Credit Derivatives and Risk Management

MICHAEL S. GIBSON

Gibson is a deputy associate director in the Division of Research and Statistics at the Board of Governors of the Federal Reserve System. *He thanks Patrick Fleming and Ankur Rughani for excellent research assistance and Michael Gordy, Pat Parkinson, Matt Pritsker, and Pat White for comments on an earlier draft. This paper was presented at the Atlanta Fed's 2007 Financial Markets Conference, "Credit Derivatives: Where's the Risk?" held May 14–16.*

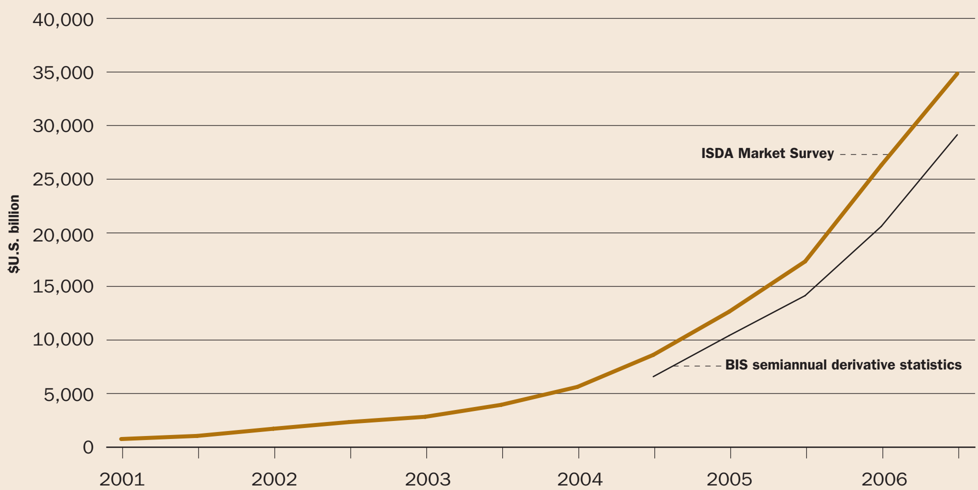
The growth of credit derivatives suggests that market participants find them useful for risk management. Figure 1 shows the growth trajectory for credit derivatives from two surveys of derivatives dealers: the International Swaps and Derivatives Association (ISDA) Market Survey, which goes back to 2001, and the Bank for International Settlements (BIS) semiannual derivatives statistics (2007), which go back to 2004. The BIS survey is more accurate because it adjusts for double counting of interdealer trades, but both surveys show a similar pattern of rapid growth. Notional amounts of credit derivatives outstanding have roughly doubled each year for the past five years.

Credit derivatives have been used by a wide variety of market participants. No single data source provides definitive information on the activity of different types of market participants, but combining several available data sources provides a relatively clear picture. I will refer to three data sources: the BIS semiannual derivative statistics (2007), a report on credit risk transfer by the Joint Forum (BIS 2005a), and the surveys by Fitch Ratings (2006).

All three data sources measure activity in the credit derivatives market with notional amounts. Notional amounts are often not a good measure of the credit risk that is actually transferred in a particular transaction. However, notional amounts are relatively easy data to collect, and for this reason they are the most common data reported. I will present the notional amount data while keeping their limitations in mind.

The most comprehensive data source is the BIS semiannual derivative statistics (BIS 2007). About fifty-five dealers contribute to this survey, which breaks out credit derivative notional amounts by the type of counterparty. Table 1 shows these data for December 2006. The largest category is reporting dealers, reflecting the interdealer nature of the market. In any dealer market, dealers rely on interdealer trading to adjust their risk profiles in response to trading flows from end users. According to dealers,

Figure 1
Notional Amounts of Credit Derivatives Outstanding



Source: ISDA, BIS

only 5 to 10 percent of their notional amount of derivatives represents hedges of their own credit exposures; the balance reflects interdealer trading and accommodation of customer demands (BIS 2005a, 16).

Banks and security firms that are not reporting dealers make up one-fifth of the total. Some of this percentage captures nondealer banks investing on their own account in credit derivatives. Some likely captures banks acting as fiduciaries for private banking or high-net-worth investors. The category of "other financial institutions" includes hedge funds, pension funds, and special-purpose vehicles and makes up another fifth of the total. Many structured credit products, including collateralized debt obligations (CDOs), make use of special-purpose vehicles. Hedge funds are active traders but tend to maintain their positions for a short amount of time; their share of trading volume would likely be larger than their share of notional amounts outstanding. This category is the fastest-growing among the nonreporting dealer categories. Insurance firms account for a small portion of outstanding notional amounts, around 1 percent, but are notable for their one-sided participation as net sellers of credit protection to dealers. Of course, exactly how much risk transfer those data represent is unclear, given that notional amounts cannot be equated with risk.

The Joint Forum report, which relied on surveys by Fitch Ratings and Standard and Poor's, also noted that insurance and financial guaranty firms were net sellers of credit protection, along with European banks (BIS 2005a). Banks overall used credit derivatives to shed credit risk. At the banks that took on credit risk with credit derivatives, exposures taken on with credit derivatives were only 2–6 percent of exposures from traditional lending. Large banks tended to be net buyers of credit protection.

