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## Session 55PD Setting Credit Risk Limits

**Track:** Investment

**Moderator:** JACK Z. REICHMAN

**Panel:** MARK C. ABBOTT†  
SCOTT S. HARTZ  
HAL WARREN PEDERSEN  
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*Summary: This panel discussion focuses on how investment actuaries determine appropriate issuer and concentration limits in a below-investment-grade portfolio. Presenters discuss the best techniques for monitoring and managing exposures as they improve or deteriorate and give an overview of opportunities for managing credit risk through synthetic structures and derivatives. As a result of this session, attendees are better prepared to work with investment professionals in setting credit risk limits in insurance portfolios and default rate assumptions.*

**MR. JACK Z. REICHMAN:** We're going to have a mixture of discussions on some technical methods and some practical methods as well as some broader overview-type pictures. Scott Hartz is the portfolio manager for John Hancock's general account bond portfolio. He's worked in this area for over 10 years.

**MR. SCOTT S. HARTZ:** I'm going to give more of a broad overview introduction and quickly define high yield. I will talk about how insurance companies' high-yield portfolios may be different than the high-yield market in aggregate and then answer a few questions: Why to invest? How much is appropriate? What risk controls and processes are needed? I will then spend just a moment on the current market situation.

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First, what is a high-yield bond? Most of you, if not all of you, are going to be familiar with this. You're probably all familiar with the Moody's and S&P ratings where BBB for S&P (BAA for Moody's) and above is investment grade: BB, BA and lower are below investment grade. What insurance companies care most about is how our regulators view the risk of our bonds through the Securities Valuation Office (SVO) rating process. That's important because that's what we file in our statutory filings. That's what is on the D Schedule. That's what most public companies put in their quarterlies and annual filings for GAAP purposes, so it's what the rating agencies look at.

The securities analysts also look at the SVO ratings, so they tend to focus on the bonds rated three through six (these ratings are considered below investment grade). The reason we need the SVO, of course, is because many of our bonds are private placements, which are unrated by the agencies. It becomes very important to me as portfolio manager to know where the SVO is going to come out on a rating. If we're making a private loan, our analyst calls the risk BBB and we come out with an NAIC -3 rating; that's not good. I've used up some of what I consider to be scarce resources, which is my capacity to invest in below investment grade bonds and I want to price that bond correctly. Maybe I have priced correctly for the risk, but not for my overall concerns on my portfolio.

Another point I would make on the SVO rating process is that they tend to be conservative. If a bond is split-rated by Moody's and S&P and is investment-grade by one and below investment grade by the other, which is often called a 5B bond, the SVO will invariably rate that a three, as you would expect. They have all the reasons in the world to be conservative on these ratings.

Now let me turn to insurance companies' high-yield portfolios and give you a little background on them. I'm going to talk a little bit about what they've looked like over time and then compare them in several different ways to the public high-yield market. First, what has the exposure been over time? We'll discuss data as of December 31, 2000. That's the last report I have from the American Council of Life Insurers (ACLI). I believe it's the last time they produced this detail on insurance company bond portfolio holdings.

The SVO moved to the one through six rating system in 1991. That's why I'll start with 1991. The industry's holdings of 3-6 bonds peaked back in that first year at nearly 9 percent. That also corresponded to the worst year for high-yield defaults. Insurance companies cut their exposure. The industry cut its exposure to a minimum of about 5 percent in 1995 when defaults were close to their minimum. The industry's exposure has been increasing ever since as actual defaults have been increasing as well, up to about 7 percent currently.

Within the high-yield portfolio, here are different levels of risk. For a rating of CCC or lower, there's not much new issuance. That's more bonds that have been downgraded and are near or at default. It's really BB and B where insurance

companies are putting their money in the high-yield market and where new issuance is coming. I think it's important to point out that insurance companies have been much more involved and heavily weighted towards BB bonds, unlike the public high-yield market, which is more heavily weighted to B bonds. It's important, because over time the rate of default is five times as high for a B bond than it is for a BB bond. There have been pretty high levels of default in the high-yield market, but I would expect for this reason, and a few others, insurance companies' portfolios wouldn't be experiencing as high a level of default as the market as a whole.

Another reason is that most life insurance companies are active in the private placement market and private placements have several types of protections. Often privates are secured and contain covenants that limit the amount of leverage. There are interest coverage tests and there are tests that don't allow banks to get secured ahead of you. The disadvantage of privates, of course, is they're less liquid and there are no public ratings on them. The advantages are, if a company starts to run into trouble, they'll trip a covenant. You're then able to go back to the company, see what's going on and have a dialogue with management and have them change things. I think it's very important to have that ability, particularly in the high yield part of the market. It's also critical not to let the banks get secured ahead of you the way they typically can in the public market. Insurance companies' high-grade portfolios are about one quarter privates, but their high-yield portfolios are almost half privates.

For the sector distribution, there's only one sector I want to point out, and that's the one where the biggest difference arises—communications. As of year-end 2000, the public high-yield market had financed a ton of start-up telecom companies. The Internet was going to grow to the sky and there was a lot of financing of companies that had no history. A lot of times the bonds had zero coupons because they couldn't pay current interest. We all know what's happened to that sector—it's gotten crushed. Insurance companies by and large have avoided that sector, which was a good thing.

Why is senior management interested in high yield? When default rates are low, senior management loves the high-yield portfolio. It's very accounting friendly. It provides a high level of income into your net investment line. It provides operating earnings; it's very stable, and very smooth. It's what everybody wants. Even if you have a few defaults, the losses come in below the operating line into realized capital losses, which is at the net income line. Security analysts out there are usually putting a multiple on your operating earnings so the losses don't show up so much. In the current environment with a lot of losses, they're starting to focus a little bit more on the net income line, and that trend is likely to continue. Senior management is beginning to have trouble stomaching the higher losses we are currently seeing.

