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Session 71PD
Expected Investment Returns

Track: Investment

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Summary: This session provides an update on where we are in the economic cycle as well as recent experience. Participants learn about recent experience defaults, prepayments, spread gains/losses and equities by major sector. Given the current economic environment, panelists discuss how actuaries from all areas of specialization might set expectations for long-term returns on various asset classes. As a result of this session, attendees get a current picture of the consensus view on the investment environment. They are better prepared to set and to hedge expectations for returns by asset class.

MR. JOSEPH KOLTISKO: My name is Joe Koltisko. Welcome to "Expected Investment Returns." This is a timely topic because there's a lot of enthusiasm among actuaries today for stochastic risk projections. But this sort of enthusiasm sometimes crowds out a discussion about how to make better business decisions. Risk is easy and returns are difficult. I think part of the reason is that we have an unproductive controversy over fair market values. Specifically, well-intentioned people disagree about the relationship between realistic investment returns and stated liabilities for pensions and insurance. This controversy is unproductive because both sorts of analysis have their proper place. How many people believe, first of all, that expected investment returns have no place in the valuation of a pension liability or an insurance liability? On the other hand, how many people feel that market values of insurance products or liabilities are irrelevant or

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immeasurable? A solid, brave group has replied. Basically I think both market values and expected returns have their place. The reason is that investment trades and hedges can be transacted only at market prices, so any valuation of insurance or pension liabilities for that purpose has to use capital markets assumptions: that is, they imply risk-neutral and arbitrage-free methods, the sort of models that traders use.

And yet no models can be calibrated to next week's market value. For strategic decisions, today's market value is less useful than a point of view or a model for how and why such values change, and this is why actuaries care about expected returns in financial markets. To be useful, such a model ought to be grounded in macroeconomic relationships, rather than being a snapshot of what the value is. I think it's more effective for us to have working models that behave like the animal we're trying to measure. With such models, we can have a sound basis for communicating about risk and returns. We need to project investment returns in order to recommend asset allocations and to report GAAP income. Pension practitioners are interested in revising asset allocation targets for their defined benefit plans. Life Product Development actuaries are concerned about sources of profit and the level of flexibility that they expect in nonguarantee elements. To do this, one has to start with an expectation for returns in various asset classes.

Today we have two distinguished guests. We have John Ryding, who is the chief market economist for Bear Stearns. He's been with Bear Stearns since 1991, and prior to that he was with the Federal Reserve System and the Bank of England. We're going to hear about current market conditions, news for the future and tools for looking at expected investment returns. We'll also hear from Richard Urbach, who is a senior principal with DFA Capital. Richard has been an architect of the financial model that his firm uses with their insurance clients, and we'll hear about the mechanism they apply to model expected investment returns.

MR. JOHN RYDING: As we approach this topic, I am reminded of the old joke that economists were created by God to make weather forecasters look good. Right now we are extremely uncertain about what the Fed is going to do when they meet next Wednesday (November 6, 2002) and what the numbers for employment and manufacturing will look like when they come out on Friday morning, which will set the stage for that meeting. So it seems daunting if not impossible to step back and ask, if we have so much difficulty trying to project whether the Fed is going to cut rates next Wednesday, what kind of sense can we make of the future? The long run surely is more uncertain than the period immediately ahead. However, that's not a perspective that I agree with. I think actually as you go further out in time, the noise around any current event in a statistical sense diminishes, and the dominant trends in the data or the economy emerge. I think that we can say some useful things about those trends. Just simply thinking about the overall structure of the economy will help us in terms of thinking about what we have seen in the past 10, 20, 30 or 40 years or whatever time horizon in which we calibrate statistical models of investment returns, and about

how they may be misleading or how they may break down.

Now, at Bear Stearns we are starting to think about some of these issues in the longer term and getting away from day-to-day. I'll talk about those longer-term trends, although people may be more concerned about what happens next week. We'll start there. The present does matter, and I want to talk about that, because whatever future average bond yields and dividend yields may be, we have a starting place, and the starting point that we are at is already a very abnormal one. It's abnormal in that we are coming out of a recession. I think we've been coming out of it for a year now, which is an extremely unusual recession, one that has no counterpart in our experience in the last 50 years. So right off the bat, we have a problem in how to think about it. The point I wanted to make was that this was an extraordinarily unusual recession, one in which the consumer and particularly the consumer's participation in the housing market was very untypical of a recession. Actually home sales were at record levels last year, consumer spending continued to grow, and that wasn't normal for a recession, because the recession was a business- and capital-spending-generated recession. It was a downturn in corporate profits that really brought about the decline in capital spending, combined with the implosion of the dot-coms and the decline in corporate capital spending as technology spending dropped.

It seemed that this year would be a year of very sluggish recovery. We're not going to get an immediate bounce back in the housing market because it never went down anywhere. The typical driver of the V-shaped recovery and a consequent strong rebound in interest rates (that is typical of recovery) would be absent, so we have to bear in mind that that is the starting point. We also have to bear in mind that the pessimism that surrounds the current economic situation may well be a poor guide for what happens over the next decade. This recovery is the second slowest recovery in the first year of any recovery from a recession since the end of the Second World War. The slowest recovery was the recovery from the 1990–91 recession, and if we think back to the attitudes and feelings of people at the time, there was a very low level of national self-esteem and the economy was very weak. Consumer confidence numbers were much weaker than the weak data that were published just minutes ago in the consumer confidence survey for October, which dropped sharply. I don't think that people could have imagined the 10 years that lay ahead of them in terms of both the rise in the equity market and, of course, its fall over the last 2½ years, as well as the decline in bond yields. I remember when I started at Bear Stearns back in 1991, people were very disbelieving of our forecast that bond yields could fall to 7.5 percent in a 30-year Treasury market, whereas now people can never imagine seeing 7.5 percent 30-year Treasuries again in their lives.

So we have to look and think about long-term regularities. We have to look at where we are in trying to build a bridge between the two, and that is not something that we can do very easily and certainly will not be able to do perfectly. To talk about those longer-term regularities, let me begin with what I think should underpin

our long-term views of the economy. We should not worry about short-term demand-side considerations, whether the consumer will double dip, how quickly or not corporate capital spending will come back, and what the shape of the inventory cycle looks like at the present time. We should instead go back to the economy's capacity growth, and the root of that growth and the root of returns in all capital markets is productivity. From the mid-1970s to the mid-1990s, we went through a period of extremely low-productivity growth. Productivity growth averaged less than 1.5 percent per year, and apart from the spikes that briefly followed the recessions, productivity growth was very low. We came into the mid-1990s, therefore, with 20 to 25 years of diminished expectations of the economy's capacity to generate productivity gains. We spent the last seven years witnessing a rather dramatic acceleration in productivity, one that continues today in the face of what is a relatively sluggish recovery, a pretty strong rebound in productivity.