Fitch Ratings has repeated its survey annually. The most recent survey, done in 2006, confirmed the broad outlines of the patterns discussed above (Fitch Ratings 2006). Insurance and financial guaranty firms remain net sellers of credit protection, mainly through portfolio credit derivatives, a category that includes synthetic CDOs, credit default swap indexes, and credit index tranches. While banks as a group remain

Table 1
BIS Semiannual Derivatives Statistics, December 2006 (Notional Amounts, $Billions)

Type of counterparty	Dealer bought protection from counterparty	Dealer sold protection to counterparty	Total (adjusted for double counting)
Reporting dealers	16,044	16,165	16,104
Nonreporting banks and security firms	2,928	2,758	5,686
Other financial institutions	2,826	2,824	5,650
Nonfinancial institutions	561	530	1,091
Insurance and financial guaranty firms	211	95	306
Total	22,571	22,372	28,838

Source: BIS (2007, table 4)

net buyers of credit protection according to Fitch's data, Fitch noted a shift in its most recent survey. Some individual banks, as well as German banks as a group, shifted to net sellers of credit protection via derivatives. One possibility is that these banks are relying more on securitization, rather than derivatives, to shed credit risk. Fitch also noted that firms responding to its survey reported having sold $377 billion of notional amount of credit protection more than they bought. Firms not reporting to the survey, including hedge funds, asset managers, and pension funds, must be shedding this $377 billion of notional credit risk.

Market Participants Using Credit Derivatives for Risk Management

Clearly, market participants are finding credit derivatives to be useful tools for risk management to support such rapid growth. To dig deeper into the usefulness of credit derivatives for risk management, I discuss how they are used by three types of market participants: commercial banks, investment banks, and investors.

Commercial banks. Commercial banks use credit derivatives to tailor their credit risk exposure. Broadly speaking, they shed credit risk via credit derivatives. Banks have used credit derivatives and other means of credit risk transfer, such as securitizations, to shed risk in several areas of their credit portfolio, including large corporate loans, loans to smaller companies, and counterparty credit risk on over-the-counter (OTC) derivatives. Banks use single-name credit default swaps (CDS) to shed the credit risk of issuers to whom they have a large exposure. Banks can transfer the credit risk of a portfolio of exposures to investors via securitization transactions, such as collateralized loan obligations (CLOs).

The Joint Forum (BIS 2005a), reporting on interviews held in 2004 with about sixty market participants, found that the largest commercial banks had shed a material, but small, amount of credit risk via credit derivatives, mainly to their large, investment-grade corporate customers. The Joint Forum also reported that a number of commercial banks had scaled back their credit hedging activity.

However, these conclusions may no longer hold. The amount of credit risk shed by banks may be rising, and hedging has spread to categories of credit risk beyond investment-grade corporate loans. A number of banks, mainly European, have undertaken large hedging transactions in the past couple of years. Table 2 reports several recent hedging transactions by large banks. These transactions are larger and more numerous than what had been reported at the time of the Joint Forum survey. In total, these transactions represent the equivalent of $88 billion notional amount of

Table 2
Recent Hedging Transactions by Large Banks

Date	Bank	Name of deal	Cash or synthetic?	Collateral	Amount
June 2005	ABN Amro	Amstel 2005	Synthetic	Corporate loans	EUR 10 bil
December 2005	ABN Amro	Smile 2005	Synthetic	Dutch SME loans	EUR 6.75 bil
November 2006	ABN Amro	Amstel 2006	Synthetic	Corporate loans	EUR 10 bil
December 2006	ABN Amro	Amstel SCO	Synthetic	Counterparty exposures on derivatives	EUR 7 bil
February 2007	ABN Amro	Smile Securitization 2007	Cash	Dutch SME loans	EUR 4.9 bil
December 2005	Barclays	Gracechurch Corporate Loans Series 2005-1	Synthetic	UK midsize corporates	GBP 5 bil
January 2007	Barclays	Gracechurch Corporate Loans 20071	Synthetic	UK SME loans	GBP 3.5 bil
February 2007	Credit Suisse	Clock Finance	Synthetic	Swiss SME loans	CHF 4.8 bil
July 2005	Deutsche Bank	GATE SME CLO	Synthetic	SME loans	EUR 1.5 bil
June 2006/ February 2007	Deutsche Bank	Craft EM CLO	Synthetic	Emerging market loans, bonds, and counterparty exposures	USD 500m/1 bil
February 2007	HSBC Trinkaus	HEAT 3	Cash	SME loans	EUR 314 mil
November 2005	HSBC	Metrix Funding	Cash	Corporate loans	GBP 2 bil
November 2006	HSBC	Metrix Securities	Synthetic	Corporate loans	GBP 2 bil
November 2006	Mizuho	n/a	Synthetic	Non-Japanese large corporate loans	JPY 560 bil
October 2006	SocGen	Atlas III	Synthetic	Corporate loans	EUR 2.8 bil
November 2006	UBS	n/a	Bilateral swap	High-yield corporate loans	USD 600 mil

Note: "SME" stands for small and medium-sized enterprises.
Source: Company and rating agency reports and financial press

Table 3
Hedging Done with Credit Default Swaps

Date	Bank	Credit exposure before hedging (billions)	Amount of hedging reported (billions)	Exposure hedged (percent)
Year-end 2006	Bank of America	USD 618	USD 8	1
Year-end 2006	Citigroup	USD 633	USD 93	15
Year-end 2006	JPMorgan Chase	USD 631	USD 51	8
2006 Q1	Société Générale	EUR 60	EUR 15	25

Source: For U.S. banks, 2006 annual reports; for Société Générale, "Safety first," *Risk*, August 2006

credit risk shed by eight large international banks over 2005–07.[1] In many of these transactions, and in contrast to similar transactions in the late 1990s, the issuing bank sold off the first-loss equity tranche of the credit risk. The categories of credit risk shed include not only loans to large corporates but also loans to small and medium-sized enterprises, loans to emerging markets, and counterparty exposure on derivatives. Most transactions listed in the table are synthetic, using credit derivatives to transfer risk off the balance sheet.

