999	B	37		AA-	BB	C	C	Fitch
10/25/2002	Summit CBO I Ltd	ACF HY Bond	04/23/1999	C	36		BBB	CC	C	C	Fitch
10/25/2002	Summit CBO I Ltd	ACF HY Bond	04/23/1999	D-1	6		BB	CC	C	C	Fitch
2/4/2003	J/Z CBO (Delaware)	ACF HY Bond	05/16/2000	A	108		AAA	AAA	AA-	AA-	S&P
2/4/2003	J/Z CBO (Delaware)	ACF HY Bond	05/16/2000	B	22		A	A	BBB	B+	S&P
2/4/2003	J/Z CBO (Delaware)	ACF HY Bond	05/16/2000	C	19		BBB	BBB	B+	CC	S&P
2/11/2003	ML CBO VII 1997-C-3	ACF HY Bond	03/13/1997	A	170		AA	CCC+	CC	CC	S&P
3/30/2003	South Street CBO 1999-1	ACF HY Bond	06/03/1999	A-1LB	10		AAA	A	BBB	BBB-	S&P
3/30/2003	South Street CBO 1999-1	ACF HY Bond	06/03/1999	A-1	55		AAA	A	BBB	BBB-	S&P
3/30/2003	South Street CBO 1999-1	ACF HY Bond	06/03/1999	A-2L	24		AAA	CCC	CCC-	CC	S&P
3/30/2003	South Street CBO 1999-1	ACF HY Bond	06/03/1999	A-2	36		AAA	CCC	CCC-	CC	S&P
7/2/2003	Eastman Hill Funding I Ltd	ACF HY Bond	07/02/2001	A-1 FL	512		AAA	AAA	AA	AA	Fitch
7/2/2003	Eastman Hill Funding I Ltd	ACF HY Bond	07/02/2001	A-1 FX	10		AAA	AAA	AA	AA	Fitch
7/2/2003	Eastman Hill Funding I Ltd	ACF HY Bond	07/02/2001	A-2 IO	522		AAA	AAA	AA	AA	Fitch
7/2/2003	Eastman Hill Funding I Ltd	ACF HY Bond	07/02/2001	A-3	10		AA	AA	BBB	BBB	Fitch

exhibit 5 (cont.) Select CDO Downgrade Actions Due to Over-Hedge Exposure

Date	Deal	CDO Type	Deal Closing Date	Class	Original Principal ($MM)	Currency	Original Rating	Previous Rating	Revised Rating	Current Rating	Agency
7/2/2003	Eastman Hill Funding I Ltd	ACF HY Bond	07/02/2001	B-1	24		BBB	BBB	B	B	Fitch
7/2/2003	Eastman Hill Funding I Ltd	ACF HY Bond	07/02/2001	Combo			BBB	BBB	CC	CC	Fitch
7/2/2003	Eastman Hill Funding I Ltd	ACF HY Bond	07/02/2001	Sub Pref	18		B+	B+	C	C	Fitch
7/30/2003	Triton CDO IV Ltd	ACF HY Bond	12/15/1999	B	27		AA-	BB+	B	CCC-	S&P
9/10/2003	MWAM CBO Series 2001-1 Ltd	ACF SF	01/24/2001	B	198		AA	AA	A-	A-	Fitch
9/10/2003	MWAM CBO Series 2001-1 Ltd	ACF SF	01/24/2001	C-1	22		BBB	BBB	BB-	BB-	Fitch
9/10/2003	MWAM CBO Series 2001-1 Ltd	ACF SF	01/24/2001	C-2	13		BBB	BBB	BB-	BB-	Fitch
9/10/2003	MWAM CBO Series 2001-1 Ltd	ACF SF	01/24/2001	Pref Shr	8		BB-	BB-	B-	B-	Fitch
10/15/2003	Sutter CBO 1999-1, Ltd	ACF HY Bond	11/17/1999	A4	24		A-	A-	A-	BBB+	Fitch
10/15/2003	Sutter CBO 1999-1, Ltd	ACF HY Bond	11/17/1999	A4-L	5		A-	A-	A-	BBB+	Fitch
10/15/2003	Sutter CBO 1999-1, Ltd	ACF HY Bond	11/17/1999	B1-L	6		BBB	BBB	BBB	BB+	Fitch
10/15/2003	Sutter CBO 1999-1, Ltd	ACF HY Bond	11/17/1999	B1-L	5		BBB	BBB	BBB	BB+	Fitch
10/15/2003	Sutter CBO 1999-1, Ltd	ACF HY Bond	11/17/1999	B2	10		BB-	BB-	BB-	B+	Fitch
11/11/2003	Phoenix CDO II Ltd	ACF SF	05/17/2000	B	39		AA	AA	BBB	BBB	Fitch
4/30/2004	Mid Ocean CBO-2000-1 Ltd	ACF SF	01/08/2001	A-1L	240		AAA	BBB	BBB	BBB	Fitch
4/30/2004	Mid Ocean CBO-2000-1 Ltd	ACF SF	01/08/2001	A-2	17		AA-	A-	BB	BB	Fitch
4/30/2004	Mid Ocean CBO-2000-1 Ltd	ACF SF	01/08/2001	A-2L	15		AA-	A-	BB	BB	Fitch
4/30/2004	Mid Ocean CBO-2000-1 Ltd	ACF SF	01/08/2001	B-1	13		BBB-	B	CCC	CCC	Fitch
7/12/2004	Ingress I, Ltd	ACF SF	05/18/2000	B	54	USD	AA	A+	A-	A-	Fitch
7/12/2004	Ingress I, Ltd	ACF SF	05/18/2000	C	21	USD	A-	BB-	B-	B-	Fitch
8/11/2004	E*TRADE ABS CDO I, Ltd	ACF SF	10/08/2002	B	25	USD	AA+	AA+	A-	A-	Fitch

exhibit 5 (cont.) Select CDO Downgrade Actions Due to Over-Hedge Exposure

Date	Deal	CDO Type	Deal Closing Date	Class	Original Principal ($MM)	Currency	Original Rating	Previous Rating	Revised Rating	Current Rating	Agency
8/11/2004	E*TRADE ABS CDO I, Ltd	ACF SF	10/08/2002	C-1	10	USD	BBB	BBB	B+	B+	Fitch
8/11/2004	E*TRADE ABS CDO I, Ltd	ACF SF	10/08/2002	C-2	3	USD	BBB	BBB	B+	B+	Fitch
8/11/2004	E*TRADE ABS CDO I, Ltd	ACF SF	10/08/2002	Comp Sec	5	USD	BBB-	BBB-	CCC-	CCC-	Fitch
8/11/2004	E*TRADE ABS CDO I, Ltd	ACF SF	10/08/2002	Pref Shr	13	USD	BBB-	BBB-	CCC-	CCC-	Fitch
8/12/2004	Bleecker Structured Asset Funding Ltd.	ACF SF	03/29/2000	A-1	19	USD	AAA	AA	A+	A+	S&P
8/12/2004	Bleecker Structured Asset Funding Ltd.	ACF SF	03/29/2000	A-2	131	USD	AAA	AA	A+	A+	S&P
8/18/2004	MKP CBO I, Limited	ACF SF	02/08/2001	A-1L	250	USD	AAA	AAA	AA-	A-	Fitch
8/18/2004	MKP CBO I, Limited	ACF SF	02/08/2001	A-2L	25	USD	AA-	A	BBB-	BB	Fitch
8/18/2004	MKP CBO I, Limited	ACF SF	02/08/2001	B-1A	7	USD	BBB-	BBB-	B+	B-	Fitch
8/18/2004	MKP CBO I, Limited	ACF SF	02/08/2001	B-1L	7	USD	BBB-	BBB-	B+	B-	Fitch
8/25/2004	Bleecker Structured Asset Funding, Limited	ACF SF	03/29/2000	A-1	45	USD	AAA	AAA	A-	BBB	Fitch
8/25/2004	Bleecker Structured Asset Funding, Limited	ACF SF	03/29/2000	A-2	315	USD	AAA	AAA	A-	BBB	Fitch
8/25/2004	Bleecker Structured Asset Funding, Limited	ACF SF	03/29/2000	B	40	USD	AA	BBB	B-	CC	Fitch
8/25/2004	Bleecker Structured Asset Funding, Limited	ACF SF	03/29/2000	C	34	USD	BBB	B	C	C	Fitch
9/10/2004	Wilbraham CBO Ltd	ACF HY Bond	07/13/2000	A-1	141	USD	AAA	A+	BBB+	BBB+	S&P
9/10/2004	Wilbraham CBO Ltd	ACF HY Bond	07/13/2000	A-2	19	USD	AA	BBB-	B	B	S&P
9/27/2004	Varick Structured Asset Fund Ltd	ACF SF	09/29/2000	A-1	39	USD	AAA	A-	BB+	BB+	S&P
9/27/2004	Varick Structured Asset Fund Ltd	ACF SF	09/29/2000	A-2	233	USD	AAA	A-	BB+	BB+	S&P
12/6/2004	Bleecker Structured Asset Funding, Limited	ACF SF	03/29/2000	A-1	45	USD	AAA	A-	BBB	BBB	Fitch
12/6/2004	Bleecker Structured Asset Funding, Limited	ACF SF	03/29/2000	A-2	315	USD	AAA	A-	BBB	BBB	Fitch
12/6/2004	Bleecker Structured Asset Funding, Limited	ACF SF	03/29/2000	B	40	USD	AA	B-	CC	CC	Fitch

exhibit 5 (cont.) Select CDO Downgrade Actions Due to Over-Hedge Exposure

Date	Deal	CDO Type	Deal Closing Date	Class	Original Principal ($MM)	Currency	Original Rating	Previous Rating	Revised Rating	Current Rating	Agency
12/6/2004	Varick Structured Asset Fund, Ltd	ACF SF	09/29/2000	A-1	50	USD	AAA	BBB-	BB	BB+	Fitch
12/6/2004	Varick Structured Asset Fund, Ltd	ACF SF	09/29/2000	A-2	300	USD	AAA	BBB-	BB	BB+	Fitch
12/6/2004	Varick Structured Asset Fund, Ltd	ACF SF	09/29/2000	B-1	25	USD	A-	CCC-	CC	NR	Fitch
12/6/2004	Varick Structured Asset Fund, Ltd	ACF SF	09/29/2000	B-2	7	USD	A-	CCC-	CC	NR	Fitch
1/24/2005	Bristol CDO I Ltd	ACF SF	10/11/2002	A-1	224		AAA	AAA	AA+	AA+	Fitch
1/24/2005	Bristol CDO I Ltd	ACF SF	10/11/2002	A-2	21		AAA	AAA	AA+	AA+	Fitch
1/24/2005	Bristol CDO I Ltd	ACF SF	10/11/2002	B	30		AA	A+	A+	A+	Fitch
1/24/2005	Bristol CDO I Ltd	ACF SF	10/11/2002	C	13		BBB	B	C	C	Fitch
2/23/2005	PPM America High Yield CBO I	ACF HY Bond	03/02/1999	A-1	449	USD	AAA	BBB-	BB	BB	Fitch
2/28/2005	FC CBO III Ltd	ACF HY Bond	11/17/1999	B	39	USD	A-	CCC	CCC-	CCC-	S&P

ACF= Arbitrage cash flow; SF=Structured Finance; HY = High Yield
Source: Morgan Stanley, S&P, Fitch

chapter 35

Correlation or Credit – What Drives Ratings Changes?

March 4, 2005

Sivan Mahadevan
Peter Polanskyj
Ajit Kumar, CFA

In the early days of the synthetic CDO market, ratings were the main drivers of valuation and relative value, and most investors were quite focused on rating agency methodologies and their evolution. Today we have a lot more experience and information with respect to valuation and pricing sensitivity of synthetic CDO tranches, due in part to the explosion of activity and liquidity, industry standard correlation models, and the benefit of having been through a rather sharp credit cycle. In many ways, the markets have moved well beyond the rating agencies, which not too surprisingly is causing a bit of a scramble at the agencies.

Ratings, and their perceived stability, nevertheless remain important considerations for a large number of investors. While the agencies themselves established their CDO ratings models years ago, there has been a flurry of methodology changes recently, spurred by the increasing transparency in and growing sophistication of investors. The current battle among the agencies involves correlation, or to be more specific, the correlation assumptions that go into their models. In our view, the agencies are trying to solve a problem that they have created, given that they use industry-standard models in non-standard ways. In contrast, today's risk-neutral correlation models show that correlation has a second order effect on the tranches that are most likely to be rated.

Who is right? In our opinion, it does not matter, because changes in correlation have not been drivers of ratings instability. The primary driver of ratings changes in synthetic CDOs over the years has been changes in credit quality of the underlying portfolio – in other words, credit selection. This may sound like an obvious statement, but there is an important message here. An underlying CDO portfolio with the same average rating as the market does not necessarily perform exactly like the market. Portfolio sampling risk is the most important driver of CDO ratings changes relative to the ratings shifts of the underlying market. The larger the portfolio, the smaller the sampling risk; but many of yesterday's synthetic CDOs did not have large underlying portfolios, so sampling risk remained a big issue. Today the market is somewhat different, with many portfolios indeed much larger, particularly CDO-squared structures.

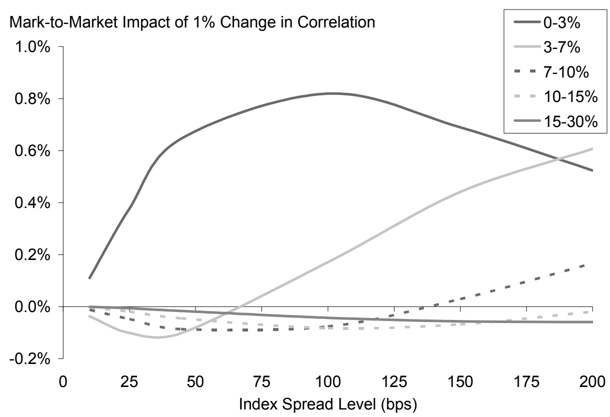
THE RATING AGENCY DEBATE

Reacting to a market that has moved ahead of them, the agencies have now adopted approaches based on correlation models to rate synthetic CDOs (including CDO-squareds). The three agencies' approaches differ somewhat though, as do their correlation assumptions, and this has been the source of a public debate recently.

Market-standard correlation models are run in a risk-neutral sense, meaning that the probability of default for a given credit is derived from market pricing. For example, a credit that trades at 50 bp (assuming flat curve) has about a 0.83% chance of defaulting every year, assuming a 40% recovery. Given full credit curves for all credits in a CDO's portfolio, the market-standard models can relatively easily calculate prices given a correlation assumption, or alternatively, imply correlation from market prices. The point is not that the default probabilities are absolutely correct but that they provide a benchmark from which to price the tranches, which reflects the market perception of absolute and relative risk within the portfolio given the maturity of the transactions.

exhibit 1

Correlation Sensitivity in Different Spread Environments



Source: Morgan Stanley

The agencies now use similar models, but not in a risk-neutral sense because their methodologies are not attempting to value instruments but rather to assign some real world probability of default. They derive a credit's default probability from ratings-based historical averages. This process implies three very important outcomes. First, the portfolios feel much less risky than those that use market-based default probabilities, because they exclude market risk premiums. Second, the resulting portfolios are significantly more homogenous than portfolios segmented by spread, with much thinner tails. Third, the risk in the portfolios appears more stable through time as compared to volatility of market spreads. These portfolios, combined with agency stress factors, tend to be very sensitive to correlation for certain types of junior and senior mezzanine tranches in the agencies' models (hence the debate).

exhibit 2 Correlation Sensitivity is Low Today for Mezzanine

	Impact on Market Value		Equivalent Index Move in bp	
	Corr. + 1%	**Corr. + 10%**	**Corr. + 1%**	**Corr. + 10%**
DJ CDX Ser 3 IG - 5 Yr				
0-3%	0.61%	6.10%	-0.8	-7.8
3-7%	-0.07%	-0.67%	0.2	2.2
7-10%	-0.07%	-0.75%	0.6	6.2
10-15%	-0.02%	-0.19%	0.3	3.9
15-30%	-0.02%	-0.20%	1.0	10.4
DJ CDX Ser 3 IG - 5 Yr Bespoke Tranches				
1-3%	0.46%	4.26%	-0.5	-5.0
2-4%	0.05%	0.83%	-0.1	-1.4
3-5%	-0.09%	-0.46%	0.2	1.2
4-6%	-0.12%	-0.82%	0.4	3.0
5-7%	-0.11%	-0.85%	0.6	4.3
6-8%	-0.10%	-0.81%	0.7	5.2
7-9%	-0.09%	-0.75%	0.7	5.8
8-10%	-0.08%	-0.68%	0.8	6.4
DJ CDX Ser 3 IG - 10 Yr				
0-3%	0.84%	8.41%	-1.6	-15.7
3-7%	0.41%	3.92%	-0.7	-6.2
7-10%	-0.03%	-0.06%	0.1	0.2
10-15%	-0.04%	-0.38%	0.2	2.2
15-30%	-0.04%	-0.36%	0.5	4.8
DJ CDX Ser 3 HY - 5 Yr				
0-10%	0.43%	4.19%	-5.1	-49.1
10-15%	0.20%	1.92%	-1.4	-12.9
15-25%	-0.12%	-0.92%	1.1	8.6
25-35%	-0.11%	-1.00%	2.7	23.3

Source: Morgan Stanley

CORRELATION IS A SECOND ORDER EFFECT TODAY

To confirm our assertion above, we have calculated correlation sensitivities for various mezzanine tranches of investment grade and high yield portfolios in Exhibit 1, based on the market's benchmark instruments and models. The sensitivity of a tranche's price to correlation varies with the size and seniority of tranches, the level of spreads, and the shape of the distribution of the portfolio, among other factors. However, the tranches that are the least sensitive to correlation today are the ones that are most likely to be rated by the agencies (everything except the highly subordinated and super-senior).