When we get the productivity data for the third quarter of this year, which we'll get in a week or so, we will see that productivity growth exceeded 5 percent. That means output per person employed or output per hour worked is 5 percent higher than it was a year ago. So I think the first thing that we need to take into our thought process when we think about long-term investment returns is what the real rate of return in the economy is going to look like. Financial markets do not exist independently of the real economy. Of course, the reverse is also true, but the productivity gains underpin, I think, the underlying real interest rate, the underlying real rate of return on capital. I believe that we'll see something like a 3 percent real productivity growth rate over the next decade or around double what we saw from the mid-1970s to the mid-1990s. To the extent that productivity gains are going to remain elevated as we go forward, we need to think about that in terms of considering where underlying real interest rates need to be for both short-term rates and conducting Fed funds policy and also where the market is going to put long-term yields.

One of the interesting features of the last year has been the dramatic fall in real yields in the 10-year Treasuries. The 10-year TIPS measure where yields have come down; at one point the 10-year yield was down 3.5 percent a few weeks ago. Those long-term real yields had dropped to 2 percent on the 10-year Treasuries, completely inconsistent in my opinion with the economy's capacity to generate productivity gains over the next decade.

Along with productivity growth, we need to add a much simpler component, something that is much easier, labor supply growth. To a large degree that's demographically determined. Productivity is much more economically determined and much more variable. You put the two together, and the outlook for labor supply growth based on demographic projections is, at least for the next 10 years, something like 1.25 percent. Add productivity gains to labor force gains, and you end up with potential gross domestic product (GDP) growth. Now, there's a slight twist in the story in that the productivity measure is nonfarm business productivity, and, of course, productivity gains are weighed down by sectors that are not in the

business arena, such as the government, which typically don't display this kind of productivity gain. So the whole economy productivity growth rate is somewhat less than those numbers that we were looking at, actually more like 2.25 percent. You add the 2.25 percent gain in expected productivity to the 1.25 percent increase in expected labor force growth, and you're going to end up conservatively, I believe, with real GDP growth over the next decade of 3.5 percent. Now, in the midst of our concern over double-dip recessions, 3.5 percent is not too bad. Maybe to some people it sounds hopelessly optimistic, but if you look at this chart, which looks at GDP growth by decade going back to the 1940s, you will see that GDP growth over a 10-year period displays remarkable stability. In fact, over the last three decades it's grown at 3.2 percent per year in each decade. When you consider some of the past disastrous policies, including the unleashing of inflation and high taxation and overregulation in the 1970s, and think of the great improvements we have in those at the present time, maybe 3.5 percent isn't such a hopelessly optimistic outlook for the next 10 years. Maybe it's actually quite conservative. I believe, when I come to my long-term projections, thinking about the 3.5 percent gain in real GDP over the next decade has been the first factor in thinking about long-term returns in the economy.

Now, of course, to any real gain we have to add inflation, and, of course, maybe we have to subtract. People seem to be worried about the "D" word, deflation, these days. I'm not. We can talk a little bit about that. If you look at inflation, inflation experience has been much more variable by decade. It's been as low as 2.1 percent per year in the 1950s, when monetary policy was relatively well run. It was as high as 7.8 percent on average in the 1970s, when not a single good thing could be said about monetary policy except that it led to Paul Volcker's taking over the Fed in 1979. So this variation in inflation tends to tell us that the nominal components of investment returns, expected components—by nominal I mean real plus inflation—may be much more variable than the real return components, and, of course, that's a great problem. I think that markets and capitalism and everything else work best when the monetary authorities deliver a pretty low and stable outlook for inflation, something approaching price stability. I think it's interesting that the debate about deflation has really picked up. It's picked up only because we're looking at a sustainable inflation rate that's lower than any in our personal experience, so we worry that if we don't have inflation, then maybe we'll get the opposite of inflation. But I think we've had only one period of deflation, at least in the United States, in the last 100 years. That was a product of an enormous monetary mistake, never to be repeated, by the Fed in the late 1920s and early 1930s.

A story of inflation was one of variable inflation rates rising through the early 1980s. Finally the United States could no longer take the pain that inflation was producing. They brought in decent monetary policies made in the form of Volcker and Greenspan, and for the last two decades we have been in a period of disinflation, which is to say a declining inflation rate. Now, of course, with the rises and falls of inflation go the rises and falls of short-term interest rates, the Fed funds

rate, which is their prime policy interest rate. When inflation and the funds rate were fairly close together, as they were in the 1960s and 1970s—which is to say that the Fed did not run up interest rates to offer a high enough premium over the then prevailing inflation rate—inflation tended to rise. In other words, the Fed kept interest rates artificially low. To do that it would have to create liquidity, and the liquidity creation fed the inflation beast.

In the early 1980s, in order to reverse the inflation trend, the reverse was true: Fed funds had to be kept unusually high in relation to inflation in order to squeeze out those inflation pressures. There was a wide spread between inflation and the Fed funds rate that the Fed operated over the last three or four years. This was a period of exceptionally tight monetary policy, and the Fed was telling us all the way, because of the decline in the unemployment rate and the shrinkage in the unused capacity in the labor market, that that posed an inflation problem, but in reality the Fed was running tight monetary policy producing a sharp drop in inflation, creating these concerns about potential deflation. But the Fed has, in my opinion, addressed those issues by finally waking up last year and cutting interest rates dramatically. Now, a 1.75-percent Fed funds rate is abnormally low. It's even abnormally low in relation to the inflation level that we have for the long term. Short-term interest rates are inevitably, whether or not the Fed cuts rates next week, going to have to come up.

Briefly, on the deflation issue, I see no evidence of deflation. My primary indicators in terms of tracking the outlook for future prices are things like the price of gold, the price of commodities, and the foreign exchange value of the dollar. These markets are very sensitive to variations in liquidity and monetary policy. The deflation risk was present last year as gold and commodity prices were falling sharply, and it got to a point where gold almost fell below $250 an ounce. At the present time, gold is around $315 an ounce, posting a decent rebound.

Commodities are up year over year; the Commodities Research Board index valuations are up about 20 percent. The dollar has come off its highs and then stabilized. None of these indicators are consistent with a serious deflation risk. At 1.75 percent, the Fed funds rate appears to have troughed. Now, if I'm wrong, if those indicators start to move south, then in the short term that deflation risk can and will be addressed by the Fed with a dramatic cut in interest rates. This is why, regardless of what the Fed will do next week, I prefer the Fed do nothing. Whatever is holding the recovery back, it's not an absence of high-powered liquidity; it's not too high a Fed funds rate. For the longer term, if they took interest rates too low at the present time, the Fed could threaten these gains that we've had in the improvement of the inflation outlook. I think for the next 10 years—and it's about what's priced into the 10-year Treasuries right now if you look at the spread between the real Treasury rate in the TIPS market and the nominal counterpart in the conventional 10-year Treasuries—that the outlook for inflation will be somewhere around 1.5 percent per year. Now, that would be an extraordinarily low

inflation rate. It would be the best decade for inflation that we've had.