Table 3 shows reported amounts of CDS hedging by the three largest U.S. commercial bank holding companies, as reported in their 2006 annual reports, and by one European bank, as reported in the financial press. (Only U.S. banking organizations appear to disclose CDS hedging in their annual reports.) For this admittedly small sample, the average percentage of credit risk hedged appears to be larger than that reported by the Joint Forum.

Several reasons could explain why commercial banks appear to be hedging more of their credit risk than they were in 2004. First, credit spreads are at low levels, reducing the cost of hedging. Second, accounting changes in Europe have made it possible for banks to carry loans at fair value, reducing the conflict that was perceived between the accounting treatment of credit derivatives and their use in risk management (BIS 2005a, 11). Third, the Basel 2 capital accord will align regulatory capital charges more closely with actual credit risks and will allow greater recognition of hedging.

Investment banks. An investment bank can use credit derivatives to manage the risk it incurs when underwriting securities. An underwriter assumes credit risk for the short time period between taking the risk onto its own books and selling it into the market. By virtue of the growth of credit derivatives, the underwriter might then be able to hedge some of that credit risk more easily.

Nonagency residential mortgage-backed securities (RMBS) have been a rapidly growing market for securities underwriting in recent years. In 2006, $574 billion of securities were underwritten and issued in this segment, up from less than $100 billion in 2000 (SIFMA 2007b). The increase in issuance volume would naturally lead to a rise in credit risk borne by underwriters because underwriters must warehouse residential mortgage loans on their books during the time it takes to assemble a pool large enough to launch a securitization. Underwriters must find a way to cope with the potential increase in credit risk, which, given the numbers cited above, might be

1. According to global CDO market issuance data reported by the Securities Industry and Financial Markets Association (SIFMA) (2007a), $107 billion of balance-sheet CDOs were issued in 2005–06.

so large as to discourage them, at the margin, from taking on additional underwriting business. One way for underwriters to cope with such a potential increase in credit risk is to hedge more of it.

New credit derivative instruments appear to be useful to underwriters who want to hedge the risk of a residential mortgage loan warehouse. Beginning in mid-2004, dealers began to trade credit default swaps on asset-backed securities (referred to as ABS CDS). By year-end 2005, Fitch Ratings (2006, 2) put the size of the ABS CDS market at $495 billion in notional amount outstanding and growing rapidly.[2] An underwriter can use an ABS CDS to buy credit protection on an RMBS with similar characteristics to the loans in its warehouse. The performance of the ABS CDS should roughly offset the performance of the warehouse loans.

Banks have used credit derivatives and other means of credit risk transfer, such as securitizations, to shed risk in several areas of their credit portfolio.

As is typical of successful and liquid new markets, there appears to be a healthy balance of supply and demand of credit risk in the ABS CDS market. In addition to underwriters seeking to hedge warehouse loans, asset managers with a negative view on the housing sector are also natural buyers of credit protection on RMBS. Investors seeking exposure to the RMBS market, including CDOs, are natural sellers of credit protection. ABS CDS have proved to be relatively liquid compared to the markets for individual RMBS. Using ABS CDS on large, recently issued RMBS, dealers created an index called the ABX.HE, which can be used to trade the credit risk of a pool of twenty RMBS deals. Of course, if sellers of credit protection become scarce because of a weaker-than-expected housing market, the ABS CDS and ABX.HE markets could see much of their recent liquidity dry up, and underwriters would lose a useful tool for credit risk management.

Investors. Investors are the third group that uses credit derivatives for risk management. An investor can use credit derivatives to align its credit risk exposure with its desired credit risk profile. Credit derivatives can be more flexible and less expensive than transacting in cash securities. The surveys cited earlier show that insurers are an important class of investors that use credit derivatives. However, other fixed-income asset managers, including hedge funds, also participate in the market. Most observers agree that of the three groups, demand from investors is most responsible for spurring the growth of the credit derivatives market.

"Investors" are a heterogeneous group, and they participate in the credit derivatives market in different ways. Some are "buy and hold" investors that seek to earn a return from a broad exposure to issuers of fixed-income securities, and others are "active traders" that seek to earn a return by predicting short-term price movements better than other market participants. The advantages of credit derivatives as a risk-management tool are different for the two groups.

Traditionally, insurance companies and pension funds have been thought of as buy-and-hold investors, and hedge funds have been thought of as active traders. But the distinctions between different types of asset managers are becoming increasingly blurred. A given asset manager may place some assets in a buy-and-hold index strategy, some with an in-house team of active traders, and the remainder with external managers who could pursue either type of strategy.

