1991 VALUATION ACTUARY
SYMPOSIUM PROCEEDINGS

SESSION 8

Practical Asset/Liability Modeling for CMOs

Randall L. Boushek

David A. Hall

PRACTICAL ASSET/LIABILITY MODELING FOR CMOs

MR. RANDALL L. BOUSHEK: By way of introduction, I am an actuary in the somewhat nontraditional role of investment officer and manager of the life company bond portfolio for Lutheran Brotherhood. Lutheran Brotherhood is a $9 billion fraternal benefit society headquartered in Minneapolis. My copresenter on the panel is David Hall. Dave is also an actuary involved in investment management. He is vice president and director of portfolio management for the Hartford Life Insurance Companies.

Our subject for this session is once again collateralized mortgage obligations (CMOs). In session 3 we focused on the basic mechanics of CMOs, how they're created, how they differ from one another, and what makes them tick. At this session we're going to spend more time analyzing specific types of CMO tranches, analyzing them under dynamic scenarios, and looking at some of the more difficult modeling issues that surround CMOs. Unlike session 3, CMO Boot Camp, we are assuming a certain level of understanding of the CMO instruments and markets for this session.

We're going to begin with a brief introduction to our material and a discussion about the philosophy of CMO modeling; however, the bulk of this session will be devoted to case studies. There will be four sets of studies that will take a look at the differences between static and dynamic modeling. I'll begin with a set of case studies on sequential tranches and accrual or "Z" tranches. Dave will follow with a discussion of case studies involving planned amortization class (PAC) and Super-principal only (PO) tranches. After that, we'll move on to CMO tranches that are a little more esoteric and that are used more to hedge the portfolio or to improve the liability match, as opposed to being the primary vehicle for the liability match. I'll tackle interest-only (IO) tranches and inverse floaters, leaving Dave to finish with our fourth set of case studies involving super POs and super floaters.

I do want to make one thing clear from the outset of this discussion, and that is that neither of us is here to promote or discuss the relative merits of any particular software packages. There are a number of risks and dangers in doing that. We are not going to name names. We are not going to mention that this package works well for this or that this one does not. Obviously, we have our own experiences and our own opinions, and we'd be happy to share those with you on an individual basis after this session or at a later date. But in a group setting like this we are not going to be expounding on the merits of any particular software package. Rather, we'll try to discuss this from a more global standpoint.

I'd like to review one chart from session 3 to point out just how important CMOs have become to the insurance industry. At my company we have roughly one third of our assets invested in mortgage-backed securities (MBSs), principally in CMOs (a subset of MBSs). In 1991 we'll devote about one half of our net investable cash flow to the purchase of CMOs. At Dave's company I believe both of those percentages are somewhat higher. In our industry as a whole we have seen a dramatic growth over the last five years in the use of MBSs in investment portfolios.

Chart 1 from Session 3 shows a breakdown by asset type of the net investment activity for fixed income purchases, for the life industry as an aggregate, for the last five years based on ACLI data. The 1991 data are complete through six months. In 1987 and 1988, MBSs represented about 14% of life company purchases. In 1991, through the first six months, MBSs, principally CMOs, represented almost 27%, nearly a doubling of the portion of investable cash flow of life insurance companies. It appears that in 1991 this will represent the single largest fixed-income category of purchases for life insurance companies.

Now, that has a lot of implications, not the least of which is the impact of CMOs on asset/ liability modeling and analysis and the need to be able to project cash flows on CMOs. In discussing the challenges that are faced in modeling CMOs, I'd like to tier them into successive challenges.

The first is modeling of the underlying collateral, that is, modeling the prepayment activity of the homeowners who ultimately underlie the CMO. Any modeling of CMOs must start with the modeling of the collateral. Every broker/dealer on Wall Street that trades MBSs has developed a dynamic multivariate prepayment model. These models seldom agree with one another, but there is a lot of time and a lot of collaboration involved in those models. There are also a number of commercially available pass-through models that are available from a number of vendors.

The next level of challenge is in isolating a tranche in a very "plain vanilla" sequential CMO, an A-B-C type corresponding to our CMO (on Charts 11-13 from Session 3), or possibly an A-B-C-Z type of CMO with a Z tranche. There have been a series of approaches developed to modeling these types of CMOs. The first is to treat a CMO tranche as a combination of positive and negative mortgage-backed pass-throughs. A second approach is to treat it simply as a serial or sinking fund corporate bond according to the best-guess percent of the Public Securities Association (PSA) model assumption. Both of those have significant modeling weaknesses.

A more recent alternative is the development of models that generically handle a vanilla sequential CMO tranche by specifying start and end dates of each tranche in the base case. These do do a good job of modeling this type of tranche. Unfortunately, vanilla sequential deals represent only a very small percentage of the outstanding universe of CMOs.

The greater challenge, and one that's being addressed now by the purveyors of modeling software, is isolating a tranche in a "flavored CMO"; that is, a CMO that involves something other than straight sequential and tail-end Z tranches.

There are a number of complexities involved in doing this, and I am of the opinion that it cannot be adequately done with one type of generic model. Every CMO is unique. The loans that underlie it and the payment propensity of those borrowers are unique. The structure of each deal is unique, as is the structure of each tranche. There is no such thing as a generic CMO, and I do not believe, other than in the simple A-B-C or A-B-C-Z style, that you can generically model CMOs.

The final challenge is modeling a deal that's been in force for some time. As difficult as it is to model a deal prospectively, from the point when it's created, it's even more difficult to model after it's been in force.

Factor updating is a process important to managing and modeling MBSs. A factor is simply the percentage of original principal still outstanding on a given MBS. Generally factors start at 1.0 and decrease to zero through time. The one exception is the accrual (Z) tranche; this type of tranche has a factor that actually increases for some time, since the interest is added to the principal instead of being paid out in cash. Modeling an in-force CMO depends not only on knowing the current factor for your tranche, but also on knowing the factor for every other tranche in the deal and how prepayments have emerged to that point.

There are a number of ways of addressing the modeling challenge. Obviously, any modeling solution can include the alternative of in-house development. It may be feasible for some firms to develop in-house mortgage-backed pass-through prepayment models. However, given the complexity of the issue, I do not think it is feasible for individual life companies to try to develop a comprehensive CMO modeling system in-house. It is just a tremendous undertaking that really needs and requires pooled resources.

Second, there are a number of actuarial asset/liability models that of necessity include an asset module that must somehow incorporate CMOs into it. I will not pass judgment on any of those models. Most of them purport to handle CMOs. I would just give you this caution. In looking at how any model, actuarial asset/liability or other, addresses CMOs, I would look very clearly to see if that model tries to handle them in a generic sense or if it somehow accesses a live database of CMO deals.

Third, every Wall Street broker/dealer that trades CMOs has some type of database or access to another dealer's database of deals. Wall Street has put its best and brightest onto the assignment of creating these CMOs. They also have staffs dedicated solely to the project of reverse engineering the deals that the staffs of other broker/dealers create, in order to get them into their own database for secondary market trading.

It is possible that your investment people can occasionally tap those databases for a look at their own portfolios, as a relationship matter with the brokers who cover them. I have on occasion asked one of our brokers to run my entire portfolio under a couple of scenarios, or a couple of the tranches I own under a multitude of scenarios. These are reasonable requests. However, asking a Wall Street brokerage firm on a relationship basis to take a portfolio of CMOs (which in my case is more than 250 tranches) and model it under 20 or 40 scenarios with any frequency is a completely unreasonable request. It is a special purpose alternative but is certainly not an effective alternative for asset/liability modeling.

Finally, there is one alternative that I think is the only really effective method of modeling CMOs, and is the only method or approach that I could comfortably rely on to support a professional opinion. This is to somehow access a live database of outstanding CMO issues, whether by tapping a Wall Street database or by using a model that has itself a reverse engineering support capability to it. There are at least three vendors who have developed (or are in the process of developing) software that they are supporting with their own reverse engineering efforts, to create a live database and update that database with as many outstanding CMOs as they can get into it.

I think that ultimately you need to access that kind of a reverse engineered database in order to model any CMO. CMOs are just such unique animals, and each tranche is so unique, that any model that I can reasonably state does a good job of modeling CMOs must somehow access that kind of a database.

Just to amplify that point a little bit, let's look at a particular example. (Details are shown on Table 1). This CMO is a Federal Home Loan Mortgage Association (FHLMC) Real Estate Mortgage Investment Conduit (REMIC) 112. It was created in early 1990 in a relatively flat yield curve environment. It has 17 tranches, far below the greatest number I have seen in any single CMO. There are nine PAC tranches in this deal, eight of them having different collars, one of them being a PAC-II. There's a targeted amortization class (TAC), companion, super floater, inverse floater, IO and two residuals. There are multiple simultaneous pay tranches, including simultaneous pay PAC tranches.

I am not aware of any generic model that can adequately handle any one of the individual tranches in this deal. You simply cannot isolate, for example, a PAC tranche and say, "Well, we can model this as a generic PAC tranche in our model." There are PAC tranches around it; there are PAC tranches with different collars. They interact differently, and they pay simultaneously. It's just a very complex issue.

With that as an introduction, I'd like to move into some case study analysis. I apologize if the numbering gets a little confusing. Each of our four sets of case studies includes a Case Study 1 and 2. In some instances, Case Study 1 or Case Study 2 may actually include up to three different bonds, analyzed separately and then together.

I will be talking, first of all, about sequential pay tranches which we'll discuss as Case Study 1. To do that I will be using two separate CMO tranches. One of these is a Federal National Mortgage Association (FNMA) REMIC 91-85-G, which is a 10-year sequential pay tranche based on FNMA 8% collateral. The other is FNMA REMIC 91-130-B, also a 10-year sequential CMO tranche based on FNMA 10% collateral.

Then Case Study 2 will focus on Z tranches, and I'll be using three different tranches in that case study. The first is FHLMC REMIC 21-Z, which is the classic tail-end Z. The early type of Z tranches were the back end of a CMO, and this is an example of a back-end Z

TABLE 1

CMO Modeling
Example: FHLMC 112 (9.5s at 180%)

A	146.5 MM	9.16%	TAC	2.8 yr	9.31%
B	5.2 MM	8.25%	PAC (185-275% PSA)	2.4 yr	8.62%
C	44.3 MM	8.25%	PAC (90-625% PSA)	3.4 yr	8.66%
D	3.3 MM	8.25%	PAC (90-385% PSA)	4.4 yr	8.80%
E	54.8 MM	8.80%	PAC (90-380% PSA)	5.6 yr	8.90%
F	45.1 MM	8.80%	PAC (90-310% PSA)	7.8 yr	9.03%
G	36.5 MM	8.80%	PAC (90-300% PSA)	9.9 yr	9.04%
H	35.9 MM	8.80%	PAC (90-300% PSA)	12.9 yr	9.12%
I	21.8 MM	6.50%	PAC (85-300% PSA)	19.1 yr	9.07%
J	5.9 MM	17.25%	PAC (65-300% PSA)	3.4 yr	8.61%
K	24.6 MM	9.00%	Companion	11.2 yr	9.77%
L	40.0 MM	9.00%	Retail	20.5 yr	9.03%
M	25.6 MM	9.46%	Super Floater	17.1 yr	**
N	6.9 MM	9.39%	Inverse Floater	17.1 yr	**
O	0.2 MM	**	IO	8.5 yr	11.25%
P	3.4 MM	**	Residual PAC	13.8 yr	11.00%
Q	12.0 MM	9.00%	Residual	11.5 yr	11.00%

tranche. The second is FNMA 89-30-X, which is an example of an intermediate or shorter dated Z tranche. This is a Z or accrual tranche, a type of tranche that has become more common in certain types of deals. Those two tranches are ones that I actually own in my portfolio. The third is FNMA REMIC 91-100-Z. This is not a tranche that I own, and it will become apparent why as we look through the case study. This is a companion Z tranche.

Take a look at FNMA REMIC 91-85 (Chart 1). This is the pattern of cash flows for this particular tranche, given an assumption of level interest rates from this point forward. Therefore, there is an inherent PSA assumption in this analysis. For example, a FNMA 8% in today's environment might have a base case PSA assumption of 135% PSA. Depending on whom you talk to on Wall Street, it might be anywhere from 135% to 180%, but let's assume it's 135%.

The striped bars indicate the interest cash flows. The solid bars indicate the principal cash flows. This is a static analysis, which might be the way that this instrument is booked into your accounting system for discount accrual purposes.

Now let's look at this same tranche under two alternative scenarios: a scenario in which interest rates decline 200 basis points over a one-year period and then level out, and a scenario in which interest rates increase 200 basis points over a one-year period and then level out. These are shown on Chart 2. You can see the change in the principal cash-flow patterns for this tranche.

There is an implicit PSA assumption associated with these interest-rate changes. I do not want to get into a detailed discussion of what the appropriate PSA assumption for a given change in interest rates for a given type of collateral is. Just use this as an example of when there is a significant change in that assumption, and the consequent change in the pattern of repayments.

