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The pricing puzzle

The rapid rise in the use of CDOs and CDOs-squared has not been matched by development in the infrastructure needed to price such instruments. Investors should be wary they're not buying structures they cannot value. **Nikki Marmery** reports

A credit investor can scarcely pick up a trade paper or research note these days without being reminded of the snowballing popularity of collateralized debt obligations (CDOs). Some 600 CDOs were launched in 2004, and over the course of the year the strength of investor demand for these structures boosted transaction sizes from an average of $40 million in January to over $200 million by year-end.

But even as the sell side rushes headlong into a race to structure ever more complex derivatives—the novelty of CDOs-squared (CDOs of CDOs), now being replaced by CDOs-cubed (CDOs of CDOs-squared)—there is one vital area of the industry that is playing catch-up. As banks jostle to win more market share in the expanding structured credit market, the buy side lacks the software and expertise needed to price and analyze these complex structures accurately.

"Some people who've invested in CDOs have no idea of the default risk," says Gary Kendall, director of CDO^2, a firm that is currently developing pricing models for CDOs and CDOs-squared. "The worst-case scenario is that as credit events happen, your principal may be wiped out."

Matthew Woodhams, global product manager for analytics at inter-dealer broker GFI, adds, "If you can't price them, you can't risk-manage them."

One hedge fund manager describes the lack of clarity on pricing CDOs as more a result of confusion than "malice or incompetence". He's not wrong. Indeed, confusion seems to be the buzzword for those battling to price CDOs, along with other words not inclined to inspire much confidence in absolute accuracy, such as 'guesstimation', 'uncertainty' and 'compromise'.

There is undeniably a good reason for this: the structures themselves are incredibly complex. The elements needed to price credit default swaps—the probability of a name defaulting, and when that event happens, how much you get back—are compounded in CDOs because of the issue of interdependence. "When you add names together you have to add in how they relate to each other: how they are correlated," explains Woodhams.

And therein lies the problem, because no one, it seems, can agree on the best way to tackle this issue.

Correlation confusion

Traditionally people have looked at historical prices to determine correlation, says Kendall from CDO^2. "But that's like determining the value of a share by looking at its price last year. Correlation is now something people imply from the market."

This can be done in two ways: using compound correlation and base correlation. The compound correlation approach is "simple to understand, but deeply flawed in terms of the numbers it throws up," says Lee McGinty, head of credit derivatives strategy at JPMorgan. "The fact that there may be more than one solution is only one of the reasons most dealers have moved away from this correlation measure."

Base correlation, which McGinty introduced in March 2004, however, is "cleaner and more elegant, but can at times seem a bit counterintuitive," he says. "This is because the correlations are quoted on equity tranches which do not trade directly."

Base correlation is now seen as the standard way to interpolate between prices in the market, says Jon Gregory, global head of credit derivatives research at BNP Paribas. "It enables you to price a tranche on a bespoke portfolio from the market prices of synthetic index tranches."

However, base correlation has thrown up more unresolved debates, because it shows the 'correlation skew'—different implied correlations at different parts of the capital structure. There is no obvious way in which to price CDOs-squared accounting for the correlation skew, says Gregory. "Banks are extending models to account for the correlation skew but there is no accepted model or one which is commercially available for this purpose."

What the market can agree on, says Gregory, is that the market standard for pricing CDOs and CDOs-squared is the Gaussian copula model—despite its basic flaw, being unable to capture the correlation skew. There are varying versions of this method being applying to CDOs. The first is simulation-based, using Monte Carlo. "Monte Carlo is like a simulation of flipping a coin," explains Michael Iver, senior vice-president of sales for the Americas for analytics firm Numerix. It simulates defaults randomly to give a distribution showing how likely a given default is.

The problem with Monte Carlo is that it is not very efficient for calculating prices in real-time. Because of the number of simulations that need to be run, "realistically you may need to spend upwards of 35 hours of calculation time to extract accurate deltas on one CDO-squared," says James Wood, director of quantitative solutions for Reoch Consulting in London.

The second, and more advanced method, is semi-analytic. "An analytic application is when you have a formula. You can't quite make the Gaussian copula into a formula so it's semi-analytic," explains Numerix's Iver. This approach is about 100 times faster than Monte Carlo. "This states that correlation only exists due to obligors sharing exposure to one risk factor. Fix that risk factor, and correlation disappears, making the calculation expressible in an analytic formula," says Wood.

The problem: "You can't use the semi-analytic method for CDOs-squared because they're 'path-dependent'. The order in which obligors default matters as much as the probability of each obligor defaulting," says Wood.