We do need to put these sensitivities into perspective. In Exhibit 2 we show the implied price change of a parallel shift in correlation. We also calculate the equivalent spread move on the underlying index to achieve the same price change. The average weekly standard deviation of the Dow Jones CDX 3 index has been 1.9 bp since it was launched last year. That being said, changes in spread can obviously be a more important driver in values – and, by extension, risk – than correlation.

WHAT DRIVES RATINGS SHIFTS?

If correlation is not that important, what should impact ratings changes? As we pour through ratings changes data for synthetic CDOs over the years, we note that most activity is driven by shifts in credit quality (up or down) of the underlying portfolios and actual defaults. While the investment grade market itself has had quite a bit of such activity over the past 5 years, we believe that most CDOs that have experienced significant negative ratings migration have had portfolios that have underperformed the market (again, this may sound obvious). Actual defaults aside, this phenomenon is a double-edged sword, though, as many of these same deals have experienced upgrades recently (31 upgrades this year; see Exhibit 3).

exhibit 3 Ratings Migration of Synthetic CDOs and Corporate Bonds

	2001	2002	2003	2004	2005 (YTD)
Downgrades	1	42	33	2	1
Upgrades			3	1	31
A-Baa Realized/Average Downgrades	111%	157%	127%	68%	
A-Baa Realized/Average Upgrades	72%	46%	59%	130%	
Ba-B Realized/Average Downgrades	144%	171%	133%	91%	
Ba-B Realized/Average Upgrades	115%	71%	95%	219%	

Note: 2001-2004 data include only Moody's rating actions. 2005 includes rating actions from Moody's, S&P and Fitch for January and February.
Note: Realized/Average tranision is defined as the calender year cohort transition divided by the 1983-2004 average transition.
Source: Morgan Stanley

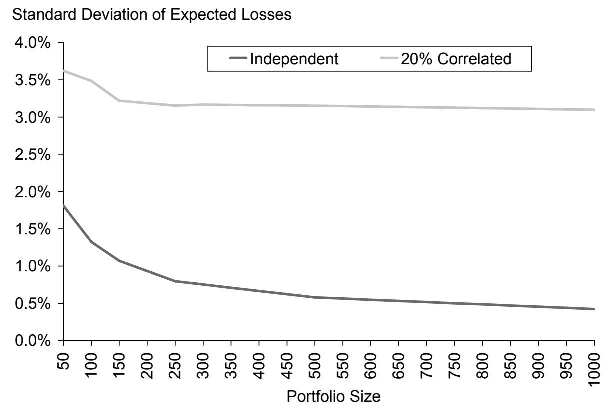
PORTFOLIO SAMPLING RISK

Portfolio sampling risk can be modeled generically and has been used historically to help design optimal basket sizes (for our early thoughts, see "Understanding Mezzanine Notes," June 24, 2002 and Chapter 12). While actually quantifying the impact of portfolio size on portfolio performance versus some broader universe is difficult, several useful insights can be gleaned from simple statistics.

In Exhibit 4, we show the uncertainty of expected losses for portfolios of varying sizes. We can think of sampling risk as the difference in uncertainty (standard deviation) between a portfolio with a given number of credits and the uncertainty of a portfolio containing the entire universe, which we assume is 1,000 credits below. In Exhibit 5, we show this differential for portfolios of varying sizes all with expected losses of around 3.2% over 5 years.

exhibit 4

Uncertainty of Expected Losses



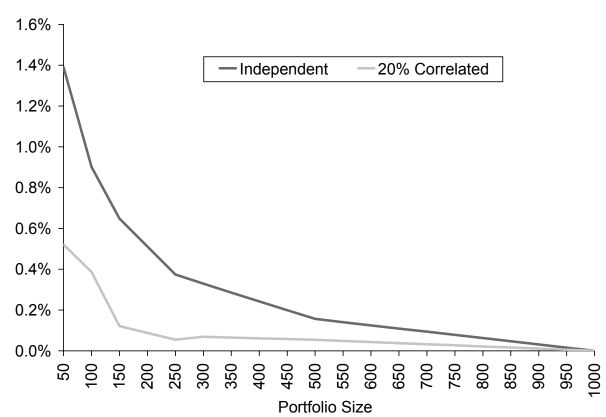
Source: Morgan Stanley

We have performed the study under two assumptions. The first is that default risk among the portfolio components is independent. The sampling risk in this portfolio drops off very quickly and the volatility of the losses levels off to a reasonably low absolute level (0.50% or 16% of the expected losses) as the portfolio size increases to include the entire universe.

Under the second assumption, we add positive correlation into the mix, which has the effect of increasing the uncertainty (volatility) of the expected losses to a much higher level. This is true not only for small portfolios but also for large portfolios (standard deviation is 3.1% or nearly 100% of the expected losses). Sampling risk drops off quickly but uncertainty of actual default experience for the entire universe increases dramatically. This uncertainty in the loss experience, even for a portfolio containing the entire universe, can be thought of as the main driver of relative portfolio performance.

exhibit 5

Portfolio Sampling Risk Falls as the Number of Credits Increases



Source: Morgan Stanley

Another way to see this phenomenon is through the historical default statistics. If actual correlation were very low, then the default statistics would be reasonably stable over time. We studied the volatilities of the Moody's cumulative 5-year default rates and found them to be 160%, 150% and 70% of the average default rates for the Aa, A, and Baa rating buckets, respectively. The results indicate that the broad universe actually experiences quite volatile default rates, similar in order of magnitude to our correlated scenario above.

LARGE PORTFOLIOS ARE MORE STABLE FOR SENIOR NOTES

Perhaps we have used a long-winded approach to make a very simple point, but the analysis is always important to support the thesis. For senior tranche investors who are seeking high ratings and relative ratings stability in synthetic tranches, credit selection is a key driver, until portfolios get large enough that the likelihood of deviating from the averages is relatively small. For senior note investors who do not want to worry about credit selection, today's large pool CDO-squared structures (200 to 300 names adjusted for overlap) may provide the relative stability at the senior level, despite all of the correlation chatter at the agencies.

Section F

Structured Credit Insights

Cash and Synthetic Convergence Themes

Please see additional important disclosures at the end of this report.

chapter 36 Bridging the High Yield Gap

September 5, 2003

Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar

Most of the recent progress in correlation trading has been focused on investment grade credit. Interest and growth here seems natural, given the rapid development of the underlying derivatives market over the past few years. Yet, with the increasingly evident shift in the US economic cycle, we argue that structured high yield credit may be poised for some increase in popularity going forward. While we can point to only a limited amount of investor interest to date, some of the synthetic infrastructure has been built, thanks to a benchmark high yield basket product and existing correlation models. So, if investors continue to reach for yield against a more confident economic backdrop, high yield structured credit may be the natural place to look.

From a derivatives perspective, the structured high yield credit market is in its infancy. Yet, from a cash perspective, it is far more developed than even the investment grade market, given the large outstanding and reasonably well-developed secondary market for high yield CBOs and CLOs. We focus our report this week on understanding this cash and derivatives "gap" and try to predict how the high yield structured credit market might develop going forward.

THE FIRST STRUCTURED CREDIT MARKET

The CDO market introduced tranched credit risk to investors, with an almost exclusive focus on high yield bonds and loans. Since 1996, we estimate that over $160 billion of CDOs backed by high yield bonds and leveraged loans have been issued, most of which are still outstanding. The secured nature of many loan transactions, combined with tight covenants and high recovery rates, has resulted in reasonable performance in the CLO sector, compared to a much poorer performance for many high yield CDOs, particularly at the subordinate note level.

This early period in the structured credit market was characterized by a lot of new issuance, but remained a fragmented market otherwise with virtually no liquidity and very little transparency. Market participants focused on understanding rating agency methodologies for analyzing default risk. Model-based pricing and correlation risks were terms used by only a few. Investors could go long only, and the "buy-and-hold" nature kept the secondary market from developing. Collateral pools were largely similar in risk profile, centered around single-B rated issuers.

WHAT IS DIFFERENT THIS TIME?

To be frank, most of the high yield CBO investors of the late 1990s will never come back to the market, even if it is vastly improved. The pain and career risk they endured during the high yield meltdown was likely too much to warrant giving the market a second chance, at least for now. The new high yield structured credit investor will likely be someone who is similar in profile to the investment grade structured credit investor today: an existing market participant who wants to use long and short tranche positions to help manage a portfolio. What will draw this investor to the market, and what risks will he or she face?

LIQUIDITY AND TRANSPARENCY

Despite a much improved secondary high yield CBO/CLO market, it is still difficult for investors to judge valuation and draw comparisons, given the heterogeneous nature of deals. The investment grade market benefits immensely from tranched TRAC-X, where multiple dealers quote two-way markets and liquidity is improving.

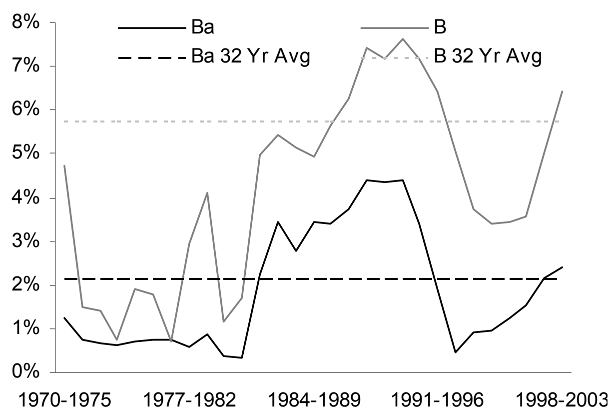
Can the same thing happen in high yield? Possibly, but it is far from clear right now. While it is natural to think that the market would welcome a benchmark tranched product, we are not certain "who" the market is. Many core high yield investors are not derivatives users. CDO managers could use their "synthetic" buckets for a tranched derivative instrument, but such usage is likely to be small. Hedge funds could be the first interested parties, motivated by the ability to go long and short tranches or employ trading strategies. CDO investors are a possibility as well, but the link between a potential tranched TRAC-X High Yield benchmark (formerly called HYDI) and existing CDOs is not necessarily strong.

WHERE DO WE GO FROM HERE? THINK ABOUT BBs

The BB part of the high yield market, from a structured credit perspective, seems intriguing to us. Given the exponential nature of the default rate/credit rating relationship, default risk in BBs is much more tame than the more widely publicized market averages (see Exhibit 1).

exhibit 1

Significant Default Experience Difference: BBs vs. Single-Bs



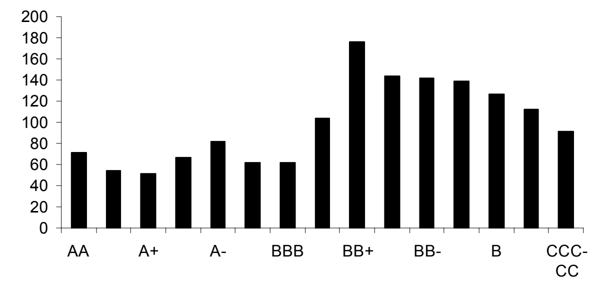
Source: Morgan Stanley, Moody's

Over a 32-year period, average annualized five-year BB default rates are 2%, with the distribution ranging from sub 1% levels to just above 4%. For single-Bs, the average was a much higher 5%, with default rates ranging from the 1% level to over 7%.

Furthermore, from a fundamental credit valuation perspective, spread per unit of corporate leverage is more attractive in BBs than in any other rating category, as our credit strategist, Greg Peters, has illustrated (see Exhibit 2).

exhibit 2

Spread Per Unit of Corporate Leverage Favors BBs



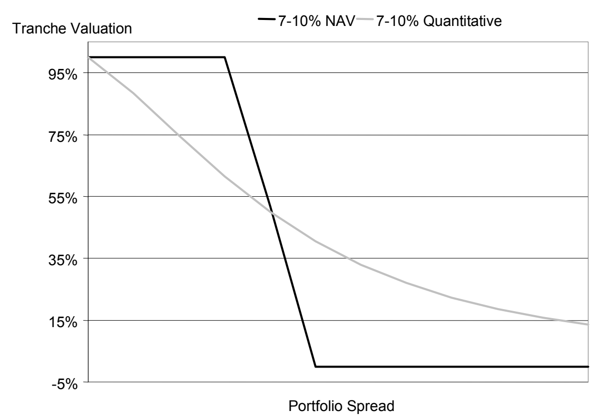
Source: Morgan Stanley

GRAHAM AND DODD VS. BLACK AND SCHOLES

Conceptually, the difference in valuation techniques practiced in the cash and synthetic structured credit markets could not be more stark. Cash players focus on fundamental analysis of the deal, while synthetic market participants use quantitative risk-neutral models.

exhibit 3

NAV vs. Derivative Pricing: Convexity Ignored?



Source: Morgan Stanley

The fundamental approach of the cash markets involves analysis of many factors, including portfolio NAV, cash flow scenarios, collateral manager quality and structural features. This approach certainly makes sense, given the nature of the cash market, with many deals having highly negotiated structural features and most having managed portfolios.

The derivative pricing techniques of the synthetic market rely on the market-implied default probabilities, default correlation and a risk-neutral framework. Valuations generated using these techniques reflect the wider range of possible default scenarios for the portfolio. The result is a price that is more sensitive to small moves in spreads but which may be more stable than that implied by fundamental approaches for large spread moves.

This difference leads to what would appear to be inconsistencies between the markets. To illustrate this point, we computed valuations based on both our internal fair value risk-neutral model and purely on portfolio NAV (or liquidation value). Exhibit 3 highlights the difference in valuation of the same instrument, a "senior" tranche of a hypothetical five-year CDO, valued using both a derivative and fundamental approach for a series of average portfolio spreads. While the pure NAV valuation is extreme, it provides a sense for the directional bias of the cash market relative to the derivatives market. All other things being equal, senior tranches tend to be valued lower in the correlation market, while subordinate tranches tend to be valued higher, relative to fundamental approaches.

WHERE DO WE START?

Clearly much development needs to happen in the high yield structured credit market before we can think about investment opportunities and relative value, and it is not clear which investors, if any, will "push the envelope." Yet, the fact that BBs seem intriguing is something that we hope is not ignored by the market place, and we argue that both high yield and investment grade investors should consider the opportunities. Furthermore, a reasonably liquid high yield CBO and CLO secondary market gives us important flow and pricing information, something we never really had in investment grade prior to the past few months.

chapter 37 A View from the Top

March 19, 2004

Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar

Given where we are in the economic cycle and credit spreads, we see both confusion and sticker shock from investors with respect to where senior notes trade. What is the right price for the top part of the capital structure in today's markets? The cash CDO and synthetic structured credit markets take very different approaches to pricing senior risk, but we would argue that these cultural distinctions are larger than the actual difference in risks.

In the structured credit world, the pricing models tell us that super senior risk (typically 10% attachment points for investment grade portfolios) is worth close to nothing in spread terms today. The traditional takers of this risk (reinsurers) are obviously not very excited about getting paid nothing, so they are on the sidelines for the most part. In the cash CDO world, specifically leveraged loan-backed CLOs, top-of-the-capital-structure senior notes (30% to 40% attachment points) are trading in the mid 40s bp (over Libor) on average in the new issue market, and perhaps 10 to 20 bp wider in the secondary market for healthy deals. Given what we know about super senior risk, are these CLO levels too generous or too tight?