What makes the real gains real is that, if inflation is higher and nominal rates end up being higher, then that comes with some possible increase in pricing power (unless you were caught by surprise in the change of inflation). People talk about companies not having pricing power because the inflation rate is low, but when companies had supposed pricing power in the 1970s, it was a disastrous time for them because they had pricing power with no control over the cost. In other words, they felt they could raise the prices and consumers would pay those higher prices, but at the same time their suppliers and their labor felt they could also raise their prices, and the company would pay the higher costs. So pricing power to some extent, if it comes from inflation, is an illusion, and the same is also true of investment yields.

You might ask, when I talk about the early 1970s, thinking about a 30-year Treasury yielding 7.5 percent, that if we were in that environment, how many problems would it solve. But at the same time people would demand higher future payouts from whatever contracts they entered into to compensate them for that inflation, and, of course, the one winner in an inflation scenario is the government, because the government has an awful lot of hidden taxes in the economy that come out of inflation. We write about and talk about and deal with markets as if taxes don't exist and add and subtract bond yields and inflation rates. My experience of April 15 for every year I've been here since 1991, and the reality for most of us, is that government is perfectly happy to take its unearned component of interest rates or stock market gains or whatever. The taxes don't exist as a system, just as an index for inflation on the investment return side. As a consequence, a given real rate and a higher inflation rate are a deadweight lost to the private sector, because the government has a bigger real tax take. Those issues matter to me.

In this framework the picture of the economy that emerges for the next 10 years is real GDP growth rate of 3.5 percent, a responsible Fed, a 1.5 percent inflation rate, getting you to something like 5 percent nominal GDP growth, maybe a little bit less than that, maybe a little bit more. That roughly is where I would expect the 10-year Treasuries starting point to average. Usually when you find investors are cheated and the bond yield is set too low because they misperceived the future inflation environment, then inflation tends to rise and the situation is unsustainable. Similarly when yields on bonds have been excessive but there is normal GDP growth, you tend to depress economic activity or inflation tends to come down. So I think that a useful benchmark is that where nominal growth is going to be, roughly where the intermediate Treasury is going to be.

We then have to move on. You see here the real TIPS yield. From the starting point, where we are, how do we get there? As I said, we have only five years of data on the real yield. With this we can observe, from the 10-year Treasury market and from the TIPS market, that with the advent of recession those real yields have

declined. The curious thing is in recovery. After what was an encouraging rise in real yields, those yields have declined and then posted a little bit of a rebound. The problem is, we're thinking about a target 5 percent Treasury yield with a 3.5 percent real yield, but we're starting with a yield that's 100 basis points lower in real terms. In order to get to those target yields, we're going to have to experience capital losses. So the yield is going to be higher, but the starting point that we're at is abnormally low.

There is, of course, another scenario, one that should be considered: the United States is Japan. This story that I have of 5 percent Treasury yields and rising real yields is nonsense, and we are in the midst of the bursting of a bubble so great that it's going to drag the economy down for the next 10 years. The Fed is going to repeat the policy mistakes that the Bank of Japan made and allow deflation to set in. That's the horror story that we're all worried about, but I would put to you a number of things. The speed with which the Fed acted over the last year has shown that they won't make that deflation mistake. They are fortunate to have the experience of Japan to look through. They write academic papers saying we don't want to make that mistake; the problem with Japan was that they didn't act quickly enough. We have much more flexible markets, labor markets, capital markets. I think a lot of things are different.

Of course, everybody wants to look at Japan and argue back to the United States. So we have the current fixation about an alleged bubble in the U.S. housing market that I don't think exists at all on a national average level. It may exist in regions, but nevertheless, if we are Japan, it's an enormously different story, one I would not put even as high as a 5 percent probability on, but nevertheless it's certainly an option to be considered. No statistical model would produce robust results between the story that I told for the United States, and a rerun of Japan's experience of the last 10 years. Again we see the same picture. You see where we are, with abnormally low Treasury yields. As we go forward we think about this. It means that our gains in the bond market much more are going to have to come from coupons and reinvestment rather than capital gains. If we are at the decade, two-decade or three-decade low levels in Treasury yields and if we're not Japan, then there's no room for bond yields to fall sustainably further. They have to rise, and that's something we need to think about.

Then, of course, there's the issue of risk. If you were a corporate borrower, you would not have experienced the declining borrowing costs that the Treasury has experienced, because we've seen these extremely wide credit spreads. To put it another way, we were last at a 4 percent 10-year Treasury yield, about where we are now, in the very early 1960s. If you were a borderline investment-grade corporation such as a Moody's BAA-, Standard & Poor's BBB-rated corporation back in the early 1960s, you could have borrowed long-term money for around 5 percent. Right now, depending on which company you are, the average bonds are yielding somewhere between 7.5 and 8 percent. It's an enormously different experience. As we go forward, if we have the recovery story that I tell, credit risk

eventually will be better borne by the private sector, and thus threats decline. The nominal yields on corporate bonds may not rise very much, may not even rise at all in a higher Treasury rate environment, because there is already so much cushion on the spread. Under the alternative scenario, we're Japan and credit risk remains extremely high, and the yield provides a very poor guide to returns because of ongoing concerns about bankruptcy and downgrades. I think that we have to see that many things about our markets right now are exceptional, and the degree of corporate risk that is priced in is exceptional. For now it may be warranted, but as we go forward, we're going to have to get some kind of mean reversion in credit risk as we have probably a slightly better than average decade as we go forward for the economic environment. The only thing I suggest is you don't hire two Nobel Prize–winning economists and a crack team of Wall Street traders, mix in leverage, and try to play that game. We tried that in 1998 with not-too-successful results.

Then, of course, you have the equity market, the ultimate expression of risk, and I can offer you some alternative thoughts and hope. I don't know how relevant it is necessarily to the group here, but maybe the equity market has finally become cheap as a consequence of a decline in prices and improved fundamentals and the drop in bond yields. I use a very simple version of a model that's become popularized, the Greenspan model. You simply take the level of corporate profits, divide it by the 10-year Treasuries to see what level of the equity market that implies, and then compare it with where the equity market is. Now, this is total equity market including the effect of funds data. It is economic profits as reported by the Commerce Department, so it's not based on the companies' financial reporting and any gains that may have been played there. It's based on IRS data, and combining that put the market back in late July and again two or three weeks ago at the biggest discount to that calculation since the late 1970s. Although it may feel like an absolutely terrible time to contemplate investing in the equity market, it may be that that is where some of the better longer-term rewards are to be found. Real rates move higher as the rate of return on capital rises, then inevitably going hand-in-hand with that is likely to be a better-performing equity market, and that is something that all investors need to think about.

One last thought before I use up my time here: That it is only as good as the economic fundamental story. If profits are going to decline, if inflation is going to take off, if there's some other horror story out there, then, of course, looking at where we are in the present and tying it with current interest rates makes little sense. To recap the fundamental story, I think it's very important to track the share of profits in the economy. It really tells the story of the problems that we had in the last recession, as that very tight episode of monetary policy that I showed (with the spread of the Fed funds rate over inflation) took pricing power away from corporations, although we had those great productivity gains. As the labor market got tighter and in some sense labor gained pricing power, companies passed on the productivity gains too much in the form of higher wages and ended up experiencing a profit squeeze. The recovery and ultimately the longer-term performance of the economy depend upon a rebuilding of those whole economy profit margins. Right

now, again, we are at relatively low levels of profits as a share of the GDP. I would expect that profit share to rise. It won't be an easy rise, but to the extent that we maintain strong productivity gains, which I think we will, then labor can experience improvement in real wages, although maybe not quite as fast as productivity is rising. Corporations can rebuild those profit margins, so I think that will also be a part of the diminishment of corporate risk.