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>
> Lee McGinty, JPMorgan

This brings us straight back to the flawed Monte Carlo method for pricing CDOs-squared. For Wood, there are two exits out of this mire. "The questions in this field now are: is there a better alternative to the Gaussian copula? And is there a semi-analytic pricing model out there for CDOs-squared?"

For McGinty, "the biggest problem is that people are hoping for a model nirvana and hoping it solves all issues." But any move to base correlation "shouldn't be a substitute for further discussion and analysis on issues like models, deltas and term structure."

The current state of confused development in pricing CDOs is largely a result of the speed of growth in this highly technical area. Development in the front office has not been matched in the back office—a phenomenon that is also causing problems in the wider credit derivatives market. The UK's financial regulator, the Financial Services Authority (FSA), warned in late February of the risks it sees in the growing number of unsigned confirmations in over-the-counter credit derivatives. Firms active in this fast-developing OTC market are failing to resource the back office sufficiently to allow it to keep pace with growth in the front-office business.

The development lag is even more pronounced in CDO pricing because the arrival of CDOs is more recent. The first systems to price credit default swaps emerged

two years ago, Kendall from CDO^2 points out. One year ago, systems to price and trade CDOs arrived. And right now, the market is looking for a system to effectively price CDOs-squared. "You create the trade, then someone has to work out how to settle it," says Numerix's Iver.

Added to that is the increasing sophistication of synthetic CDOs and the credit default swaps they reference. The latest additions, according to Fitch's Global CDO Group in February, are lower-rated reference assets, esoteric asset types, and securities with special features, such as Pik-able (payment-in-kind) securities that may defer interest. "These less liquid assets make the already challenging task of standardizing documentation and overcoming liquidity risk in structured finance CDS even more difficult," cautions Fitch. "There is still a great deal of uncertainty associated with recovery rates and valuation processes for synthetic structured finance assets."

The issue is particularly troublesome for investors, because while the sell side has the resources to develop its own sophisticated models to battle through the pricing fog, the buy side does not, and there aren't off-the-shelf models of similar sophistication available. "The good investment banks have short cuts," says Wood. "Smaller banks and end users are doing it the slow way."

Now for some good news. Vendors and consultancies are currently working on providing pricing models specifically for the buy side, combating some of the difficulties outlined above. CDO^2 for example, recently launched its CDO Sheet, which uses a semi-analytic model for CDOs and Monte Carlo simulation for CDOs-squared. Clients use CDO Sheet alongside existing trade management systems, paying about the same as for a Bloomberg license, says Kendall.

Calypso Technology, which uses both Monte Carlo evaluation and a semi-analytic model based on that

The contenders: who can help with CDO pricing

While sophisticated models for CDOs-squared may still be thin on the ground, below are some of the vendors and consultancies who can help the buy side set up models to value credit structures

Company	Application Networks Develops and markets JRisk, which is used for trading, processing and risk-managing cash, derivatives and structured products across all asset classes.	Calypso Technology Sells cross-asset front- to back-office trading software. Its credit derivatives product prices, risk-manages and processes trades.	CDO^2 Produces a structured credit pricing and risk tool, combining new analytics with grid computing technology.
Selling point	Complex structures. JRisk supports highly structured and hybrid transactions including the ability to structure CDOs-squared and credit-contingent products.	Extensibility. The credit derivatives module provides off-the-shelf pricing models, but may also be integrated with users' models and third-party analytics—e.g. Numerix.	Speed to market. Its complete package (spreadsheets, market data and pricing servers) can be set up in under a week.
Target client base	Leading investment banks and hedge funds. Clients include banks such as JPMorgan, SG CIB and Wachovia and hedge fund Sanno Point Capital Management.	Investment banks and credit hedge funds. For credit derivatives, these include Citigroup, HSBC, Wachovia, FrontPoint Partners, NewSmith Capital Partners, SunTrust and TD Securities.	Targets smaller banks and hedge funds—those with limited resources to develop and implement their own models.
CDO pricing system	JRisk supports all flavors of CDO (cash, synthetic, mixed, tranched) for any type of collateral backing. Users may integrate JRisk with their in-house model libraries in addition to third-party vendors such as Numerix and Quantifi. These models include both closed form and Monte Carlo simulation-based approaches.	Uses Monte Carlo evaluation to price CDS basket swaps, as described by David Li, *On Default Correlation: A Copula Function Approach* (RiskMetrics Group, 2000). Calypso also supports the JPMorgan version of Large Pool Model and John Hull and Alan White's semi-analytical model.	CDOSheet uses semi-analytic factor copula models, such as the single-factor Gaussian, for CDOs. Users have a choice of copula to use and can imply tranche or base correlation as well as calculate deltas and default risk for each deal.
CDO-squared pricing system	In JRisk CDOs-squared and beyond can be structured and the risk analyzed at the individual name level.	Calypso is working to adapt the above models to price CDOs-squared.	Monte Carlo simulation. The copula can be calibrated against each constituent CDO tranche using semi-analytic methods to ensure validity. The simulation can then be run on many computers at the same time, giving pricing and deltas in minutes.
What's next?	Increased back-office support from mid-2005.	Full support for correlation skew and interfaces with Creditex and Markit pricing data, both planned for April 2005.	From April, CDOSheet will be deployed on Sun Grid, from Sun Microsystems, giving customers computer processing resources as needed for complex analyses rather than having the machines in their own offices.