Buy and hold. Suppose a buy-and-hold investor develops a negative view about a particular sector—for example, telecom. Consider an investor that does not use credit derivatives. It can only rebalance its portfolio away from telecom issuers by

Table 4
Alternative Scenarios Faced by an "Active Trader"

Scenario	Change in market value: Sell $10MM at ten years	Buy $10MM at five years	Net
1. XYZ defaults	Deliver bonds	Receive bonds	Zero
2. XYZ credit spread falls by 10 basis points at all maturities	+$76,347	–$43,837	+$32,510
3. XYZ credit spread increases by 10 basis points at all maturities	–$76,347	+$43,837	–$32,510

Source: Bloomberg page CDSW, using a BBB spread curve as of April 16, 2007

selling some of the telecom bonds it holds. Secondary markets for corporate bonds are notably illiquid for seasoned issues, so the transaction cost of selling seasoned telecom bonds will be high. The investor's best option for replacing the telecom bonds will be newly issued bonds, which have low transaction costs because they are relatively liquid. However, the particular bonds that happen to be issued at a given time may be influenced by the particular trends in the market at that time, such as which sectors are undergoing leveraged buyouts, and may not be exactly the replacements that the investor is looking for.

Now consider an investor that does use credit derivatives. This investor can shift its exposure away from telecom issuers by buying credit protection on telecom issuers using credit default swaps. The bid-ask spread is generally lower for credit default swaps than for corporate bonds, and the difference is larger when the bonds are seasoned. To replace the telecom exposures, this investor can sell credit protection on other, nontelecom issuers or simply sell credit protection on a credit default swap index.

Active trader. Now consider an investor that is an active trader with a view that, over the next three months, Issuer XYZ's credit risk standing will improve and its credit spreads will tighten. One obvious trade based on such a view is to buy one of Issuer XYZ's bonds or sell credit protection on Issuer XYZ with a single-name credit default swap. However, buying a bond or selling credit protection exposes the investor to the risk that Issuer XYZ defaults, a risk the investor may not want to take.

As mentioned above, one benefit of credit derivatives is that an investor can use them to take a customized exposure to particular components of credit risk, such as spread risk, default risk, recovery risk, or correlation risk. In this example, the investor wants to be exposed to the spread risk of Issuer XYZ but not default risk.

To achieve this goal, suppose that the investor sells $10 million notional amount of credit protection on Issuer XYZ with a ten-year maturity and buys $10 million notional amount of credit protection on Issuer XYZ with a five-year maturity. These two positions have the same $10 million exposure to default risk, but the longer maturity position has a greater sensitivity to credit spreads (higher credit duration).

Table 4 shows what happens in three different scenarios. Scenario 1 shows what happens if Issuer XYZ defaults. The investor will receive $10 million face value of Issuer XYZ's bonds on the five-year CDS and will deliver $10 million face value of bonds on

2. While the asset-backed securities market includes securities backed by a range of collateral, including credit card loans and auto loans, nearly all ABS CDS contracts reference RMBS or commercial mortgage-backed securities.

Table 5
Spreads on iTraxx Europe Tranches on March 1, 2007 (Basis Points per Annum)

Tranche	Five-year	Ten-year
0–3 percent	500 + 9.98% up-front	500 + 40.85% up-front
3–6 percent	46	334
6–9 percent	13	88
9–12 percent	6	39
12–22 percent	2	13
Index	23	43

Source: www.creditfixings.com

Table 6
Deltas on iTraxx Europe Tranches on March 1, 2007

Tranche	Five-year	Ten-year
0–3 percent	27.5	13
3–6 percent	4	11
6–9 percent	1.25	4.25
9–12 percent	0.6	2.1
12–22 percent	0.2	0.8
Index	1	1

Source: www.creditfixings.com

the ten-year CDS. Clearly, such a trade is hedged against the default of Issuer XYZ within the next five years.

Scenarios 2 and 3 show what happens when Issuer XYZ's credit spread curve narrows or widens at all maturities in a parallel shift. As expected, in scenario 2, the issuer gains on net when the credit spread narrows, and the opposite occurs in scenario 3 when the credit spread widens. Of course, credit spread curves do not always shift in parallel, and an additional risk of this trade (not shown in the table) is that the credit spread curve steepens.

Without credit derivatives, such a trade would only be possible if Issuer XYZ happened to have bonds outstanding with five-year and ten-year maturities and if the investor could borrow a bond to establish a short position. While the stars may align on occasion for both of these conditions to be satisfied, a liquid credit derivatives market clearly offers more possibilities for customizing risk exposures along these lines.

Credit index tranches. Credit index tranches are another example of how credit derivatives can produce different risk-return trade-offs. A credit index such as CDX (in North America) or iTraxx (in Europe) is a liquid product that provides exposure to a broad segment of the credit derivatives market. Credit index tranches take the risk of a credit index and divide it into pieces with different seniority. Because these tranches on credit indexes are standardized, they are relatively liquid compared to other tranched credit products, which are usually customized on a one-off basis. Table 5 shows the tranches for the iTraxx Europe index, along with the spreads on each tranche at the five- and ten-year maturities as of March 1, 2007. The spread represents the cost paid by a buyer of credit protection.

Understanding the relative risk of credit index tranches is difficult but is obviously important for investors who are choosing the risk and return of their investment portfolio. A common way that market participants compare the risk of different tranches is to use a model to compute the relative size of the position in the underlying index that would have the same sensitivity to a small movement in the index credit spread as the tranche. This measure is called "delta," and, by construction, the delta of a position in the index equals one. Delta can be seen as a measure of the tranche's leverage.

Table 6 shows the deltas of the iTraxx tranches. The deltas themselves purport to measure the risk of a tranche relative to a position in the index. One can also use deltas to compare the risk of different tranches. For example, at the five-year maturity, the 3–6 percent tranche is twenty times riskier than the 12–22 percent tranche.