Beyond the geography of earnings issue, I would argue that the high-yield market at various points in time is a good risk return trade-off. It is also a good risk return

at almost all times in certain spots. Risk is a continuum, and the difference in risk between the lowest quality investment grade bond, a BBB- bond, versus the highest quality junk bond, (BB+ bond) is not very large. Yet the difference in the return of the two bonds is very significant. The amount of additional spread you can get in the current market is 150 or 200 basis points. The reason, of course, is not because of the fundamental risk return, but more the supply/demand issues, what the bond market calls the technicals. Like I said earlier, for most managers, the high-yield portion of the portfolio is a scarce resource. They're very choosy. There's this step-function once you move into the below investment grade arena in terms of spreads. Insurance companies do a lot of investing in the higher quality part of the high-yield market, which I think has been a very good strategy.

I also believe that certain times are better to invest in this market, and clearly with hindsight you can see what the right times are. Spreads generally follow the default rates. Spreads should move in anticipation of default rates—obviously a hard thing to anticipate. In 1990 and 1991, spreads were high, defaults were high and then defaults came down rapidly. If you bought high-yield bonds at that point in time, you just made a killing. The total returns were very good. Then if you piled into the market when defaults were very low, it didn't look like there was much risk. Spreads were correspondingly low in the mid-1990s and default rates have done nothing but go up since, so the returns have not been very good lately.

The head of my group, Roger Nastou, has a couple of investing rules of thumb and one of them is, when you and the market look at an investment and you just want to throw up, that's when you should buy. Put in high-yield market terms, his rule of thumb is once junk bond spread hit 1000 basis points over Treasuries, that's the time to buy. He's been around a long time; he's been through a few cycles, and that's worked every time. We're sort of at that point in the cycle now, and the question is: Will that rule still work? I think it's likely, but only time will tell.

How much high yield is appropriate for a portfolio? There are a number of considerations starting with the rating agencies. The rating agencies are going to be most concerned when defaults are high. I usually am involved in the rating agency discussions at my company, and I can remember in the mid-1990s, we'd sit down with them and they'd say, "Let's just skip the bond presentation and go right to the commercial mortgage presentation." Those were the good old days. Currently, they come in and they want to spend a long time on the bond portfolio. Clearly, it's a more difficult environment. At the time that you really want to invest in the market when spreads are high and defaults are high, it's hard to get it by the rating agencies. Their comfort level, and ours as well, is based on two factors. The first is capital. The more capital you have, the more risk you can take. Risk-based-capital (RBC) factors are obviously higher for high-yield bonds, so whatever capital model you use, be it RBC, your own or the rating agency's, clearly you've got to come to a decision that's related to the amount of capital that you have.

The other very important consideration is the expertise of your bond group. If

they've been investing in the high-yield market for a long time through cycles, and they do a lot in the private market, the rating agencies are going to be much more forgiving. Whereas companies that step in when it looks like there's not much risk in the market, as a number of companies did in the mid-1990s, have been hurt tremendously. How much you want to have in high yield is definitely going to be a function of the expertise of the group.

Now let's move to what this panel is actually supposed to be about, which is risk controls and maximum issue limits. This is something all companies have been focused on much more in the last year or so. I'll give you a little example to illustrate why. WorldCom, which was actually an A credit about a year ago and probably BBB at the end of last year, defaulted in the second quarter. WorldCom was a huge issuer on the corporate bond market. They probably represented about 2 percent of the investment-grade corporate market. Their bonds, after they defaulted, were trading at about 20 cents on the dollar. If you had market weighted that bond at 2 percent with an 80 percent loss rate, you would have had losses of 1.6 percent of your portfolio. That's higher than the worst year we've seen in our portfolio for the whole portfolio for the last 30 years. Companies can't just pick out market weights of bonds. There are huge issuers in the corporate market and losses would be catastrophic if you market-weighted them.

Lehman Brothers did a survey back in August 2002 to go over limits that companies have. They surveyed 30 fairly large companies, and the average for BBB bonds was about .5 percent, as opposed to the 2 percent that WorldCom represented. Our approach to setting limits was as follows: We started with our BBB portfolio equal to about 40 percent of the total portfolio. Let's say we've got \$20 billion in BBBs. Let's also say \$200 million seems like a good maximum limit. If we stretch it and say that the manager goes to the limit on all the bonds in the portfolio, that would be like one hundred \$200 million positions. We did that for each of the credit qualities. Then, based upon default history from Moody's, and correlation history from Moody's, we modeled out the worst case loss we could have 1 percent of the time and .5 percent of the time. Then we looked at our capital and decided how much capital we were willing to have at risk for that sort of event. That's how we came up with our issuer limits. We did the same thing for sector limits. By the way, in the Lehman survey, about half the companies had no sector limits. I think a lot more people are thinking about them today than they were a year ago. What we found in our research was that, at least based on the history, the correlations within sectors weren't really large enough to make sector limits that meaningful. We still have them. We did the modeling and put them in place, but we found that the maximum single issuer limits and the average credit quality were much more important in determining the maximum loss you could expect. The average credit quality is a huge consideration in setting up an overall portfolio.

I will end on the challenges of the current environment, and Mark is going to talk a lot more about this. I just want to highlight "fallen angels," which is an investment-

grade bond that's been downgraded to below investment grade. They've been particularly problematic in the current environment for a few reasons. First, there have been a lot of them and they have been big. So, our below-investment grade bond portfolio is growing in a passive sense, which is not good. Second, it's been particularly troublesome because we might like to sell those bonds once they get downgraded, but liquidity has been particularly bad. While you can get quotes on these bonds, it's very hard to move many bonds when they get downgraded. This is largely due to supply-and-demand pressures. The high-yield bond market is getting a lot of in-flow passively and there just aren't enough buyers to support it.

Finally, you need to consider recovery values. If you do hold the position in the current cycle, which is typical of bad cycles, recovery rates go way down. You're wishing you had sold them as soon as they got downgraded if they continue to fall. There's obviously a lot of pressure from the rating agencies and senior management, as I've already talked about.