I'll finish by saying that thinking about the long-term story is something we're doing in a longer-term piece that we hope to publish in the future, which ties in with what some of our people in the financial modeling and bond area and so on will add. Thinking about the economic story is very important, but I think the long-term regularities are much more predictable than what's going to happen next week or next year. And with that I will hand it over to our other presenter for his insights.

DR. RICHARD M. A. URBACH: I guess you all have an interest in hearing what the future holds for us. I think I can safely assume that you are faced with the problem of analyzing your business in the context of an uncertain future. This is more of a "how to do it" presentation, rather than a view on where we're going and why. I am here to talk about how we've created realistic distributions for possible economic futures, which we can call an artificial economy. We've nicknamed it GEMS.
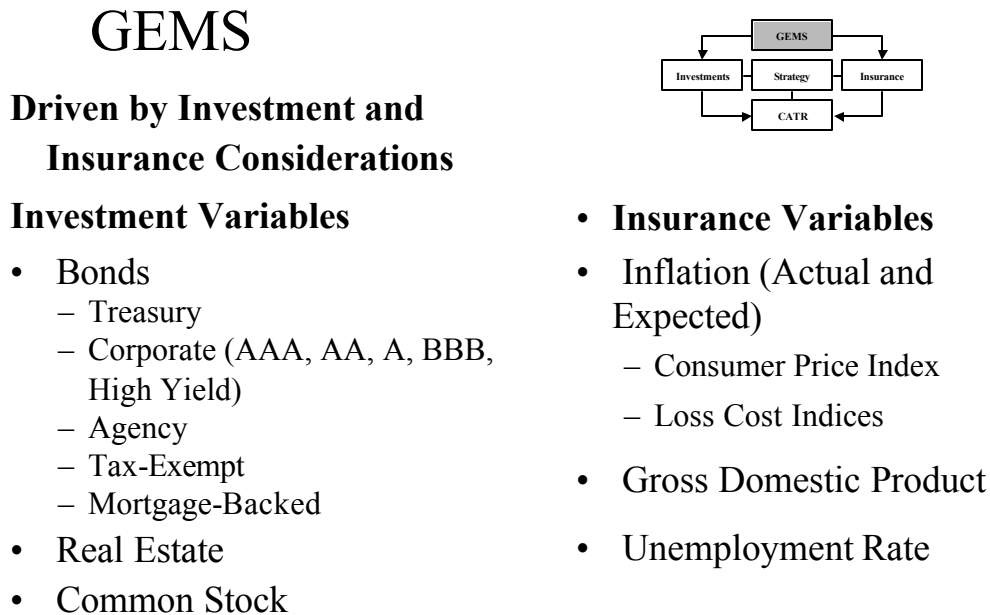
What I want you to know is that to estimate expected investment returns, your model should be rigorously grounded in economic facts. Its parameters need to be valid and stable. This is a full-time job for an econometrician, and one you should probably out-source.

The purpose of GEMS is to help evaluate the impact of changing strategy in a business under an uncertain economic future. In order to meet that goal, GEMS must incorporate all the financial variables in the economy that have a material impact on the insurance company's regulatory requirements. GEMS gives a comprehensive framework to model insurance companies from the investment side all the way through tax and accounting.

From the investment side, GEMS models Treasuries and a wide array of corporate bonds, agencies, tax exempts, mortgage-backeds, real estate and common stock. On the macroeconomic side, we model inflation, realized and expected, GDP and unemployment. GEMS utilizes a variety of models to do this, but they're all linked in the cascade structure. One thing you should note is that we can also run multicurrency scenarios. More specifically, the Treasury term structure really is attached to each national economy. Figure 1 shows a two-factor outline structure. Most of you are familiar with that jargon. The stock index and dividend models are coupled with the Treasury term structure, with additional sources of independent risk. We modeled municipal bonds, with stochastic maturity, and spread to Treasuries. We also model corporates. Our corporate model considers each bond to have a life of its own, and it's governed by a default process. That default

process governs both the corporate spread and a rate of transition. That model is not top-down; it's bottom-up. The default process actually creates the structure and the ratings transitions. GEMS can model mortgage-backeds, including prepayment options, and as I said before, multicurrency economies.

Figure 1

GEMS

Driven by Investment and Insurance Considerations

Investment Variables

- Bonds
  - Treasury
  - Corporate (AAA, AA, A, BBB, High Yield)
  - Agency
  - Tax-Exempt
  - Mortgage-Backed
- Real Estate
- Common Stock

• Insurance Variables

- Inflation (Actual and Expected)
  - Consumer Price Index
  - Loss Cost Indices
- Gross Domestic Product
- Unemployment Rate

Bringing the GEMS structure alive is a matter of statistical estimation. You can have a very robust model, but if it's badly paramaterized, it won't perform well. You can have a mediocre model that's well paramaterized, and it will come out a lot better. So bringing it alive is a matter of parameter estimation. We don't ship the model with static parameters. We constantly revise and validate the elements of GEMS. I'm going to describe the estimation process we use before the module ever links up to insurance data. It starts with the estimations, it then moves on to a simulation, and finally that simulation is analyzed in great detail and that whole process is repeated as new data become available. Conventional wisdom and anecdotal evidence are not a basis for estimating 200-plus parameters that actually drive that artificial economy. The development of each of these GEMS models actually includes an algorithm for estimating parameters from real market data.

Much of this validation process is automatic, based on recovery of items in commercially available market data stored in the data warehouse. Some of that data are processed again because we have to massage them to get them into a form that is acceptable to the estimation algorithms. We have a browser that acts a bit like, in econometrics, an analysis tool to help us in doing research for new models and in investigating patterns. The estimator itself enables us to estimate any particular model on any particular window of the historical record. They don't all

have to be modeled on the same period either. We can also do this in a matter of minutes instead of the days and weeks it used to take us really to do this in an ad hoc fashion.

The validator, finally, is a comparison of some block of the historical records and the simulated economies. The comparison is based on detailed analysis. Figure 2 summarizes this. We have the data warehouse in the center, the estimator draws up some specified portion of the historical records, and the parameters are estimated, stored and then taken up by something called the populator. We pick out particular parameter sets to test. We also pick up some historical window to compare that against. Only then do we create the simulation. The validator then looks at the simulation as one database and the historical record as another, processes that to the statistical analysis module, and organizes the whole thing in terms of tables so that it can be applied for a particular situation.