Table 7
Market Spreads and Expected Weighted Average Spreads on iTraxx Europe Tranches on March 1, 2007 (Basis Points per Annum)

	Five-year		Ten-year	
Tranche	Market	Expected	Market	Expected
3–6 percent	46	45.5	334	289
6–9 percent	13	12.8	88	84
9–12 percent	6	5.8	39	38
12–22 percent	2	2	13	12.9
Index	23	22.9	43	42.2

Source: Author's calculations

However, delta only measures one dimension of a tranche's risk: exposure to credit spread risk. Other dimensions of risk, such as default risk, may give a different sense of the relative risk of different tranches. In the field of derivatives pricing, the risk and return of different positions that are exposed to the same single underlying risk factor must satisfy the formula

$$\frac{\text{expected excess return}}{\text{risk}} = \text{a constant.}$$

This idea underpins the Black-Scholes formula and many other asset-pricing models.

I will apply this idea to get a back-of-the-envelope sense of the relative default risk of iTraxx tranches. Defaults among names in the iTraxx Europe index correspond to the single underlying risk factor of the theory. The 0–3 percent tranche is quite sensitive to the timing of defaults, in addition to the number of defaults, so it does not fit the assumption of exposure to a single risk factor, and I therefore omit it from this analysis.

I compute the expected excess return on each tranche as the expected weighted average spread less the expected default loss. Each of these is measured in basis points per annum. To compute the expected weighted average spread per annum, I start with the market spreads from Table 5. The spread actually received is less than the market spread because the spread is paid on the remaining balance outstanding on the tranche, which can be reduced when defaults hit the tranche. Using the single-factor Gaussian copula model of Gibson (2004), I use single-name CDS spreads on the 125 names that make up the iTraxx Europe index to compute the probability distribution of defaults on the index. This calculation assumes a flat correlation of 15 percent across all names. Using this market-implied probability distribution of defaults, Table 7 shows the expected weighted average spread on each tranche from Table 5, along with the market spread.

I compute the expected default loss using the same model of Gibson (2004) and the same flat correlation of 15 percent, but I use historical default probabilities for each credit in the index based on its credit rating and assume a constant recovery rate on defaulted issuers of 40 percent.[3] The expected default losses for each tranche are shown in Table 8.

3. Historical default probabilities are taken from Moody's Investors Service (2007, exhibit 26).

Table 8
Expected Default Loss on iTraxx Europe Tranches on March 1, 2007 (Basis Points per Annum)

Tranche	Five-year	Ten-year
3–6 percent	29	73
6–9 percent	3.2	14
9–12 percent	0.5	3
12–22 percent	0.03	0.3
Index	15	16

Source: Author's calculations

Table 9
Relative Risk of iTraxx Europe Tranches on March 1, 2007 (Risk of Underlying Index = 1)

Tranche	Five-year	Ten-year
3–6 percent	2.0	8.1
6–9 percent	1.2	2.6
9–12 percent	0.7	1.3
12–22 percent	0.3	0.5
Index	1	1

Source: Author's calculations

Subtracting the expected default loss in Table 8 from the expected weighted average spread in Table 7 gives the expected excess return for each tranche. This calculation is the concept in the numerator of the above formula. Using the formula, the ratio of expected excess return for two tranches of the same maturity should equal the ratio of risk for the two tranches. Dividing the expected excess return of each tranche by the expected excess return of the index gives a relative ranking of the risk of the tranches, similar to the concept of delta introduced above.

Table 9 shows the result of my back-of-the-envelope calculation to compare the sensitivity to default risk of the iTraxx tranches. Perhaps it is comforting that when one compares Table 9 with the deltas in Table 6, the two independent risk measures agree on which tranches are more or less risky than the index (that is, which have a relative risk greater or less than one). However, the actual numbers in the two tables differ by quite a bit in some cases. For example, according to Table 6, the 3–6 percent five-year tranche is four times riskier than the index, while according to Table 9, it is only twice as risky.

The conclusion from this discussion of the risk of credit index tranches is that, while they broaden the range of risk-return choices that investors have available in the credit markets, they also pose a challenge to understand the various dimensions of risk they are exposed to. I now turn to a more general discussion of the risk-management challenges posed by credit derivatives.

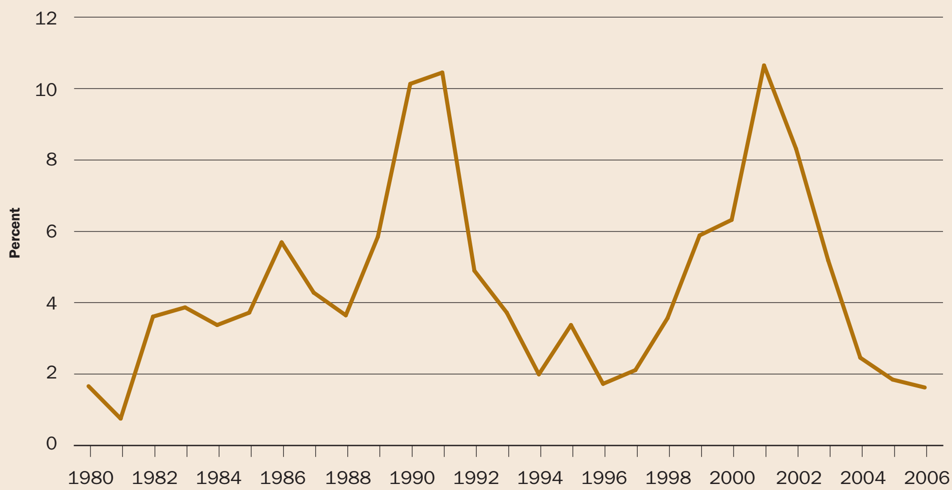
Credit Derivatives and Risk-Management Challenges

The first half of this paper has shown how commercial banks, investment banks, and investors use credit derivatives for managing credit risk. However, credit derivatives pose risk-management challenges of their own. In the second half of the paper, I discuss five of these challenges.