CHART 1

Case Study 1A: FNMA 91-85-G (FN 8%)
Annual Cash Flows - Level Rates

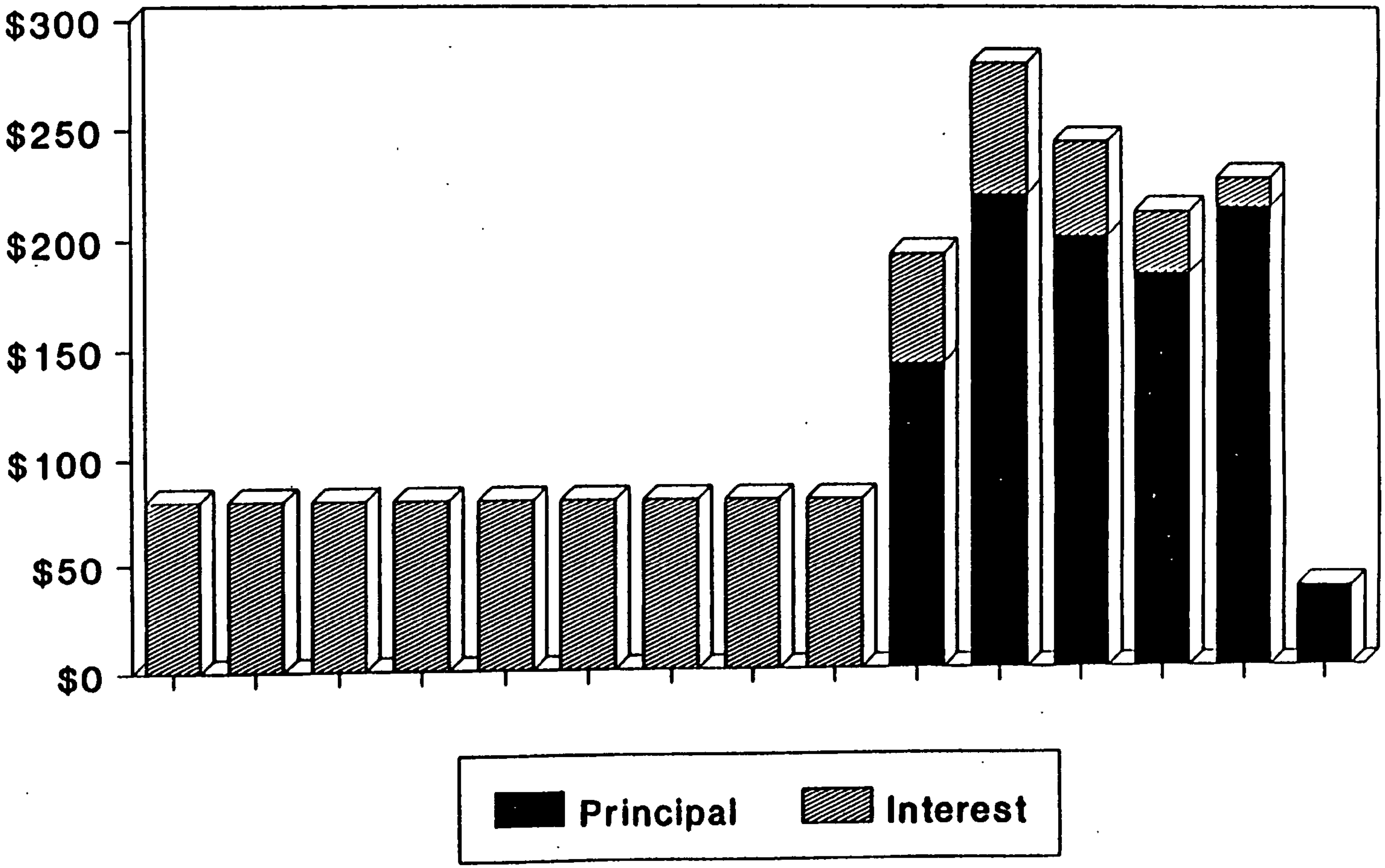
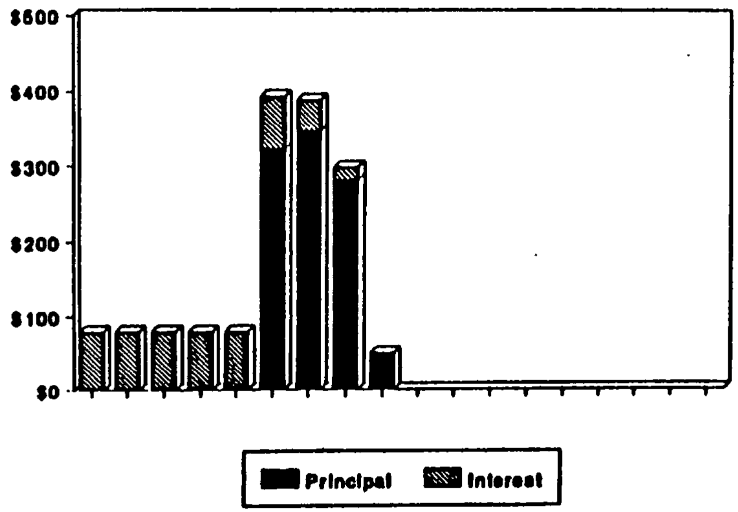
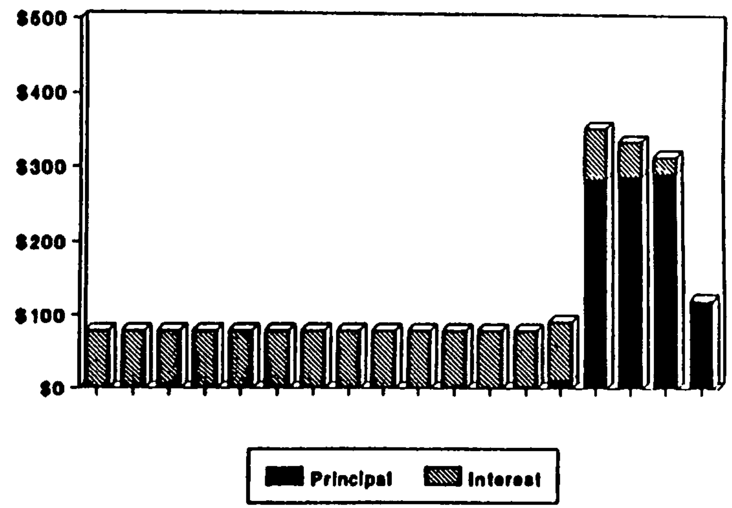


CHART 2

Case Study 1A: FNMA 91-85-G (FN 8%)
Annual Cash Flows



Rates -200 bp



Rates +200 bp

Summarizing the results numerically for these three scenarios (Table 2), we can look at the average life of the principal (that is, the average time to principal repayment), the average cash-flow duration, and the payment window or the time frame in which the principal is repaid.

TABLE 2

Case Study 1A: FNMA 91-85-G (FN 8%)
Summary for Scenarios 1-3

Scenario	Average Life (yrs)	Cash-Flow Duration (yrs)	Payment Window
-200 bp	5.8	4.6	4.5 - 7.4
Level	10.9	7.3	8.6 - 13.3
+200 bp	14.9	8.8	13.2 - 16.6

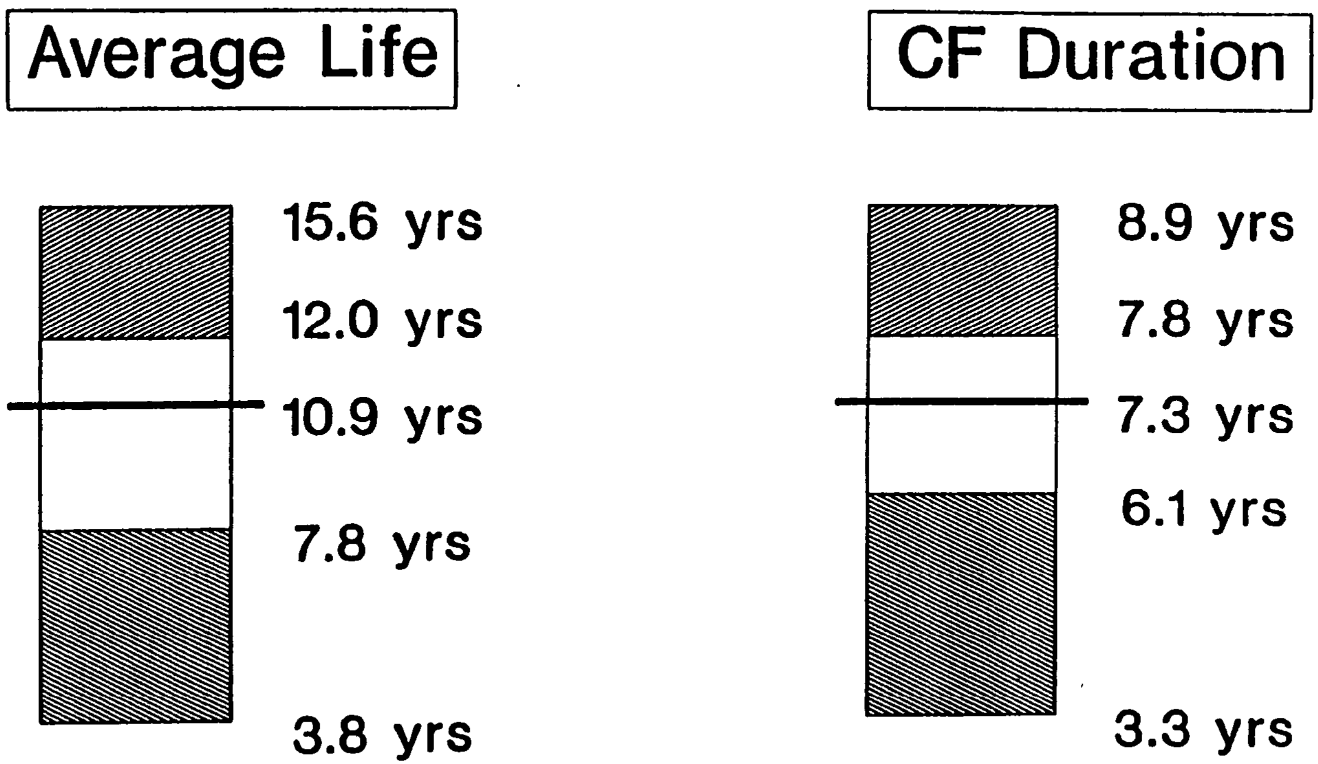
As a portfolio manager, one of the requirements I have for a sequential CMO tranche is that, in up and down 200 basis point scenarios, my average life does not decline by more than half and does not extend by more than a factor of 1.5. This is a tranche that would qualify for a further review for purchase for my portfolio.

Those are our three key scenarios. If we look at a multiscenario analysis of this tranche, looking not only at the level and the up-and-down interest rate scenarios but also at a series of randomly generated scenarios, including not only the New York Seven but also a dozen or so other scenarios, oscillating and otherwise, this gives a distribution or a dispersion of the average lives and the cash-flow durations for this particular tranche.

Chart 3 shows the distributions of the average life and cash-flow durations of such a set of random scenarios. The white region in the middle represents the 80% confidence level. In other words, the striped region at the bottom is the outside 10% on the short end. The striped region at the top is the outside 10% of the scenarios on the extension end. In this analysis, 80% of the average lives for this tranche fall somewhere between 7.8 years or 12 years. Thus,

CHART 3

Case Study 1A: FNMA 91-85-G (FN 8%)
Summary for 20 Scenarios



I can say that there's a reasonable probability that this tranche is going to have somewhere between an eight- and a 12-year average life, with extremes of about four and 15 or 16 years. As a portfolio manager, I'm comfortable with that type of an analysis.

Now I'd like to contrast that with a 10-year tranche that has a similar initial profile in the base case (Chart 4). However, this tranche has been created from FNMA 10% collateral. Therefore, our initial PSA assumption is considerably higher in a level-rate environment, perhaps on the order of 200% or 225% PSA.

Even though the payments have a similar pattern in the base case, if we look at our up-and-down 200 basis point scenarios (Chart 5), we do see a significantly greater degree of variability in these cash flows. First of all, FNMA 10% collateral, which starts with a higher PSA, is subject to a greater degree of shortening. These mortgages have a gross weighted average coupon (WAC) of 10.75%, placing them right at the cusp of the refinancing curve. It will not take much of a further shock in interest rates before these types of loans enter into a rapid prepayment phase. This will accelerate the prepayment function and significantly shorten the average life of this tranche compared to a tranche backed by FNMA 8% collateral (8.75% mortgages) which has a much further out-of-the-money threshold for significant prepayment activity.

Similarly, because we're starting with a much higher prepayment assumption for FNMA 10% collateral, there is much more room for prepayments to slow down. If we have a significant rise in interest rates, we could see that prepayment speed cut in half. It's unusual to see MBSs of any coupon prepay much slower than 50-75% PSA, but it would not be unusual to see 10% collateral prepay at something like 75-100% PSA in a significant rise in interest rates.

Therefore, this tranche can both shorten and extend more significantly than a sequential tranche backed by FNMA 8% collateral. Numerically you can see the difference in Table 3. This is