We have taken our first steps in applying correlation models (i.e., risk-neutral models of default) to leveraged loan-backed CLOs and find that 30% to 40% subordination in today's markets translates into extremely little default risk for the tranche. However, CLO structures are far more complex than static synthetic CDOs, so the output of the models should be compared subjectively with the structural and technical aspects of this market, which we do generically in this chapter.

In a nutshell, it takes extremely high correlation, combined with extremely low recovery rates for typical top-of-the-capital-structure CLO notes to experience any pricing stress, based on a risk-neutral approach (pricing related to default risk) and today's market prices for the underlying collateral. From a fundamental perspective, even after adjusting for potential structural risks, we find such senior risks attractive in today's CLO markets, but caution investors that technical forces may keep the tranches from rallying much further from here.

Furthermore, in continuing with our theme of balancing long credit positions with cheap forms of out-of-the-money protection, we recommend that investors consider hedging tail risks in CLO senior notes with long protection positions in 3-100% tranches of investment grade portfolios. In the scenario of extremely high default rates (where investment grade and high yield can be well correlated), this protection will likely be a good hedge against CLO senior pricing stress.

CAN CLOs BE QUANTITATIVELY MODELED?

The risk-neutral pricing models that are popular in the structured credit markets are based on the notion that a credit's default risk is related to the spread at which it trades. In a portfolio context, the distribution of this risk, along with the default correlation of these credits, is used to generate expected values for tranches in a capital structure. In the structured credit world, the structures tend to be simple (static portfolios, no triggers), so the models are reasonable indicators of tranche risk as implied by the underlying markets.

CLO structures, on the other hand, are more complicated for many reasons, including the following.

- The underlying portfolios are often not static.
- There is expected reinvestment of proceeds from maturing and prepaid loans.
- There are triggers than can pay down tranches and/or delever the structure.
- The senior notes can get called by equity holders.

CLOs THROUGH A RISK-NEUTRAL LENS

Using the very generic CLO description in Exhibit 1, we take a first look at the "fair value" of a CLO senior note in a risk-neutral framework. The variables that most impact the analysis include the correlation assumption for the portfolio of loans, the recovery rate assumptions and the spread distribution of the underlying loans.

exhibit 1 Hypothetical Leveraged Loan CLO Senior Note

Average Portfolio Spread	L+287 bp (85% par loans, 15% riskier credits)
Subordination	35%
Average Life	7 Years
Coupon	L + 41 bp
Total Cost of Liabilities	69 bp

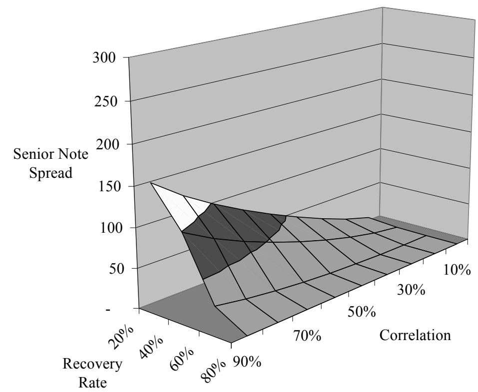
Source: Morgan Stanley

Exhibit 2 illustrates the valuation of the tranche in spread terms given changes in recovery rates and correlation levels. Our first insight is that very high correlation, combined with very low recovery rates, is bad for senior notes. The extreme case we modeled would result in a spread of 150 bp (the upper left corner of the surface). However, typical assumptions for both of these variables (30% for correlation and 60% for recovery rates) results in a spread of just 1 bp for the tranche, indicating that the likelihood of loss in the tranche is extremely remote (see Exhibit 3 for the data behind the graph).

chapter 37

exhibit 2

Senior CLO Note Sensitivity to Correlation and Recovery Rates



Source: Morgan Stanley

Interestingly, today's market levels of mid-40s bp for such notes imply correlation/recovery rate relationships that seem unreasonable to us (see shaded regions of table in Exhibit 3). As a benchmark, average historical recovery rates for senior secured high yield loans are in the 60% range, based on Moody's studies. Implied correlation in the tranched TRAC-X market ranges from about 20% to 35% for tranches today.

exhibit 3 The Numbers Behind the Graph – Senior CLO Note Valuation (bp)

	Correlation								
Recovery	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**
20%	4	14	28	43	60	78	98	121	149
40%	1	5	13	22	34	46	61	78	99
60%	0	0	1	2	4	7	10	15	22
80%	-	-	-	-	-	-	-	-	-

Source: Morgan Stanley

THEORY VS. PRACTICE – STRUCTURAL AND TECHNICAL FORCES

There are several important caveats to the above analysis that are important to consider. First, most CLOs require significant reinvestment of collateral during their life, given short-maturity loans and potential prepayments. All else equal, this reinvestment increases the credit risk of the underlying portfolio. However, if the structure is relatively healthy when the bulk of the reinvestment occurs, then the incremental risk to the senior notes is small, given the remaining term structure and subordination, even if market spreads are wide at the time. A tight spread environment may force the equity holders to call the structure, which could leave senior note holders with reinvestment risk themselves.

Second, triggers of any sort are difficult to model, and investors should be concerned about those that can have a negative impact on senior notes, such as any diversion of principal proceeds.

Third, the non-static nature of CLOs introduces a variable that is also difficult to model. In today's credit environment, there is little incremental risk to senior note holders for poor CLO management, but that changes when the credit environment changes.

INVESTMENT STRATEGIES

We find good fundamental support for getting long senior CLO risk in today's markets. However, technical factors certainly limit how much these notes can rally, if any, at this point. We also caution investors to look at the details, in particular subordination levels, as this is one of the biggest factors in any risk-neutral approach to pricing credit risk.

For investors who want to hedge the blow-up risk that could lead a CLO senior note to significantly deteriorate, we recommend doing so in places where senior-like risk is priced at tight levels relative to CLOs. One such example exists in the synthetic investment grade market with the now popular 3-100% tranches. Protection on the 3-100% tranche of TRAC-X currently trades at roughly 32 bp or 46% of the index spread.

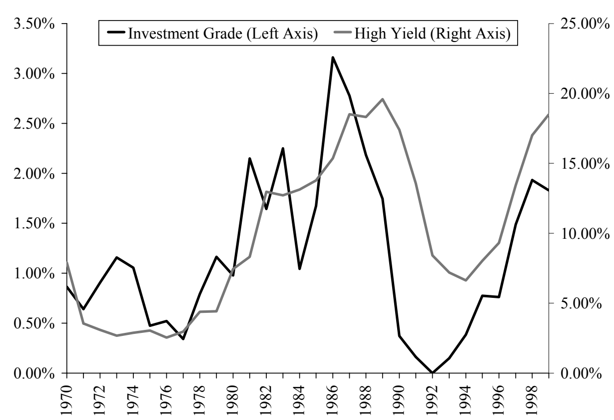
While one can question the links between investment grade and high yield performance for marginal changes in spread levels, we argue that the markets are indeed linked in times of abnormally high default rates, which is the true risk to senior notes. One can look at historic instances of extreme default rates for evidence of this link. In past periods of abnormally high default rates, we find high default correlation between investment grade and high yield (see Exhibit 4).

Anecdotally, the worst-case 5-year BBB loss rate (assuming 40% recovery in default) is 3.2% since 1970, while for high yield bonds it is 19.5%. Factoring in higher recovery, the implied loss rate for loans would be 13.1%. We point out that the maximum BBB default rate is greater than the 3% attachment point, while the maximum implied loan default rate would eliminate less than half the subordination from the CLO senior note.

We believe that 13.1% loss in subordination in a CLO structure (combined with likely wider market spreads) is less painful for a CLO senior note than 3.1% loss in subordination (and wider spreads) is for the 3-100% tranche. This is driven primarily by the time decay benefit that will accrue to the senior note because of the remaining subordination and that will not benefit the 3-100% tranche (under the assumption that losses have significantly reduced subordination).

exhibit 4

Aggregate Default Losses Are Well Correlated – High Yield vs. BBBs (5-Year Cumulative)



Source: Morgan Stanley

chapter 38 Origami with CLO Paper?

May 21, 2004

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As the CDO market continues its multi-year evolution, it is clear that what used to be thought of as one investment class has split off into two fairly separate schools of thought, at least from a valuation perspective. In the cash flow CDO world, popular valuation techniques are based on rating agency models and net asset value calculations, while in the synthetic tranched credit world (where the word "CDO" is not used much anymore), correlation-based derivatives pricing models are the norm. In our view, when the underlying collateral is corporate credit, this cultural divide is too stark, as the risks in a cash or synthetic deal are more similar than they are different.

With credit fundamentals improving across the board and near-term default risk as low as it has been in years, the new issue CLO market has been very active this year (over $8 billion of issuance, 30% of the CDO market). Over time, CLOs have arguably been the best-performing of the CDO asset types. Today, demand for transactions from good (and even mediocre) managers is pushing pricing to levels not seen since the early days of the market (Libor + 37 bp is the recent tight print for AAA CLO paper).

As we have written in previous research (see Chapter 37), when looking at senior CLO notes through a correlation lens, we are quite comfortable with market pricing levels, as there is very little default risk in the top part of the capital structure, resembling super senior tranches in synthetic deals. The next step, though, is to focus on pricing sensitivity to changes spreads, recovery rates and correlation, itself. In CLO mezzanine notes, much like in the synthetic world, these risks are difficult to model and pose some challenges to the conventional wisdom, particularly with respect to portfolio diversity. Varying recovery rate assumptions can lead to opposing sensitivities to correlation, creating an origami-like sensitivity surface for this "paper" and confusing the argument that diversity is a good thing at all levels of the debt capital structure.

THE DIFFICULTY OF MODELING MEZZANINE NOTES

In the synthetic tranched credit world, structures are simple, as they rarely have triggers that divert cash flows. Nevertheless, mezzanine notes pose an interesting challenge to the simplest versions of these models, because their pricing can be relatively invariant to changes in correlation values, while their deltas are not (see Chapter 13). Is diversity a good or a bad thing for these tranches? It is not clear, and in fact, our intuition tells us that there must be tranches in the CLO world that suffer from the same fate.

THE CORRELATION LENS – FOCUS ON INTUITION

One thing the derivative models can do is give some indication of the relative importance of typical assumptions used by the market in examining valuation for various tranches. In CLOs, recovery rate assumptions are important and can have a significant impact on valuations implied from correlation models. Intuitively, if average recovery rates are high (say 60-80%) then even a small amount of subordination would greatly reduce the risk in junior parts of the capital structure. If the average recovery is markedly lower (20-40%) then the most junior portions of capital structure become much riskier, while the senior portions may only be marginally affected.

exhibit 1 Generic CLO Capital Structure Assumptions

Tranche	Attachment	Detachment	Size
Equity	0%	8%	8%
Jr Mezzanine	8%	12%	4%
Mezzanine	12%	15%	3%
Jr Senior	15%	25%	10%
Senior	25%	100%	75%

Source: Morgan Stanley

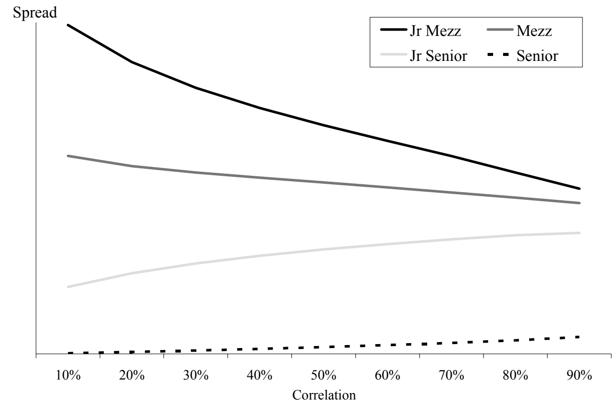
Historically high recovery rates are a key investment motivation in CLO structures, particularly at the subordinate level. So understanding the risk of unusually low recoveries (independent of actual default rates) is important. In Exhibit 1 we show a generic capital structure and focus on clarifying the correlation (or diversity) sensitivity of the notes. We caution readers that our modeling does not reflect any structural features present in these notes nor do the notes reflect the managed, short-dated nature of the underlying portfolio and the associated reinvestment risk.

DIVERSITY SENSITIVITY TO RECOVERY RATES

If we fix recovery rates at a 60% level, which is a popular market assumption, we find that senior tranches' spreads increase as correlation rises, meaning that they are "short" correlation or "long" diversity. Said another way, a lower correlation portfolio (which translates into higher diversity) lowers the risk in the tranches. This is intuitive and supports the "diversity is good" argument. The two mezzanine notes, however, do not necessarily benefit from higher diversity. The junior mezzanine note's spread clearly rises as diversity improves (correlation falls) in the portfolio, which implies that an investor in this tranche prefers a low diversity portfolio to one with high diversity. The more senior mezzanine note has a similarly shaped curve, but it is much flatter, and we caution that tranches like this can suffer from the correlation "invariance" problem that we see for 3-7% tranches in Dow Jones CDX today (again, see Chapter 13 for more details).

exhibit 2

60% Recovery Rates – Diversity Hurts Mezzanine

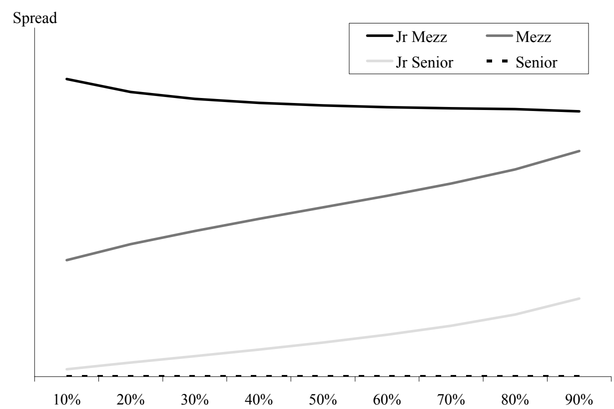


Source: Morgan Stanley

If we move to an 80% higher recovery assumption (which is not unheard of in the leveraged loan world), we find that the mezzanine note spread to correlation relationship becomes upward sloping, implying that it behaves just like the senior notes (i.e., diversity benefits the tranche, see Exhibit 3). Wider underlying spreads would work like lower recovery rates, moving the more senior tranches to become "long" correlation in nature.

exhibit 3

80% Recovery Rates – Mezzanine Benefits from Diversity

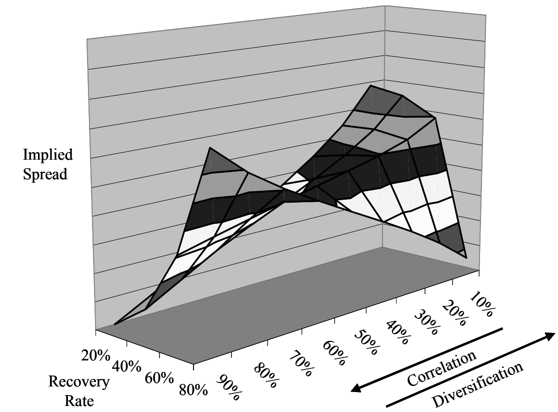


Source: Morgan Stanley

CLO MEZZANINE NOTE ORIGAMI

As we implied above, conventional wisdom is that diversification within an underlying leveraged loan portfolio is good for the debt investors in a CLO. However, much like what we see in the synthetic investment grade market, with today's relatively tight spreads, CLO mezzanine notes can be at an inflection point with respect to this rule of thumb.

exhibit 4
CLO Mezzanine Note Origami



Source: Morgan Stanley

Although three dimensions are sometimes hard to grasp at first, the "origami" image in Exhibit 4 demonstrates the changing correlation sensitivity for this part of the capital structure. Low recovery rates result in risk rising with diversity, while high recovery rates imply that risk falls as diversity increases.

TURNING CONVENTIONAL WISDOM ON ITS HEAD

In today's spread environment, CLO mezzanine notes reside in the portion of the capital structure that is most sensitive to the lens we used to evaluate them, much like what market participants have learned to accept in the synthetic investment grade markets, using the market's most basic models. One can think of such mezzanine notes as the untrustworthy ally. When aggregate risk in the portfolio is relatively low, their interests are aligned with senior notes; however, as soon as aggregate risk increases, they switch sides to align with the equity tranche. Either way, the sharper the lens, the better the results.

chapter 39 Seasoning for Convergence: The First Steps

January 11, 2005

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The emergence of standardized benchmark high grade and high yield credit derivative indices marked a significant turning point in structured credit markets. After an extended period during which several indices were in vogue, credit derivative markets finally came together to standardize the indices. The Dow-Jones CDX IG and Dow-Jones CDX HY indices now trade as market standards for the investment grade and high yield markets for North American credits. Similarly standardized indices now trade for Europe, Japan, Non-Japan Asia and Emerging Market credits.

