THE WALL STREET JOURNAL. ONLINE

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September 12, 2005

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Slices of Risk

How a Formula Ignited Market That Burned Some Big Investors

Credit Derivatives Got a Boost From Clever Pricing Model; Hedge Funds Misused It

Inspiration: Widowed Spouses

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September 12, 2005; Page A1

(See Corrections & Amplifications item below[0].)

When a credit agency downgraded **General Motors** Corp.'s debt in May, the auto maker's securities sank. But it wasn't just holders of GM shares and bonds who felt the pain.

Like the proverbial flap of a butterfly's wings rippling into a tornado, GM's woes caused hedge funds around the world to lose hundreds of millions of dollars in other investments on behalf of wealthy individuals, institutions like university endowments -- and, via pension funds, regular folk.

David Li

All this traces back, in a sense, to a day eight years ago when a Chinese-born New York banker got to musing about love and death -- specifically, how people tend to die soon after their spouses do. Therein lies a tale of how a statistician unknown outside a small coterie of finance theorists helped change the world of investing.

The banker, David Li, came up with a computerized financial model to weigh the likelihood that a given set of corporations would default on their bond debt in quick succession. Think of it as a produce scale that not only weighs a bag of apples but estimates the chance that they'll all be rotten in a week.

The model fueled explosive growth in a market for what are known as credit derivatives: investment vehicles that are based on corporate bonds and give their owners protection against a default. This is a market that barely existed in the mid-1990s. Now it is both so gigantic -- measured in the trillions of dollars -- and so murky that it has drawn expressions of concern from several market watchers. The Federal Reserve Bank of New York has asked 14 big banks to meet with it this week about practices in the surging market.

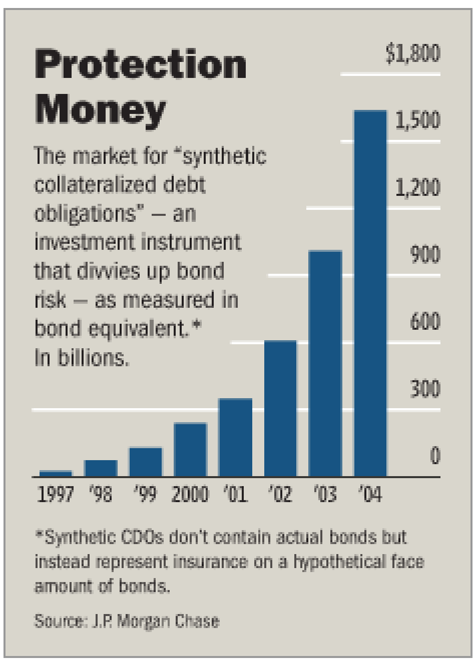
The model Mr. Li devised helped estimate what return investors in certain credit derivatives should demand, how much they have at risk and what strategies they should employ to minimize that risk. Big investors started using the model to make trades that entailed giant bets with little or none of their money tied up. Now, hundreds of billions of dollars ride on variations of the model every day.

"David Li deserves recognition," says Darrell Duffie, a Stanford University professor who consults for banks. He "brought that innovation into the markets [and] it has facilitated dramatic growth of the credit-derivatives markets."

The problem: The scale's calibration isn't foolproof. "The most dangerous part," Mr. Li himself says of the model, "is when people believe everything coming out of it." Investors who put too much trust in it or don't understand all its subtleties may think they've eliminated their risks when they haven't.

The story of Mr. Li and the model illustrates both the promise and peril of today's increasingly sophisticated investment world. That world extends far beyond its visible tip of stocks and bonds and their reactions to earnings or economic news. In the largely invisible realm of derivatives -- investment contracts structured so their value depends on the behavior of some other thing or event -- credit derivatives play a significant and growing role. Endless trading in them makes markets more efficient and eases the flow of money into companies that can use it to grow, create jobs and perhaps spread prosperity.