CHART 4

Case Study 1B: FNMA 91-130-B (FN 10%)
Annual Cash Flows - Level Rates

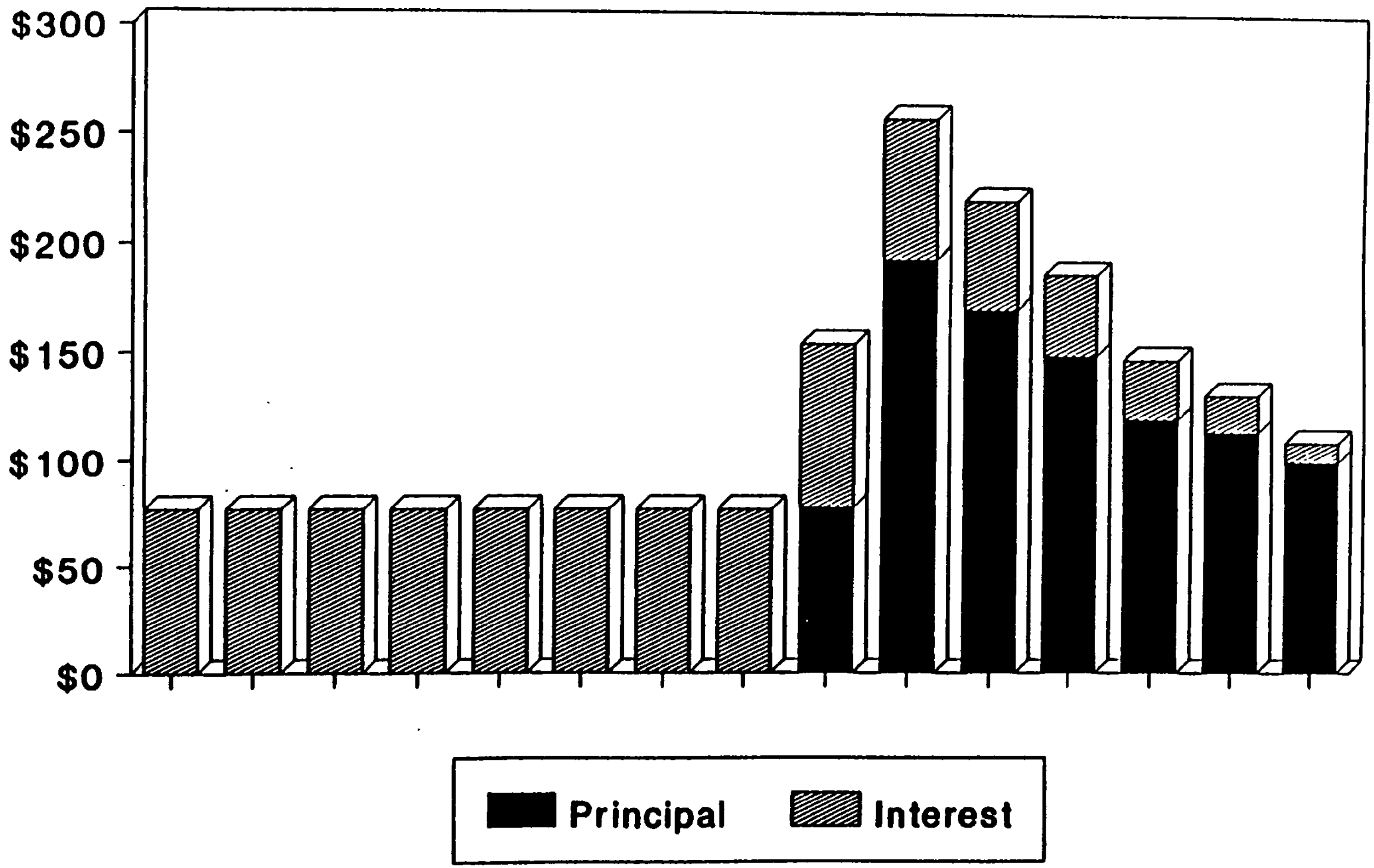
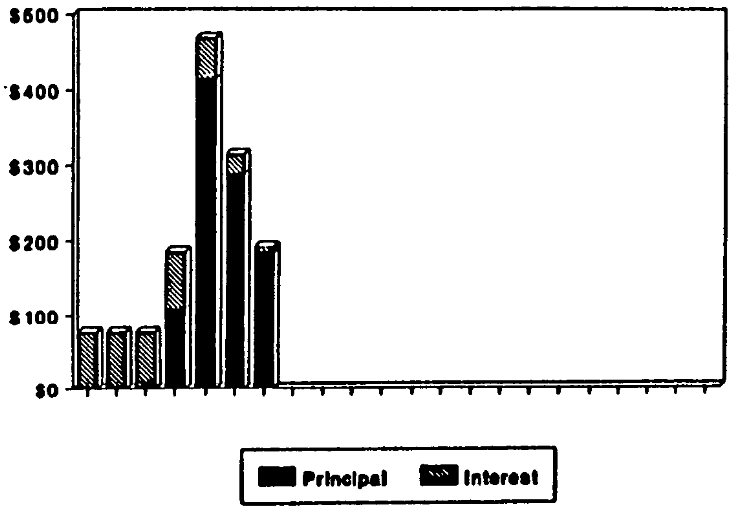
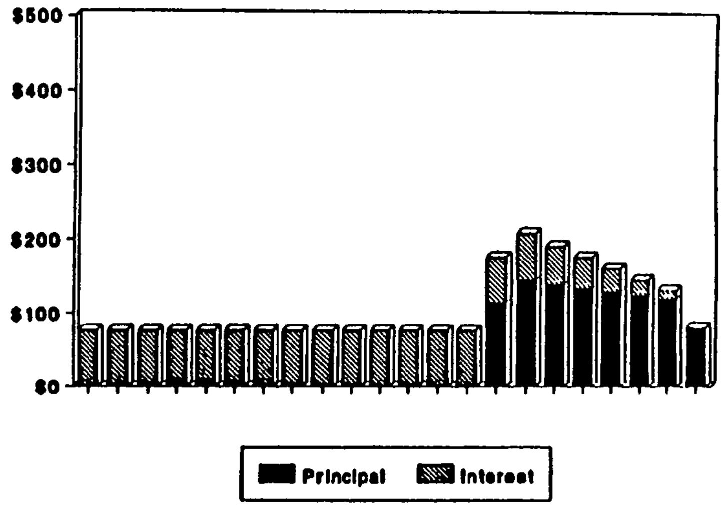


CHART 5

Case Study 1B: FNMA 91-130-B (FN 10%)
Annual Cash Flows



Rates -200 bp



Rates +200 bp

a tranche that does not get through my screening criteria. It shortens by more than half and extends by more than 1.5 (looking at just two scenarios), even though its base case is an identical 10.9-year average life with a very similar payment window.

TABLE 3

Case Study 1B: FNMA 91-130-B (FN 10%)
Summary for Scenarios 1-3

Scenario	Average Life (yrs)	Cash-Flow Duration (yrs)	Payment Window
-200 bp	4.3	3.6	3.0 - 6.1
Level	10.9	7.4	7.8 - 15.0
+200 bp	17.0	9.5	13.4 - 20.9

The point here is that it's very important to look at the type of collateral that underlies these tranches, which appear on the surface to be identical, and to look at how they perform under multiple scenarios.

If we look at the dispersion diagrams for the average life and cash flows (Chart 6), you can see that the expected average life in the base case is near the upper end of the confidence interval for this particular tranche. You can see also that the extremes, the 2.8 and 18.8 years, are wider. If you recall, our FNMA 8% tranche had a four-year 80% confidence interval. This tranche has a seven-year, 80% confidence interval, which is an unacceptable risk for my portfolio.

If I compare my two tranches side-by-side (Table 4), again we can see the greater average life and duration variability in what, in the base case, looks like two identical CMO sequential pay tranches.

CHART 6

Case Study 1B: FNMA 91-130-B (FN 10%)
Summary for 20 Scenarios

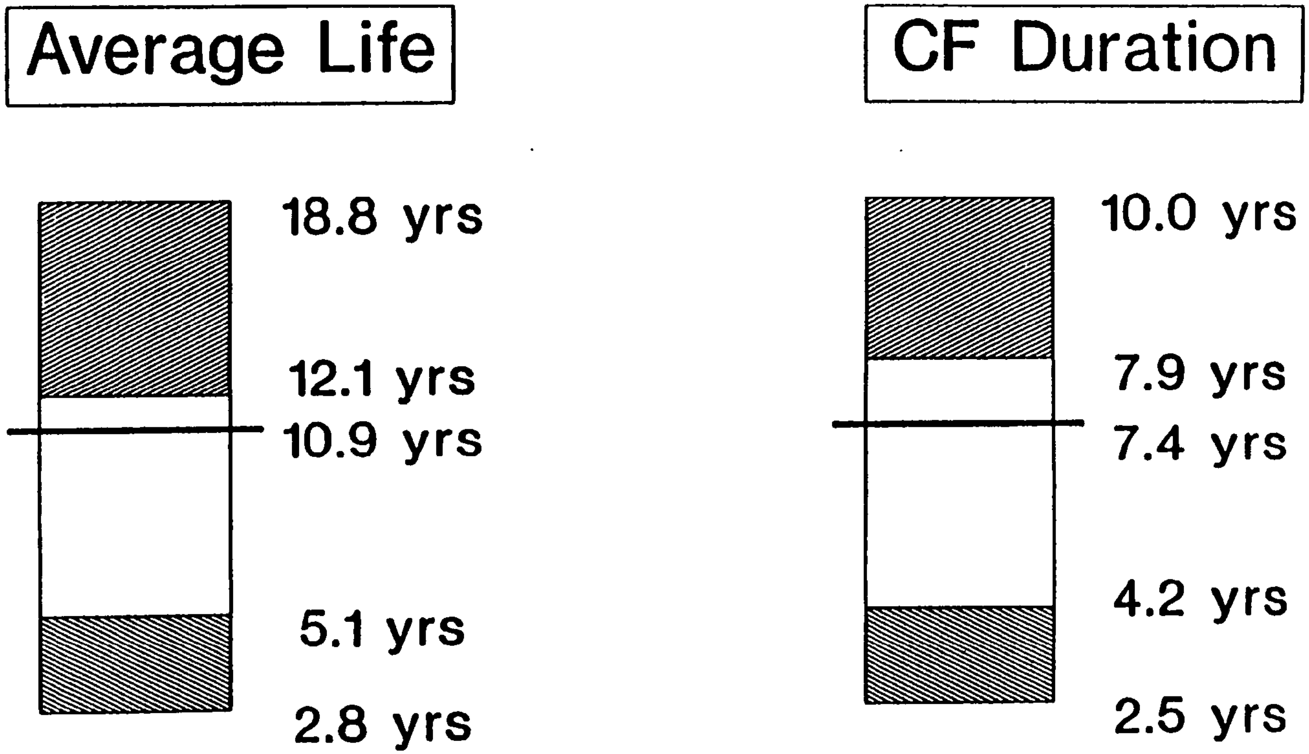


TABLE 4

Case Study 1
Comparative Summary for Scenarios 1-3

Scenario	Average Life (yrs)	Cash-Flow Duration (yrs)	Payment Window
	FNMA 91-85-G (FNMA 8%)		
-200 bp	5.8	4.6	4.4 - 7.4
Level	10.9	7.3	8.6 - 13.3
+200 bp	14.9	8.8	13.2 - 16.6
	FNMA 91-130-B (FNMA 10%)		
-200 bp	4.3	3.6	3.0 - 6.1
Level	10.9	7.4	7.8 - 15.0
+200 bp	17.0	9.5	13.4 - 20.9

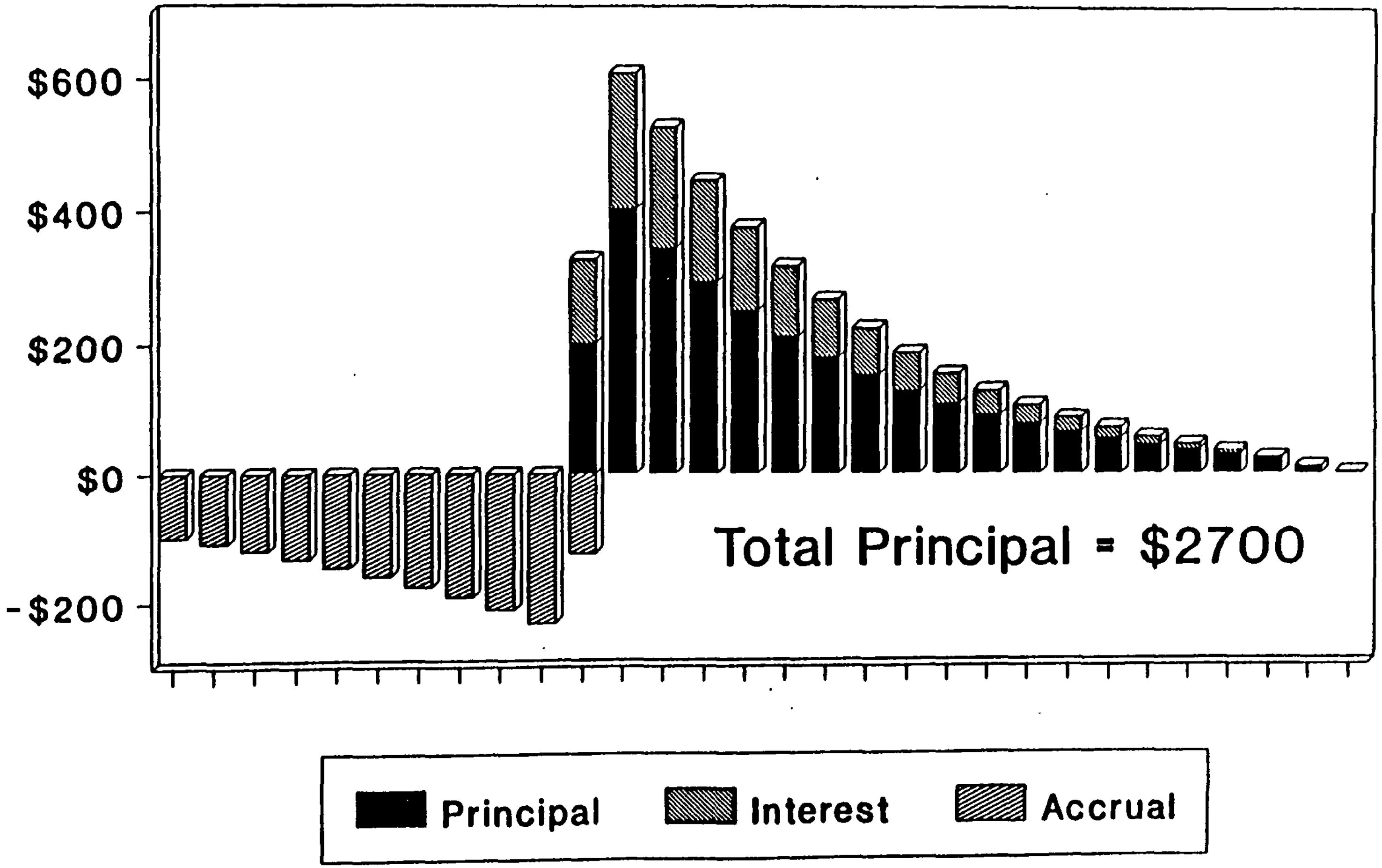
At this point, I'd like to then move into Case Study 2, which is an analysis of Z or accrual tranches. The graphs for these will look a little bit different (see Chart 7).

I'll mention again that a Z or an accrual tranche does not generate cash flows for some period of time. Instead, the coupon on a Z tranche is used to increase the outstanding principal value, much like a payment in kind (PIK) corporate bond. The early striped bars below the zero level represent that increase in outstanding principal; note that it is a compounding function. The first coupon increases the outstanding principal. The next coupon is based in the increased amount of outstanding principal, and therefore generates a little bit more.

At some point this tranche then enters its payout phase. It ceases accruing and begins paying down interest and principal. This is a back-end Z. Thus, it has cash flows that extend all the way to the end of the deal. In this particular case, based on a $1,000 initial amount of par value, the aggregate amount of principal that will be repaid is $2,700.

CHART 7

Case Study 2A: FHLMC 21-Z
Annual Cash Flows - Level Rates



If we look at this tranche under two alternative scenarios, in this case down 300 and up 300 basis points, you can see the change in pattern of both the accruals and the cash flows in Chart 8. In the case of a down-300-basis-point scenario, we can see that the total amount of principal that will ultimately be received has now declined from $2,700 to $1,970 (per $1,000 of initial par value). This is because there is less time for that Z to grow. In an up-300-basis-point scenario, we've seen that total amount of principal ultimately to be repaid increases from $2,700 to $3,520 because of the slower prepayments that are associated with that scenario.

Numerically you can see the average life variability and the cash-flow duration variability in Table 5. This begins as a little longer tranche than the nonaccrual tranches discussed earlier. Z tranches have typically a little longer average life and certainly a longer duration. Because of the cash-flow patterns and because cash flows are deferred for such a long time period, a Z tranche has a cash-flow duration that is typically nearly equal to its weighted average principal life.