Credit risk. One fundamental reality of credit derivatives is that they do not eliminate credit risk. They merely shift it around. As a result, when the credit cycle turns and default rates rise, someone, somewhere, will lose money. Consider Figure 2, which shows global speculative grade default rates since 1980. Clearly, no one should be surprised if, when the credit cycle turns, the speculative grade default rate hits 10 percent, which is what it hit in 1990–91 and in 2001.

Although credit derivatives cannot eliminate losses from credit risk, they can transform credit risk in intricate ways that may not be easy to understand. This issue does not arise with single-name credit default swaps, where the exposure is nearly identical to that of a corporate bond, or with credit default swap indexes, where the exposure is nearly identical to that of a portfolio of corporate bonds. But where complex

Figure 2
Speculative Grade Default Rate



Source: Moody's Investors Service (2007, exhibit 21)

credit derivatives such as CDO tranches are concerned, a legitimate risk-management issue may develop.

Do market participants understand their exposures to credit risk that they have taken on with complex credit derivatives? Given the breadth of market participants who are active in the credit derivative market, there is no definitive way to answer this question.

However, we can point to evidence from the last credit cycle that some market participants did not fully understand the exposures they had from their participation in the credit derivatives market. In 2001, American Express "lost hundreds of millions of dollars on investments in collateralized debt obligations."[4] The chief executive officer of American Express was quoted as saying he "did not comprehend the risk" of its CDO holdings. The U.K. bank Abbey National was reported to have suffered "disastrous losses in its high-yield portfolio, including CDOs"[5] and, as a result, to have liquidated its wholesale credit portfolio, including selling off $8 billion of CDO tranches in 2003 (Lucas, Goodman, and Fabozzi 2006, 383). In both cases, the banks were reported to have retained first-loss tranches of CDOs they had underwritten. And first-loss tranches naturally contain a great deal of credit risk.

CDO investors, too, naturally suffered losses in the 2001–02 credit cycle. But since many investors do not account for their investments on a mark-to-market basis or may not make detailed accounting statements public, less information was made available in the public domain about these losses. According to reports in the financial media, dealers commonly restructured CDO tranches that were exposed to troubled issuers. Credit risk would have manifested itself in a decline in the mark-to-market value of such a tranche. The dealer could replace a troubled issuer in the CDO's reference portfolio with a less risky issuer. The mark-to-market loss would be "paid for"

4. See *Financial Times*, "Out of depth in the collateralized debt pool," July 22, 2001.
5. See *Euromoney*, "Market dislocation boosts CDO trading," April 2003.

by lowering the coupon that the investor would receive on the CDO tranche for the remaining life of the deal.[6]

This brief review of the experience in the last credit cycle of 2001–02 reinforces the point that credit derivatives do not eliminate losses from credit risk. These lessons that I have reviewed here are certainly no secret to participants in the credit markets, many of whom had first-hand experience of living through that credit cycle.

Given the rapid growth of the credit derivatives market, it may be fortunate that one of the most widely used complex credit derivative structures, the CDO tranche, is a mature product has already been through a stressful credit cycle. This experience should contribute to financial stability during the next credit cycle, whenever that may come to pass.

Although credit derivatives cannot eliminate losses from credit risk, they can transform credit risk in intricate ways that may not be easy to understand.

Of course, new flavors of CDOs will always present new challenges. One relatively new product is a CDO using asset-backed securities for collateral instead of corporate debt. In 2006, 60 percent of CDO issuance used asset-backed securities as collateral (SIFMA 2007a). These CDOs transfer the credit risk of asset-backed securities, primarily RMBS. Given the slowing growth of house prices in recent months, credit risk in the RMBS sector is likely to be increasing.

Counterparty risk. Counterparty risk is the risk that the counterparty to a credit derivative contract will default and not pay what is owed under the contract. For credit derivatives, as with other OTC derivatives, counterparty risk is an important risk that needs to be managed. Given the growing role of hedge funds in the credit derivatives market, counterparty risk is becoming even more prominent, since hedge funds generally are among a dealer's riskier counterparties.

In many cases, dealers use collateral to reduce counterparty risk. According to the 2006 ISDA Margin Survey, 63 percent of all counterparty risk exposure on credit derivatives is currently collateralized by large dealers. For hedge fund counterparties, a larger share is likely to be covered by collateral since dealers nearly universally require hedge fund counterparties to post collateral to cover current credit exposures.

However, despite the widespread use of collateral and margin, some important risk-management challenges are associated with counterparty risk on credit derivatives. One challenge is simply measuring the exposures on complex credit derivatives. One of the key measures of counterparty risk is potential future exposure. Potential future exposure takes into account the possible future moves in credit spreads or future defaults that could create a larger credit exposure if the market moves in the dealer's favor. This potentially larger credit exposure is something that is already present in the current derivative contract and therefore should be measured like any other credit exposure.