Figure 2

GEMS Estimation and Validation

- Data warehouse
  - automatic feeds from vendors of market data
  - some data passed through coupon and dividend stripping algorithms

- Browser
  - research/analysis for modeling economic and financial variables

- Estimator
  - can apply estimation algorithms for some or all GEMS models
  - allows re-parameterization and/or initialization in minutes

- Validation
  - comprehensive comparison of the historical (actual) and simulated economies
  - comparison is based on a detailed statistical analysis

There are practical considerations in selecting data windows. Characteristics of the data can change significantly over different historical windows. Aspects of the current economic environment can differ from recent historical data. A recent example is the low interest rate environment over the past two years. After such an environment develops, you have the question of whether that should be interpreted as a change in regime or just an extreme with a transitory departure from the historical record. The distinction is fairly important because most of the models we deal with in modeling an economy are basically stationary models. While the stationary model then exhibits a wide variety of behaviors, it does so with a single set of parameters. It is not a regime-switching environment. Regime-switching environments are difficult to calibrate in any reliable way. So the problem arises as to how you really use current economic situations when you're trying to parameterize these economies.

As the key economic variables move away from historical levels, these stationary models will induce short-term bias in the duration of those variables. One does not want the bias, and liberty has to taken with respect to the estimation process. At some point we cross the line between scientific estimation and speculation. You're imposing a view at some point on the simulation, which means you're imposing your view on your model of the future. This is generally an issue for any "equilibrium" model.

A benchmark is necessary in all validation processes. We have to make some sense out of the historical record to compare it to any kind of simulation of the future economic environment. Parameterization should induce distributions and dynamics

that not only reflect the salient features or the benchmarks, but also exhibit novel but plausible behavior. You'll want strange things to come up that are plausible, things you haven't seen before, to test your business study. The benchmarks should also reflect rational relationships that persist over some reasonable time frame in the historical record. For example, it doesn't make much sense to create an artificial economy where investors are not compensated for risk, even though the evidence for that may be hard to find in the historical records.

Choosing your best benchmark is really tantamount to finding a period in the historical record that possesses some set of desirable statistics. In the investment context, the most important characteristic is joint distribution and dynamics of the return that make the financial assets, and I emphasize joint. It is not good enough to get individual processes for stock returns, bond returns and inflation. You have to get joint behavior right for a realistic economy. In a broader context you need to be concerned also with behavior, not just returns, but price levels and other indicators of economic activities.

Now, we searched over most of the historical records going back about 75 years looking for some clue as to what reasonable benchmarks we could find. Looking at the return of structures since the Depression, you can see in Figures 3 and 4 that there's quite a variable relationship that existed since the early part of the last century. Even if we try to smooth that out a bit and look at rolling windows going forward, we still see that there are, especially in the past 30 years, departures from earlier periods in history. So it's difficult to see where you need to find a relationship that was fairly stable in terms of the returns. However, we turned around and started to look then at the volatility of those returns over time.
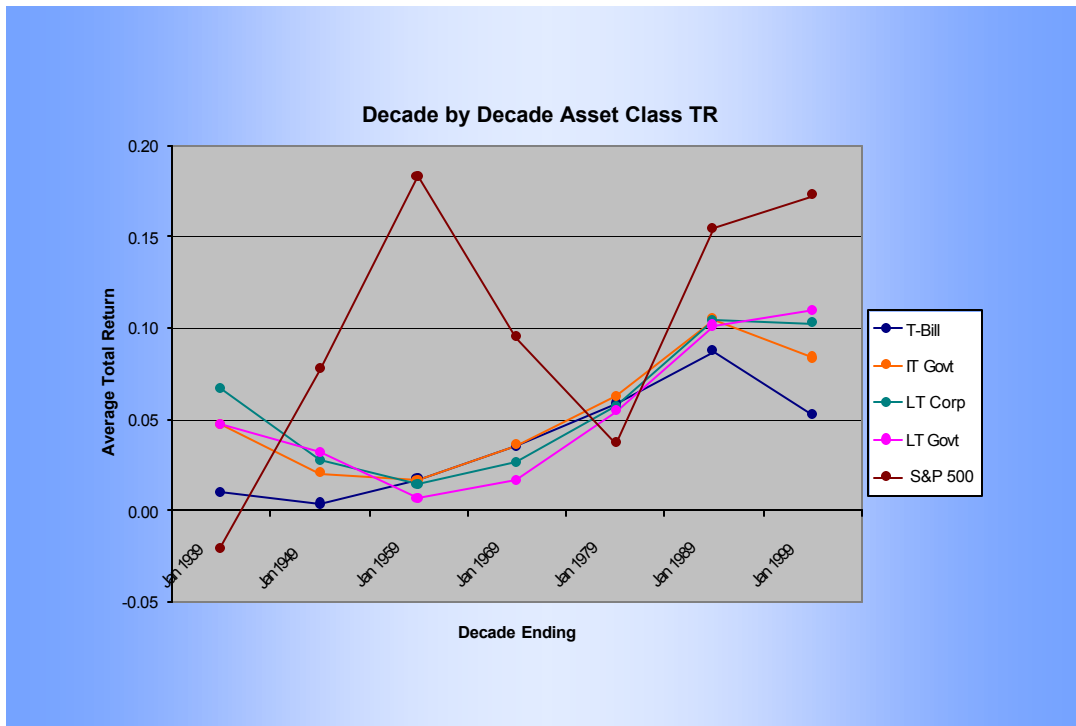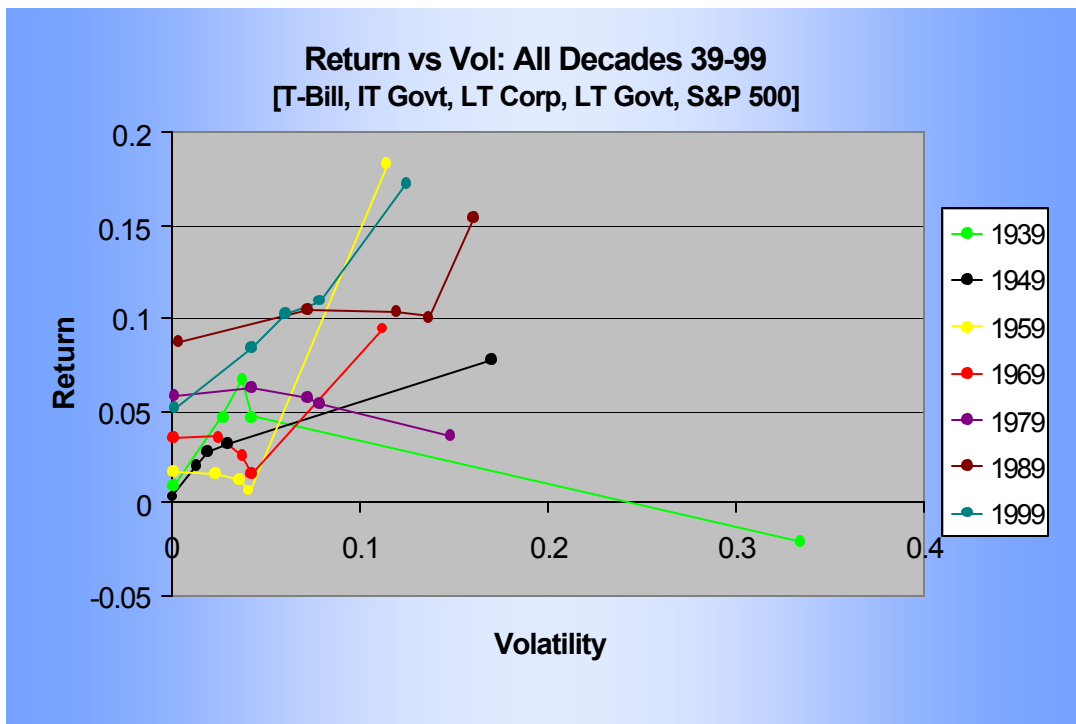
Figure 3