TABLE 5

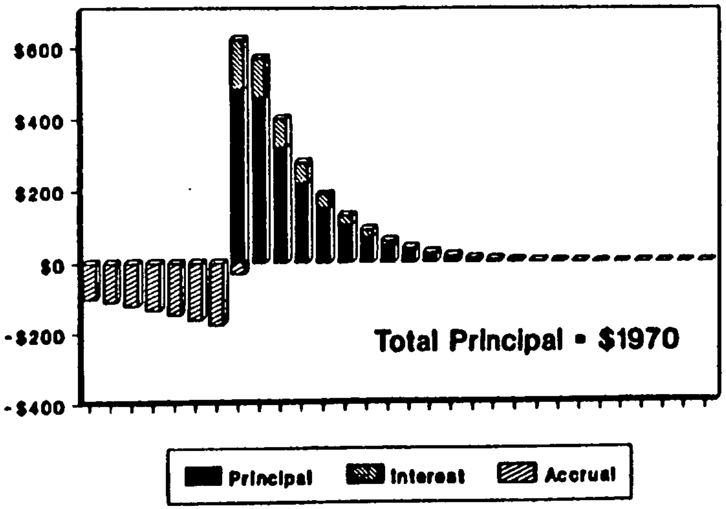
Case Study 2A: FHLMC 21-Z
Summary for Scenarios 1-3

Scenario	Average Life (yrs)	Cash-Flow Duration (yrs)	Payment Window
-300 bp	7.1	6.5	4.4 - 27.2
Level	12.8	11.2	7.7 - 27.2
+300 bp	16.8	14.7	10.6 - 27.2

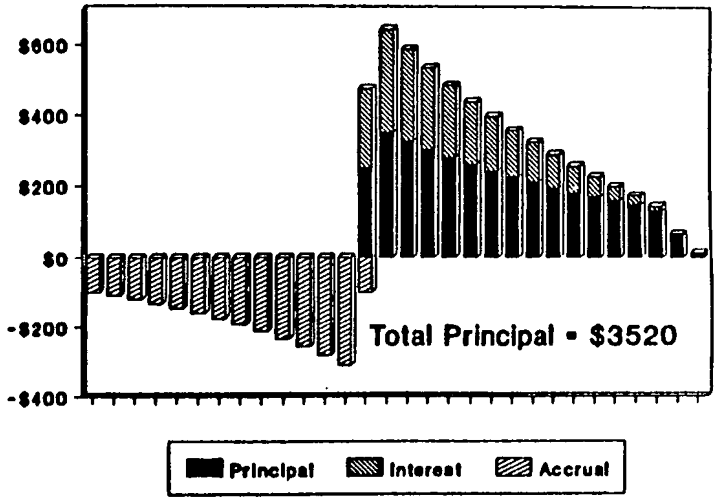
If we look at the dispersion diagram (Chart 9), we can see a relatively wide confidence interval, owing in large part to the fact that this is a back-end Z, and so it has everything in the cash-flow stream beyond a certain point. The same is true for the cash-flow duration dispersion.

CHART 8

Case Study 2A: FHLMC 21-Z
Annual Cash Flows



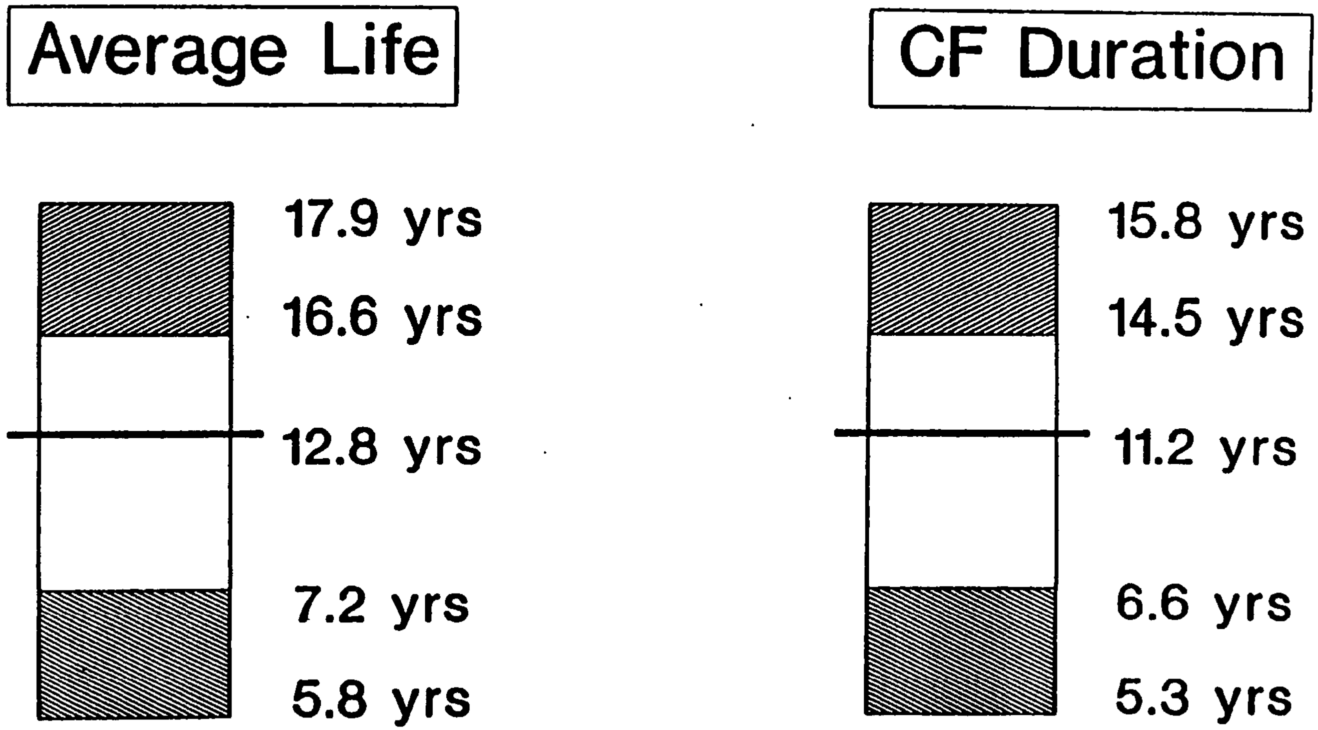
Rates -300 bp



Rates +300 bp

CHART 9

Case Study 2A: FHLMC 21-Z
Summary for 20 Scenarios



Now, I'd like to look at a bond that some of you may be less familiar with, and that is a Z tranche that is embedded early on in the deal. It is not the tail end of a deal.

I need to have you correct one error in Chart 10. Since you cannot accrue in a second year once the bond has started paying down, please eliminate the accrual bar (lower striped bar) in the second-to-last bar on this chart.

This is roughly a five-year average life Z bond. An analysis of this bond (which is based on FNMA 9.5% collateral), reveals considerable stability in its average life in a down-300-and-up-300-basis-point scenario (Chart 11 and Table 6). It does not shorten significantly, nor does it extend significantly.

TABLE 6

Case Study 2B: FNMA 89-30-X
Summary for Scenarios 1-3

Scenario	Average Life (yrs)	Cash-Flow Duration (yrs)	Payment Window
-300 bp	2.6	2.5	1.9 - 3.3
Level	4.5	4.4	3.3 - 5.8
+300 bp	6.4	6.2	4.8 - 8.1

Numerically (Chart 12), you can see the tightness in the average life band and the cash-flow duration band. This is also an instrument that has a very tight prepayment window. It's not uncommon in even a five- or seven-year tranche to have prepayment windows that are seven or eight years wide. The market will "pay up" for a CMO tranche with a narrow window. In other words, it will give you a slightly lower yield for a CMO tranche that has a much tighter prepayment window associated with it.

CHART 10

Case Study 2B: FNMA 89-30-X
Annual Cash Flows - Level Rates

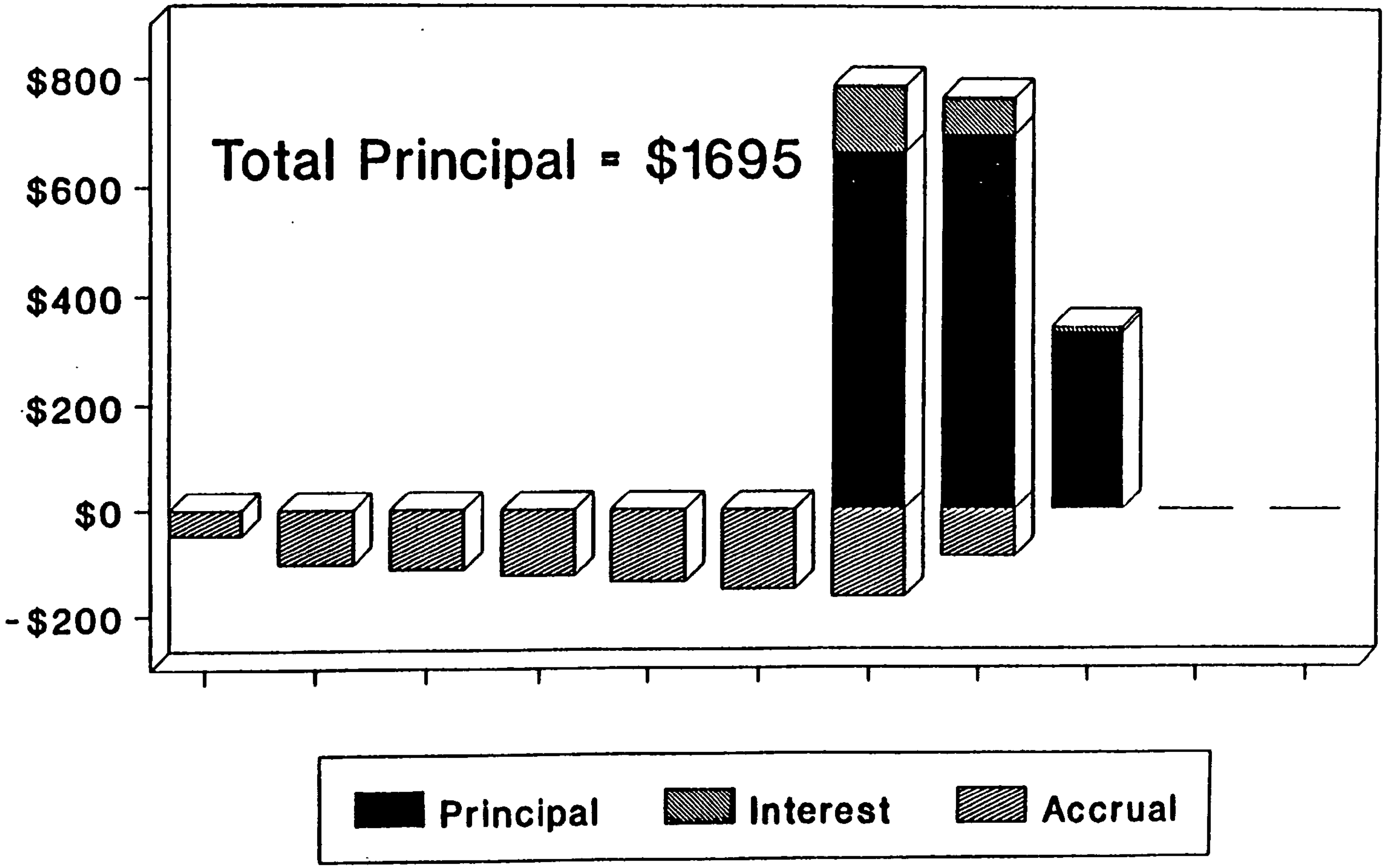
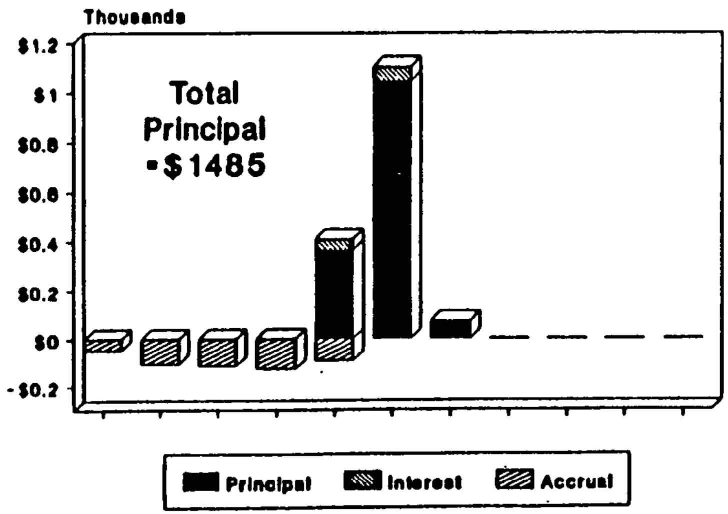
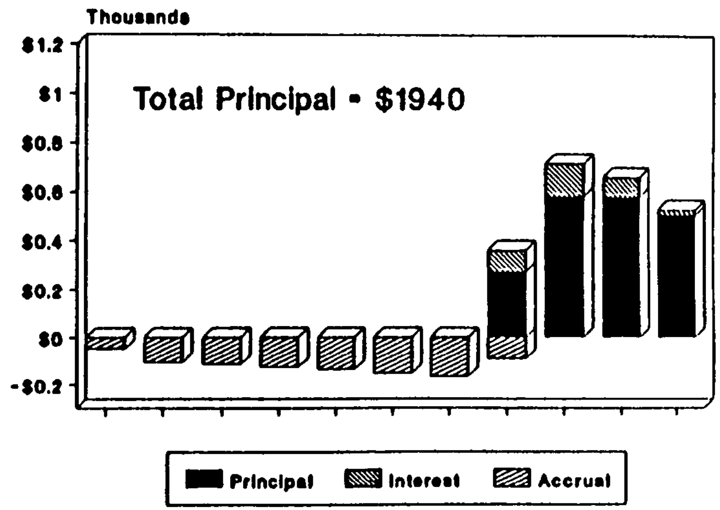