The explosion of liquidity in the trading of benchmark tranches of these indices has added yet another momentous dimension. Expressing refined trading views through correlation trading has become the latest *mantra* in the structured credit lexicon.

The counterpart of the benchmark tranches on the cash side is the already mature but fragmented world of cash CDOs. In principle, corporate credit backed CDOs enable investors to take levered credit exposure on portfolios of corporate bonds and/or loans in much the same fashion as benchmark tranches do. In place of a standardized portfolio of underlying reference entities with the indices, CDO portfolios are largely disparate in their collateral composition. While precise statistics in secondary trading of cash CDO tranches are hard to come by, we note that secondary trading volumes have been surging in the cash CDO tranches.

Much has been written about the importance of a well-developed synthetic structured credit market to complement the cash CDO markets. On the surface, the red-hot CLO market, the vintage high yield CBO market and the new-fangled high yield CDX market have a lot in common and the convergence of the synthetic and cash structured credit markets has seemed like a natural progression.

WHY THE SLUGGISH CONVERGENCE?

However, the much anticipated convergence has been slow on the uptake. Clearly, there are several material differences between cash CDOs and their synthetic counterparts in the standardized index tranches that explain this apparent sluggishness of the two markets to converge. Cash CDOs have complex waterfall structures that determine payouts to different tranches. Some of these structural features take the form of triggers that determine and change payouts to different tranches according to per-set rules. Most CDOs have optional redemption features that give the equity tranche holders early call rights. The CDO manager determines the composition of the underlying portfolio subject to trading rules and limitations embedded through various covenants in the CDO governing documents. The portfolios are actively traded for the first few years and become static only at the end of the reinvestment period (typically 3-5 years). For CLOs, the senior secured nature of the leveraged loans renders the delivery of senior unsecured collateral under standard credit default swaps ineffective as hedging instruments.

Although the differences in the valuation approaches between the two markets appear to be narrowing as more elaborate models emerge for cash CDO valuation, it is still the case that ratings and static analyses of cash flows under constant default rates with deterministic shocks to key variables play a dominant role in the cash CDO markets. In contrast, synthetic structures are routinely valued under risk-neutral valuation framework with the use of Gaussian copula-type models having emerged as the market standard valuation methodology.

SEASONED HIGH YIELD CBOs: A NEW OPPORTUNITY

However, it is now possible to explore the links between some seasoned high yield CBOs and the high yield CDX index to evaluate if some of the barriers enumerated above can be overcome. The deliverable in the event of default in liquid credit default swaps (CDS) is senior unsecured collateral, the same class of collateral as in high grade and high yield bonds. Thus, credit default swaps have emerged as a reasonable instrument for hedging credit risk of senior unsecured bonds, the typical collateral in many seasoned CBOs.

Further, several seasoned high yield CBOs, issued about five years ago, are now beyond their reinvestment periods or getting close to the point when trading in the underlying portfolios effectively ceases and the portfolios become static. By evaluating the composition of these now static CBO portfolios and analyzing them with respect to the high yield CDX index, it may be possible to take the first steps towards the convergence of the cash CBOs and synthetic structured credit markets. If there is sufficient overlap in the composition of a particular CBO and the HY CDX index, it may be possible use tranches of the index to hedge existing exposures for investors currently long CBO tranches. With the increased secondary trading in cash CDO tranches, it may further be possible to take long/short positions between the HY CDX index tranches and specific seasoned CBO tranches. We explore this topic further.

exhibit 1 Industry Sector Distribution of HY CDX Index

Industry Sector	% of Total
Aerospace/Defense	1.00%
Agriculture	1.00%
Airlines	1.00%
Apparel	1.00%
Auto Manufacturers	1.00%
Auto Parts&Equipment	6.00%
Chemicals	7.00%
Commercial Services	3.00%
Computers	1.00%
Electric	5.00%
Electronics	3.00%
Entertainment	1.00%
Environmental Control	1.00%
Food	3.00%
Forest Products&Paper	4.00%
Healthcare-Services	3.00%
Home Builders	3.00%
Insurance	2.00%
Iron/Steel	2.00%
Leisure Time	1.00%
Lodging	4.00%
Machinery-Diversified	2.00%
Media	7.00%
Office/Business Equip	2.00%
Oil&Gas	7.00%
Packaging&Containers	3.00%
Pharmaceuticals	1.00%
Pipelines	3.00%
REITS	4.00%
Retail	5.00%
Semiconductors	1.00%
Telecommunications	11.00%

Source: Morgan Stanley

A MEDIUM-SIZED UNIVERSE OF SEASONED CDOs

We identified 48 seasoned CDOs whose reinvestment period has either ended during 2004 or will end during 2005. Even though the focus of this report is on high yield bonds, we included some CLOs in the analysis since several vintage CLOs have a permissible high yield bond bucket.

Using data on collateral holdings of each of these CBOs obtained from Intex[1], we compare their holdings to the composition of the reference portfolio of the HY CDX index. We identify the % of bond issuers that overlap between each CBO and the index, by number and notional volume. We focus on the tail risk by identifying the bond notional in the CBO rated CCC or below and comparing it to the similarly defined tail risk in the index's reference portfolio. For each bond issuer in the collateral portfolio, we use the lower of the S&P and equivalent Moody's rating to determine if the issuer constitutes part of the tail risk.

Before discussing the overlap between the collateral portfolios of the CDOs and the reference portfolio of the index, it is useful to examine the composition of the index itself. The reference portfolio of the HY CDX index is an equally weighted static portfolio of 100 bond issuers. Exhibit 1 shows the industry sector composition of the index. Telecommunications is the single largest sector in the index with 11% of the notional.

The ratings distribution of the index, using the lower of the S&P and equivalent Moody's ratings, expressed in S&P ratings terminology is in Exhibit 2. 16% of the index is rated CCC or below. BB and B ratings categories constitute over 80% of the index.

exhibit 2 Ratings Distribution of the HY CDX Index

Rating	% of Total
BBB-	2.0%
BB+	9.0%
BB	11.0%
BB-	20.0%
B+	11.0%
B	12.0%
B-	19.0%
CCC+	7.0%
CCC	6.0%
CC	3.0%

Source: Morgan Stanley

Exhibit 3 describes the 48 CDOs analyzed along with their portfolio composition, overlap ratios in the total portfolio and in the tail risk component. Overlap ratios capture the ratio of the bonds overlapping between a CDO's collateral portfolio and the index's reference portfolio.

[1] *As of Dec 23, 2004.*

exhibit 3 Comparing CBO Portfolio Composition with DJ HY CDX Index Reference Portfolio

				Asset Portfolio Composition				# of Unique	# of Unique	Overlap Ratio (%)			Tail Risk
Name of the CDO	Issue Date	Reinvestment End Date	WAM (Months)	% Bonds	% Loans	Other	Total	Bond Issuers in CDO	Issuers Common to CDO and Index	# of Issuers	Bond Notional	Total Asset Notional	Overlap Ratio (%)
Porticoes Funding	12/22/98	01/22/04	36	100%	0%	0%	100%	54	12	22%	21%	21%	8%
FMA CBO Funding II	09/15/99	09/25/04	47	100%	0%	0%	100%	47	14	30%	26%	26%	23%
Strong CDO III	10/01/00	10/15/04	66	100%	0%	0%	100%	85	23	27%	27%	27%	54%
INNER HARBOR CBO 1999-1 LTD.	12/21/99	01/15/04	59	100%	0%	0%	100%	124	29	23%	29%	29%	19%
American General CBO 2000-1 Ltd.	08/24/00	08/24/05	52	100%	0%	0%	100%	101	26	26%	30%	30%	6%
Gleacher CBO 2000-1	05/09/00	05/09/05	66	100%	0%	0%	100%	98	30	31%	31%	31%	35%
Admiral CBO	08/19/99	08/12/04	51	100%	0%	0%	100%	36	11	31%	32%	32%	21%
FREEDOM 1999-1 CDO (PREVIOUSLY CIGNA COLLATERALIZED HOLDINGS 1999-1 CDO)	11/17/99	09/30/04	49	100%	0%	0%	100%	75	24	32%	33%	33%	24%
RAINIER CBO I LTD.	07/18/00	07/28/04	63	100%	0%	0%	100%	110	37	34%	38%	38%	38%
BATTERY PARK CDO, LIMITED	12/22/99	02/10/05	47	100%	0%	0%	100%	74	23	31%	39%	39%	32%
Juniper CBO 2000-1 Ltd.	04/04/00	04/15/04	57	100%	0%	0%	100%	87	33	38%	43%	43%	48%
STRONG HIGH YIELD CBO II LTD.	**11/23/99**	**02/10/05**	**55**	**100%**	**0%**	**0%**	**100%**	**63**	**25**	**40%**	**51%**	**51%**	**42%**
Flagstone CBO 2001-1	10/18/01	11/15/05	77	100%	0%	0%	100%	157	45	29%	31%	31%	29%
Phoenix CDO, Limited	03/31/99	03/31/04	39	100%	0%	0%	100%	43	12	28%	38%	38%	49%
AIG Global Investment Corp CBO-3	11/02/99	10/24/04	51	100%	0%	0%	100%	63	25	40%	45%	45%	28%
UBS Brinson CBO Limited	09/02/99	08/15/04	52	99%	1%	0%	100%	71	21	30%	35%	35%	19%
ML CBO Series 1999-Putnam-1	06/24/99	08/10/05	51	99%	1%	0%	100%	109	42	39%	39%	38%	36%
Cedar CBO	12/10/99	06/10/04	51	98%	2%	0%	100%	134	50	37%	44%	43%	25%
CENTURION CDO I, LIMITED	05/04/00	05/10/05	58	97%	3%	0%	100%	139	48	35%	41%	40%	31%
Muzinich Cashflow CBO	04/26/00	05/08/05	59	95%	5%	0%	100%	68	31	46%	54%	51%	37%
Muzinich Cashflow CBO II Ltd.	10/18/00	11/08/05	64	94%	6%	0%	100%	100	30	30%	31%	29%	28%
Wilbraham CBO Ltd.	07/13/00	07/13/05	55	92%	8%	0%	100%	70	16	23%	32%	29%	25%
Titanium CBO I Limited	10/25/00	10/25/05	60	90%	10%	0%	100%	100	24	24%	28%	26%	20%
CANYON CAPITAL CDO 2001-1 LTD.	04/11/01	04/30/05	71	84%	16%	0%	100%	118	25	21%	25%	21%	24%

exhibit 3 (cont.) Comparing CBO Portfolio Composition with DJ HY CDX Index Reference Portfolio

Name of the CDO	Issue Date	Reinvestment End Date	WAM (Months)	Asset Portfolio Composition % Bonds	% Loans	Other	Total	# of Unique Bond Issuers in CDO	# of Unique Issuers Common to CDO and Index	Overlap Ratio (%) # of Issuers	Bond Notional	Total Asset Notional	Tail Risk Overlap Ratio (%)
SAAR HOLDINGS CDO, LIMITED	03/16/99	03/24/04	49	78%	22%	0%	100%	63	12	19%	24%	19%	6%
Magma CDO (previously Whitney Cash Flow Fund II)	11/09/00	11/15/04	73	74%	26%	0%	100%	67	17	25%	32%	23%	27%
Blue Eagle CDO I S.A.	12/19/00	12/19/05	64	72%	27%	1%	100%	39	4	10%	13%	10%	40%
Catalina CDO	12/02/99	12/12/04	67	70%	30%	0%	100%	62	21	34%	35%	25%	55%
Bedford CDO, Limited	05/11/99	05/11/04	52	60%	40%	0%	100%	60	23	38%	38%	23%	46%
Ecureuil Credit Plus CDO	12/13/01	01/13/05	78	60%	33%	7%	100%	63	7	11%	9%	5%	4%
Archimedes Funding	11/05/97	11/08/04	31	40%	60%	0%	100%	13	0	0%	0%	0%	0%
Archimedes Funding II	10/22/98	10/08/05	33	34%	66%	0%	100%	13	2	15%	10%	3%	0%
Ares III CLO	12/15/99	01/12/05	64	30%	70%	0%	100%	62	17	27%	29%	8%	38%
ML CLO Series 1998-Pilgrim America-3	09/16/98	09/23/04	46	27%	73%	0%	100%	20	8	40%	35%	9%	25%
Indosuez Capital Funding VI, Ltd	09/14/00	09/14/05	72	27%	73%	0%	100%	34	13	38%	44%	12%	32%
Ares IV CLO Ltd.	11/14/00	12/22/05	63	25%	75%	0%	100%	72	19	26%	32%	8%	32%
Stanfield/RMF	05/04/00	04/15/05	65	23%	77%	0%	100%	66	19	29%	28%	7%	20%
Centurion CDO II, Ltd.	11/02/00	11/12/05	64	22%	78%	0%	100%	121	32	26%	27%	6%	16%
First Dominion Funding III	12/16/99	12/22/04	60	22%	78%	0%	100%	72	15	21%	21%	5%	36%
Monument Capital	05/13/99	05/13/04	51	22%	78%	0%	100%	39	19	49%	44%	10%	56%
Stanfield CLO, Ltd.	06/24/99	07/15/04	58	21%	79%	0%	100%	43	12	28%	35%	7%	25%
Longhorn CDO (Cayman) Ltd	03/15/00	05/10/05	61	20%	80%	0%	100%	25	10	40%	61%	12%	63%
SIMSBURY CLO, LIMITED	09/15/99	09/24/04	62	20%	80%	0%	100%	43	9	21%	20%	4%	13%
AIMCO CDO, Series 2000-A	06/22/00	08/22/05	64	17%	83%	0%	100%	86	17	20%	20%	3%	26%
Octagon Investment Partners III, Ltd	12/08/99	12/15/04	61	15%	85%	0%	100%	56	26	46%	54%	8%	76%
AMMC CDO I	04/15/00	01/15/05	61	15%	85%	0%	100%	10	4	40%	40%	6%	84%
ADDISON CDO, LIMITED	10/19/00	11/08/05	66	11%	89%	0%	100%	25	11	44%	45%	5%	56%

Source: Intex Solutions Inc and Morgan Stanley calculations

AN ILLUSTRATIVE EXAMPLE

To illustrate, consider Strong High Yield CBO II Ltd highlighted in Exhibit 3. Issued originally in November 1999, the CDO's reinvestment period ends in February 2005. The weighted average maturity of the assets in the portfolio is 55 months (4.6 years). The collateral portfolio of the CDO consists of 100% high yield bonds with 63 unique bond issuers. 25 of the bond issuers in the CDO's collateral portfolio are also in the index's reference portfolio. Unlike the index, the bonds in the CDO's collateral pool are not equally weighted. In notional terms, about 51% of the bonds in the portfolio overlap between the CDO and the index. In terms of tail risk, 42% of the bond notional in the tail risk component of the portfolio overlaps with the index's reference portfolio.

In Exhibits 4 and 5, we compare the non-overlapping components of the index and the CBO in terms of industry sectors and ratings. The mismatch between the index and the CBO in the non-overlapping portion is significant. The non-overlapping portion of the CBO is weighted more heavily in the CCC ratings category than the index is. While the industry sectors also show a mismatch, the extent of the mismatch can be evaluated by sector specific views.

exhibit 4 Sector Distribution of Non-Overlapping Notional

Industry Sector	**Strong CBO II**	**DJ HY CDX Index**
Commercial Services	11.5%	4.0%
Media	9.2%	5.3%
Retail	8.5%	4.0%
Lodging	7.9%	5.3%
Chemicals	6.3%	5.3%
Office/Business Equip	5.9%	1.3%
Entertainment	5.9%	0.0%
Office Furnishings	5.1%	0.0%
Telecommunications	4.6%	9.3%
Advertising	4.2%	0.0%
Iron/Steel	4.1%	1.3%
Cosmetics/Personal Care	3.9%	0.0%
Distribution/Wholesale	3.4%	0.0%
Leisure Time	3.4%	0.0%
Trucking&Leasing	2.5%	0.0%
Healthcare-Services	1.9%	4.0%
Packaging&Containers	1.7%	4.0%
Electric	1.7%	5.3%
Oil&Gas Services	1.7%	0.0%
Pharmaceuticals	1.7%	1.3%
Diversified Finan Serv	1.7%	0.0%
Electronics	1.7%	2.7%
Forest Products&Paper	1.5%	4.0%
Aerospace/Defense	0.2%	1.3%
Environmental Control	0.0%	0.0%
Semiconductors	0.0%	0.0%
Auto Parts&Equipment	0.0%	5.3%
Apparel	0.0%	0.0%
Oil&Gas	0.0%	8.0%
REITS	0.0%	5.3%
Home Builders	0.0%	4.0%
Food	0.0%	4.0%
Pipelines	0.0%	4.0%
Machinery-Diversified	0.0%	2.7%
Insurance	0.0%	2.7%
Airlines	0.0%	1.3%
Auto Manufacturers	0.0%	1.3%
Agriculture	0.0%	1.3%
Computers	0.0%	1.3%
Total	**100.0%**	**100.0%**

Source: Intex Solutions Inc and Morgan Stanley

exhibit 5 Ratings Distribution of Non-Over Lapping Notional

Rating	Strong CBO II	DJ HY CDX Index
BBB	1.69%	0.0%
BBB-	0.00%	2.7%
BB+	0.00%	12.0%
BB	0.00%	12.0%
BB-	10.66%	21.3%
B+	4.23%	8.0%
B	18.10%	10.7%
B-	17.43%	21.3%
CCC+	18.13%	6.7%
CCC	8.46%	5.3%
CCC-	11.16%	0.0%
CC	5.07%	0.0%
C	5.07%	0.0%
Total	**100.00%**	**100.00%**

Source: Intex Solutions Inc and Morgan Stanley

What does this example illustrate? Roughly speaking, about half of the credit risk in the CBO can be hedged by taking an offsetting position in the index. Assuming that issuers in the tail risk, as defined here, constitute issuers most at risk for default, 42% of the tail risk can also be hedged with the index.