Figure 4

We found there is a stable relationship in the volatility between the major asset

classes. This may look a bit confusing, but I'll explain what it is. You have return versus volatility here, and these are each of the decades from the Depression to the end of the century. From left to right of the dots on each of the lines, you have Treasury bills, intermediate-term governments, long-term corporations, long-term governments and the Standard & Poor's index (Figure 5). If the relationship I just described—the Treasury bill, long-term Treasuries, etc.—if that ordering didn't hold over every decade, you would see the lines not going from left to right, but zigzagging. So the relationship holds from decade to decade, and just to make that a bit clearer, we take out the Depression and we get a slightly clearer picture (Figure 6). That goes in relationships over the whole decade.
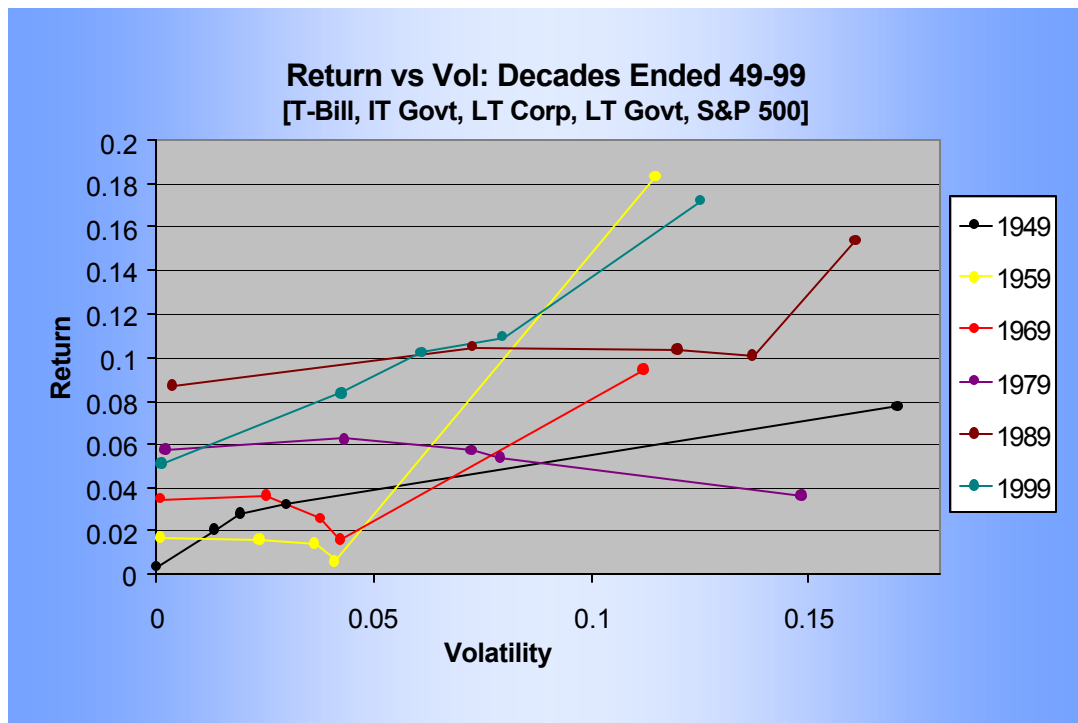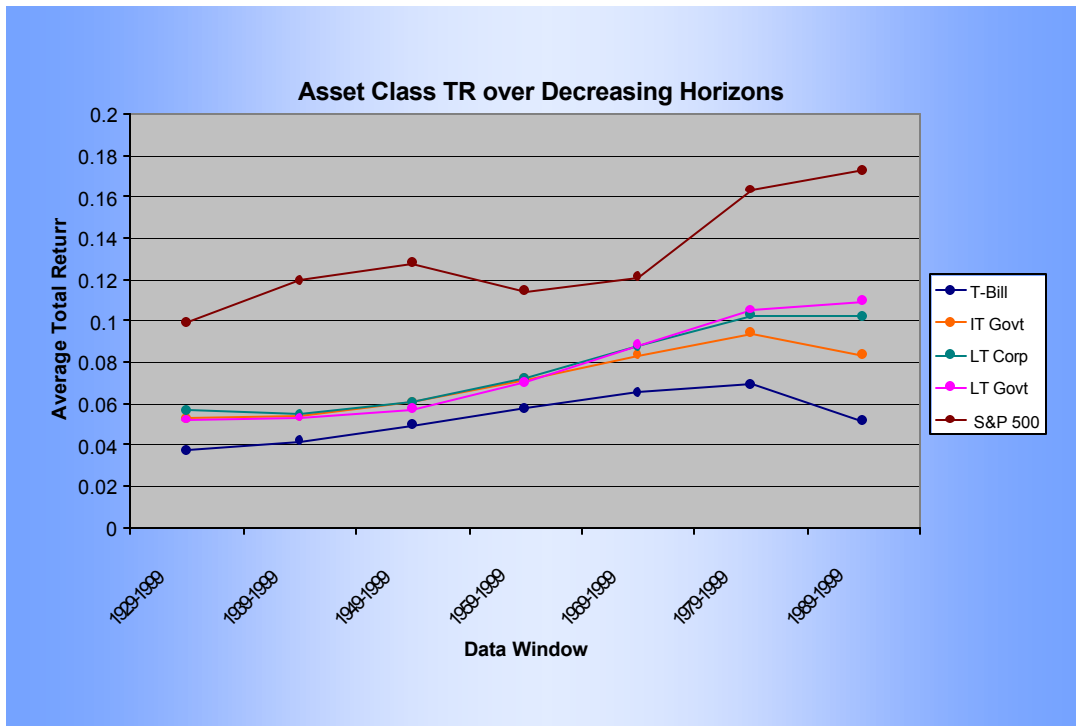
Figure 5

Figure 6

Now, why would we do that? Because that's one of the things we can hang our hat on to an extent. We take two of those periods, let's say 1949–99 and 1959–99, and we get those two blue and maroon volatility versus return plots (Figure 7). We can draw a cylinder around those. We can say, if we parameterize this on the postwar data, then what we expect to see from the simulation in regard to the volatility of the return, from those asset classes, is something that lies in the cylinder. That's a reasonable benchmark that's been parameterized from that period of time.