Market participants are aware of not only the need to measure potential future exposure on complex credit derivatives but also the difficulties in measuring it. As one article by a practitioner puts it, "unfortunately, models that can estimate [counterparty risk exposure] exactly are hard to build and calibrate" (Pugachevsky 2006, 372). That article describes a technique to approximately measure counterparty risk exposure on synthetic CDO tranches, defining counterparty risk exposure as the amount that would be expected to be lost if the counterparty defaults in the future. In a stylized example of CDO tranches with a notional amount of $5 million, the article estimates the counterparty risk exposure to be around $50,000, or 1 percent of notional. Certainly that seems like a material amount of counterparty risk.

According to an estimate from www.creditflux.com, there were $450 billion of synthetic CDO tranches and $1.7 trillion of credit index tranches traded in 2006. One percent of this roughly $2.2 trillion in notional amount would total $22 billion in counterparty risk exposure, the amount that dealers would collectively expect to lose if all their CDO counterparties simultaneously defaulted. If two-thirds of that is collateralized, dealers in aggregate would have roughly $7 billion in uncollateralized counterparty risk exposure currently in their portfolios, before accounting for hedging. These figures are certainly only a very rough approximation of the order of magnitude of the counterparty risk created by complex credit derivatives. In particular, the actual loss from counterparty default could well be larger than the expected loss. And, of course, any counterparty credit exposure amount should be compared with a dealer's capital that is available to absorb potential losses.[7] All told, it appears that counterparty risk should be a material concern of participants in the credit derivatives market.

Model risk. Complex credit derivatives require complex models for valuation and hedging. While a few complex credit derivatives, such as credit index tranches, are traded in liquid markets with some price transparency, most are not. Products without a liquid market are referred to as "mark-to-model." The risk of loss due to a flawed model is known as model risk.[8]

Model risk materialized in the market for tranched credit derivatives in May 2005.[9] Following the downgrade of General Motors to below-investment-grade status, the market prices of some credit index tranches moved in ways that would be considered as either extremely implausible or impossible, according to the way certain models were being used for valuation and risk management at that time. For example, in the first week of May 2005, the credit spread on the CDX.NA.IG index widened, signaling higher credit risk, but the spread on the 3–7 percent mezzanine tranche tightened, signaling lower credit risk. Market commentary attributed this to an imbalance of market liquidity in the mezzanine tranche market. In some cases the models themselves were not the problem, but models were being used in a way that gave false confidence about the effectiveness of hedging strategies.

In fairness to those who build models for a living, it has to be said that the flaws that were revealed by the May 2005 episode were not a surprise to many model builders. Even before May 2005, modelers were documenting the flaws of the standard

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6. One example of such a report appeared in *Risk* magazine in September 2004: "By autumn 2002, all the talk in the structured credit community was about restructuring. Investors were increasingly looking for resilience in the ratings of their holdings. In its public CDO ratings, Moody's began explicitly mentioning the removal of WorldCom from portfolios as a reason for ratings upgrades.

   "But such new-found resilience comes at a price. Although some claim it is a cheaper option than selling an entire CDO tranche, restructuring is by definition an expensive process, involving the unwinding of distressed default swap positions and replacing them with stronger credits at tighter spreads. And that process is likely to mean wider bid/offer spreads for investors" (Dunbar 2004, 32).
7. For comparison, the three largest U.S. bank holding companies each had over $75 billion in tier 1 capital in 2006.
8. Rebonato (2001) provides the following more complete definition of model risk: "Model risk is the risk of occurrence at a given point in time (today or in the future) of a significant difference between the mark-to-model value of a complex and/or illiquid instrument held on or off the balance sheet of a financial institution and the price at which the same instrument is revealed to have traded in the market—by brokers' quotes or reliable intelligence of third-party market transactions—after the appropriate provisions have been taken into account."
9. The International Monetary Fund (2005, 21–23) describes the episode.

model used for tranched credit products, the Gaussian copula model. As one paper published in 2004 noted, "despite the popularity of the Gaussian copula model, there are clear and valid questions over its theoretical foundations" (Gregory and Laurent 2004).

Of course, any model is only an approximation of reality, and model improvement must be a continuous process for products as new as tranched credit derivatives. In the two years since the May 2005 episode, research into alternatives to the Gaussian copula model has exploded. While eventually this research is likely to lead to better models and a reduced level of model risk for complex credit derivatives, there could be a long wait until that occurs. For the foreseeable future, those who trade complex credit derivatives will need to pay careful attention to measuring and managing their exposure to model risk.

Market participants are aware of not only the need to measure potential future exposure on complex credit derivatives but also the difficulties in measuring it.

Rating agency risk. Rating agencies play an important role in the credit derivatives market. As noted in a recent central bank research report, the structured finance market, including the credit derivatives market, relies heavily on ratings (BIS 2005b). Given the complex nature of many credit derivatives, many investors rely on rating agencies to assess the credit risk of a particular transaction. However, according to that report, large institutional investors do not rely solely on ratings for making investment decisions.

The debate over the role of rating agencies in the market for complex credit derivatives has two sides. One side argues that rating agencies are fully transparent in the methodologies they use to rate synthetic CDOs. They publish detailed criteria reports that are available to the general public without charge, and in some cases they allow their models to be freely downloaded. They implicitly acknowledge that their ratings of structured finance transactions are fundamentally different than their ratings of corporate debt, for example, by compiling and publishing separate default and migration statistics for the two groups, rather than pooling them into a single group. This approach should discourage investors from treating an AAA rating on a structured credit derivative exactly like an AAA rating on a corporate bond.