But investors who use credit derivatives without fully appreciating the risks can cause much trouble for themselves and potentially also for others, by triggering a cascade of losses. The GM episode proved relatively minor, but some experts say it could have been worse. "I think this is a baby financial mania," says David Hinman, a portfolio manager at Los Angeles investment firm Ares Management LLC, referring to credit derivatives. "Like a lot of financial manias, it tends to end with some casualties."



Mr. Li, 42 years old, began his journey to this frontier of capitalist innovation three decades ago in rural China. His father, a police official, had moved the family to the countryside to escape the purges of Mao's Cultural Revolution. Most children at the young Mr. Li's school didn't go past the 10th grade, but he made it into China's university system and then on to Canada, where he collected two master's degrees and a doctorate in statistics.

In 1997 he landed on the New York trading floor of Canadian Imperial Bank of Commerce, a pioneer in the then-small market for credit derivatives. Investment banks were toying with the concept of pooling corporate bonds and selling off pieces of the pool, just as they had done with mortgages. Banks called these bond pools collateralized debt obligations.

They made bond investing less risky through diversification. Invest in one company's bonds and you could lose all. But invest in the bonds of 100 to 300 companies and one loss won't hurt so much.

The pools, however, didn't just offer diversification. They also enabled sophisticated investors to boost their potential returns by taking on a large portion of the pool's risk. Banks cut the pools into several slices, called tranches, including one that bore the bulk of the risk and several more that were progressively less risky.

Say a pool holds 100 bonds. An investor can buy the riskiest tranche. It offers by far the highest return, but also bears the first 3% of any losses the pool suffers from any defaults among its 100 bonds. The investor who buys this is betting there won't be any such losses, in return for a shot at double-digit returns.

Alternatively, an investor could buy a conservative slice, which wouldn't pay as high a return but also wouldn't face any losses unless many more of the pool's bonds default.

Investment banks, in order to figure out the rates of return at which to offer each slice of the pool, first had to estimate the likelihood that all the companies in it would go bust at once. Their fates might be tightly intertwined. For instance, if the companies were all in closely related industries, such as auto-parts suppliers, they might fall like dominoes after a catastrophic event. In that case, the riskiest slice of the pool wouldn't offer a return much different from the conservative slices, since anything that would sink two or three companies would probably sink many of them. Such a pool would have a "high default correlation."

But if a pool had a low default correlation -- a low chance of all its companies stumbling at once -- then the price gap between the riskiest slice and the less-risky slices would be wide.

This is where Mr. Li made his crucial contribution. In 1997, nobody knew how to calculate default correlations with any precision. Mr. Li's solution drew inspiration from a concept in actuarial science known as the "broken heart": People tend to die faster after the death of a beloved spouse. Some of his colleagues from academia were working on a way to predict this death correlation, something quite useful to companies that sell life insurance and joint annuities.

"Suddenly I thought that the problem I was trying to solve was exactly like the problem these guys were trying to solve," says Mr. Li. "Default is like the death of a company, so we should model this the same way we model human life."

His colleagues' work gave him the idea of using copulas: mathematical functions the colleagues had begun applying to actuarial science. Copulas help predict the likelihood of various events occurring when those events depend to some extent on one another. Among the best copulas for bond pools turned out to be one named after Carl Friedrich Gauss, a 19th-century German statistician.

Mr. Li, who had moved over to a **J.P. Morgan Chase** & Co. unit (he has since joined Barclays Capital PLC), published his idea in March 2000 in the Journal of Fixed Income. The model, known by traders as the Gaussian copula, was born.

"David Li's paper was kind of a watershed in this area," says Greg Gupton, senior director of research at Moody's KMV, a subsidiary of the credit-ratings firm. "It garnered a lot of attention. People saw copulas as the new thing that might illuminate a lot of the questions people had at the time."

To figure out the likelihood of defaults in a bond pool, the model uses information about the way investors are treating each bond -- how risky they're perceiving its issuer to be. The market's assessment of the default likelihood for each company, for each of the next 10 years, is encapsulated in what's called a credit curve. Banks and traders take the credit curves of all 100 companies in a pool and plug them into the model.