Even though there is not a 100% overlap between the index and the CBO, it might still be possible to explore trading opportunities between the two. We will argue that to take offsetting positions in the mezzanine tranches of the CBO and the HY CDX index an overlap of 100% is probably not necessary. Remember that the risk exposure of a mezzanine holder is not to the default of the entire portfolio but losses in a defined range. The further up in the capital structure, the less is the sensitivity to the overlap in the tail risk portion. In contrast, lower down the capital structure, tail risk overlap is more material. Obviously, tail risk overlap matters more to equity tranches than to mezzanine tranches.

While there remains a basis risk, it may be possible to hedge the non-overlapping component with single name credit default swaps. It seems to us that at the minimum there is a potential to further explore trading/hedging strategies between a mezzanine tranche of the Strong High Yield CBO II and an appropriate tranche of the HY CDX index.

More generally, our analysis shows that the overlap ratios vary widely – between 0% and 51%, with a majority of cases in the 30-45% range. Tail risk overlap ratios also cover a similarly broad range. Where there is a significant overlap, a potential exists to explore the relationships further which may offer trading and/or hedging opportunities. Several market participants are already using the single-name CDS market to hedge specific exposures in CBO tranches on a delta–adjusted basis. We argue that application of HY CDX index and the tranches of the HY CDX index is the next natural progression in the path towards convergence of cash and synthetic markets.

NEXT STEPS

Clearly, this is only a first step in the analysis. A more complete analysis should include further examination of tranche analytics to determine the index tranche most appropriate for exploiting the relationships between the two markets. Our definition of tail risk can be further refined by adding the level of spreads to the analysis. Besides the commonality of credit exposure, there are other issues that need to be evaluated. Included among issues not explored here but deserve to be analyzed are: the option that the CBO equity holders have, to force an early redemption of the debt tranches and the unequal weighting of individual issuers in the CBO's underlying portfolio. The valuation divide between synthetic and cash CDO markets implies that there is a potential for mark-to-market risk when taking offsetting positions in these markets, even when the overlap of exposures is perfect.

We do not intend to make light of these complexities. Notwithstanding such challenges, this analysis marks our first steps in the exploration of the convergence between the cash CDOs and the synthetic structured credit markets. We are sure to revisit this issue in the future. Watch this space.

Section G

Structured Credit Insights

FTD Basket Investment Themes

Please see additional important disclosures at the end of this report.

chapter 40 Levering the Lightly Levered

September 12, 2003

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Peter Polanskyj
Anisha Ambardar

Leverage may be an overused term in financial markets, but it is a word that aptly describes how investors or corporate management can "re-size" an investment or enterprise, thereby changing its risk and return profile. In credit markets we are all used to thinking about "corporate" leverage (debt/EBITDA), but tranched basket products allow investors to add "structural" leverage as well. The "total" leverage resulting from this exercise is an interesting concept to consider, and we argue that investors hunting for yield in this market should combine these leverage concepts and compare resulting opportunities. In this chapter we focus on identifying investment ideas based on both of these notions of leverage, using first-to-default baskets as the structural vehicle.

GETTING PAID FOR CORPORATE LEVERAGE?

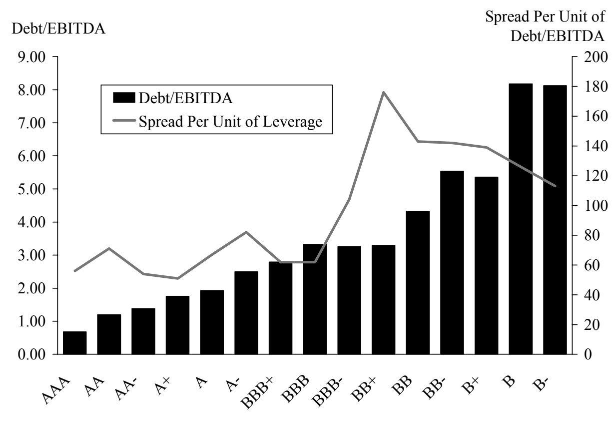
Corporate leverage metrics, which we define as outstanding debt divided by an earnings measure like EBITDA, are an important driver of credit risk and as such are key inputs in the analyst rating process (used both by credit analysts and rating agencies). Greg Peters, our chief credit strategist, has combined corporate leverage with spreads to create relative value tools in both investment grade and high yield markets. Broadly speaking, corporate leverage rises with decreasing credit quality, but the shape of this curve is not necessarily consistent with market spreads (see Exhibit 1, where results are based on second quarter balance sheet data from 600 non-financial issuers). Based on Greg's research, for direct credit investors, the "sweet spot" in spreads versus leverage currently is in the high-quality space (AAA/AAs) and in BBs. As a caveat, we remind readers that corporate leverage is not the only driver of credit risk, although it is an important one.

"TOTAL" LEVERAGE OPPORTUNITIES

Structured credit investors can use this valuable corporate leverage information in two important ways. First, on a "total" leverage basis, levering up AAAs and AAs (where ultimate ratings could be AA to A) may be better than buying single-As and BBBs outright since resulting structures may offer more spread per unit of "total" leverage than the outright investments. The same argument could be made for levering up BBs versus buying single-Bs outright.

exhibit 1

The Sweet Spots: Spread Per Unit of Corporate Leverage



Source: Morgan Stanley, Factset

A review of Moody's historical cumulative 5-year default data and current spread levels provides some further insight on this front. We introduce another relative value measure – spread per unit of default risk[1] – in order to reflect the impact of both corporate and structural leverage.

When we compare the average spread per unit of default risk of a levered AAA/AA basket against that of an average BBB credit, we find (under the conservative assumption of zero default correlation) that the levered product offers approximately 2.4 *times* the spread per unit of default risk. Additionally, a similar analysis for a levered BB basket results in 1.5 *times* the spread per unit of default risk when compared to an average B credit.

Our second argument for structured credit investors is that, while the data in Exhibit 1 is based on average numbers, the outliers in these distributions are interesting credits as well, from a long or short perspective. In Exhibit 2, we show the distribution of corporate leverage numbers for 265 single-A and BBB issuers. The leverage numbers range from near zero to above 10x, with the average being 2.7x. Selling first-to-default protection on some of the lightly levered names in this universe may be a good relative value trade for investors with positive or neutral views on the credits otherwise.

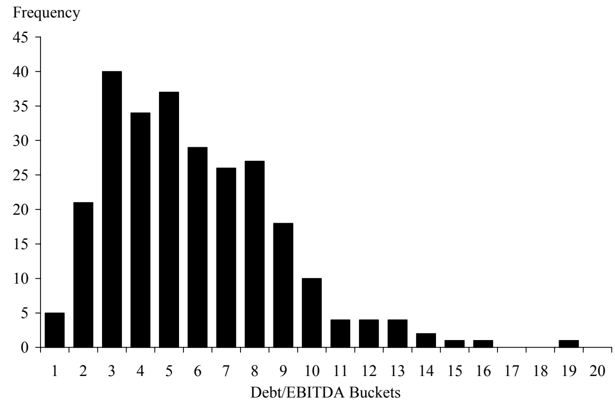
TAKING THE CONCEPT FORWARD: SMALL BASKET IDEAS

First-to-default baskets are good vehicles for credit pickers to take on incremental, name-specific credit risk. Based on the flows we have seen this year, first-to-default basket usage is quite different from usage in the product's bigger cousin: single tranches of large portfolios including TRAC-X. Ignoring the hedge fund universe for a moment, we have found flows in the small-basket market tilted toward large, credit-savvy real-money investors who welcome the opportunity to implement credit views and often look for such opportunities away from the core part of the investment grade market, where they generally already have enough exposure. Flows in the large-basket products are probably more evenly distributed among all credit investors, given that exposure to large issuers and diversification are welcomed in many portfolios.

[1] *Defined as credit spread/annualized 5-year default probability.*

exhibit 2

Relative Value - Dispersion in A/BBB Corporate Leverage



Source: Morgan Stanley, Factset

With this background in mind, we have designed three first-to-default baskets that we believe are well-suited for investors confident enough to take on some additional credit risk by levering up attractively levered companies today. While we think the baskets themselves are interesting, the methodology behind creating them is probably even more important.

LEVERING HIGH-QUALITY NAMES

First-to-default baskets built from AAA and AA credits have been the most popular flow in this small market this year, with real-money investors being the natural sellers of protection. The idea of levering up lightly levered names is appealing, both from a credit risk perspective and from a diversification perspective, given that most large credit investors have adequate exposures to the core A and BBB parts of the corporate markets.

exhibit 3 Levering the Lightly Levered Credits

	High Quality	Mid	BBB Outliers	Mid	BBs	Mid
Underlying Credits						
	Home Depot	18	Sprint	110	D.R. Horton	160
	UPS	13	EDS	220	Nextel	255
	Merck	13	Delphi	160	Lear	155
	SBC Comm.	40	Altria Group	332		
	IBM	33				
Avg Debt/EBITDA		0.9x		1.7x		2.9x
	Bid	**Offer**	**Bid**	**Offer**	**Bid**	**Offer**
FTD Prem	85	103	613	643	405	495
% of Total	73%	88%	75%	78%	71%	87%
Correlation	60%	35%	44%	37%	61%	30%

Source: Morgan Stanley

Our benchmark high-quality basket (comprised of FNMA, AIG, GECC, PFE and WMT) has an average default swap premium of 27 bp today, 10 bp tighter than its level in early February, the wide of this year's spreads. The bid side of the first-to-default basket, however, has tightened from a 130 bp level to 96 bp today. Implied correlation is high, given our subjective view that these credits are not very correlated, but today's implied correlation level of 55% is lower than peak levels of 60%.

The high-quality basket we show in Exhibit 3 is different in nature from our benchmark basket. It includes five credits that are all non-financial in nature and have an average debt/EBITDA ratio of 0.9x, well below the average level of 1.5x for AAs. The seller of first-to-default protection on this basket receives 73% of the total premium, with an implied correlation of 60%.

HIGH YIELD

On an absolute basis, the BB sector appears attractive when looking at the spread per unit of corporate leverage metric, but an investor must be comfortable with a levered investment in BB credits. We have selected a basket with three names and are thus applying less structural leverage than we do above. Investors could add names to generate more structural leverage and achieve a more single-B-like "total" credit quality. The names in this basket are somewhat tighter than typical BBs, but the basket's average corporate leverage is significantly lower than the average BB measures (2.9x vs. 4.4x). The resulting spread on the basket is 405 bp, with implied correlation of 61%.

OUTLIERS IN A CORE MARKET

While average spread per unit of corporate leverage numbers appear less attractive in the BBB sector, dispersion in leverage among the issuers is a good source of relative value, as we highlighted in Exhibit 2. Our "BBB Outliers" basket in Exhibit 3 was constructed as a result of this dispersion and contains four BBB credits with average corporate leverage of 1.7x versus 3.1x for BBBs as a whole. The spread on the first-to-default basket is 613 bp, where ultimate default risk may be BB-like. With this basket in particular, investors need to be comfortable with the non-leverage-related factors affecting credit quality in the underlying names.

chapter 41 Managing Merger Mania

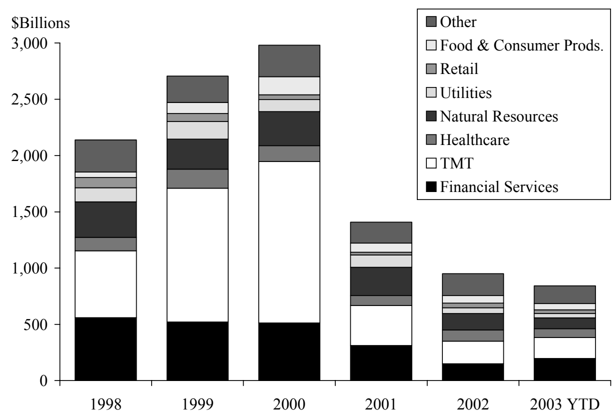
October 31, 2003

Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar

In a credit market that continues to be amazingly tight and compressed, a pickup in merger activity is introducing both volatility and opportunity. For credit investors wondering how they are going to make money in 2004, merger activity may be one area that merits their attention. At the single-name level, understanding mergers is all about credit analysis. Balance sheets, debt ratios and credit ratings are the key areas requiring focus. Investors with keen insight into the resulting impact are the ones who will be rewarded first, if fundamentals eventually play out.

Mergers have an interesting impact on first-to-default baskets, and we feel this effect is not well understood in the marketplace. Depending on the nature of "replacement" language in contracts, sellers of protection on a first-to-default basket are effectively long a merger option on the names in the basket. This merger option does not require the investor to pick the specific credits that could merge; the candidate credits simply need to be included in the basket. Investors can thus focus on a sector or group of credits where merger activity is a possibility and get rewarded when an actual merger occurs. By contrast, in the single name world, one has to pick the right credits and also correctly discern the direction of spreads to benefit. We focus this chapter on better understanding the merger options inherent in small baskets and are fortunate to be able to track valuations in a real-life example involving our Benchmark Bank Basket.

exhibit 1
Can We Expect More Merger Activity?



Source: Morgan Stanley, Thomson Financial

MERGERS AND CORRELATION

In the context of baskets and tranches, a merger between two reference entities is equivalent to an upward jump in average correlation (because the correlation of the two names goes to 1). Such a jump can have a dramatic impact on the valuation of small baskets. Those who are long correlation (e.g., sellers of first-to-default protection) will benefit when a merger occurs, and often the benefit can more than offset a potential widening of spreads, if the merger is not bondholder friendly.

Let's focus on a specific example: On October 27, Bank of America and FleetBoston Financial announced a merger. In the default swap market, Fleet traded about 8 bp wider than Bank of America prior to the announcement; afterwards, both traded at or near the original Bank of America level (of about 20 bp mid-market).

exhibit 2 BAC and FBF Merger – FTD Basket Jumps 10 bp

	Before Merger Announcement	After Merger Announcement
FTD Bank Basket	67/80	57/67
Total/Avg Spread	116/23	108/22
BAC	20	20
C	20	20
FBF	28	20
ONE	22	22
WFC	26	26

Source: Morgan Stanley

Our Benchmark Bank Basket has a total of five banks, including both Bank of America and FleetBoston. The basket trades without replacement language (which we will discuss below). As such, from the perspective of a first-to-default buyer or seller, it will effectively be a four-name basket going forward, if the announced merger goes through. Going from five to four credits can be considered a reduction in structural leverage (see Chapter 40), which benefits the seller of first-to-default protection (because the investment becomes less risky). Based on market pricing, the basket's premium rallied 10 bp (from 67 to 57 bp on the bid side), purely as a result of the announced merger (spreads on the other banks did not move).

THE MECHANICS – BASKETS WITHOUT REPLACEMENT LANGUAGE

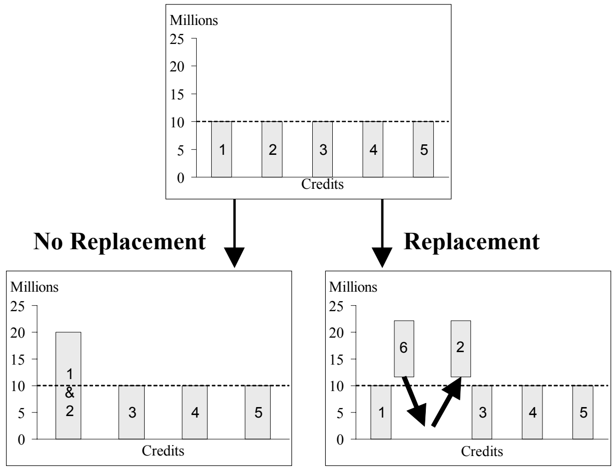
The mechanics behind merger treatment in baskets are important to understand, as there are two types of language that trade in the market (see Exhibit 3). In the simplest form (i.e., without replacement language), a five-name first-to-default basket where two reference entities merge effectively becomes a four-name basket once the merger closes.