The other side of the debate argues that the one-dimensional nature of traditional credit ratings makes them insufficient for comparing the risk of corporate debt and structured credit derivatives and that using the same rating scale for the two is misleading. While the expected loss or probability of default of a BBB-rated corporate bond and a BBB-rated synthetic CDO tranche may be the same, their risk differs materially in other important dimensions. For example, synthetic CDO tranches are much more sensitive to the credit cycle, or to business cycle risk, than a portfolio of similarly rated corporate debt (Gibson 2004). Calculations reported in Gibson (2004) show the expected loss measured as a percent of notional amount on a stylized mezzanine CDO tranche in a recession could be eight times larger than on a portfolio of corporate bonds.

The tranches of the iTraxx index, discussed in detail in the first half of this paper, can also be used to illustrate some of the points about rating agency risk. A credit rating provides a third way to look at the relative risk of the various tranches. Table 10 reproduces the two relative risk measures introduced above along with the ratings associated with each ten-year maturity tranche from one rating agency. In several ways, the ratings give a quite different message about the relative risk of various tranches. According to the rating, the 6–9 percent tranche is less risky, rated A, than the index itself, rated A–/BBB+. But the other two risk measures consider that tranche to be at least twice as risky as the index. The tranche's spread of 88 basis points is twice as high as the index's spread of 43 basis points. Comparing the ratings of the 6–9 percent and 9–12 percent tranches shows a large difference between an AAA rating and an A rating. In terms of historical default probability for corporate bonds, an A rating has roughly ten times higher default probability than AAA over a ten-year horizon. Yet the other two risk measures consider the 6–9 percent tranche to be roughly twice as risky as the 9–12 percent tranche. And it seems particularly odd that the 9–12 and 12–22 percent tranches can be rated the same when no scenario exists in which the 12–22 percent tranches takes a single dollar of loss without the 9–12 percent tranche losing its entire principal amount. Without taking a stand on which risk measure is better or worse, it seems clear that relying on a rating to tell the entire story of the risk on a tranched credit derivative product is a bad idea.

Table 10
Various Relative Risk Measures for iTraxx Europe Tranches at Ten-Year Maturity on March 1, 2007

Tranche	Spread risk (Table 6)	Default risk (Table 9)	Rating
3–6 percent	11	8.1	B+
6–9 percent	4.25	2.6	A
9–12 percent	2.1	1.3	AAA
12–22 percent	0.8	0.5	AAA
Index	1	1	A–/BBB+

Source: Author's calculations; ratings from Fitch Ratings as of September 20, 2006

Settlement risk. When an issuer defaults, credit derivatives that reference the issuer's debt must be settled. Traditionally, settlement in the CDS market was based on physical delivery by the protection buyer of the referenced issuer's debt securities in exchange for par. Physical settlement is the natural settlement mechanism when a CDS is used to hedge the credit risk of owning a bond. Cash settlement is less desirable in that situation because the value of owning the bond of the defaulted issuer may diverge from the cash settlement price on a CDS, reducing the effectiveness of the hedge.

As the credit derivative market has grown, it has become common for the notional amount of CDS outstanding referencing a particular issuer to be larger than the face value of the issuer's bonds outstanding. In October 2005, Delphi Corporation defaulted with $2 billion of deliverable bonds and approximately $28 billion of credit derivatives outstanding. Because settlement must occur within a fixed time period after a default, a single bond can be used (and reused) for settlement of CDS only so many times. The potential exists for an artificial scarcity of the bonds of defaulted issuers that are needed for CDS settlement, driving up the price of the bonds. In the worst case, if the protection buyer cannot obtain the bonds it needs to settle its contracts by the deadline, the contract expires worthless. This situation has the potential to affect the price of CDS in advance of a default, making CDS less useful as hedges and distorting the price signals that the CDS provides to the market.

Since the growth of the credit derivatives market shows no signs of slowing down, settlement risk is likely to continue to increase as long as physical settlement is the standard in CDS contracts. Market participants are certainly aware of the issue and are working on a solution. In the wake of the Delphi default, dealers rushed to organize a cash settlement auction in which more than 570 counterparties participated.

Although all participants in the credit derivatives market have a broad interest in seeing the market function well, their interests may diverge in a settlement situation when some are protection buyers, some are protection sellers, some would probably prefer physical settlement, and some would prefer cash settlement. Getting marketwide agreement on an auction mechanism may not be easy, especially when the agreement is made after the default occurs. Moreover, the example of the European auctions of mobile-phone licenses reinforced the basic fact that differences in auction design can lead to vast differences in outcomes (Klemperer 2002).

The auction mechanism that was used for the Delphi auction in November 2005 has been tweaked since then to discourage gaming and to encourage broader participation. In the most recent large default in the CDS market, Dura Automotive Systems in late 2006, the most recent auction mechanism was tested and seemed to work well. However, each auction is an ad hoc process that must be quickly agreed to following a default. Settlement risk will still be high until the auction settlement mechanism is incorporated into standard CDS documentation and is tested in actual defaults, including some in less benign market environments.

Conclusion

I have documented the striking growth of credit derivatives, from nearly nothing a decade ago to tens of trillions of dollars in notional amounts outstanding at the end of last year. Driving this growth, market participants—including commercial banks, investment banks, and investors—appear to find a variety of credit derivative products to be useful for their own risk-management purposes. I discussed a number of the ways that credit derivatives can be useful for risk management. At the same time, credit derivatives are posing some significant risk-management challenges. Many of these challenges reflect the immaturity of the credit derivatives market. For the credit derivatives market to develop and mature, market participants must address these risk management challenges.

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