**MR. REICHMAN:** I work for a rating agency. Talking about the good old days reminded me of my very first meeting with a company that had about 40 percent of its invested assets in commercial mortgages. They brought in the guy who did the mortgages because this was the bulk of the meeting as far as we were concerned. This guy knew his stuff: he knew every tenant on every floor, and he proceeded to talk about it in a monotone. I noticed that all 10 people from the company we were visiting were sound asleep. I turned around to point this out to my partner, the senior analyst, and found out that he was asleep. The only two people awake in the room were the speaker and me, because of my newness at this. Actually, it's been an interesting 10 years since I started at Standard & Poor's because we started with the junk bonds, moved on to commercial mortgages, mortgage-backed securities and liquidity crisis. People weren't that sophisticated about some of the more interesting derivatives in the mid-1990s. Now we've moved on. The interesting thing from our perspective is that there's always going to be risk. Insurance companies, although we always think of ourselves as very conservative, always take some risk.

Mark Abbott, the next speaker, is the head of quantitative research at Guardian Life.

**MR. MARK C. ABBOTT:** I want to talk a little bit about how bad the credit markets have been, what we do at Guardian, and what you should think about in terms of setting your risk limits for credit. I think diversification is an important part of it. Nikunj is going to talk a lot more about some of his advanced quantitative credit research. I'll just set the tone in today's market, cover a few of the models and lay the groundwork for why it's important to look at credit in various ways. I'll provide an overview, current market concerns and then go through the quantitative credit process, because I think having a process is more important than anything else. You should be looking and reviewing the amount of exposures that you actually have. How well you manage that process is going to determine whether you're

successful or not.

In the current market, we really had a lot of moving parts. Recently fixed income has outperformed equity. However, the corporate bond market, the crux that we're talking about, recently has really underperformed the Treasury market. We've had a tremendous number of downgrades, rising default rates and "fallen angels," investment-grade credits that were downgraded to below investment grade. We've had a decoupling in a couple of sectors from the other credits and telecom and energy are good examples of that. In general, we have seen an exaggerated corporate credit market volatility over the last six or so years that I've never seen before in the credit market. The biggest problem, as Scott mentioned, is not only difficulty exiting transactions, but even acquiring credits that weren't these huge names. The branding and consolidation that has happened over the last five years as a result of these huge conglomerate mergers has made people question how much to own when the market weight could be devastating to your portfolio performance if there is a whisper of negative news. That's caused some other issues in terms of benchmark that I'll get to. The bottom line is that you need to make sure that you are focused on good fundamental research in order to identify which companies have the potential to become distressed and you need to have exit strategies before they hit the headlines, because by that point it's too late. Or you need to be diversified with small issuer exposure limits.

What has contributed to all of this volatility? I'm not going to go into all the details, but basically we've had a credit recession. Actually Ed Altman coined that term at a PRMIA meeting in New York a couple of months ago, and I like it because it really reflects what's been happening over the last several years. This liquidity crisis, not only in terms of acquiring bonds or exiting bonds, is being forced by the banks, which cut off their liquidity to the corporations, so almost all corporates are in funding crisis mode these days. Coupling that with low rates and unclear recovery, we still have many potential credit disasters in our forecast.

Many of the current equity market ratios indicate that it is still overvalued. That is certainly a cause for concern. If balance sheets are not repaired, I think the liquidity crunch that we still are having will cause some additional problems.

Through September 2002, we now have negative equity returns going all the way back five years. If you did cumulative returns, essentially this would now be negative. If you look at recent periods—whether it's a one-, two-, three-, four- or five-year holding period—there are few periods of positive equity returns. The credit market itself has been devastated. Actually, the number is \$105.5 billion in "fallen angels" year to date through the end of September 2002. (Fallen angels are investment grade credits that have been downgraded to high yield. The year 2002 had \$142 billion in fallen angels through December 2002.) We've gone well beyond where we were in 1991. The interesting thing is, in 1991 or just thereafter, the high-yield market did extremely well. It actually recovered and the returns were very positive. As Scott was saying about the market, in the past, after the defaults

had occurred and you knew who the losers were, you could do very well by investing where there is no appetite for that sort of risk at that time. But right now it's frightening. Basically we just had probably the worst experience we've ever had since Chapter 11 filings were actually put into place and it is not clear that it's over yet.

As far as the liquidity crisis, the banks are protecting themselves at this point in time. Their liquidity in the market is probably at the lowest level in a long time. Of course, the interest rates have gone down even lower, down to 3.6 percent recently. This is at least as low as anyone has seen in 40-45 years. The expectation is for it to stay low or perhaps even rise slowly so fixed income in general is not going to produce a large amount of income. Going after credit and perhaps even junk credit to get that extra yield pick-up is perhaps the game that a lot of companies will start to play over the next couple of years to keep their dividends high. They will basically get higher returns and stabilize their earnings.

Then there's a big wild card, which is what is going to happen with geo-political risk. We just don't know whether there is going to be something that's going to exacerbate the market or not. There's a huge uncertainty.

Things were fairly stable prior to June 1997, and then the bottom fell out. All of a sudden you had huge volatility, just with the market short of shaking and going up and down. It's gone much further south recently.

We've really changed dramatically in terms of performance and the expectations. The corporate market has just not done well. People have thought it would recover and it just has not done it yet. We're still in that period where there are a lot of penalties for those who have been in the corporate market. Expectation is that once we're over the hump again, it could be the place to be. Returns could definitely exceed some of the other more conservative, less volatile asset classes in the market.

If you had a Treasury portfolio matched in terms of each of its yield curve exposures, that was an equivalent portfolio to that credit benchmark; this is the return above that portfolio that you would get (Figure 1). If you decouple it further and just look at the pure option-adjusted spread (OAS), not returns, the pipelines and the wirelines have much larger spreads, especially recently, than the index on a whole. That certainly indicates their risk.