CHART 11

Case Study 2B: FNMA 89-30-X
Annual Cash Flows



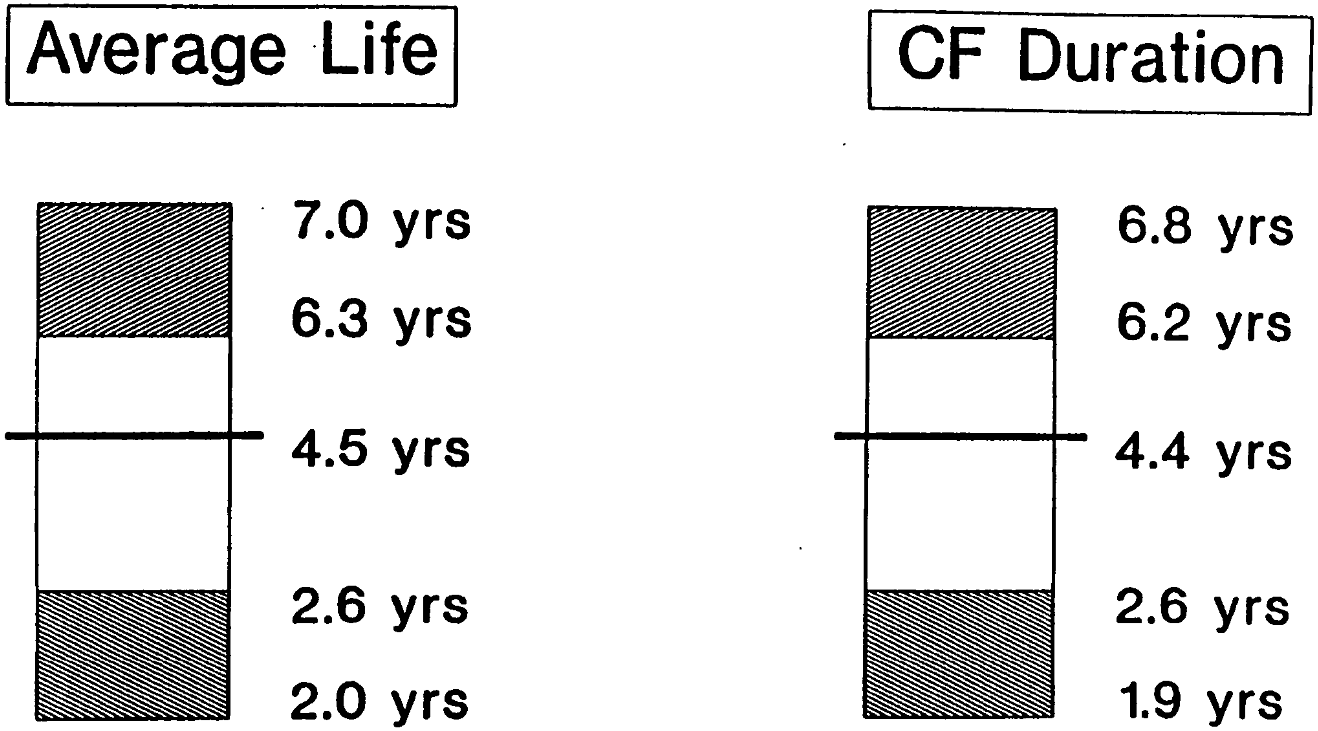
Rates -300 bp



Rates +300 bp

CHART 12

Case Study 2B: FNMA 89-30-X
Summary for 20 Scenarios



From the dispersion graph you can see that the 80% confidence interval is a very narrow 3.5 years on this instrument. This is a very stable bond and it is a very good instrument for an asset/liability match.

Now I'd like to contrast that with a Z tranche that also begins life in the base case as an intermediate Z. The collateral on this deal is actually FNMA 9%, which is a little better collateral (in terms of holding in average lives) than FNMA 9.5%.

In the base case you can see (Chart 13) that the total principal that would be repaid is $1,490 per initial $1,000 of par. However, in this case if we change the scenarios up 300 or down 300 basis points you can see that the cash-flow patterns have changed "slightly" (Chart 14). This is a companion or support Z tranche. It supports the stability of PAC and other tranches that are embedded into this CMO. In the left-hand graph you can see that we have very little chance to accrue principal. In fact, the aggregate amount of principal that would be paid is $1,120, versus the $1,490 in Chart 13. In the other case, as interest rates go up, you can see the significant extension involved in this instrument, and the total principal that's repaid is significantly increased to $3,405.

Clearly, the average life extension and the average life shortening (Table 7) do not fit my screening parameters for this instrument. However, compensation is provided for that in the form of yield. You can get a significantly higher base case yield for this instrument, perhaps 150 to 200 basis points higher than you can the previous Z. Nonetheless, the risk involved is significantly higher, and to my mind does not justify that higher yield. It's not a very bad prepayment window in the base case, but there's a significantly varying average life.

CHART 13

Case Study 2C: FNMA 91-100-Z
Annual Cash Flows - Level Rates

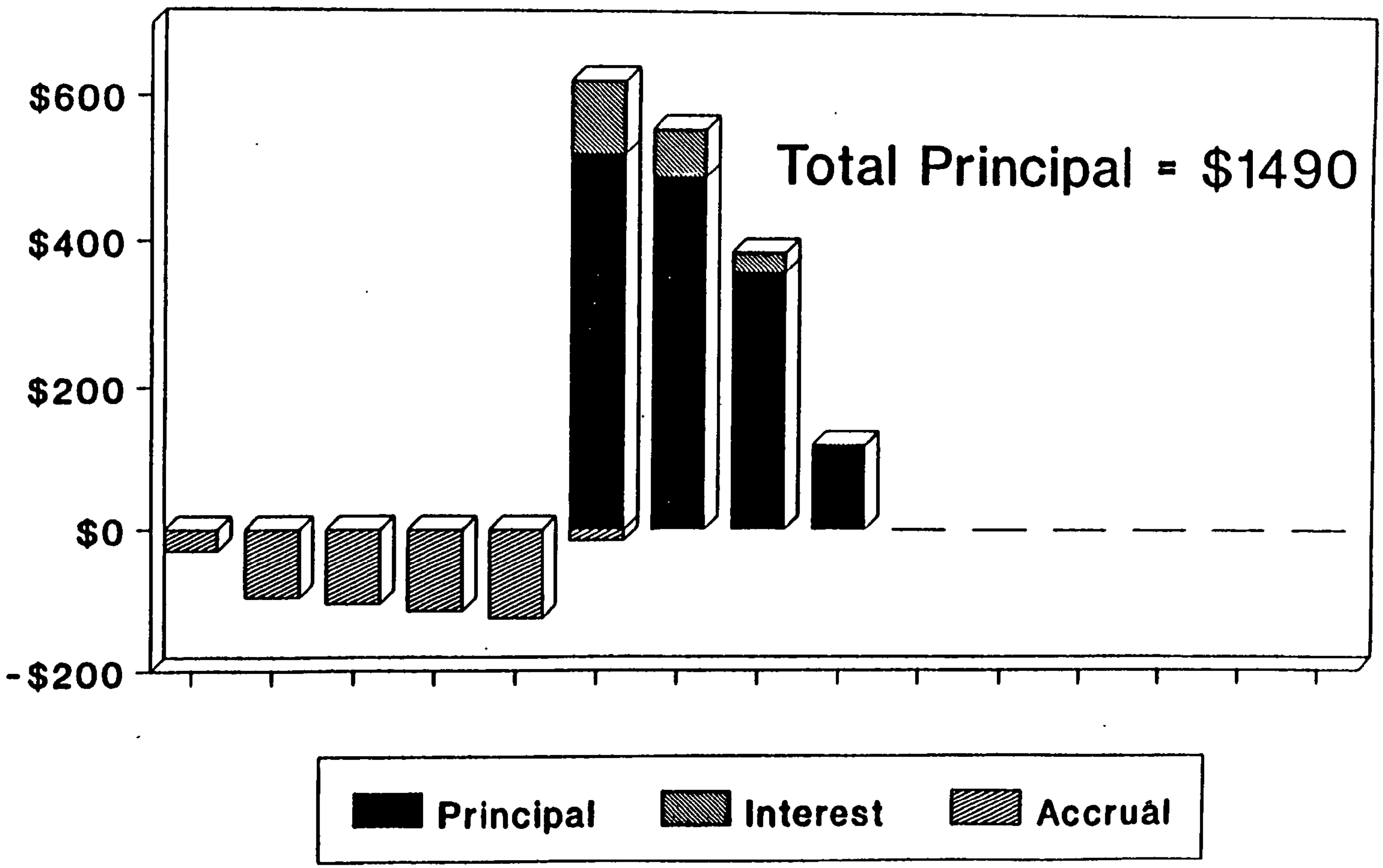
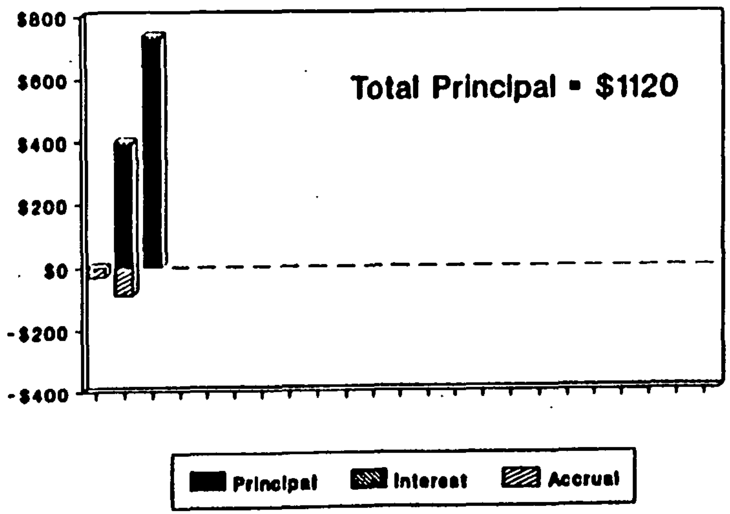
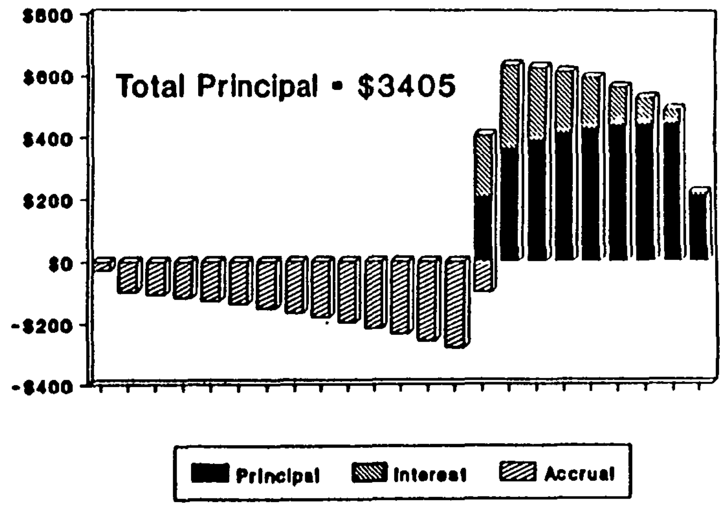


CHART 14

Case Study 2C: FNMA 91-100-Z
Annual Cash Flows



Rates -300 bp



Rates +300 bp

TABLE 7

Case Study 2C: FNMA 91-100-Z
Summary for Scenarios 1-3

Scenario	Average Life	Cash-Flow Duration (yrs)	Payment Window
-300 bp	1.3	1.2	1.1 - 1.3
Level	5.8	5.6	4.4 - 7.7
+300 bp	17.9	16.9	13.6 - 21.8

Finally, the dispersion graph for this particular tranche is shown in Chart 15. The 80% confidence interval is 16 years wide, which is a very poor fit for any type of a liability that you're trying to match durations to, because of the extreme variability in the duration of this particular bond.

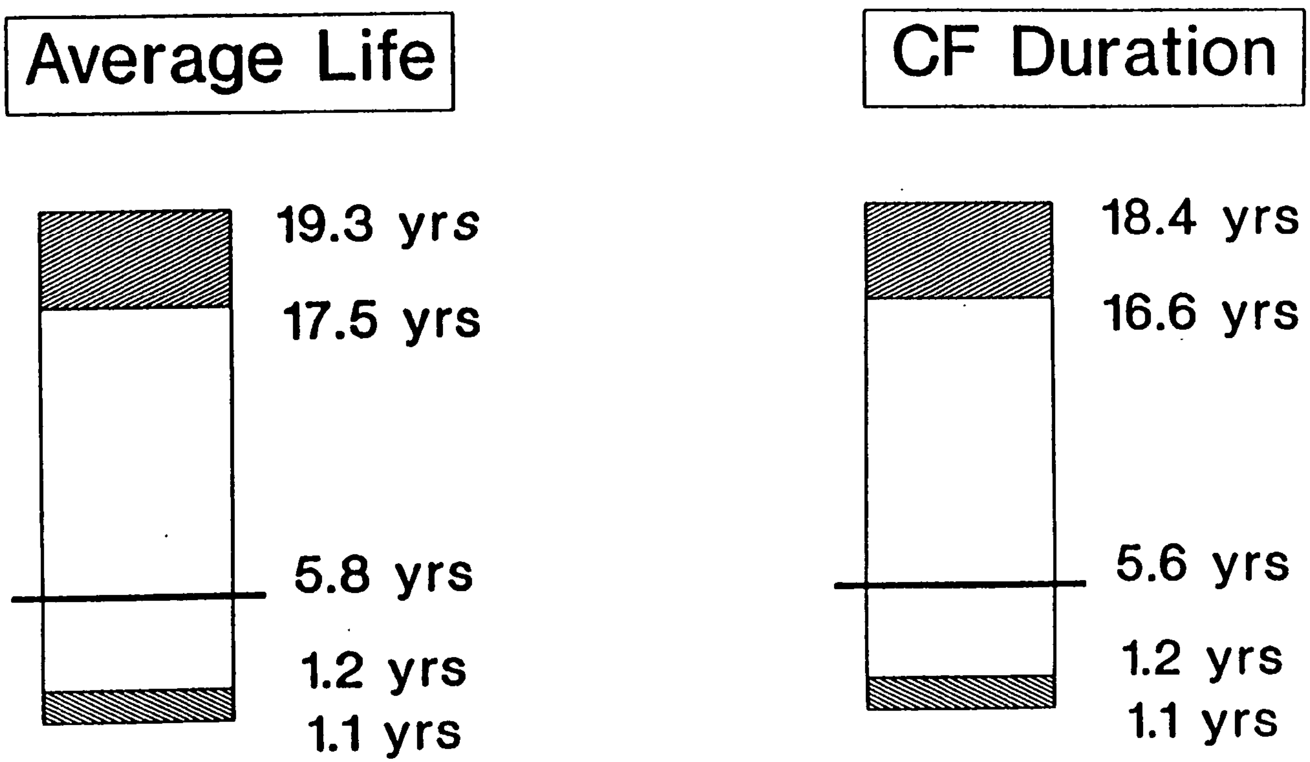
MR. DAVID A. HALL: What do I mean when I talk about static versus dynamic modeling? In actuarial terms, static models are somewhat comparable to deterministic pricing models. They evaluate performance based upon expected values of various contingencies, and do not evaluate standard deviations around those means or variability as it emerges around the mean.