developed by academics John Hull and Alan White, is currently adapting these models to support correlation skew in order to price CDOs-squared.

In the meantime, these firms are working within the current boundaries. "I'm trying to provide top-tier investment banks' analytics to institutions that are not one of the top 15," says Wood at Reoch. For now, this means using the Gaussian copula, then either using semi-analytic models where possible, e.g. for CDOs, and using a Monte Carlo simulation that is "very aggressively enhanced" for CDOs-squared. This is achieved using techniques such as importance sampling, Malliavin calculus and low-discrepancy sequences, with the end result that Reoch's CDO-squared model calculates deltas in under an hour.

But further development cannot come soon enough for the buy side, which is under increasing regulatory pressure to demonstrate solid risk management. "I spend a lot more of my time explaining CDO valuation principles to our clients than in the past," says BNP Paribas' Gregory. This comes as a direct result of accounting rules such as IAS 39, which requires an explanation of the valuation principles behind investments. To do that, clients either need to show prices from a secondary market (i.e. two-way prices) or to value investments themselves using an independent system. As there is no secondary market in CDOs, they have little option but to start valuing CDOs themselves.

In addition, clients need to be able to hedge the risk they're holding—and to do that, they need to know the value of investments at any given point. "Banks and relatively advanced hedge funds need to be able to hedge," says Wood. "The drivers [to greater transparency on pricing] are half more knowledgeable trading, and half corporate governance."

Hedge funds are also under pressure to show more robust processing controls for trades, says Iver at Numerix, as they seek more institutional money. Alongside all this, increasing interest in structured credit as a whole is underpinning the urgency to solve the problem. Solutions may not be imminent: "I'd be surprised if anything came out in the next year," says Gregory. But they are on the way.

That leaves just one fly in the ointment: is there even such a thing as the right price for CDOs? "The right price is what you're prepared to pay," responds GFI's Woodhams. "The real question is: is there a sound foundation for pricing? And the answer is: the market is getting there." ■

	GFI GFI's Fenics Credit pricing and risk management system prices baskets of credit default swaps. GFI's brokers use a separate internal system for pricing CDOs.	**Numerix** Numerix's analytics platform is used by the sell and buy side in credit, fixed income and FX to manage risk on a single analytics platform.	**Reoch Consulting** A credit derivatives consultancy providing valuation models and source code, as well as quantitative and operational consultancy.
	The 'reality check'. When clients do get access to GFI's CDO pricing system via Fenics, they will be using a system test-driven by the firm's inter-dealer brokers.	Depth of analytics. Numerix enables users to price CDOs using a wide variety of models.	Lending power: its model library of exotic credit derivative trades, and high-speed CDO/CDO-squared pricing models.
	End users: those without recourse to the large pool of resources that major investment banks have.	Banks and some hedge funds use Numerix's Toolkit, which enables them to build their own models. Engine is for end-users, who use it for pricing, structuring and risk management.	Second- and third-tier banks; hedge funds, insurers and pension funds; and any institution having trouble calculating accurate greeks for CDOs and CDOs-squared.
	Fenics Credit, which is available to the buy side, prices CDS baskets, but the firm's in-house proprietary CDO pricing system is not yet available externally. It is based on a model described by academics John Hull and Alan White, and comprises both compound correlations and base correlation.	Numerix uses two versions of a Gaussian copula model. One is simulation based, an upgrade of Monte Carlo with control variance. The other is semi-analytic.	A semi-analytic CDO model, some 100 times faster than basic Monte Carlo, according to Reoch.
	GFI says it is not yet seeing these trades in the market yet, although they are "coming onto the radar screen".	Numerix is "looking into it".	An enhanced Monte Carlo model, including high-speed calculation of deltas, which it says is about 20 times faster than basic Monte Carlo.
	CDO pricing on Fenics Credit.	More instrument coverage and integration with partners. Also looking at offering market data.	An efficient gamma calculation for CDOs-squared and Bermudan credit options, for cancelable CDOs, for example.