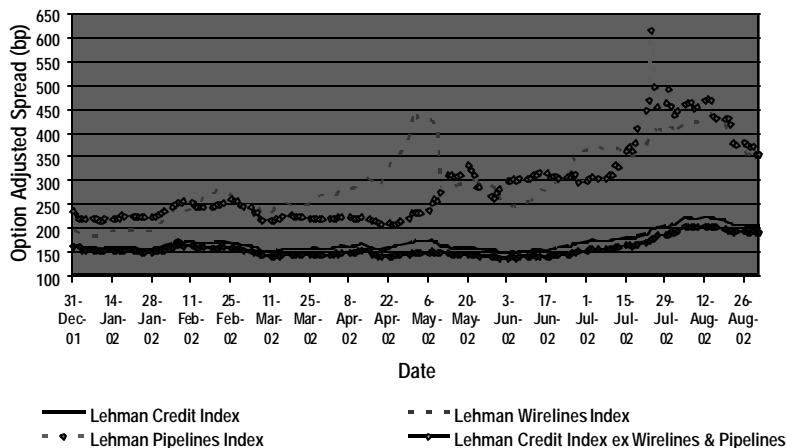


Figure 1

## Corporate Bond Valuations

### - Anything But Telecom and Pipelines!

(From December 31, 2001 through August 31, 2002)



Source: Lehman

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The fallen angels in the headlines were recognizable company names that were basically the ones that were being marketed over the last several years with the largest issuer size. If you were in even a couple of those, as Scott mentioned, your return measured relative to a benchmark would probably have been hammered. Most investors had exposure to some of these companies as they were buying what was available in the market. Limiting your exposure made a difference between those that were successful and those that have had huge volatility in terms of their investment portfolios and being hit with negative returns.

Another interesting observation is that in prior markets investing in distressed credits, as soon as the actual effect of the rating change had been made, was not a bad deal. You usually were actually able to capitalize some additional returns in relatively quick rebounds. The expectation was that things would get better once the downgrades had occurred. I think that has changed recently so that is no longer the indication.

Next, consider lagged correlations in the periods of large defaults versus the subsequent actual returns. In periods when there have been peaks (such as 1991), the default rates were very high. However, the returns also ultimately became very high that year. We haven't seen that yet recently, but that's something that people who have large positions in the high yield corporate bonds are hoping will happen.

One issue that we're now facing, especially if you are managing a general account,

is that management's appetite for risk has diminished. The news in every quarter's investment report is their intense desire to limit absolute credit exposure, especially to these huge names. Market weights in these huge issues have caused benchmarks to become more volatile. If you had followed that paradigm and tried to replicate market weights in the corporate index, you'd probably be in big trouble right now. Your tracking relative to the index would have been pretty good prior to downgrades, but not since. These indices have a huge advantage because as soon as the credits become distressed, they're able to exit the market that month and have full liquidity. We have no way of getting that sort of liquidity in the market to exit a fallen angel junk credit in our investment grade portfolio. Liquidity has become a huge problem. As a result, there have been difficulties in managing issuer exposure in a lot of companies, and this has contributed to the recent negative life insurance industry views by the rating agencies. I think one way to manage the exposure is to customize benchmarks to essentially force us to limit our exposure so we can maintain a reduced tracking error to these benchmarks that we use in guiding the management of our portfolios.

We have other issues resulting from the credit recession. Fallen angels comprise over 20 percent of the Lehman High Yield Index; these huge issues have fallen from the investment rate component down into high yield. They're dominating the negative performance of the high yield index, because they're continuing to go south where they didn't used to do that sort of thing. By not holding these fallen angels, high yield portfolio managers looked pretty good in 2002 relative to the Lehman High Yield Index. (Note: CSFB's High Yield II index has a long lag before fallen angels enter the index, whereas Lehman's High Yield Index adds them at the end of the month after they were downgraded. As a result, CSFB's performance was less negative than Lehman's.)

The underperformance due to a downgrade basically depends on the rating. If you have a low-rated bond to begin with, essentially the losses can stretch out over a long, long period so you actually have time to sense what's going on, but you're going to be hurt unless you act at the beginning if you own that credit. With the higher weighted bond, you're going to do better.

If you typically held these distressed bonds, you would do pretty well. You would have returns of about +16.56 percent. That's excellent. If you followed that philosophy over the last couple of years, your return would have been a disastrous -23 percent. Over the whole long haul, so far it's still slightly positive. I don't know if that's going to continue, but there's definitely been a change in the behavior. Now, as soon as it's in the headline, you've got to get out of the bond. That's definitely a recent phenomenon that we have seen during the last two years. It was really exacerbated, I think, after the Enron debacle at the end of 2001.

How should you slice up your portfolio in managing your limits? I would say that in addition to looking at credit quality sectors, specific issuer constraints, you might want to look at your exposure across the yield curve as well, adding the relation of what your exposure is in these particular regions. Diversify into as many high-yield

issuers as you can afford to and do as much independent fundamental research as you can for any issuers you load up in.

Most companies have either used dollar limits or percent limits. There's a new breed starting to use statistical diversification, and they are even using tracking error more from a quantitative credit exposure. We're starting to do that at Guardian and that has helped us react to increased volatility and become conservative more quickly by having parametric sensitivity limits that force proportionally smaller issuer limits when the market gets more volatile.

I'm going to touch base on some of these quantitative metrics. Essentially, there are several different varieties of models, and there are a lot of them. Ed Altman's Z-score is one of the classic models. Everyone who has the resources to implement it should certainly be using it, because it's still a valid model. If you're buying off-the-shelf models, certainly KMV's EDFs are a good model. The EDFs are a structural model. They model a firm's equity and debt components in a company and look at the probability where they exhaust their equity. One criticism is that as a company becomes distressed and nears the lower high-yield tiers, that stock price moves a lot. However, since it is very low already to begin with, it's going to have a large percentage impact on these EDFs. There's a lot of volatility in those lower-quality junk EDFs. Moody's has something called RiskCalc PDs. Since acquiring KMV, they only maintain these for the nonpublic market, and that follows the same paradigm. You have to have something that's a proxy for the equity price.

CreditSights is a new player; they have a product called BondScore CREs. This is a hybrid model that does not implicitly use the equity price, but instead uses the size of the market capitalization of the firm, which is the function of the equity price in their models to do some of the same things. They model the balance sheet in a slightly different way as well as using some ratios or various statistics, such as debt to earnings, the volatility of cash flows and things of that sort. I like the idea that it is a hybrid; you have a little bit of one and the other. Then we have some more of the structural models that followed CSFB's model like McKenzie's model and Risk Metrics' CreditGrade's model. They all model some of the data. They leave it up to you to plug your own data into the model and to give a factor analysis. Standard & Poor's also has a risk model where you can plug all your data into that model.