Figure 7

1949-1999 and 1959-1999 Return vs Volatility
**[T-Bill, IT Govt, LT Corp, LT Govt, S&P 500]**
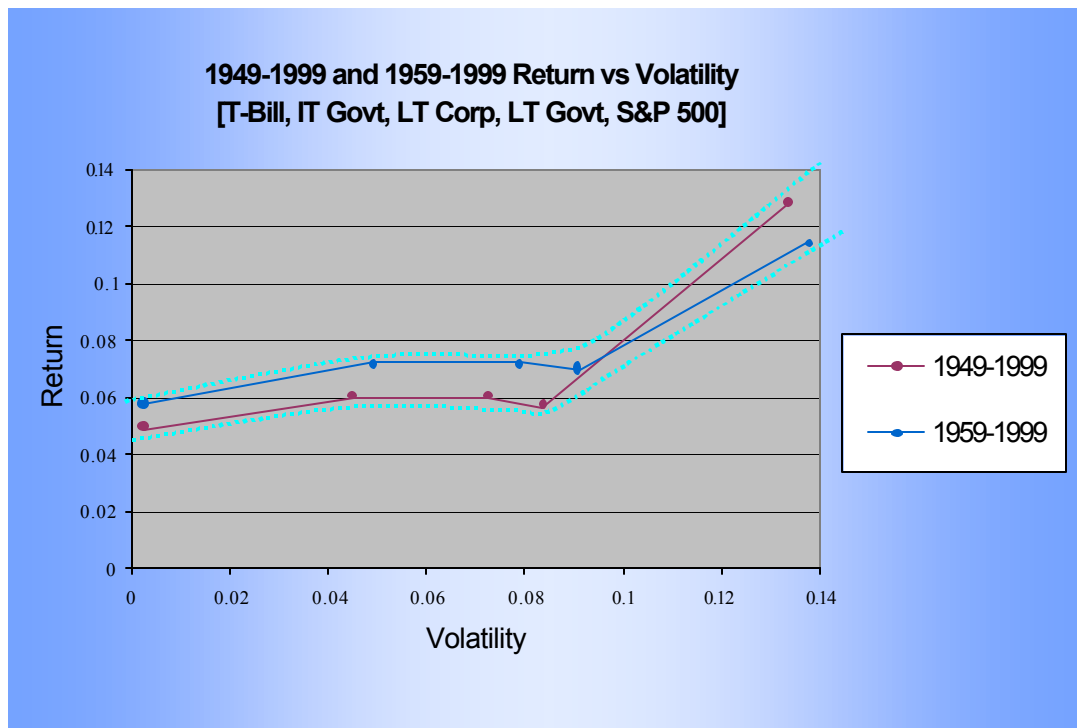
The one step in this whole validation process that's not automated is arguably the most important. The statistical and graphical analysis might be examined in great detail. The univariate-multivariate behavior as well as correlation should be examined, and one of the most critical aspects to get right, as I mentioned, is the joint distribution of the dynamics of the returns. The coincidence of history is vital. Deviations between historical records and simulations should be understood, depending on the current economic environment. Sometimes those deviations are justified.

Now, let me explain Figure 8, because it's a bit cryptic. Along the left, the vertical axis is returns, the horizontal axis is volatility of those returns, the upper plot is the volatility return plot of the historical window of 1982–99, and the bottom plot is a simulation based on postwar parameterization. It is a simulation that is initialized to average postwar yield levels. Incidentally, points are again ordered in the same order in terms of volatility. If you start from the left, the risk-free rate, we've added some new asset classes there: medium-term annuities, medium-term Treasuries, then mortgage backs, long-term municipal bonds long-term Treasuries and finally equities. Again, notice that they maintain the same order of the volatility relationships, and one would expect to see that come up. What I want to do is quickly highlight that what we should be preparing from the earlier benchmarks are these points, which are the original asset classes we looked at from the historical record, and in fact, these do fit into the benchmarks. So we start the simulation off at the average postwar levels of interest rates.

Figure 8

Return vs. Volatility
(avg. yld pw parameters; hist window 82-99)
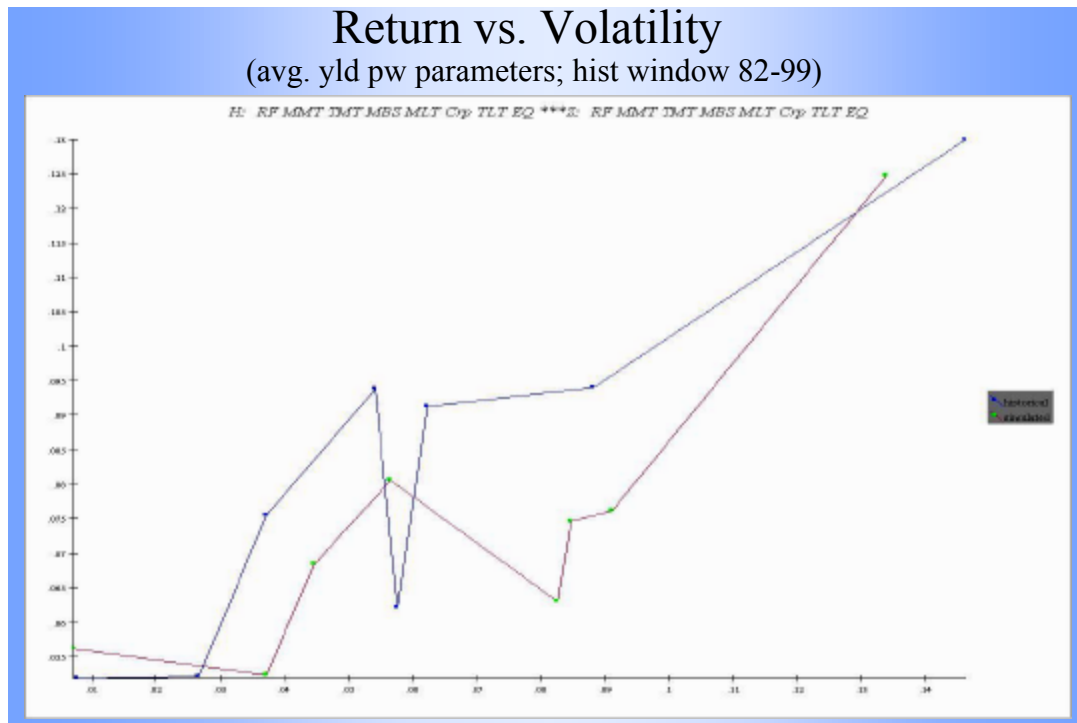
What happens if we keep those parameters but start off at the levels of interest rates that prevailed at the end of 2001 and beginning of 2002? We run a simulation as if we were starting that simulation at the end of last year and still use historical parameters. What would happen to this? What happens is this—and in order to make it clear to you, I'll do a little bit of manual animation and go back and look at this. What happens when you start at the lower levels is that you depress the volatility and the return, and both drop. There are good reasons for that. These are mean reversion models, and if we start off at extremes of the historical record, we'd be starting off at the extreme postwar record by starting at yields that prevailed at the end of last year and the beginning of this year. That trend will first reduce the volatility, and, because yields are rising in that trend, it will also depress the returns. So you can see the effect of that.