The model runs the data through the copula function and spits out a default correlation for the pool -- the likelihood of all of its companies defaulting on their debt at once. The correlation would be high if all the credit curves looked the same, lower if they didn't. By knowing the pool's default correlation, banks and traders can agree with one another on how much more the riskiest slice of the bond pool ought to yield than the most conservative slice.

"That's the beauty of it," says Lisa Watkinson, who manages structured credit products at Morgan Stanley in New York. "It's the simplicity."

It's also the risk, because the model, by making it easier to create and trade collateralized debt obligations, or CDOs, has helped bring forth a slew of new products whose behavior it can predict only somewhat, not with precision. (The model is readily available to investors from investment banks.)

The biggest of these new products is something known as a synthetic CDO. It supercharges both the returns and the risks of a regular CDO. It does so by replacing the pool's bonds with credit derivatives -- specifically, with a type called credit-default swaps.

The swaps are like insurance policies. They insure against a bond default. Owners of bonds can buy credit-default swaps on their bonds to protect themselves. If the bond defaults, whoever sold the credit-default swap is in the same position as an insurer -- he has to pay up.

The price of this protection naturally varies, costing more as the perceived likelihood of default grows.

Some people buy credit-default swaps even though they don't own any bonds. They buy just because they think the swaps may rise in value. Their value will rise if the issuer of the underlying bonds starts to look shakier.

Say somebody wants default protection on $10 million of GM bonds. That investor might pay $500,000 a year to someone else for a promise to repay the bonds' face value if GM defaults. If GM later starts to look more likely to default than before, that first investor might be able to resell that one-year protection for $600,000, pocketing a $100,000 profit.

Just as investment banks pool bonds into CDOs and sell off riskier and less-risky slices, banks pool batches of credit-default swaps into synthetic CDOs and sell slices of those. Because the synthetic CDOs don't contain any actual bonds, banks can create them without going to the trouble of purchasing bonds. And the more synthetic CDOs they create, the more money the banks can earn by selling and trading them.

Synthetic CDOs have made the world of corporate credit very sexy -- a place of high risk but of high potential return with little money tied up.

Someone who invests in a synthetic CDO's riskiest slice -- agreeing to protect the pool against its first $10 million in default losses -- might receive an immediate payment of $5 million up front, plus $500,000 a year, for taking on this risk. He would get this $5 million without investing a dime, just for his pledge to pay in case of a default, much like what an insurance company does. Some investors, to prove they can pay if there is a default, might have to put up some collateral, but even then it would be only 15% or so of the amount they're on the hook for, or $1.5 million in this example.

This setup makes such an investment very tempting for many hedge-fund managers. "If you're a new hedge fund starting out, selling protection on the [riskiest] tranche and getting a huge payment up front is certainly something that's going to attract your attention," says Mr. Hinman of Ares Management. It's especially tempting given that a hedge fund's manager typically gets to keep 20% of the fund's winnings each year.

Synthetic CDOs are booming, and largely displacing the old-fashioned kind. Whereas four years ago, synthetic CDOs insured less than the equivalent of $400 billion face amount of U.S. corporate bonds, they will cover $2 trillion by the end of this year, J.P. Morgan Chase estimates. The whole U.S. corporate-bond market is $4.9 trillion.

Some banks are deeply involved. J.P. Morgan Chase, as of March 31, had bought or sold protection on the equivalent of $1.3 trillion of bonds, including both synthetic CDOs and individual credit-default swaps. **Bank of America** Corp. had bought or sold about $850 billion worth and **Citigroup** Inc. more than $700 billion, according to the Office of the Comptroller of the Currency. **Deutsche Bank** AG, whose activity the comptroller doesn't track, is another big player.

Much of that money is riding on Mr. Li's idea, which he freely concedes has important flaws. For one, it merely relies on a snapshot of current credit curves, rather than taking into account the way they move. The result: Actual prices in the market often differ from what the model indicates they should be.