Finally, I'm going to cover one more point—the actual quantification of the diversification. If you just consider the pure downgrade risk, you're going to think that you want to have the ratio of the size or the number of the issues. You would have to have a lot more of the lower credit issues, and that makes sense. If you factor idiosyncratic risk that you would have from the number of issues, it actually reduces your ratio so that you probably need to have four of these junk bonds or the lowest rated investment rated bond to each one of the highest rated bonds. In other words, you need to have much smaller bond positions for lower quality, a fourth the size essentially, for each of those bonds.

**MR. REICHMAN:** We're talking about some of the rating agency constraints on setting credit risks. I was the architect of the capital ratio that we used for life insurance companies. One of the key ingredients in setting the capital that we like to see set aside for credit risks is the recovery rate on bonds, and that was assumed to be 50 percent. That's under review, because it doesn't seem like that's probably a correct number. At the end of the day we may not change it because other things have changed, too. If it all comes out in the wash, why bother? The number of corporate bond credits that are on credit watch today for possible downgrade is about five or six times as high as historically. How is that reflected in liquidity and in spreads? How does that affect some of the things that you do?

**MR. ABBOTT:** As Scott was saying, it's made the market trade very thin and it is difficult if you actually want to move in or out of any sizeable position. You can only do it several millions at a time. There's just very little liquidity out there. To quantify how bad it has been, if you looked at the market having fallen 30 percent, which I think some people feel qualifies bonds for impairment if those devaluations were sustained for a year, 10 percent of what used to be in the investment-grade portfolio would qualify for more than temporary impairment at this point. The impact is huge. I think the other side of the coin is, you've got all of these distressed credits out there and people just don't want to take the loss. They don't want to believe the market is going to turn around for a while. That's really hampered liquidity and may make more credits fall lower.

**MR. HARTZ:** Yes, I would agree with those comments. I'd say that it's a bit of a continuum. I would say even for BBB- credits not on credit watch, people are more concerned about downgrades.

**FROM THE FLOOR:** You mentioned absolute limits are the more contemporary risk control mechanism. I'm not sure what you meant. I was assuming you meant the fixed-dollar limits, but there was something more to it.

**MR. HARTZ:** I was actually trying to make a point. I didn't do as good a job as I'd hoped, in that typically we think about limits relative to the tracking error of our portfolio. We're going to try to get exposures that are somewhat in line with the larger market-weighted issues, but I think when you come down to it, that sort of tracking error and risk that is relative to it is not something that corporate management wants. I was talking more about absolute risk exposure here—not to any benchmark at all. I was trying to emphasize how bad it would be, how negative those returns could be. I think companies need to think more about that risk appetite and it is relative to just the general account. It's relative to your risk appetite and not relative to a benchmark. It's absolute risk. How much are you willing to take? How many losses are acceptable in a normal environment? How much can you stomach in the worst times? If it is more than that, you probably do not want that exposure.

**MR. ABBOTT:** That's pretty natural if you're managing an insurance company portfolio. What are you managing against? You're managing against your liabilities. You're not managing it against some Lehman benchmark. Maybe incentive comp has been set up against Lehman benchmark or whatever, but I think people are rethinking that. They are saying, "What we really care about is how this is performing against the liabilities, which doesn't bear much of a relationship to the Lehman benchmark other than how the underlying Treasury rates are moving."

**MR. REICHMAN:** Nikunj Kapadia is an assistant professor at the University of Massachusetts, Amherst campus. He has worked at Bear Sterns. He has a Ph.D. in finance from New York University and he's also on the editorial board of the *Financial Analyst Journal*.

**MR. NIKUNJ KAPADIA:** I am going to discuss some recent work that we have done with the objective of quantifying portfolio credit risk—the total credit risk of a portfolio that may consist of several credit-sensitive instruments. Often we think of setting limits to credit exposure at the issuer level or at the sector level. But there is probably some common risk across all issuers and sectors, some kind of systematic risk that cannot be diversified. We would like to understand the nature and magnitude of the systematic risk so that we can understand portfolio credit risk. To understand systematic risk, we need to understand joint default risk, or the correlation between defaults. Much of our discussion today is a summary of some of our empirical findings regarding correlations between defaults and how they apply to the analysis of portfolio risk.

Our work uses Moody's RiskCalc database of default probabilities. This consists of a monthly time-series of default probabilities for each issuer starting from 1987. Moody's uses a "hybrid" model to estimate these default probabilities, combining equity market variables indicated by the theoretical setup of Merton (1974) and supplemented with information from financial statements. The database covers almost all U.S. nonfinancial public firms.

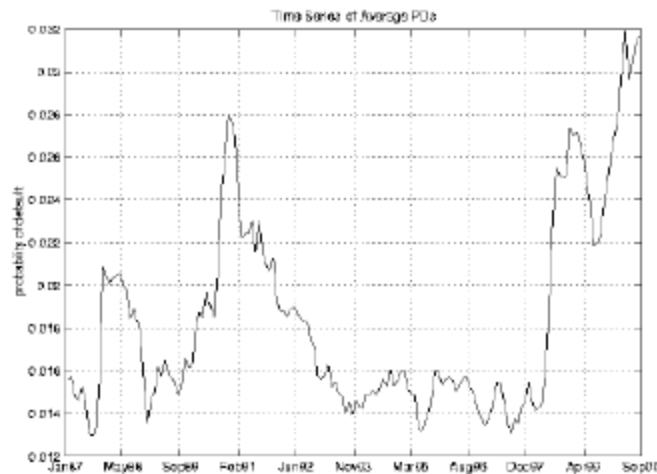
The time-series of default probabilities is useful for understanding the correlation between default risk. If there are common factors that affect default risk across all firms, then we will find that default probabilities behave similarly over time. They will be affected by the same shocks and thus have positive correlations. Examining the correlation between shocks to the issuer-specific default probabilities tells us a lot about joint default risk and thus portfolio risk.