I'll be showing some examples of how static cash-flow projections can significantly distort the apparent performance of certain types of CMO tranches.

Dynamic modeling better illustrates real world variability. It recognizes changing risk profiles and introduces to some extent a bit of art in place of science. When you evaluate some of the more exotic CMO forms, I think you have to take an artistic look at what's going on, and think about how these things behave without necessarily being able to reduce performance strictly to one or two numbers.

CHART 15

Case Study 2C: FNMA 91-100-Z
Summary for 20 Scenarios



The two case studies that I'm going to discuss in this part of the program will deal with, first, exploring the concept of a PAC range (or PAC collar) drift, and second, evaluating the impact of prepayment noise or variability on the performance of a super PO.

Let's begin with a brief review of a PAC tranche. In the example I will use, I am constructing a PAC with a collar or range of protection from 90% PSA to 300% PSA.

The graph (Chart 16) indicates that the scheduled sinking fund of this PAC tranche is simply the lesser of the cash flows available under either of those two level-prepayment scenarios.

You can see (Chart 17) that, in a base case assumption of 165% PSA, there is plenty of excess cash flow at all times to fully support the PAC tranche and continue to pay off the excesses to the support tranche. In a slower scenario the support tranche falls to the end of the deal.

Chart 18 shows the cash flows at 90% PSA (the slow end of the PSA collar). All the cash flows in the early period go to the PAC; and the support, instead of wrapping around the entire deal, slips to the end of the deal. The dotted line in this graph is just a shadow of the 165% PSA cash flows.

Conversely, at 300% PSA (which is the fast speed embedded in the PAC schedule), the support all jumps to the front of the deal (Chart 19). The PAC schedule still is not breached. This is because there are still sufficient cash flows available, even after the support is gone, to fully amortize the PAC tranche on schedule.

Chart 20 shows a prepayment speed above the protected range, in this example 400% PSA. You can see that before long all the support has been extinguished, and all that's left is the PAC. So now it has to accelerate somewhat ahead of schedule. Although it has significant prepayment protection, there still is some out-of-the-money risk of shortening. The converse would be true if we ran a projection at a speed slower than 90% PSA.