However, the "contractual" notional amount of the merged entity in the basket doubles to reflect that it was once two reference entities. Yet, this change in exposure size of the merged entity does not matter to the seller or buyer of first-to-default protection. A credit event in any of the four names (including the merged entity) would still trigger the contract. A credit event experienced by the merged entity, however, has a larger notional impact. Therefore, it would simultaneously trigger both a first-to-default and a second-to-default contract.

chapter 41

exhibit 3

Replacement Language Matters – Impact of a Hypothetical Merger Between Credits 1 & 2



Note: Assumes $10 million notional of first-to-default exposure.
Source: Morgan Stanley

REPLACEMENT LANGUAGE – OPERATIONALLY PUZZLING

The impact of a lack of replacement language seems intuitive to us, given either the correlation or leverage reduction analogies we described above. The seller of first-to-default protection sees a reduction in risk when there is a merger, so the seller of second-to-default protection must see an increase in risk, for which he or she must be compensated. Market clearing levels should take this into consideration, if the market is efficient about this. In fact, we would argue that the merger option is one factor that keeps implied correlation in small baskets higher than in large baskets.

First-to-default baskets trade with “replacement” language in the marketplace as well (see Exhibit 3). Here, when a merger occurs, instead of dropping an entity in the basket, the buyer and seller of protection must mutually agree on a replacement credit, and often this replacement credit is one that trades at a similar spread level. Clearly, there is significant correlation risk in this exercise, and the buyer and seller of protection will have opposite correlation views. Furthermore, the operational aspects of going through this process for each basket that experiences a merger can be tedious. We have much more experience with baskets that trade without replacement language, which again seems more intuitive to us. We thus recommend that both buyers and sellers of first-to-default protection avoid replacement language.

THE MERGER IMPACT – WHAT IS IT WORTH?

The 10 bp impact in pricing that we saw for our Benchmark Bank Basket may not seem like a lot of spread movement for being long a merger option and getting it right. However, we do consider it a reasonable move on a relative basis, given the nature of the basket. The average premium of the five banks was 22 bp, and the basket was priced at a relatively high correlation already (76%, on the bid side) before the merger announcement.

exhibit 4 What Is the Impact of a Merger Worth?

	Average Spread of Credits in Basket (bp)			
Correlation	**20**	**50**	**100**	**150**
20%	18	41	78	111
40%	15	32	57	80
60%	11	22	39	53
80%	6	13	22	29

Source: Morgan Stanley

In order to better understand the value of the merger options, we examine the pricing impact across credits with a variety of spreads and correlations. Generally, the merger impact becomes more valuable for riskier (e.g., higher spread) credits, as well as for baskets where implied correlation (before the merger announcement) is low. For example, the expected spread move in a basket with an average premium of 50 bp, at a correlation of 40% (which is typical for diversified industrial first-to-default baskets), would be 32 bp (see Exhibit 4). At 150 bp of average premium, it would be worth 80 bp. This assumes no movement in spread of the merged entity or other credits in the basket.

To the extent that a merger drives the merged entity's spread wider, the impact of the merger would be more muted than indicated in the table. As an example, for a basket with average spread of 50 bp, trading at 60% correlation, the gain on the merger of two entities (roughly 22 bp of first-to-default premium) would be fully offset by a 33 bp (66%) widening in spread for the merged entity.

WHAT ARE THE TRADES TO DO?

It depends on one's view of where the merger activity is going to be. Historically, financial services and TMT have been popular sectors (see Exhibit 1), given both consolidation and growth opportunities. Our main point is that the first-to-default basket market is not yet sophisticated enough to reflect market merger views, so investors may find some interesting merger option opportunities.

chapter 42 Levering the Fundamentally Fit

April 2, 2004

Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar

Credit fundamentals continue to improve among US investment grade issuers, based on corporate leverage statistics and cash balances. Gregory Peters, our chief credit strategist, has noted that 60% of issuers have reduced leverage fairly consistently over the past six quarters (see "A Fundamental Improvement," March 22, 2004). Valuations, for the most part, already reflect this bondholder-friendly environment, although our credit analysts can point to at least some single-name opportunities.

We have argued in previous research that structurally levering credits that are lightly levered themselves is a good way to express a strong fundamental credit view (see Chapter 40). Six months since our initial thoughts, credit fundamentals are even stronger, and there are numerous opportunities to express this view through specific first-to-default baskets. In particular, we find credits with little outstanding debt, large cash balances relative to outstanding debt, or debt payment schedules that are further off (say beyond five years) to be attractive candidates for inclusion in baskets. We go through several examples in this chapter.

Liquidity, though, is always the number one question when investors consider customized structured credit opportunities. In the 18 months or so that we have closely tracked the first-to-default segment of the correlation markets, transparency has improved and, equally importantly, flows have rapidly increased, which we comment on in more detail, as well.

SELLING FTD PROTECTION – INSURANCE COMPANIES ONLINE

The biggest theme in the first-to-default market is the entrance of insurance companies as sellers of protection. While this flow is not necessarily new and has certainly taken some time, we find quite a number of insurers (life insurers in particular) today who have investment programs in place. The motivation for getting involved has been the quintessential desire for yield, along with an appetite for credit risk in "non-traditional" names (highly rated issuers and non-US or off-the-run credits, where fundamentals are good, but spreads are tight). In fact, both of these sentiments have overshadowed the potential earnings volatility insurers take on for getting long credit risk through derivatives instead of cash instruments. We expect the insurance flow into the first-to-default market to be a continuing theme.

Away from insurers, the market continues to broaden, but is still fragmented in our view. We see some selling of first-to-default protection in the hedge fund community, either outright or versus deltas. There are also pockets of interest in shorter maturities (less than five years) on potentially riskier names, a strategy that we support as well when credit fundamentals are strong.

BUYING FTD PROTECTION – FAR FROM COMPELLING?

In the current market environment, buying first-to-default protection outright has been far from a compelling trade, as there has not been nearly enough spread decompression (or idiosyncratic risk) to justify the levered premiums for these baskets. Yet we argue that buying first-to-default protection is a good hedge for those who take on significant idiosyncratic or concentration risk in their credit portfolios. The argument is that not all credits (where perceived credit risk is high) will ultimately default, but reducing concentration is important nevertheless. As such, carefully placing credits in a series of baskets and buying first-to-default protection will save premium.

Bank loan portfolios are a natural application, and portfolio managers are increasingly buying first-to-default protection as an alternative to outright single-name protection positions. Yet the flows here are still relatively small and may not pick up substantially until banks' appetite for protection picks up. Another very good use of first-to-default protection is in portfolios of equity and mezzanine tranches, given the significant jump-to-default risk. Those who manage portfolios of these risks spend a good amount of time hedging single-name risk for the obvious reasons, but the idea of spreading the idiosyncratic risk around in first-to-default baskets to save premium outlays is appealing, in our view, and will likely grow as liquidity grows in small baskets.

THE UNLEVERED ALL-STARS

As we examine corporate leverage statistics for the generally healthy investment grade market, we find some extremely fundamentally fit corners of the market. In particular, from a default risk perspective, three themes strike us as interesting.

- Out of a 286 issuer universe in Gregory's study, 40 credits have Debt/EBITDA ratios that are below 1.0x (the investment grade median is 2.1x, the average is 2.5x).
- The median ratio of cash to debt is 14%, but 27 credits have more cash than debt on balance sheets.
- While the average credit has almost half of its outstanding public debt due in the next five years, 40 credits have less than 20% of their public debt due in the next five years. Twenty of these credits have less than 10% of debt due in the next five years. Thirty credits have virtually no debt due over the next three years.

While valuations, in many cases, reflect this fundamental fitness, medium term default risk is very low for these names, barring any major change in a company's capital structure. For fundamentally minded investors, these are strong arguments for increasing exposure to default risk.

One point we would like to drive home is the distribution of debt payments. In the default swap markets, it is possible to have a liquidity point for a credit even if the credit has little or no debt due on or before that date (e.g., five-year CDS for a credit with most of its debt due after five years). In the corporate bond market, on the other hand, this is impossible, by definition.

exhibit 1 The Healthy Tail of an Improving Leverage Distribution

Credit	Debt/ EBITDA (Gross/ Rent Adj.)	Cash/ Debt	% Public Debt Due Next 5 Years	Morgan Stanley Recommendation
Dell Inc.	0.14	1,012%	40%	
Home Depot Inc.	0.20	376%	100%	
Exxon Mobil Corp.	0.25	115%	62%	
3M Co.	0.61	63%	53%	Equal-weight
ChevronTexaco Corp.	0.73	42%	72%	Equal-weight
Apache Corp.	0.74	1%	13%	Equal-weight
Coca-Cola Co.	0.80	64%	69%	
Newmont Mining Corp.	0.85	135%	55%	Overweight
Applied Materials Inc.	0.89	978%	63%	
Occidental Petroleum	1.10	14%	52%	Equal-weight
Hewlett-Packard Co.	1.39	169%	84%	
Wyeth	1.48	61%	15%	Equal-weight
Kohl's Corp.	0.89/1.88	8%	10%	Equal-weight
Limited Brands	0.54/2.8	483%	0%	
Investment Grade Median (286 Issuers)	**2.13**	**14%**	**42%**	

Note: Data as of 12/03 or 9/03 when unavailable
Source: Morgan Stanley, FactSet, Bloomberg

BASKET IDEAS

Levering the fundamentally fit is a good way to play a constructive view on default risk. In Exhibit 2 we show three baskets that specifically implement the fundamental themes we discussed above, although investors could certainly mix and match the themes in a basket context.

The first basket plays on the low leverage theme, with five credits whose average Debt/EBITDA ratio is 0.95 (versus the 2.13 median for investment grade issuers). The seller of protection would earn a premium of 115 bp (or 79% of the total spread). The second basket carries the cash on balance sheet theme, with all issuers having cash levels on par with or significantly greater than debt. This earns a premium of 110 bp (80% of the total spreads). The last basket is perhaps the most extreme. Selling first-to-default protection on five technology companies that have little or no debt outstanding is really a play on the risk premium in the marketplace. This basket would pay 60 bp for very little actual default risk, which is made clear by examining the capital structures of these companies. The debt/equity ratios of Dell, Intel and Oracle are 0.57%, 0.65% and 0.51%, respectively, while Microsoft and Cisco have no outstanding debt.

We find these ideas compelling from a default risk perspective, but caution that mark-to-market risks, which can be driven by a variety of sources including increasing risk premium or M&A activity, should not be ignored. Selectively using single-name protection (for worrisome names) in basket strategies can help mitigate some of this risk.

exhibit 2 Levering the Fundamentally Fit – 3 FTD Basket Ideas

Ticker	Name	Spread (Mid)
Low Leverage Basket		
APA	Apache Corp.	25
KSS	Kohl's Corp.	39
OXY	Occidental Petroleum	36
AMAT	Applied Materials	26
DELL	Dell Inc.	19
Total Spread		145
FTD Spread (Bid/Offer)		115/126
FTD as % of Total		79%/87%
Cash Rich Basket		
HPQ	Hewlett-Packard Co.	31
LTD	Limited Brands	32
NEM	Newmont Mining	33
HD	Home Depot Inc.	15
AMAT	Applied Materials	26
Total Spread		137
FTD Spread (Bid/Offer)		110/120
FTD as % of Total		80%/88%
Little or No Debt Basket		
DELL	Dell Inc.	19
INTC	Intel	17
MSFT	Microsoft	13
CSCO	Cisco	15
ORCL	Oracle	15
Total Spread		79
FTD Spread (Bid/Offer)		60/65
FTD as % of Total		76%/82%

Source: Morgan Stanley

chapter 43 Basket Weaving 101

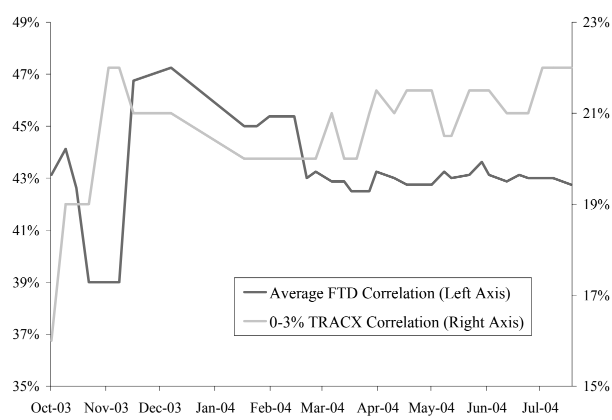
August 13, 2004

Sivan Mahadevan
Peter Polanskyj
Anisha Ambardar
Angira Apte

The apparent difference in relative pricing between large baskets and small baskets has been a subject we have continually had interest in as the structured credit market has developed. In the early days, we pointed to the difference in the absolute level of correlation as an indication of the high level of idiosyncratic risk associated with first to default positions as compared to the much broader credit exposure in large baskets (see Chapter 9).

Today, we have the opportunity to look at how these relationships have developed over time. We also note that the recent introduction of first-to-default baskets created from the names in the CDX index has the potential to bring the large and small basket markets closer together, creating opportunities to trade the relative value between the two families of instruments. In this chapter, we examine the interrelationships among benchmark products in both large and small basket spaces during this year. We then attempt to use historical pricing from actively traded benchmark products to measure the implied performance of large and small basket products based on the CDX index.

exhibit 1
Implied Correlations Remain at Different Levels



Source: Morgan Stanley

A BRIEF “HISTORY” OF BASKETS

Exhibit 1 illustrates the implied correlations for the 0-3% tranche of the Dow Jones TRAC-X Series 2, as well as the average correlation of our six benchmark FTD baskets since October 2003. We can see that the implied correlations continue to be at different levels on an absolute basis but did move in reasonably similar patterns in late 2003 through early 2004. Recently, there has been somewhat of a divergence, as FTD correlations have remained relatively flat while the 0-3% tranche implied correlation has increased.

exhibit 2 Large and Small Basket Strategies

	Underlying	
Strategy 1		
0-3%	CDX	
Strategy 2		
Basics CDX FTD	F, BOMB, DPH, DOW, IP	
CP & Retail CDX FTD	MO, ABS, SRAC, SWY, TSN	
Energy CDX FTD	DUK, HAL, FE, D, COP	
Financials CDX FTD	GECC, CIT, CFC, AIG, COF	
TMT CDX FTD	T, TWX, EDS, MOT, VZ	
	Strategy 1	**Strategy 2**
Notional Exposure Per Credit	3,333,333	10,000,000
Total Portfolio Exposure	416,666,667	250,000,000
Position Notional	10,000,000	50,000,000
Number of Credits	125	25

Source: Morgan Stanley

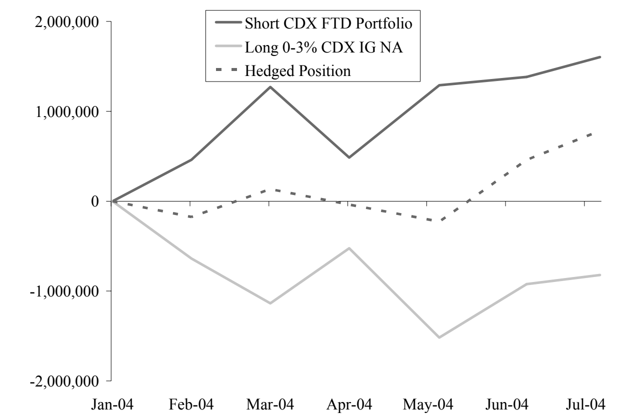
Given the differences in structure between the large and small baskets, implied correlations alone cannot tell the full story. With this in mind, we thought it would be a worthwhile exercise to examine how the strategies of going long credit through a 0-3% tranche of CDX while shorting a portfolio of CDX FTD baskets would have performed. In Exhibit 2, we describe two strategies we studied historically. The first is a position in the 0-3% tranche of CDX and the second is a portfolio of five CDX FTD baskets, which is weighted to be roughly equivalent on a premium basis.

As we currently have limited actual price history for both CDX tranches and CDX first-to-default baskets, we recreated theoretical values for the baskets from single-name spread levels for purposes of this study. We generated the theoretical values using the par spreads for all the underlying credits and the implied correlations from similar, but actively traded benchmark products. In the case of the CDX FTD baskets, we used our benchmark FTD basket implied correlations and in the case of tranched CDX, we used the implied correlations from the same tranches of Dow Jones TRAC-X Series 2.