We ask some simple questions. How do the default correlations change over time? How do they vary in the cross-section across different credit classes? Let me quickly summarize some of our major findings. First, we find that correlations vary with the business cycle. In particular, in periods like the present, when defaults are high, the correlation between defaults is also high. In a sense, correlations between default probabilities are asymmetric. Correlations are low when defaults are low, and high when defaults are high. An implication for portfolio risk is that the risk at

the level of the portfolio is affected by both an increase in default probabilities and an increase in the correlation between defaults. Second, when we consider cross-sectional variation across different rating classes, we find, surprisingly, that the correlation between defaults is the highest in highest grade firms—firms that were rated Aaa or Aa. We also find that the correlation of the highest grade firms vary the most over time and are the least stable.

Here are some details of our findings (Figure 2). The graph shows how the average default probability in the economy has varied over time between 1987-2000. As we would expect, default probabilities go up in the 1991-92 recession, are at their lowest levels in the mid-1990s' in the boom years, and then start rising up again from late 1999.

Figure 2



Next, we consider the correlations between these default probabilities at the individual issuer level. Here is how we compute the correlations. First, we fit a simple time-series model to describe the dynamics of the default probabilities of each issuer and thus compute the monthly shock to each default probability. Second, for every pair of firms, we measure the correlation as the correlation between these shocks. We do this for every pair of firms, using the several

thousand firms in our database. We then tabulate the average level of the correlation.

We report the results for each of four sub-periods over our sample period, 1987-2000. We observe that the average correlation changes substantially over each of the sub-periods. In particular, we find that the period in the mid-90s—sub-period III in the table—has the lowest default probabilities, and also has the lowest default correlations. In the last sub-period, when default probabilities in the economy increase, default correlations also increase. These results also suggest that default risk is systematic—both default probabilities and default correlations are affected by the business cycle.

Our finding holds across all rating groups. However, there are substantial differences in magnitude. In particular, as can be observed, the highest-grade firms have the highest within-group correlations. We verify both the time-series and cross-section findings with a principal component analysis, and the results are robust. We also verify the asymmetry in correlations by plotting "exceedance correlation" graphs.

The next question that arises is, if we make the hypothesis that both default probabilities and default correlations are varying over time, how should they be modeled so that we can actually implement a portfolio risk model? The main feature of the data that we want to capture is that correlations are asymmetric, in that they increase with the mean default level of the economy. To model the business cycle, we consider a regime-shifting model with two regimes. We estimate the model using the mean default level of the economy and find a good fit. The two regimes correspond to a low and a high default, as we would expect. Now, using these two regimes, we can estimate the default process for each issuer, allowing for a different correlation in each regime.

We use the model to illustrate the differences in the correlation structure across the two regimes using a "heat map." As an illustration, we take 100 firms in each rating class and compute the correlation for each pair of firms. We then color code the correlation, with the reds signifying high correlations and the greens signifying low correlations. The lower half of the graph plots the correlations across all these firms in the low-default regime, and the upper half in the high-default regime. We see a striking difference in the amounts of reds and greens across these two regimes. The high default regime has significantly more "hot spots" that indicate high correlation of defaults between groups of firms. The same sets of companies in the low-default regime have much lower correlations. Also, when we compare these heat maps across different rating classes, we can see that there are more hot spots within high-grade firms than within medium or low-grade firms.

The regime-shifting model can be used to model default risk in a portfolio. The distribution of defaults when we account for regime-dependent correlations is different than when we assume zero correlation or constant correlation. The time variation in correlations results in fatter tails in the distribution of defaults—the total

number of defaults in the portfolio are either much higher or much lower as compared with the other cases.

In summary, we make the following observations. First, default correlations are unstable and vary with the business cycle, increasing as defaults in the economy increase. Second, there are cross-sectional differences across rating classes, with the highest-grade firms showing the highest correlations. Third, there is significant evidence of systematic risk that affects all issuers. Both default probabilities and the correlations of defaults are sensitive to the business cycle.

**MR. JASON S. STEIGMAN:** So the implications for portfolio management, if I understand it correctly, is that when you're in a time like this where correlations are high or getting higher, then you can diversify up to a point. However, diversification doesn't get you much beyond a certain point because everything is correlated?

**MR. KAPADIA:** That's right.

**MR. STEIGMAN:** Wouldn't that argue that this is the time to pick the credits you think are going to come back, because when the economy gets better you're cutting off your upside by the more you diversify?

**MR. KAPADIA:** The implication is simply that we cannot diversify risk beyond a certain limit. However, these results do not tell us about how the instruments are priced. To do that, we would have to have a model that links the incidence of defaults to the pricing of default risk. Without such a model, your question cannot really be answered. However, it is an interesting question and precisely where more research needs to be done.

**MR. HARTZ:** We have this debate all the time about diversification versus return. Of course, senior management would like to be extremely well diversified and have superior returns. You can't have both. You can be perfectly diversified and get average returns, so there's got to be a balance. Your point was, in an environment when there's a lot of risk and spreads are wide, there's probably a good chance to add excess returns. If you're perfectly diversified, again, you're just going to get the average return and so maybe you do take a little more risk in that environment. However, risk is two-sided, I guess, so it could work out or it could not.

**MR. ABBOTT:** You still need to have the fundamental research that's linked to this because certainly on our team they have names that they really do not like. They're not going to go into those. They have those that they would like actually to put on larger positions, but they don't want to exceed the limits that they've established for the purpose of diversification. I think there's a balance. If you have a larger strategic expectation, you want to put on a heavier weight in that asset class, but ultimately security-specific returns are going to drive additional performance in the investment portfolio.



**MR. REICHMAN:** Nikunj, some of the questions that you may not be focused on, not being in the actuarial profession per se, I think have some implications for us even in terms of some of the asset/liability management issues, because they really seem to raise questions about some of our cherished assumptions about covariants and how many things go wrong at the same time. I also would like to suggest that it implied to me that we should think of setting credit risk limits as something like flying a plane. There are various stresses on the system, and if one thing goes wrong, it creates the likelihood for others to go wrong. We obviously will not get to that point hopefully, but I thought it would be very interesting, and it will be very interesting following up with you.