CHART 16

Simple PAC Structure
Building a 90-300% PSA PAC Schedule

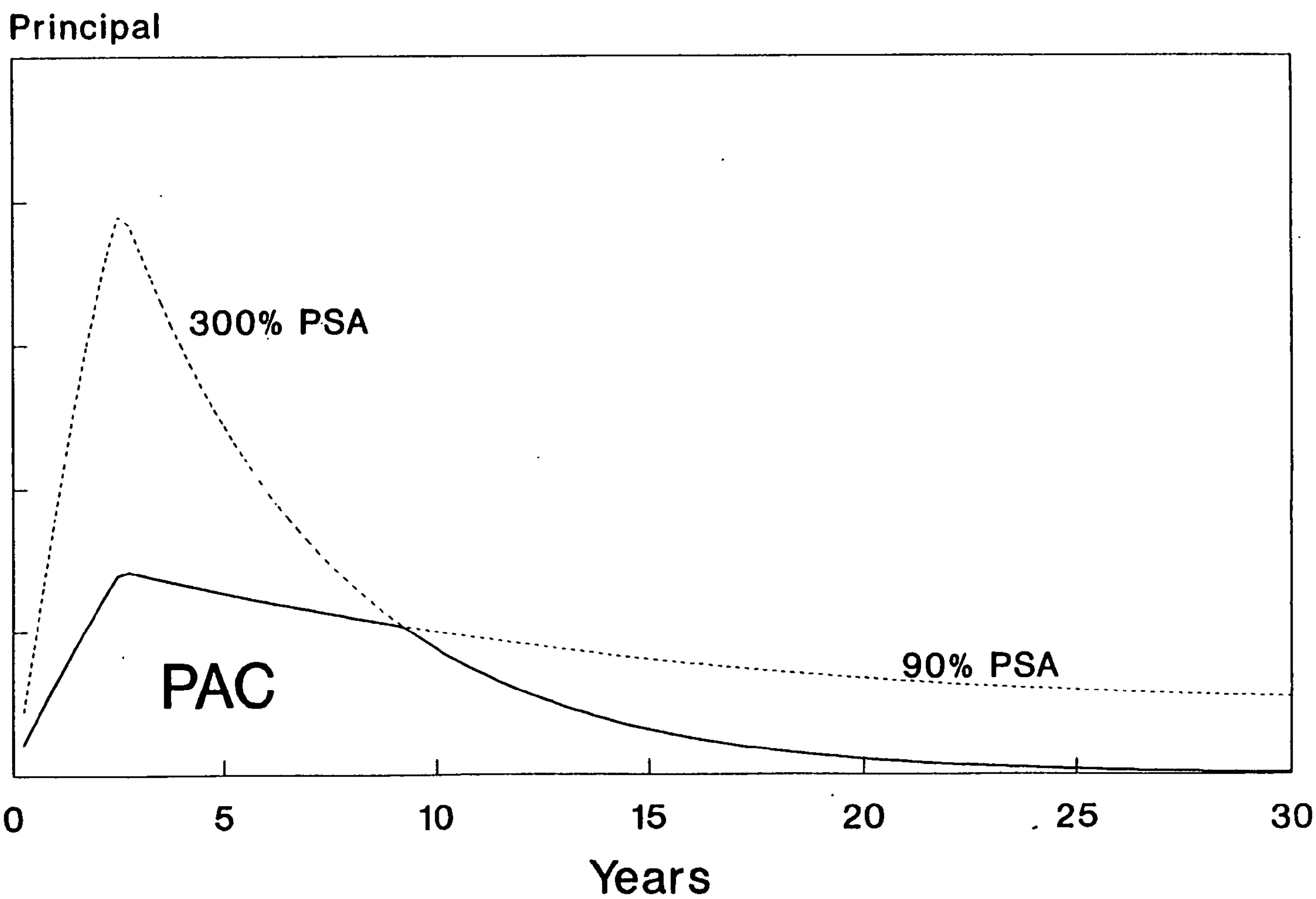


CHART 17

90-300% PSA PAC Structure
Projected at 165% PSA

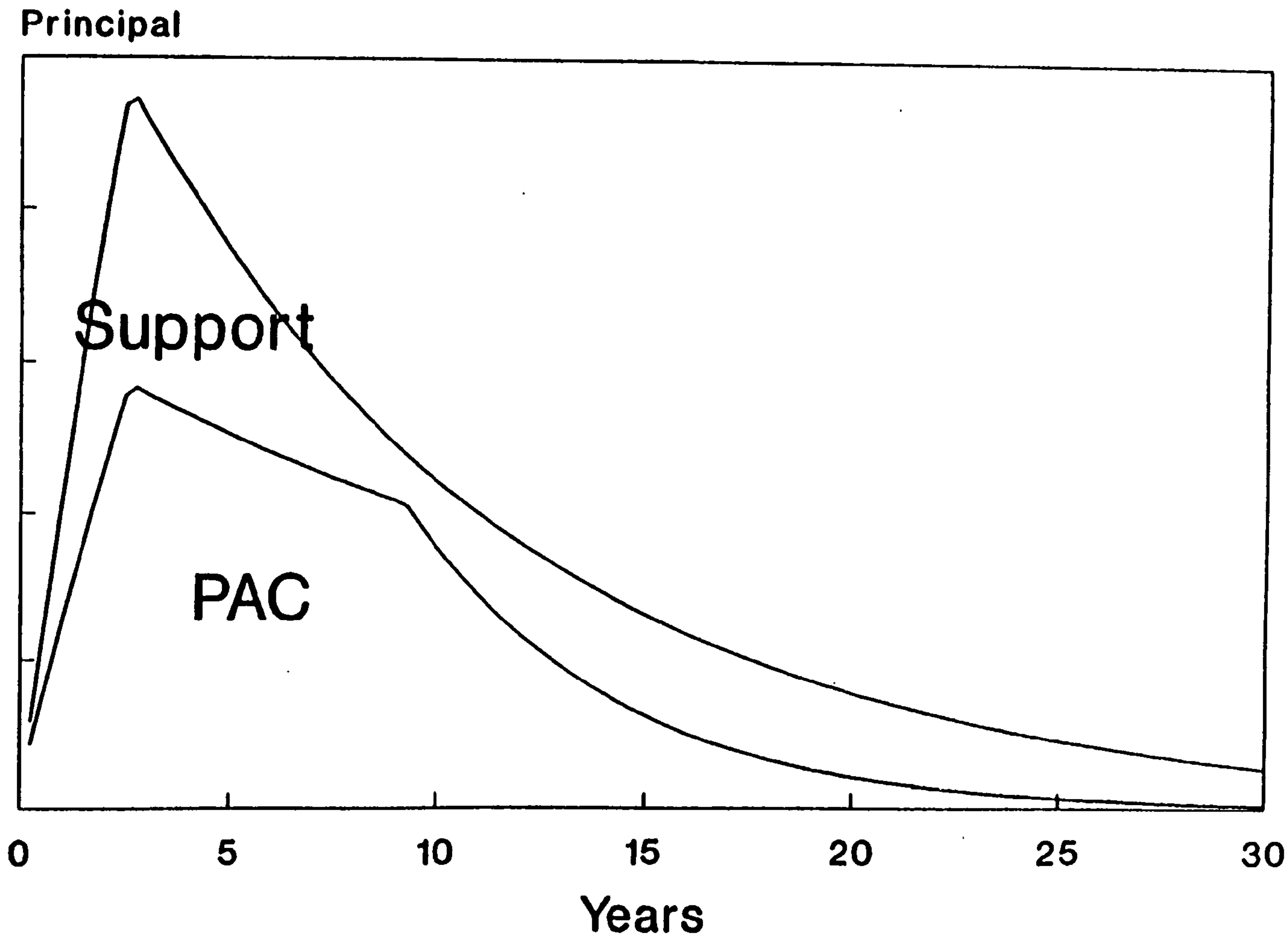


CHART 18

90-300% PSA PAC Structure
Projected at 90% PSA

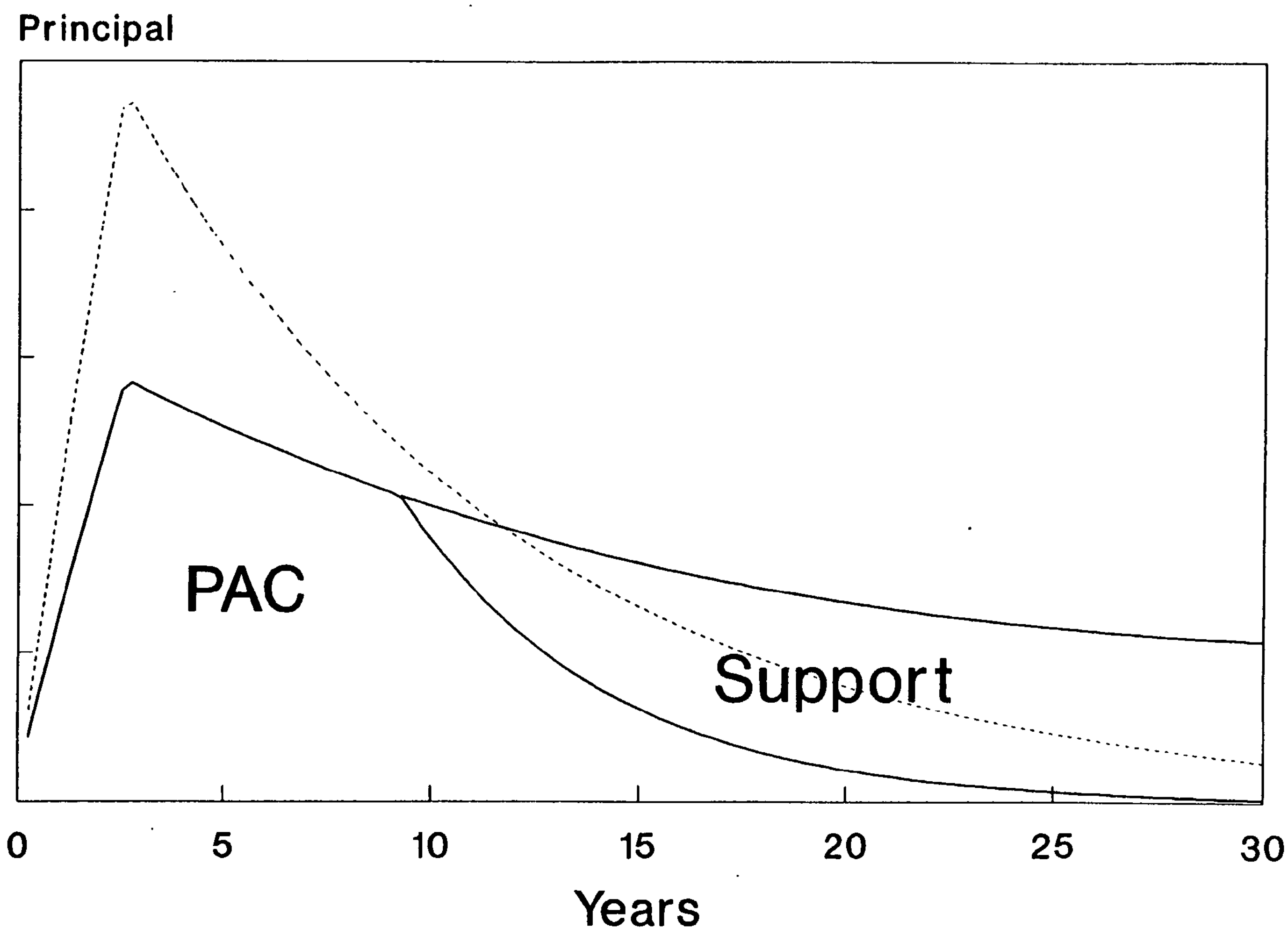


CHART 19

90-300% PSA PAC Structure
Projected at 300% PSA

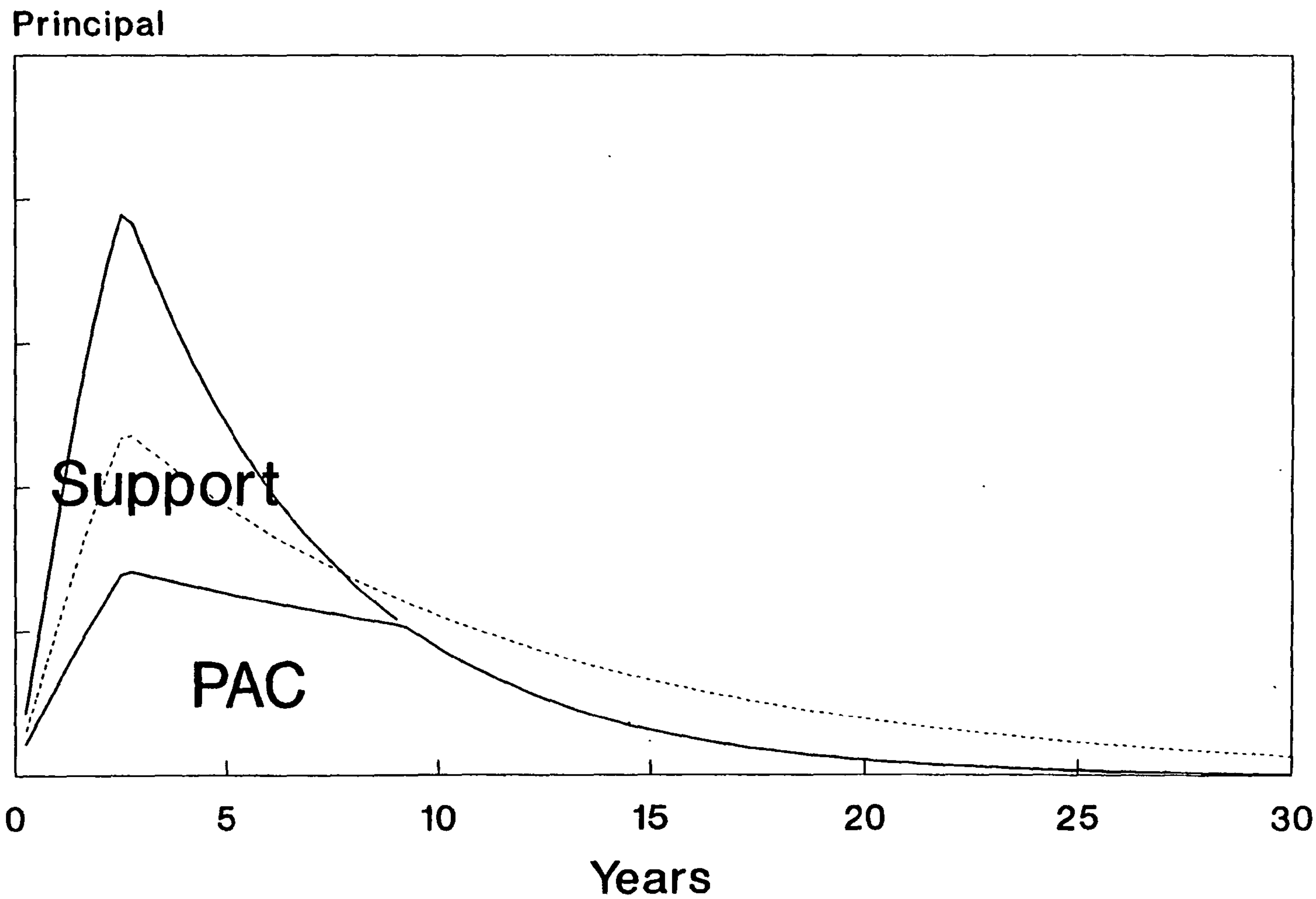
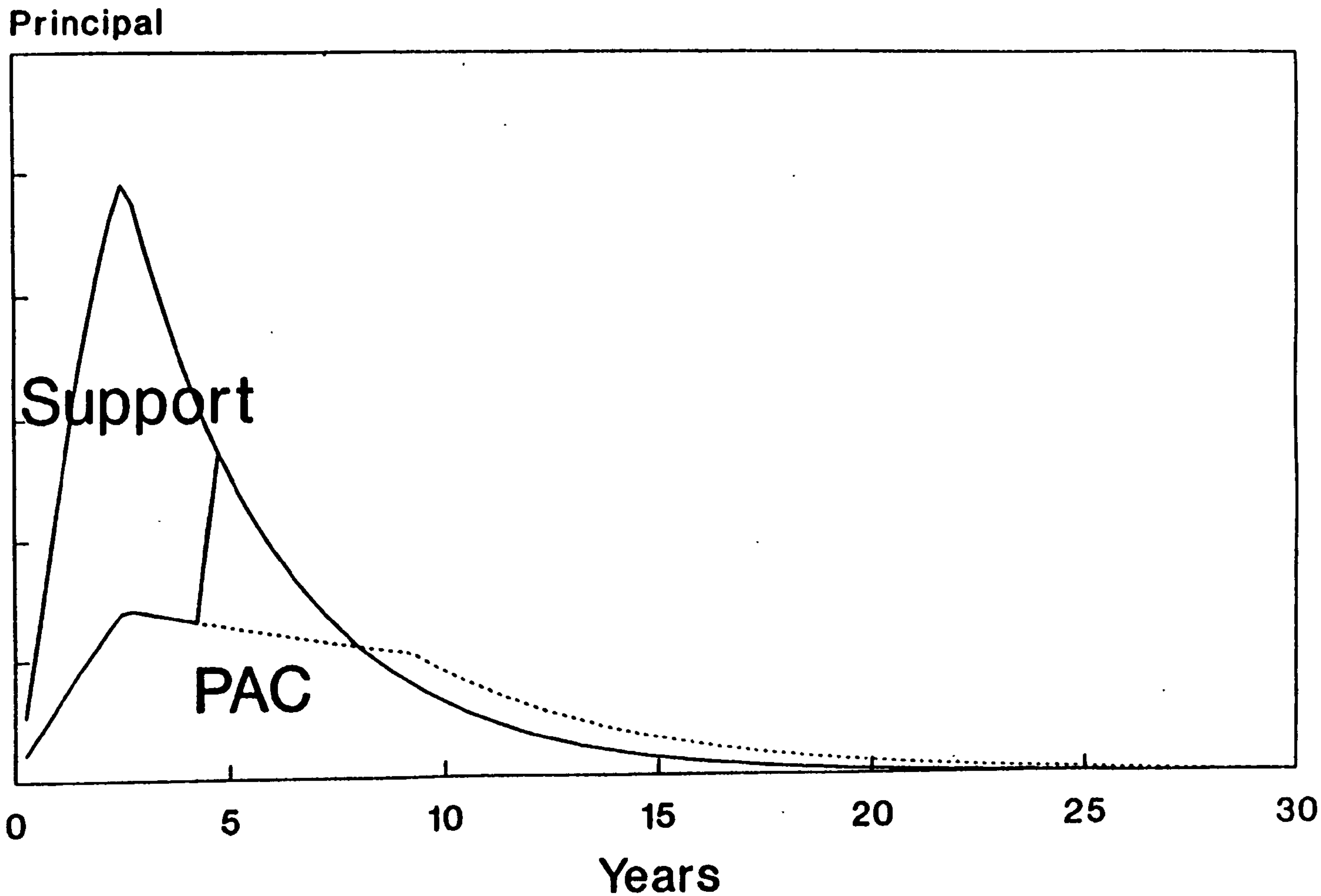


CHART 20

90-300% PSA PAC Structure
Projected at 400% PSA



Where am I going with this? We describe this as a 90-300% PSA-protected PAC, and what investment people and actuaries like to be able to say about this type of structure is that no matter whether prepayment speeds are fast, slow or variable, as long as they remain within that 90-300 range throughout the duration of this deal, the PAC schedule will be able to be met. Intuitively, that's a comfortable thing to be able to say. Unfortunately, it's not true.

Let's look at how dynamic modeling can affect the behavior of this PAC range. I'll show that at times you can have prepayments outside the range that can be supported, and you can have prepayments within the range that cannot be supported.

For my next example (Table 8), I've used the PAC that we've looked at before. However, I have tranched it into two sequential tranches. This example is a PAC that has an average life of 10 years at issue.

In effect, I have created two PACs out of this deal, and you might think of there being a dividing line somewhere in the five- to 10-year range which breaks this into a short PAC and a long PAC.

My comments will address the long PAC, which at issue has an expected average life of 10 years. It would be expected to pay principal from about year six through the end of the deal.

If we look at how the average life would be expected to vary, based upon a projection measured from issue date, you can see that at level-PSA projections throughout the life of the deal, from a level 90% PSA through to a level 300% PSA, it does maintain its schedule and does have a 10.3-year average life.

TABLE 8

Demonstration of PAC Range "Drift"
Original PAC Protected Range is 90% - 300% PSA

PSA	(A) Original Average Life	(B) Original Minus 5	(C) After 5 years at 100% PSA	(D) After 5 years at 250% PSA
50%	13.5	8.5	6.9	9.5
80	10.7	5.7	5.6	7.4
90	10.3	5.3	5.34	6.9
100	10.3	5.3	5.3	6.5
140	10.3	5.3	5.3	5.4
150	10.3	5.3	5.3	5.3
300	10.3	5.3	5.3	5.3
330	9.6	4.6	5.3	5.3
350	9.2	4.2	5.3	5.0
400	8.1	3.1	5.0	4.4
500	6.6	1.6	4.2	3.5
600	5.5	0.5	3.5	2.9

(A) Average Life, in years, projected at issue date

(B) (A) - 5 years

(C) Actual projected average life remaining after 5 years of prepayment experience at 100% PSA

(D) Actual projected average life remaining after 5 years of prepayment experience at 240% PSA

If we use speeds somewhat slower than 90% PSA we see a little bit of extension. At a 50% PSA, for example, it extends to a 13.5-year average life. And at faster speeds, we see some shortening. At an extreme of 600% PSA, it would have a 5.5-year average life. The 600% PSA is a fairly extreme speed to be sustained by virtually any type of collateral.

So, we have something that has good prepayment stability when measured from issue.

In Table 8, the second column is just the first column minus five years, sort of a ballpark of what you might expect the remaining average life of this to be five years from now, since it's not scheduled to begin paying any principal until after the fifth year.

What I'm going to do now is walk through a couple of examples of different experience during the first five years, and see how those change the behavior of this tranche when viewed from that 60th month forward.

In the first example (column C), I've assumed that prepayment experience for the first five years has been at 100% PSA, which is very clearly within the protected range.

Now I'm standing at the five-year date, and I'm looking at the behavior of this tranche going forward at various PSA speeds within the protected range. If it continues to pay at 100%, I'll still have 5.3 years to go, which is what you would expect since we started at 10.3 and five years have elapsed. As it turns out, I now will have that 5.3-year average life remaining for speeds all the way up to 350% PSA.

Why has that happened? It's happened because there is now more support available in the deal relative to the PAC than there would have been had we been paying at a faster speed along the way. This means that, as that support has remained (because we've been paying at a slow speed), it is now able to protect against a wider range of prepayments. I'll have some graphical examples to depict that later on, because it's a tough concept to visualize without seeing a picture.

In effect, we started out with a security that was protected at speeds of 90-300% PSA, and five years from issue we have a security that turns out to be protected from 100-350% PSA. Both the lower end and the upper end (of the protected collar) have "drifted" somewhat, the upper end more than the lower. If it now slows down to a 90% PSA, we have a slight extension from what we would have expected. On the other hand, if it speeds up faster than 350% PSA, we would start to accelerate through the schedule again.

Let's look at a different example. In column D I've modeled the behavior for the first five years at a 240% PSA prepayment rate. In this instance, when projected forward from that time, my protected range (the PSA range through which the average life remains at 5.3 years) has contracted more dramatically.

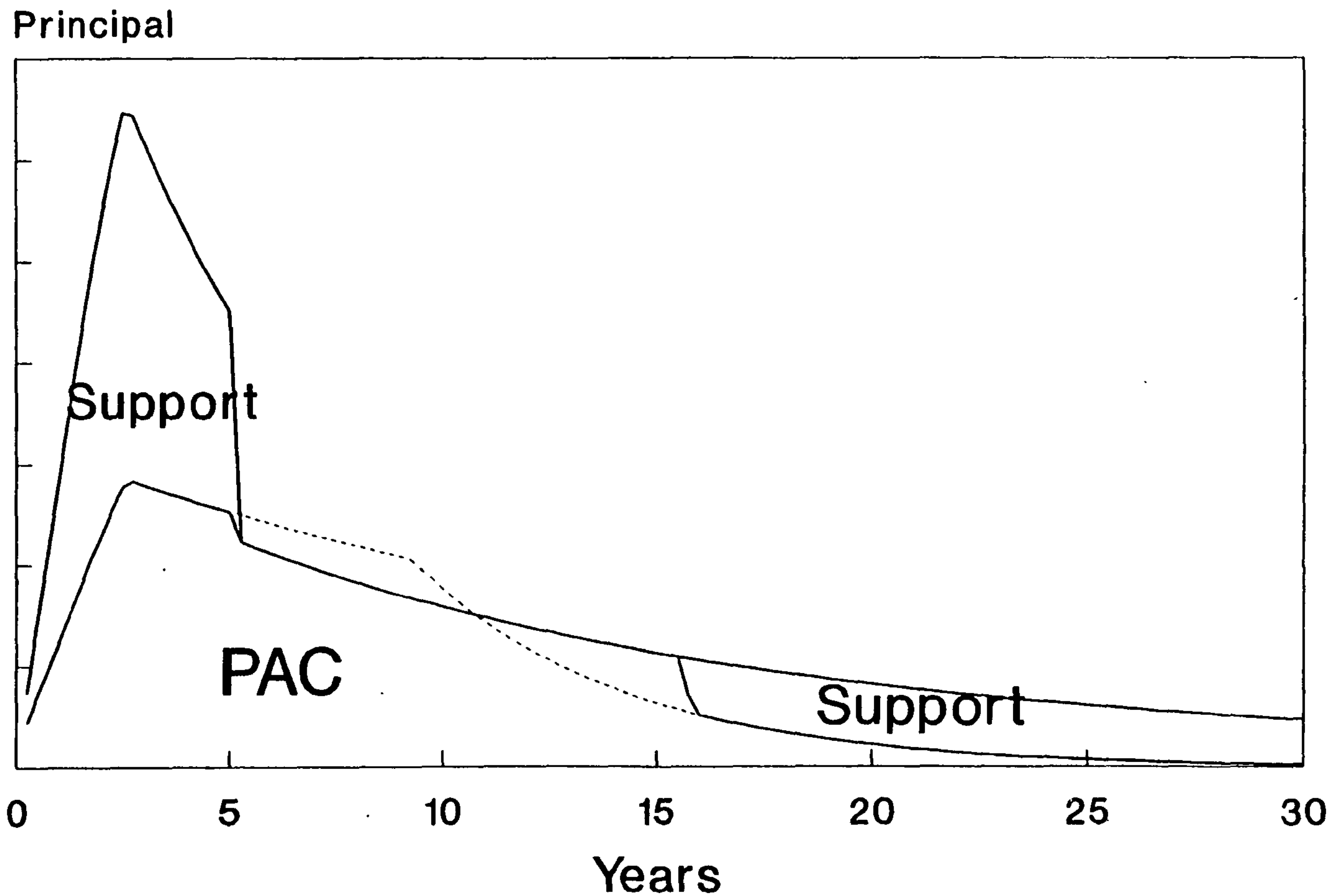
At this point, only speeds as slow as 150% PSA will still provide the scheduled cash flows, and the slowdown to 140% will begin to lengthen us through the schedule.