We then modified the initial notional amounts to generate a combined portfolio that would minimize the standard deviation of the total package profit/loss over the period. The result was to increase the notional of the CDX tranche by approximately 38% to $13.8 million. Exhibit 3 shows the implied profit/loss for both of the strategies and the combined package over the historical period.

exhibit 3

Theoretical P/L of Hedged Position



Source: Morgan Stanley

DIFFERENT RISKS ACROSS DIMENSIONS

While we would expect some level of consistency between these two strategies (both being first loss positions in overlapping portfolios), there are several factors that can affect returns in a different manner than our historical analysis indicates.

First, the breadth of risk is much greater for the tranched CDX position with its 125-name underlying portfolio. The first-to-default exposure is much more idiosyncratic in nature, with only one-fifth the number of names and significantly greater notional exposure per name (see Exhibit 2). Additionally, the aggregate notional amount is much greater for the FTD portfolio (both the initial and adjusted portfolios).

Another way to measure this difference in broad-based versus idiosyncratic exposure is to consider the sensitivity of the strategies to individual credit spread moves and market-wide spread moves, which we summarize in Exhibit 4. Both strategies have similar sensitivities to the moves of any single credit within the portfolio but the CDX FTD strategy is much less sensitive to moves in all the names in the underlying portfolio.

exhibit 4 FTDs vs. Tranches – Spread Sensitivity Varies

	Strategy Risk Metrics (in BP)	
	0-3% of CDX	**CDX FTD Portfolio**
DV01 Tightest Credit (bp)	0.53	0.42
DV01 Widest Credit (bp)	0.76	0.64
DV01 All Credits (bp)	78.26	12.96
Correlation DV01 (bp)	74.93	6.92

Source: Morgan Stanley

Another fundamental difference is the sensitivity of the positions to changes in correlation. Again in Exhibit 4, we summarize the correlation sensitivity of the two strategies. Because the 0-3% tranche is a “thinner” exposure to a broader universe than the FTD basket portfolio, the sensitivity to correlation changes is much more significant, reflecting the more levered nature of the 0-3% tranche.

BASKET WEAVING

To date, the markets for large and small baskets appear to have been trading relatively independent of one another, which is a dynamic we find interesting. With the increased liquidity in both the CDX FTD baskets and tranches, we would keep an eye out for opportunities to trade relative value using combinations of large and small baskets.

chapter 44 When Mergers De-Lever

January 7, 2005

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Peter Polanskyj
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One theme that appears to be a common sentiment in several sectors this year is the potential for M&A activity. The markets have experienced a decent amount of it already in the telecom, media, and retail sectors, and our sector analysts feel that there is potentially more to come in the same sectors as companies look for strategic growth opportunities, consolidation benefits or, simply, synergies.

One can build many investment strategies centered on potential changes in a company's capital structure due to mergers, with long/short pairs or debt/equity strategies being the most natural. In the case of M&A activity, the key driver of performance is getting the market direction right on the various legs, but that has proven frustrating, as debt holder-unfriendly activity has not necessarily been treated as bad news by credit market participants, at least not recently.

For investors with first-to-default basket-type exposure to a portfolio of credits where there is consolidation, a merger represents a reduction in risk, as the number of potential reference entities that can default is reduced (by one) when two companies merge. From a default correlation perspective, one can think of this as rising correlation because the correlation of the two merged companies goes to 100%. The seller of protection would benefit from this action alone, although a widening of spreads on the underlying names could offset the benefit if the names were not delta-hedged or they underperformed their deltas.

This structural consolidation idea is not new, and we addressed it initially when there was a mini-wave of M&A activity at the end of 2003 (see Chapter 41 of this book and Chapter 15 of *Credit Derivatives Insights – Single Name Instruments & Strategies,* February 2005). We find the current landscape, particularly in the retail, media, and telecom sectors (across both high yield and investment grade) to be potentially fruitful for such ideas as well, given our analysts' views. We caution, though, that getting the direction of spreads right is still important, which can be based on anticipated ratings actions, as well as impact of business sizes. Furthermore, a key detail to focus on is the use of "replacement" language in standard FTD contracts, which can take away any consolidation advantage and introduce other (unwanted) risks.

REPLACEMENT LANGUAGE – AN IMPORTANT DETAIL

As an aside, albeit an important one, there are two ways one can trade an FTD basket in the market today: with or without merger replacement language. Replacement language refers to the right the buyer of protection has to replace a reference entity that merges with another, when both appear in the basket. The terms of the replacement (when replacement language is selected) are complicated, allowing the buyer of protection to select at least three reference entities that meet certain guidelines including sector, spread, and geographic region (all similar to the merged entity). The seller of protection must then select one of these reference entities, and it would then be used as the "replacement" credit in the basket for the merged entity.

Replacement language creates a risk-management headache because there can be a lot of subjectivity associated with selecting the replacement entity, even with the market-standard guidelines. The seller and buyer of protection will have opposite views on correlation, for example, and the delta hedging shifts can be onerous. Furthermore, we are not aware of any good tests that this replacement language has been through yet, and we are certain that such tests would highlight other shortcomings, much like the market saw with the original restructuring credit events years ago.

For these reasons, we continue to recommend that investors consider FTD baskets without merger replacement language (see Chapter 41 for our initial thoughts). As such, the seller of first-to-default protection is effectively long a merger option, as two entities that merge would result in a "structural de-levering" of the basket, which benefits the protection seller, and is a key motivation of our FTD basket ideas.

WIRELINE WARS

The battle between long distance and local carriers continues today and our telecom research team sees consolidation across these business lines as a reasonable outcome given the evolving economics of the telecom space. Given our analysts' view that these mergers would likely not be significantly negative credit events for the acquirer in either case, we find the strategy of selling protection in a first-to-default basket (without replacement language) to be an attractive way to play the current dynamics in the industry. Exhibit 1 illustrates a basket containing the major RBOCs and likely long distance players involved in this type of merger activity. The basket would benefit from structural de-levering driven by a merger between any of these players but would have the most upside in the acquisition of a long distance carrier by an RBOC. As with the wireless basket we recommended in earlier research, there is also the potential that multiple mergers occur within the basket (see Chapter 15 of *Credit Derivatives Insights – Single Name Instruments & Strategies,* February 2005).

exhibit 1 Positioning for Wireline Consolidation

Name	Spread Mid	% of Total
Wireline FTD Basket	**272/318**	**67%/78%**
AT&T	111	
MCI Inc	230	
Bell South	23	
SBC Communications	24	
Verizon Global	21	
Total Spread	**409**	

Source: Morgan Stanley

RETAIL MERGERS WOULD BE A RE-LEVERING EVENT

The retail sector provides another perspective on merger activity, as increasingly acquisitive behavior would likely need to be financed in the credit markets. As such, structural de-levering gains in an FTD basket due to mergers would likely be offset (or more than offset) by issuance-driven spread widening. The recent acquisition of Marshall Fields by May Department Stores provides an interesting example. In order to finance the merger May issued $2.2 billion of bonds and its default swap premium widened from 48 bp in early May 2004 to 76 bp in early July 2004.

exhibit 2 Retailer Merger Long/Short Package

	5 Year CDS			Net Carry
	Bid	Offer	Notional	(on Long Notional)
Federated	30	35	(40,000,000)	
Dillard's	185	205	10,000,000	
Package			(30,000,000)	45.0

Source: Morgan Stanley

Frank Henson, our Retail analyst, believes that both May Department Stores and Federated have the potential to be acquirers and that Dillard’s (among others) could be a potential target. Federated (Underweight) is the tightest trading of the three names. With this in mind, we created a long/short package (see Exhibit 2) made up of a long position in Dillard’s and a short position in Federated which has four times the notional. This package is positive carry and would benefit if Federated was acquisitive (in a credit-unfriendly manner) whether or not the target was Dillard’s. The package would also benefit if Dillard’s was acquired by any entity in a credit-enhancing transaction. We have increased the short notional amount because it creates a package that is net short, which is consistent with Frank’s Underweight rating of the sector.

MEDIA INTEGRATION

In the media space, Danielle Levine continues to see the potential for merger activity. We have designed a basket (see Exhibit 3) that would benefit from consolidation, integrating content providers with the owners of distribution channels. Most of the potential acquirers trade fairly tight while the potential targets/merger partners are at wider levels, making the possible upside from structural de-levering that much greater, assuming the acquirer’s spreads do not markedly widen. The risk that the acquirers widen in the merger should not be ignored, however, and can be hedged to some degree by delta hedging these credits while remaining unhedged for the likely targets. In the case of the media basket, this package would still be a positive carry trade.

exhibit 3 Media Content & Distribution Merger Basket

Name	Spread Mid	% of Total
Media FTD Basket	**272/321**	**62%/74%**
Viacom	27	
Cablevision	190	
Echostar	152	
Time Warner	38	
Disney	29	
Total Spread	**436**	

Source: Morgan Stanley

Section H

Structured Credit Insights
Glossary

Please see additional important disclosures at the end of this report.

Glossary

ARBITRAGE CDO
CDO designed to take advantage of the funding gap (i.e., earn the spread between the yield of the underlying assets and the cost of CDO liabilities).

ATTACHMENT POINT
Defines the amount of losses in the reference pool of assets that needs to occur before the tranche starts to experience losses. Can be expressed as a percentage or as an absolute value.

BACK-END DEFAULT RISK
The default risk of a portfolio that is weighted towards the maturity date of the tranche, rather than in the near future. Opposite of Near-Term Default Risk.

BALANCE SHEET CDO
CDO created to allow the sponsor (typically a bank) to remove credit exposure from its balance sheet in order to achieve regulatory capital relief. Balance sheet CDOs are typically static.

BASE CORRELATION
Base correlation methodology considers all non-equity tranches as a portfolio of long 0% to the detachment point tranche and short 0% to the attachment point tranche. The implied correlation figures calculated in this fashion from given tranche prices are referred to as base correlation.

BERNOULLI DISTRIBUTION
A probability distribution of an event with two possible outcomes. Defaults can be represented by a Bernoulli distribution, where p equals to probability of default and 1-p equals the probability of a no-default scenario.

BERMUDA-STYLE OPTION
An option that can be exercised by the holder only on a series of preset dates up to the final maturity date. Bermuda-style call options are typically embedded in senior CDO notes and held by equity holders, thus providing equity holders the opportunity to unwind a CDO structure should deleveraging occur.

BESPOKE
Typically refers to a customized portfolio/collateral pool (may be customized by either the buyer or seller).

BINOMIAL EXPANSION TECHNIQUE (BET)
Valuation methodology used by Moody's to rate cash CDOs. Reduces a given portfolio to a number of uncorrelated assets (see Diversity Score) and calculates the expected loss on each of the tranches by varying the number and probability of defaults. The expected loss values are then used to assign ratings to the various tranches.

CARRY

The differential between the yield on an investment and the cost of funding the position. Also the difference between buy and sell legs in a relative value relationship. Typically measured in basis points.

CASH CDO

A stand-alone special purpose vehicle that invests in a diversified pool of assets in a funded fashion, as opposed to using credit derivatives (unfunded). Investments are funded through the issuance of multiple classes of securities.

CASH FLOW CDO

A CDO whereby the principal and interest of the liabilities of the structure are paid using the cash flows generated by the underlying collateral.

CASH FLOW METHODOLOGY

Values a CDO by discounting the scheduled cash flows of the various tranches over one or multiple paths. Also incorporates default, recovery and reinvestment assumptions as potential impacts on the expected cash flows.

CASH FLOW TRIGGERS

Structural features of a cash CDO that can determine and change payouts to different tranches based on the performance of the underlying collateral.

CDO SQUARED

A CDO whose underlying collateral pool includes tranches of other CDO structures.

CDO EVALUATOR

Proprietary S&P model used to rate various CDO tranches. Uses a Monte Carlo simulation to generate a probability distribution of defaults for each asset, taking individual credit ratings, number of assets, industry concentration and default correlation into consideration.

COLLATERALIZED BOND OBLIGATIONS (CBO)

A securitized pool of assets comprised predominantly of bonds. Examples of collateral may include investment grade bonds, high yield bonds, convertible debt, mezzanine debt or emerging market debt.

COLLATERALIZED LOAN OBLIGATIONS (CLO)

A securitized pool of assets comprised predominantly of loans, which may be investment grade, high yield or both.

COLLATERALIZED MORTGAGE OBLIGATIONS (CMO)

A securitized pool of assets comprised predominantly of mortgages.

COMPOUND CORRELATION

The implied correlation of a tranche, given its market price. Certain tranches may have more than one solution for a given price.

CONVEXITY
The changes in delta given a change in underlying spreads. Typically measured as a ratio of the mark-to-market of a tranche, given a move of 100 bp in underlying spreads to the PV01 of a tranche multiplied by a factor of 100.

COPULA FUNCTION
Function used to transform a given set of loss distributions for individual credits into a joint loss distribution for a portfolio of credits.

CORRELATION SENSITIVITY
See RHO.

CORRELATION SKEW
When different tranches referencing the same underlying portfolio trade at different implied correlations. Also refers to the difference in correlation for attachment and detachment points of a tranche.

COLLATERAL MANAGER
Party responsible for making the investment and trading decisions in the reference portfolio. Decisions are typically made within pre-designated guidelines.

CREDIT-LINKED NOTE
When credit risk is embedded into a note that pays a fixed or floating coupon reflecting the riskiness of a credit. See Funded Form.

CREDIT ENHANCEMENT
Feature of a CDO designed to decrease the credit risk of the structure. Forms of credit enhancement may include overcollateralization, guarantees from insurers (see Wrapped Tranches) and letters of credit.

CROSS SUBORDINATION
Provision of a CDO-Squared that allows the unused subordination of an inner tranche to be transferred to another inner tranche for the purpose of absorbing losses from the underlying inner CDO.

DEFAULT PV
The present value of all expected default losses to the maturity of a credit derivative contract.

DEFAULT-ADJUSTED CASH FLOWS
The expected cash flows of a CDO that are modified to reflect the likelihood of default. Multiply the probability of default by the expected cash flow and discount using LIBOR to derive a present value.

DELTA
Tranche sensitivity to changes in underlying portfolio spread, measured as a ratio of tranche PV01 to portfolio PV01. The delta of a tranche generally increases as the subordination of the tranche decreases.

DELTA MIGRATION

Refers to the instability of tranche deltas with respect to movements in index spreads, changes in correlation and the passage of time.

DELTA-NEUTRAL

When the value of a tranche is unaffected by small changes on underlying spreads in the underlying index because of an offsetting hedge using the index or other tranche.

DETACHMENT POINT

Defines the amount of losses in the reference pool of assets that need to occur for a complete loss of principal for the tranche. Can be expressed as a percentage or as an absolute value.

DIVERSITY SCORE (N)

Moody's-developed numerical statistic (N) reflecting the number of uncorrelated homogenous assets with identical default probabilities and equal par values, reduced from a given portfolio.

DOUBLE BINOMIAL METHOD

Used to value CDOs comprised of two distinct pools of underlying assets. Each pool is assumed to be uncorrelated and each has a distinct default probability and diversity score.

EQUITY

The most subordinated tranche of a CDO. Also known as a first-loss piece, as any losses experienced by the underlying collateral pool will reduce the notional of the tranche before flowing upwards to the other tranches. Typically trades on a points upfront basis for synthetic indices.

FIRST-LOSS PIECE

See Equity.

FIRST-TO-DEFAULT BASKET

A levered investment on the default risk of a reference portfolio where the buyer of protection is protected against the first default of the basket, at which point the contract is settled and terminated. Basket size typically ranges from four to ten credits and can be funded or unfunded.

FUNDED FORM

When credit risk is embedded into a note that pays a fixed or floating coupon reflecting the riskiness of a credit and the protection seller pays the full principal amount at the inception of the trade. If a credit event occurs, losses result in a writedown of the principal; otherwise known as a Credit-Linked Note.

FUNDING GAP

The difference between the yield of the assets in the reference pool and the yield of the CDO's liabilities.

HAZARD RATE
The forward probability of default over a specified time horizon. Can be inferred from CDS premiums or asset swap spreads.

I-GAMMA
Sensitivity of a tranche value to jump-to-default risk or changes in the spread distribution of the underlying portfolio.

IDIOSYNCRATIC RISK
Risk that is specific to a security and unrelated to market risk.

IN-THE-MONEY
Refers to tranches where default losses are expected to reduce the notional as implied by the index premium. Such tranches are typically traded on a points upfront basis.

INNER CDO
Refers to the CDO tranches comprising the reference portfolios in a CDO-Squared.