Hal Pedersen has been a professor of actuarial science at the University of Manitoba and at Georgia State University. He's currently a principal at DFA Capital Management and he works on credit risk and financial modeling. He also has a Ph.D. in finance and master's and bachelor's degrees in math and actuarial science.

**MR. HAL WARREN PEDERSEN:** I'm going to try to give you a quick overview of the way our firm looks at some of these credit risk issues. Our firm uses a DFA tool. We look at the overall asset allocation across different asset classes. We have a model that allows us to model the entire firm or just the economic portion of the portfolio. We've had some discussion from the other panelists on investment returns, and Nikunj gave us an excellent overview on default risk. The real problem comes when you try to put it together. When you look at default risk and pricing and try to get some reasonably realistic simulations that allow you to look at what may or may not happen to your firm and also try to pick up some of the market risk and systematic variation that we're bound to see, it is a challenging problem. Putting that all together involves a number of steps. Certainly, you have to have linkages among your assets. We have a number of investment and insurance variables that we use. Even though we're talking about credit risk, these are all relevant because a large firm is not going to look at the performance of a hypothetical junk or high-yield bond portfolio in isolation. You're going to want to look at what that does to all your RBC. You want to consider if those assets move together or not. You need to make some allowances for what's going to happen to your overall firm performance as you change your credit risk limits.

In our system, we have most of the assets that you'd want to include: obviously, treasury bonds, corporate bonds modeled with different ratings, agencies, munis, some mortgage-backed securities, real estate and equities. We've also got some foreign exchange and other related models, which, since we'll just stick to the U.S. market, we don't need to go into, then some insurance variables that are relevant on the other side. That's all put together, generally speaking, as follows. At the apex of the model is our Treasury model, which feeds into the other pieces of the system. Ultimately, we produce our nominal asset returns, which at the end of the day on the investment side is the key thing to get right. We have to get asset returns and the correlations between them moving correctly.

I will give a quick description of what goes on in this artificial economy. We allow for the joint distributions of dynamics. We'd like, as far as possible, to get tractable equations, not just for simulation, but also for estimation. The more you can get your hands around the estimation, the more likely you are to be able to get realistic returns and realistic economic scenarios. We have found, through a process of actually having a hard-coded estimation algorithm and a tool for validating the simulations, that we can get a lot closer to the real data. If you can't get close to the data, then, of course, all these analyses are not going to have a great deal of value. We apply various mathematical techniques, including some stochastic differential equations and some econometric models, while always making sure that these linkages reflect, as far as possible, what we think the reality is. Of particular interest for our discussion today is what we do with corporates. We have a model that relates the spread to Treasuries. As part of this model the rating transitions evolve, which as we've already seen, is going to be a key part of this. Those rating transitions should reflect a benchmark, either the S&P studies or the Moody studies or both. These studies are very similar. If your corporate bonds are not modeled in a way that reflects how they actually move in reality, then you're not going to be able to take Scott's advice on getting out early or marking your NAIC ratings and all the things that come into play when you actually try to implement any sort of investment strategy.

Just to give you an idea of what this model ultimately looks like, I'll discuss a set of actual yields for AAA bonds. We have a yield curve underlying the model in the Treasury market. We get some dispersion around the mean. As we move out through time for high-yield bonds, the dispersion gets a little bit wider. The model has individual bonds running around in it, and as part of that we have to pay some attention to the correlation of how the bonds in a rating class move. That allows us to get into the portfolio and do a little bit more with a company's asset allocation.

As we move down in rating class, of course the spreads are going to widen a little bit and the yields are going to go up. We're now looking at BBB, the lowest investment grade bond. If we go down from BBB, we've now got high-yield bonds. Here we have some outliers. Those aren't normally going to be nice if we bought them when the yield spread was lower. We want to see some activity like these outliers, but we still want to reflect some historical reality on where the yield spreads are. That gives you an idea of what's going on behind the covers on the model.

If you run out a simulation with bonds of different maturities and different rating classes after some period of time, then you can slice the system and look at the yield spreads. This is not that different from what you've seen in real data and looked at studies by Moody's, S&P or any of the major ratings firms. You'll see that at any given time you'll have a general tendency to a slope in the yield spreads and you'll also find that the yield spreads for bonds of different rating classes overlap. You could have a bond rated A that has a higher yield spread than a bond rated BBB. That's not an arbitrage opportunity or a contradiction. That is simply an

economic fact. But you ought not to see a whole lot of spreads dominating one another in the wrong direction.

As Nikunj, Scott and Mark emphasized, one of the key things that's going to determine the returns on your portfolio is your defaults. Certainly high-yield bonds at issue have a high yield. If your model doesn't pick up the defaults, then high-yield is going to be a great asset class. If, on the other hand, your model has too many defaults, it's going to be a poor asset class. The trick in this whole thing is to get your model to reflect high defaults at times, low defaults at other times and to come out with what you believe is a reasonable calibration to the data.

A lot of defaults have occurred recently, so our latest calibrations have increased defaults. On the high-yield bonds, we have in these illustrations a relatively favorable calibration for the high-yield class. Of course, if we run out even more simulations, this might settle down to something closer to the median. This is a critical part of any simulation involving corporate bonds, because if these things aren't right, then your returns are going to be out of whack.

Scott mentioned WorldCom's bond. I thought you might find this interesting. We did a rating history and price history for WorldCom. Things started to fall apart in May 2002. As Scott mentioned, if you had the foresight to get out when the downgrades began, you still could have done pretty well. In fact, when we looked at this it seemed to me that Standard & Poor's gave plenty of warning, but if you hung around to the last quote, it was at about \$15 in June 2002. If you had that bond in your portfolio that certainly wreaked some havoc. Downgrades like this are difficult to model because they are sudden, dramatic events. One way you can do it is to use some sort of systematic market risk parameter. You are also going to have idiosyncratic behavior in the way your bonds evolve. Recently we've seen both market forces and an idiosyncratic behavior effect in firms like WorldCom.