Investment banks try to compensate for the shortcomings of the model by cobbling copula models together with other, proprietary methods. At J.P. Morgan, "We're not stupid enough to believe [the model] is omniscient," said Andrew Threadgold, head of market risk management. "All risk metrics are flawed in some way, so the trick is to use a lot of different metrics." Bank of America and Citigroup representatives said they use various models to assess risk and are constantly working to improve them. Deutsche Bank had no comment.

As with any model, forecasts investors make by using the model are only as good as the inputs. Someone asking the model to indicate how CDO prices will act in the future, for example, must first offer a guess about what will happen to the underlying credit curves -- that is, to the market's perception of the riskiness of individual bonds over several years. Trouble awaits those who blindly trust the model's output instead of recognizing that they are making a bet based partly on what they told the model they think will happen. Mr. Li worries that "very few people understand the essence of the model."

Consider the trade that tripped up some hedge funds during May's turmoil in GM securities. It involved selling insurance on the riskiest slice of a synthetic CDO and then looking to the model for a way to hedge the danger that the default risk would increase. Using the model, investors calculated that they could offset that danger by buying a double dose of insurance on a more conservative slice.

It looked like a great deal. For selling protection on the riskiest slice -- agreeing to pay as much as $10 million to cover the pool's first default losses -- an investor would collect a $3.5 million upfront payment and an additional $500,000 yearly. Hedging the risk would cost the investor a mere $415,000 annually, the price to buy protection on a $20 million conservative piece.

But the model's hedge assumed only one possible future: one in which the prices of all the credit-default swaps in the synthetic CDO moved in sync. They didn't. On May 5, while the outlook for most bond issuers stayed about the same, two got slammed: GM and Ford Motor Co., both of which Standard & Poor's downgraded to below investment grade. That event caused a jump in the price of protection on GM and Ford bonds. Within two weeks, the premium payment on the riskiest slice of the CDO, the one most exposed to defaults, leapt to about $6.5 million upfront.

Result: An investor who had sold protection on the riskiest slice for $3.5 million had a paper loss of nearly $3 million. That's because if the investor wanted to get out of the investment, he would have to buy a like amount of insurance from somebody else for $6.5 million, or $3 million more than he was getting.

The simultaneous investment in the conservative slice proved an inadequate hedge. Because only GM and Ford saw their default risk soar, not the rest of the bond world, the pricing of the more conservative slices of the pool didn't rise nearly as much as the riskiest slice. So there wasn't much of an offsetting profit to be made there by reselling that insurance.

This wasn't really the fault of the model, which was designed mainly to help price the tranches, not to make predictions. True, the model had assumed the various credit curves would move in sync. But it also allowed for investors to adjust this assumption -- an option that some, wittingly or not, ignored.

Because numerous hedge funds had made the same credit-derivatives bet, the turmoil they faced spilled over into stock and bond markets. Many investors worried that some hedge funds might have to dump assets to cover their losses, so they sold, too. (Some hedge funds also suffered from a separate bad bet, which relied on GM's bond and stock prices moving in tandem; it went wrong when GM shares rallied suddenly as investor Kirk Kerkorian said he would bid for GM shares.)

GLG Credit Fund told its investors it lost about 14.5% in the month of May, much of that on synthetic CDO bets. Writing to investors, fund manager Jean-Michel Hannoun called the market reaction to the GM and Ford credit downgrades too improbable an event for the hedge fund's risk model to capture. A GLG spokesman declines to comment.

The credit-derivatives market has since bounced back. Some say this shows that the proliferation of hedge funds and of complex derivatives has made markets more resilient, by spreading risk.

Others are less sanguine. "The events of spring 2005 might not be a true reflection of how these markets would function under stress," says the annual report of the Bank for International Settlements, an organization that coordinates central banks' efforts to ensure financial stability. To Stanford's Mr. Duffie, "The question is, has the market adopted the model wholesale in a way that has overreached its appropriate use? I think it has."

Mr. Li says that "it's not the perfect model." But, he adds: "There's not a better one yet."

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Corrections & Amplifications:

Lisa Watkinson manages structured credit products at Lehman Brothers, where she has worked since Aug. 15. This article incorrectly reported that she works at Morgan Stanley, her previous employer.

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