INTEREST COVERAGE TEST
Ratio of the expected interest generated by the underlying collateral pool to the interest due on the given tranche, plus the interest due on all tranches senior to it.

JUMP-TO-DEFAULT RISK
The risk of a credit spread gapping significantly wider to imply a high probability of default in the near term, as opposed to a gradual spread widening.

JUNIOR TRANCHE
Tranche that is subordinated to the senior tranche in terms of its claim on the underlying collateral pool. Ratings and spreads on junior tranches will reflect the increase credit risk of the securities. Junior tranche investors are typically long correlation.

LEVERAGE
With respect to CDOs and other securitized assets, leverage refers to the size of the equity tranche relative to the total size of the structure.

M-GAMMA
Sensitivity of a default-neutral position to parallel shifts in spreads of underlying credits.

MAKE-WHOLE PREMIUMS
When a security or debt tranche is called by either the issuer or the equity tranche holders, a premium payment (in addition to the par payment) may be required to compensate the debt holders for the early retirement of debt.

MANAGED
When the reference portfolio may be traded by the collateral manager according to designated guidelines and restrictions.

MARK-TO-MARKET
The current market value of a security or a position that reflects any unrealized gains or losses since inception.

MARKET VALUE CDO
Cash CDO in which the principal and interest of the structure are paid using the proceeds generated by the sale and trading of the underlying collateral.

MARKET VALUE METHODOLOGY
Values a CDO by equating the market value of the assets (the underlying collateral) to the market value of the liabilities (comprised of the debt equity and management fees).

MEZZANINE TRANCHE
A Junior Tranche that has some subordination.

MODIFIED MODIFIED RESTRUCTURING (MOD-MOD-R)
Under this definition, the main difference from Mod-R is that the protection buyer can deliver a deliverable obligation with maturity up to 60 months after restructuring (in the case of the restructured bond or loan) and 30 months in the case of all other deliverable obligations. The majority of European-domiciled credit default swaps trade on a Mod-Mod-R basis.

MODIFIED RESTRUCTURING (MOD-R)
In the case of a restructuring credit event, the protection buyer must deliver obligations with a maturity date prior to a) 30 months following the restructuring and b) the latest final maturity date of any restructured bond or loan, but not shorter than the CDS contract. Most North American-domiciled credit default swaps trade on a Mod-R basis.

MONTE CARLO SIMULATION
Technique that uses randomly generated values as inputs for given variables to construct a probability distribution of the resulting outcomes.

MULTISECTOR CDO
CDO whose underlying collateral pool references a combination of bonds and loans from different credit market sectors (e.g., corporate credits, ABS, MBS, CMBS, Emerging Markets, etc.).

MULTIVARIATE GAUSSIAN COPULA
The correlated multivariate normal distribution used to generate a portfolio loss distribution given single-name loss distributions.

NEAR-TERM DEFAULT RISK
Risk that the underlying portfolio/tranche is expected experience defaults in the near future. Typical of equity tranches. Opposite of Back-End Default Risk.

NO RESTRUCTURING (NO-R)
Provision within a CDS contract which does not consider restructuring to be a valid credit event. No-R protection typically trades cheaper than Mod-R protection.

NTH-TO-DEFAULT BASKET

Similar to a First-to-Default basket, it is a levered investment on the default risk of a reference portfolio except it is the Nth credit event that triggers the contract. May be funded or unfunded.

OUT-OF-THE-MONEY

Refers to tranches where the likelihood of default losses penetrating the tranche notional is low. Protection purchased on senior tranches is typically out-of-the-money.

OUTER CDO

Refers to the CDO whose underlying portfolio references other CDO tranches in a CDO-Squared.

OVERCOLLATERALIZATION TEST

Valuation metric comparing the value of a CDO's underlying collateral to the structure's liabilities. A ratio greater than 1 represents an over-collateralization of the CDO's liabilities. See Par Coverage Test.

OVERLAP RATIO

Ratio of bonds overlapping between a CDO's collateral portfolio and a standardized synthetic index's reference portfolio, assuming the CDO investor uses that synthetic index as a hedge.

PAR COVERAGE TEST

An overcollateralization test used to measure the overcollateralization of senior and junior tranches. To calculate, divide the sum of the par value of performing assets and the expected recovery value of defaulted assets by the par amount of the tranche plus the par amount of any tranche senior to it.

PAYMENT-IN-KIND

Provision where the interest on a tranche/security is deferred and instead added to the principal amount of those tranches in order to mitigate a potential default by the tranche and extend the life of the structure.

PREMIUM PV

The present value of all expected premiums to the maturity of the CDS contract.

PREPAYMENT

When an issuer partially or completely pays down the debt ahead of the scheduled maturity date, thus shortening the weighted average maturity of the debt.

PV01

The change in price of a tranche a 1 bp change in each of the underlying credits in the portfolio.

RAMP-UP PERIOD

Period of time where the CDO collateral manager invests in assets using the proceeds from the issuance of debt tranches from the CDO.

RECOVERY RATE
The value of the deliverable obligation received by the protection seller when a credit event occurs, calculated as a percentage of par. Recovery rates tend to be lower in a high default rate environment.

REINVESTMENT PERIOD
Length of time over which the CDO manager may reinvest the proceeds of matured or traded securities. When this period ends, the underlying portfolio will become a static one.

REPLACEMENT LANGUAGE
Provision within a Nth-to-default basket where the buyer of protection has the right to replace a reference entity that merges with another entity in the basket. Replacement entities must typically meet certain guidelines, such as sector and spread.

RE-RATING METHODOLOGY
Values a CDO by inferring a rating for a CDO tranche by calculating its expected loss and considering its risk characteristics. The tranche is then compared to similar structures in the market to determine a comparable spread.

RISK-NEUTRAL DEFAULT PROBABILITY
Probability of default implied by CDS pricing for a given time period. A risk-neutral default probability results in expected losses that match the present value of the CDS premium.

RHO
Change in tranche value due to changes in correlation.

SENIOR TRANCHE
Tranche bearing the least credit risk in the structure as it has a priority claim on all cash flows generated by the collateral pool. All other tranches are subordinated and their principal remains outstanding until the senior tranche is fully paid off. Generally carries the highest rating in the structure. In synthetic indices, senior tranche investors are typically short correlation.

SINGLE TRANCHE SYNTHETIC CDO
Form of arbitrage CDO that allows the investor to customize the reference pool of assets by selecting the credits, as well as the attachment and detachment points.

SPECIAL PURPOSE VEHICLE (SPV)
A stand-alone, bankruptcy-remote entity whose purpose is limited to the acquisition and financing of specific assets. Cash and synthetic CDOs, as well as other securitized asset pools, are typically issued from an SPV.

STRUCTURAL DELEVERING
Refers to the decrease in overall leverage when two entities in a Nth-to-Default basket (without replacement language) merge.

STRUCTURED CREDIT BID
The proliferation of investors (protection sellers) in synthetic CDOs, resulting in a significant tightening of credit spreads as dealers buy protection from these investors.

SUM OF SPREADS
The sum of the premiums on the underlying credits in a basket. A buyer of protection on an Nth-to-Default basket will pay a percentage of that sum of spreads, based on the default correlation assumption.

STATIC
When the reference portfolio is fixed at inception.

TIME DECAY
Refer to Theta.

TRANCHE THICKNESS
The difference between the attachment and detachment point for a given tranche. Defines the maximum amount of losses that the tranche can experience.

THETA
Change in tranche value due to the passage of time.

TRANCHE
A defined portion of credit risk within a securitized pool of assets. Each tranche has a specific attachment and detachment point, representing its exposure to losses that may reduce its principal amount. The priority of a tranche's claims on underlying collateral varies, depending on whether it is equity, mezz, or senior within the capital structure.

TRUSTEE
Party responsible for ensuring compliance with pre-designated trading and structural guidelines within a CDO structure. Periodically provides reports to investors detailing the status of the structure's assets and liabilities, as well as compliance updates.

UNFUNDED FORM
When no upfront payment is made by the seller of protection at the inception of the trade and no principal payment is paid at maturity. Payments between the buyer and seller of protection are comprised of premium payments and a termination payment should a credit event occur. Typical form of a plain vanilla credit default swap.

UPFRONT PREMIUM PAYMENT
A payment made by the buyer of protection to the seller at the time of purchase. Certain tranches (e.g., equity and junior mezzanine) and credits with a high default probability tend to trade on a points-upfront basis, with or without a running premium.

UPGRADE-DOWNGRADE RATIO
Compares the number of ratings upgrades versus the number of downgrades in a class of CDO tranches to determine the direction and magnitude of ratings migration.

VECTOR

Approach used by Fitch to rate CDOs by assigning probabilities to expected losses. It uses a Monte Carlo simulation to model default distributions using individual asset default rates and asset correlations.

VINTAGE

The year that the CDO was originally issued.

WATERFALL MECHANISM

Typical structure of a securitized pool of assets with tranches of varying seniority, whereby losses are absorbed by the most junior tranches, while claims on the underlying assets are prioritized by seniority.

WEIGHTED AVERAGE LIFE (WAL)

The weighted average period of time over which the principal of a tranche is expected to remain outstanding since the time of issuance.

WEIGHTED AVERAGE MATURITY (WAM)

The weighted average period of time until the final principal payment of each tranche, weighted by the size of each tranche.

WEIGHTED AVERAGE RATING FACTOR (WARF)

A numerical metric indicating the credit quality of a portfolio (which can vary across ratings agencies). Typically, the higher the WARF, the lower the credit quality of the portfolio. Most CDO structures will designate a maximum WARF value as guidelines.

WEIGHTED AVERAGE SPREAD (WAS)

The weighted average spread of the CDO structure, found by multiplying the spread of each tranche by the tranche notional.

WRAPPED TRANCHES

Tranches which are guaranteed by bond insurers and are thus assigned ratings reflecting the creditworthiness of the bond insurer.

Disclosures

Credit Products Rating Distribution Table
(as of April 1, 2005)

	Coverage Universe		Investment Banking Clients (IBC)		
Rating	Count	% of Total	Count	% of Total IBC	% of Rating Category
Overweight	167	24%	90	22%	54%
Equal-weight	396	57%	242	59%	61%
Underweight	134	19%	75	18%	56%
Total	697		407		

Coverage includes all companies that we currently rate. Investment Banking Clients are companies from whom Morgan Stanley or an affiliate received investment banking compensation in the last 12 months.

Analyst Ratings Definitions
Overweight (O) Over the next 6 months, the fixed income instrument's total return is expected to exceed the average total return of the relevant benchmark, as described in this report, on a risk adjusted basis.
Equal-weight (E) Over the next 6 months, the fixed income instrument's total return is expected to be in line with the average total return of the relevant benchmark, as described in this report, on a risk adjusted basis.
Underweight (U) Over the next 6 months, the fixed income instrument's total return is expected to be below the average total return of the relevant benchmark, as described in this report, on a risk adjusted basis.
More volatile (V) The analyst anticipates that this fixed income instrument is likely to experience significant price or spread volatility in the short term.

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Issuer Name: May Department Stores
Fixed Income Research 12-Month History
Issue Type: $
Current Rating: Overweight --as of 03/02/2005
Previous Rating: --as of 12/20/2004 -- Equal-weight

Issuer Name: Federated Dept. Stores
Fixed Income Research 12-Month History
Issue Type: $
Current Rating: Overweight --as of 03/02/2005

Issuer Name: AT&T
Fixed Income Research 12-Month History
Issue Type: $
Current Rating: Equal-weight (No Changes in Past 12 Months)

Issuer Name: Bellsouth
Fixed Income Research 12-Month History
Issue Type: $
Current Rating: Equal-weight (No Changes in Past 12 Months)

Issuer Name: SBC
Fixed Income Research 12-Month History
Issue Type: $
Current Rating: Equal-weight (No Changes in Past 12 Months)

Issuer Name: Verizon
Fixed Income Research 12-Month History
Issue Type: $
Current Rating: Equal-weight (No Changes in Past 12 Months)

Issuer Name: Viacom
Fixed Income Research 12-Month History
Issue Type: $
Current Rating: Equal-weight --as of 03/21/2005

Issuer Name: Time Warner Inc.
Fixed Income Research 12-Month History
Issue Type: $
Current Rating: Equal-weight --as of 11/12/2004
Previous Rating: --as of 07/12/2004 -- Underweight
Previous Rating: --as of 04/16/2004 -- Equal-weight

Issuer Name: Walt Disney
Fixed Income Research 12-Month History

Issue Type: $
Current Rating: Equal-weight --as of 04/29/2004

Issuer Name: Kohl's
Fixed Income Research 12-Month History
Issue Type: $
Current Rating: Equal-weight (No Changes in Past 12 Months)

Issuer Name: Limited
Fixed Income Research 12-Month History
Issue Type: $
Current Rating: Underweight (No Changes in Past 12 Months)

Issuer Name: 3M
Fixed Income Research 12-Month History
Issue Type: $
Current Rating: Equal-weight (No Changes in Past 12 Months)

Issuer Name: Bank Of America
Fixed Income Research 12-Month History
Issue Type: $ Sr Unsec
Current Rating: Equal-weight --as of 10/14/2004
Previous Rating: --as of 05/10/2004 -- Suspended
Issue Type: EUR
Current Rating: Underweight --as of 01/27/2005
Issue Type: STR
Current Rating: Underweight --as of 01/27/2005

Issuer Name: Citigroup Inc.
Fixed Income Research 12-Month History
Issue Type: $ Sr Unsec
Current Rating: Equal-weight --as of 10/14/2004
Previous Rating: --as of 05/10/2004 -- Suspended
Issue Type: EUR
Current Rating: Overweight --as of 01/27/2005

Issuer Name: Wells Fargo & Co.
Fixed Income Research 12-Month History
Issue Type: $ Sr Unsec
Current Rating: Equal-weight --as of 10/13/2004
Previous Rating: --as of 05/10/2004 -- Suspended

Issuer Name: Wal-Mart
Fixed Income Research 12-Month History
Issue Type: $
Current Rating: Equal-weight (No Changes in Past 12 Months)

Issuer Name: Sprint Fon Group
Fixed Income Research 12-Month History
Issue Type: $
Current Rating: Equal-weight --as of 10/26/2004

Issuer Name: Delphi
Fixed Income Research 12-Month History
Issue Type: $
Current Rating: Underweight --as of 03/04/2005
Previous Rating: --as of 09/30/2004 -- Equal-weight

Issuer Name: Altria
Fixed Income Research 12-Month History
Issue Type: $
Current Rating: Equal-weight --as of 09/27/2004
Previous Rating: --as of 07/13/2004 -- Overweight
Previous Rating: --as of 06/04/2004 -- Equal-weight

Issuer Name: Nextel Partners
Fixed Income Research 12-Month History
Issue Type: $ Sr. Disc Notes
Current Rating: Equal-weight (No Changes in Past 12 Months)
Issue Type: $ Sr. Notes
Current Rating: Equal-weight (No Changes in Past 12 Months)

Issuer Name: Nextel Comm Inc
Fixed Income Research 12-Month History
Issue Type: $ Series D Pfd
Current Rating: Overweight (No Changes in Past 12 Months)
Issue Type: $ Sr. Notes
Current Rating: Overweight (No Changes in Past 12 Months)

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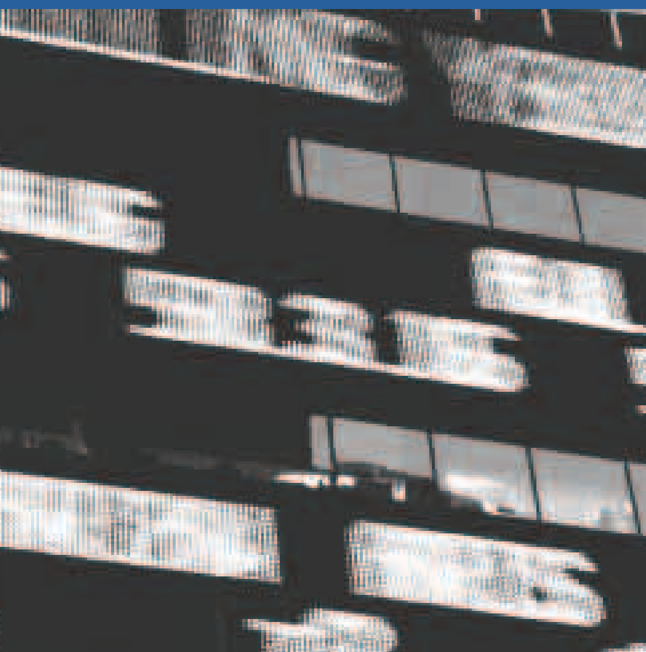

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