Now, suppose we re-estimated out in June, and, in fact, not only did we just re-estimate data that became available in the first part of the year, but we also tried to impose a bit of a view weighting the more recent data more heavily. What will happen to the return volatility curve is that you will get a steep increase in the volatility and an increase in the returns again. A year ago we prepared these. The top plot now is a comparison with the last 10 years, not the last 20 years of data. Those will reflect the returns of the volatility in the last 10 years. The reason that the curve has now moved up or the simulation has now moved up in terms of volatility and returns is that, in order to incorporate extraordinary events in the first

part of this year, the model has to increase the volatility of the processes, to have the interest rate moves you see in the past six months to increase the volatility of the process. The problem with the simulation is that, once you have increased that volatility in these simulations, it is then embedded in the entire 15 years. That volatility persists in the whole simulation, which is generally problematic with these types of models.

Taking a closer look at some of the asset classes that we have on the original diagram, we have real corporate returns as distribution. The top, blue plot is in the historical record. The maroon is the simulation. As you can see, the lower, maroon distribution covers the historical record quite nicely. It also provides, in the terminology in the business, fatter tails, so that we see some of the returns that we haven't seen before in that particular part of their records. Some of those are closed under certain economic conditions. One would not be entirely surprised to see those kinds of returns.

Looking at this in a different way, we also take a look getting really down to the mechanics of what's going on inside the simulations. In Figure 9 you have an annual transition matrix that is based on Moody's transition data. The thing you should notice is that the bonds tend to remain in their class: that is, the bulk of the distribution lies along the horizontal, and if bonds tend to transition at all, they tend to get downgraded. The term "simulation" mimics the same sort of dispersion of transition probabilities, that is, they're skewed to the right and most of the mass is right along the diagonal. We've also taken a look at some real bonds, in this case Coca Cola bonds (Figure 10). We looked at the returns as generated by the spreads and transitions to isolate the effect of the spreads themselves. We removed and we simulated the Treasury yield curve and replaced it with a real Treasury yield curve and then overlaid the simulated spreads. So you can see the result tracks fairly well.
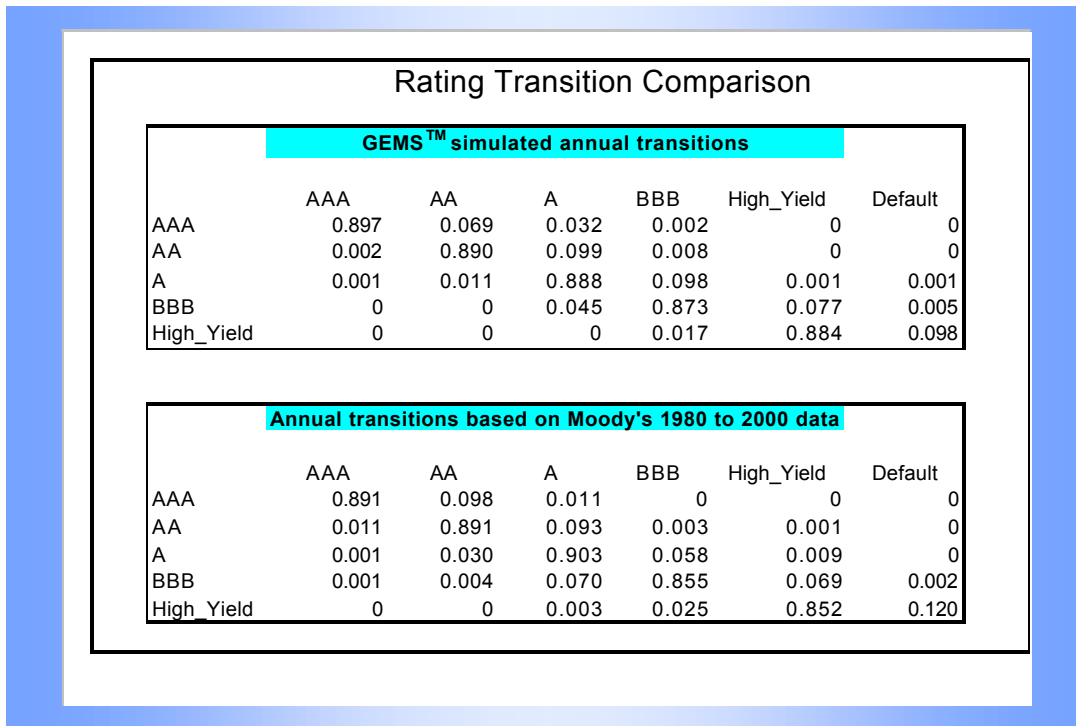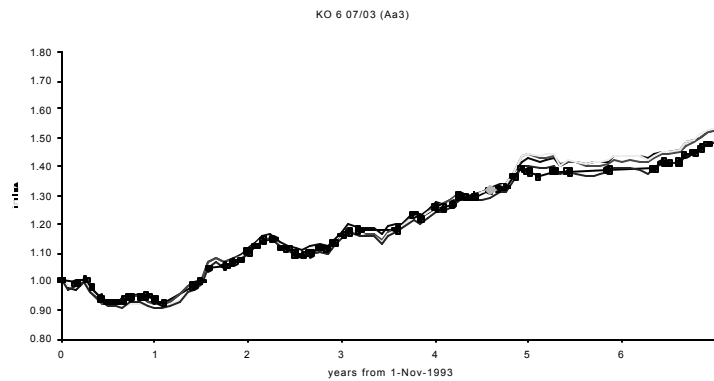
Figure 9

Rating Transition Comparison

GEMS^{TM} simulated annual transitions

	AAA	AA	A	BBB	High_Yield	Default
AAA	0.897	0.069	0.032	0.002	0	0
AA	0.002	0.890	0.099	0.008	0	0
A	0.001	0.011	0.888	0.098	0.001	0.001
BBB	0	0	0.045	0.873	0.077	0.005
High_Yield	0	0	0	0.017	0.884	0.098

Annual transitions based on Moody's 1980 to 2000 data

	AAA	AA	A	BBB	High_Yield	Default
AAA	0.891	0.098	0.011	0	0	0
AA	0.011	0.891	0.093	0.003	0.001	0
A	0.001	0.030	0.903	0.058	0.009	0
BBB	0.001	0.004	0.070	0.855	0.069	0.002
High_Yield	0	0	0.003	0.025	0.852	0.120

Figure 10

Coca Cola

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Calibration of these models to reflect historical returns is really a challenging task.

The periods of history for which key financial variables deviate substantially create substantial modeling difficulties. One such example is the recent low interest rates, which I already described. They induce mean reversion, which depresses the returns in the simulation and the volatilities. The manner in which difficulties are resolved directly determines how well this model is going to perform. If one adopts a mean reverting model, there is bias in some direction. If you incorporate a regime change in these models, it's hard to find a basis for calibrating or validating these models.

One additional point to keep in mind is that it's probably better to stay away from speculations in these types of environments. Stick with the historical record and update the parameter estimation often. If your time horizons are short, you have to be prepared to reassess your situation much more frequently. So update the simulation on a quarterly basis and let the historical data do their own talking.