Look at how the volatility has increased in the last few years. If you are trying to model something like this, it almost looks like an unstable process. It also looks like the volatility is growing without bound. There are ways to handle this, but if you are a high-yield portfolio manager, I wonder how this ride has been, so to speak. What does an average mean when you have that kind of volatility? You can certainly look at the average default rate, and if you're going to calibrate your model to the history, you have to get that average default rate right. You must also have a lot of systematic variation in default rates, otherwise you're not going to pick up the types of cycles that we've seen in each of the previous presenters' work. It's interesting to see just how big that default rate spike was in the early 1990s. We have yet to see what ultimately happens in our current environment. If default rates begin to go down, then we'll see those superior returns that high-yield managers are obviously hoping for. If it doesn't go down, then things aren't going to improve for some time.

I'm not a believer that it's easy to do any predictive sort of modeling with this. The

best you can do is to use this to give you some general guidelines on what different credit allocations are going to do to your portfolio.

The thing to emphasize is you've got to incorporate default rates correctly and you're not going to be able to deal with these nondiversifiable components using average default rates. Clearly, we have to have wide variations in default rates and if you have a high-yield bond yielding 14 or 15 percent, if you don't get the default rate somewhere close to what the economy should support, your predictions are going to be well off. No matter how good you are, you run the risk of a lot of model error. That's just a fact of life.

You can also, and I think this is an important part on any analysis on credit risk limits, look at what happens to your company in a holistic fashion. One of the things that we do is we look at what we call your distress probability, which takes into account all your lines of business, all of your asset allocations, and then we look at how frequently along each path you actually hit your RBC limit. Certainly nobody wants to ever hit their RBC limit, and exactly where that limit should be is a matter of some question, but in this particular simulation your mean investment returns go up as they ought to as you allocate more of your funds to junk. There is a dramatic increase in standard deviation as you get up to 50 percent in junk. Initially your distress probability goes down a little bit. That's consistent with some of the things Scott was saying where you get a little bit extra yield, and if it's managed correctly, it may even have some diversification. Of course, your RBC constraints begin to go through the roof, and although a 50 percent allocation to high-yield is not realistic, this gives you an idea for this parameterization of what's going to happen. I don't think a 5.5 percent distress probability is realistic as a deliberate strategy. I don't think you'd want to set up a portfolio like that, but that's just a benchmark way of looking at it. Of course, your mean investment return is going up, but your defaults are picking off a good bit of your portfolio as you go.

If you are going to calibrate high-yield models, that's going to be a very challenging task. One of the biggest difficulties and one of the most important things to get right is the correlation in defaults. If that's not addressed in a reasonable fashion, you immediately bias the attractiveness or lack thereof of a high-yield bond portfolio. Certainly, the erratic nature of the returns on high yield is going to require a careful interpretation of your model inferences, and in some cases, I would be more comfortable recommending overall stress testing rather than trying to assign probabilities to exactly where your high-yield portfolio will take you.

My personal opinion is that without proper care, many of the nondiversifiable aspects of high-yield bonds make this a fairly dangerous asset class.

**MR. ABBOTT:** I was wondering if you had any sense of what percent in high yield would give you an equivalent distress probability? What would its enhancement of the return be?

**MR. PEDERSEN:** That was a fairly small simulation, so I'm not sure how much sampling error there's going to be. I didn't include all the different percentages. I did run 20 and 30 percent allocations to high yield. I think around 15-20 percent is where we found the thing to begin to come back up, but to do that properly you need to run more paths than I did.

**MR. REICHMAN:** Your own model is an ongoing work. I can speak only, of course, from the rating agency from Standard & Poor's perspective, but I suspect a lot of the same things are going on at our competitors. The speed of rating changes has increased, and it's clearly been targeted by a lot of different audiences as something that's important. I think that's going to have some effect on some of the results we've looked at today. I can also tell you that there's a feedback loop. We are planning to start incorporating a daily watch of spreads to trigger potential rating changes; sometimes the market is more alert to something. That's going to be one of the key benchmarks that we use. Last, your own ability to do this work is a function of how much time you need to spend talking to your boards about credit risk.

**MR. DAVID J. ECHEVERRIA:** With respect to spreads, that was an interesting comment because using just plain rating agency ratings is somewhat limiting. You keep hearing the word bifurcated market, that they're a bunch of A's, but they're completely across the map. Can you comment on any effect the credit derivatives market or any kind of speculation effect it's had on the market in general? It's obviously increased volatility. If you're using spreads, that's basically because people are going short the market. Would you say that's a good predictive factor or we just don't know right now?

**MR. REICHMAN:** I'd say from our perspective, we're not sure yet if it's a good predictor factor. We think there's definitely something there. I'll tell you, our concern to rating insurance companies has been more of what sort of risk they've taken from some of the derivatives they've written, particularly default guarantees. That's probably going to be more of a trigger in changing ratings of insurance companies. I don't think we are capable of telling you what the overall effect on the market would be, and I would turn that over to some of the market people.

**MR. ABBOTT:** I think that it's certainly added to some of the liquidity in the market. Guardian has been evaluating entering the credit default swap (CDS) market, but we're thinking about doing so defensively. Ultimately I think if you were using it to get this credit exposure by selling CDS, you could certainly get access to smaller names and perhaps enhance your diversification benefit by doing so. I don't think that insurance companies have entered the market as largely as the banks have at this point in time. CDS is not used by more insurers because they have shorter tenor than corporate paper and unattractive loan restructuring provisions common to bank loans since they were developed by banks to hedge their counterparty loan exposures.

In terms of spreads, we use them for early warning signs. When a credit default swap all of a sudden becomes much more active in terms of the volume, we're aware of it. We have the analysts looking at these factors to reconfirm their own belief. We'll use the quantitative credit models, putting those in front of them, whether they're information about spreads from Lehman and the changes that are occurring there, or the actual default probabilities from some of the quant models. We treat them all equally in terms of weight.