Similarly, the 300% PSA level seems to remain unchanged. Actually, the breakpoint here has drifted to somewhere between 300% and 330%, but it didn't round to a tenth of a year shorter until 330% PSA. In this instance, slowing down to a 90% PSA or 100% PSA, which was near the slow end at issue, now results in an extension of more than a year beyond what the original average life was supposed to be.

Let's look at some pictures now, and I hope they'll be worth a thousand words. Chart 21 is an example where we have a fast prepayment speed for some period of time. During the first five years, the total cash flows are projected at a 240% PSA. The PAC is staying on schedule, and the support is picking up all the excess.

CHART 21

90-300% PSA PAC Structure
Projected at 240% PSA for 5 years, 120% thereafter



But at the fifth year we suddenly slow down our prepayment assumption to 120% PSA; and at 120% PSA we no longer have enough cash flow to meet the full PAC schedule! So we begin to fall behind. We get further and further and further behind, until somewhere into the 11th year or so. At that point you start catching up. Although there are cash flows now available which are in excess of the schedule, they will not go to pay down the support until the PAC has fully caught up, which does not occur until sometime after the 15th year. From that point forward we're back on schedule. The support picks up.

In this particular example, our PAC has lengthened somewhat. This is because a portion of the cash flows that should have occurred in that five- to ten-year range have now drifted to the ten- to fifteen-year range. The support is wrapping around that.

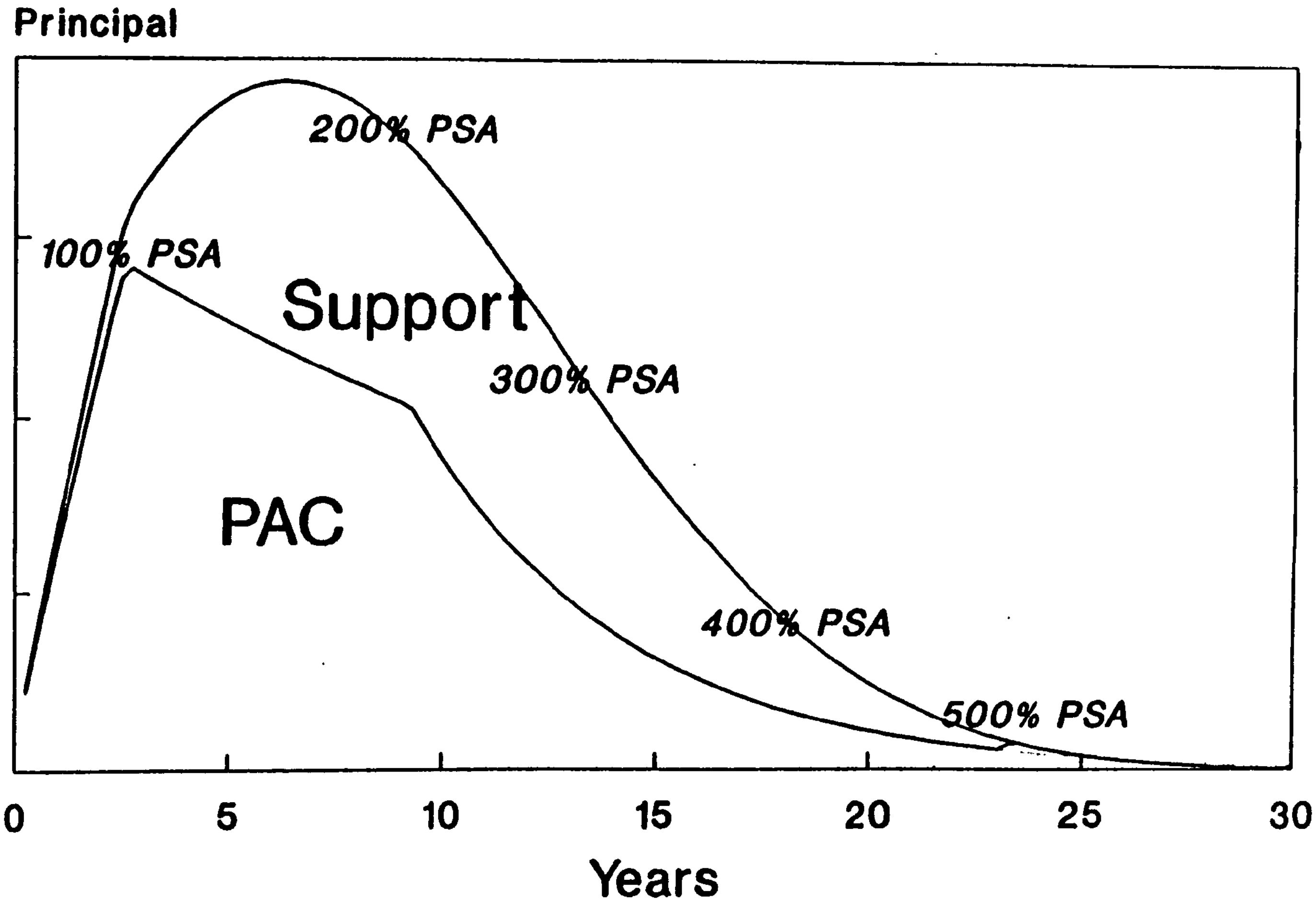
Again, you need to notice that throughout this entire scenario, prepayment speeds have always been within that 90-300% range. They've never gotten outside. In fact, they stayed comfortably within.

In the next example (Chart 22), I've assumed that prepayments were at 100% PSA for the first 30 months, followed by some gradual acceleration. I'm assuming that in each month thereafter, the prepayment speed increases at 20% of the PSA model annually. So, five years later we're paying at 200% of the PSA model. Ten years later we're up to 300% PSA, and at each five-year interval thereafter we have accelerated to an even faster speed.

What I want you to notice in this projection is that, even when speeds have gotten well beyond what the original protected range was, the PAC is still in no trouble whatsoever. The scheduled cash flows of the PAC (which are shown on the lower curve in the graph) are well within the ability of the total principal flow's support level (which are shown on the upper, rounded curve). In fact, it's not until you get out to about year 24 that you can see that the support has finally disappeared. Then there's just a little bit of "noise" going on at year 24, when the PAC has to accelerate slightly.

CHART 22

90-300% PSA PAC Structure
Projected at 100% PSA for 30 months,
Grading up 20% PSA per year thereafter



Very clearly this is a situation where speeds can pick up dramatically, as long as they have been paying slower than the maximum speed for some time, and still leave the PAC schedule intact.

What does all this mean in terms of modeling the behavior of PAC tranches? It means that the blanket statement, "If prepayments always stay within the PAC Range then the schedule will never be breached," is really not true. And this has several implications.

It means that in projecting the behavior of cash flows on PAC tranches (which I'm sure many of you have in your portfolios), you can't make the blanket assumption that in a standard environment (if PSA speeds simply stay within the protected collar) PAC cash flows will be on schedule.

You also can't make the assumption, in some of your grade-up scenarios or grade-down scenarios, that at the point where your prepayment assumption exceeds that initial collar, your PAC schedule will be invaded. This is why generic types of models have a lot of difficulty in capturing the true behavior of some of these securities.

There also is an impact if you need to do terminal market pricing at some horizon date in your analysis, because five years from now, if you're trying to assess what the market value of the remainder of the security is, the amount of protection remaining in the deal could be drastically different, depending on the actual prepayment history.

Look at this fast prepayment example: five years from now, this PAC will still look like a very stable bond. There's a lot of support left, and it will probably trade at fairly tight spreads to Treasuries based upon its average life stability. But go back to the fast-and-slow example: At this five-year point, this PAC suddenly has very little support left in the deal; and on a yield spread basis it will undoubtedly have widened substantially because it's really not a very protected tranche anymore. And so understanding how the other parts of the deal have been paying down is important, not only in assessing what the cash flows will be going forward, but also in assessing what the pricing of that security will be.

Let's move onto the second case study, evaluating a super PO (Chart 23). What is a super PO? A super PO is simply a support tranche in a deal which has either PACs or TACs, and which has a zero coupon. In this example the support tranche for this deal, if it has no coupon on it, is a super PO. We're going to look at the support of this TAC (whose payment schedule is based upon 165% PSA).

Randy went through an example of a support class, which was an accrual tranche, and showed you how the variability of that tranche made it very unattractive. But now I'm going to use an example of a support tranche, and show you why the variability of that tranche makes it very attractive.

First for a quick review, if this (165% PSA) is our base case speed, this support tranche (or super PO) will pay down after the TAC is extinguished, so it will have a very long average life. Therefore, because it has no coupon, it will trade initially at a very deep discount to par (because all of the investment income is going to be the accrual of that discount to the ultimate date).

Suppose prepayment speeds are slower than the TAC schedule, such as 100% PSA (Chart 24). Then the TAC will extend somewhat. This will also cause the support of the super PO to drift backwards; but it doesn't extend very much because it was at the tail end of the deal to begin with.

Conversely, suppose we get a prepayment speed that's faster, in this case a 325% PSA (Chart 25). Then the support moves almost entirely to the front, absorbing all of the excess cash flows over and above the TAC schedule. So we have incredibly dramatic shortening. In

CHART 23

Simple TAC Structure
165% PSA TAC Projected at 165% PSA

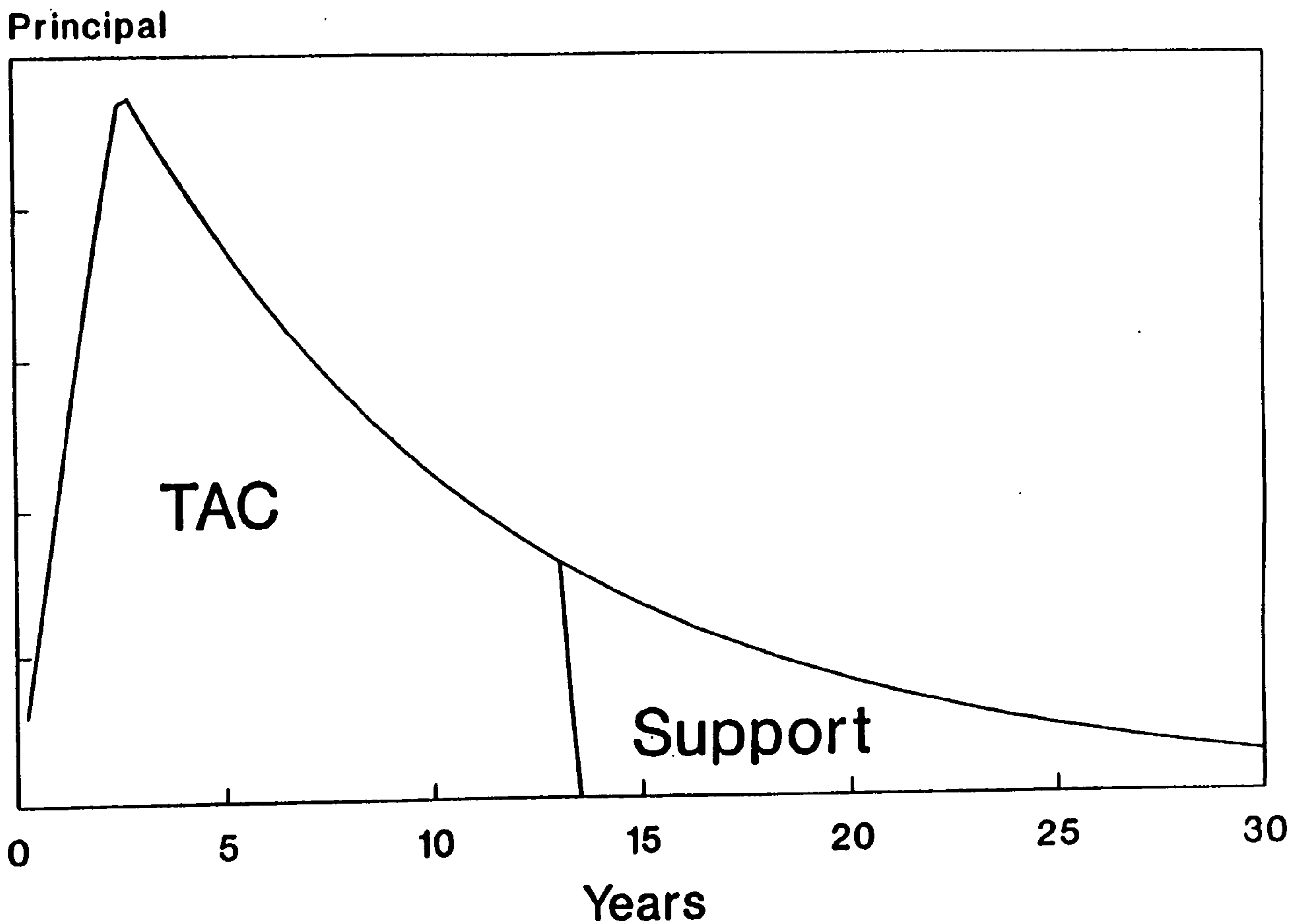


CHART 24

Simple TAC Structure
165% PSA TAC Projected at 100% PSA

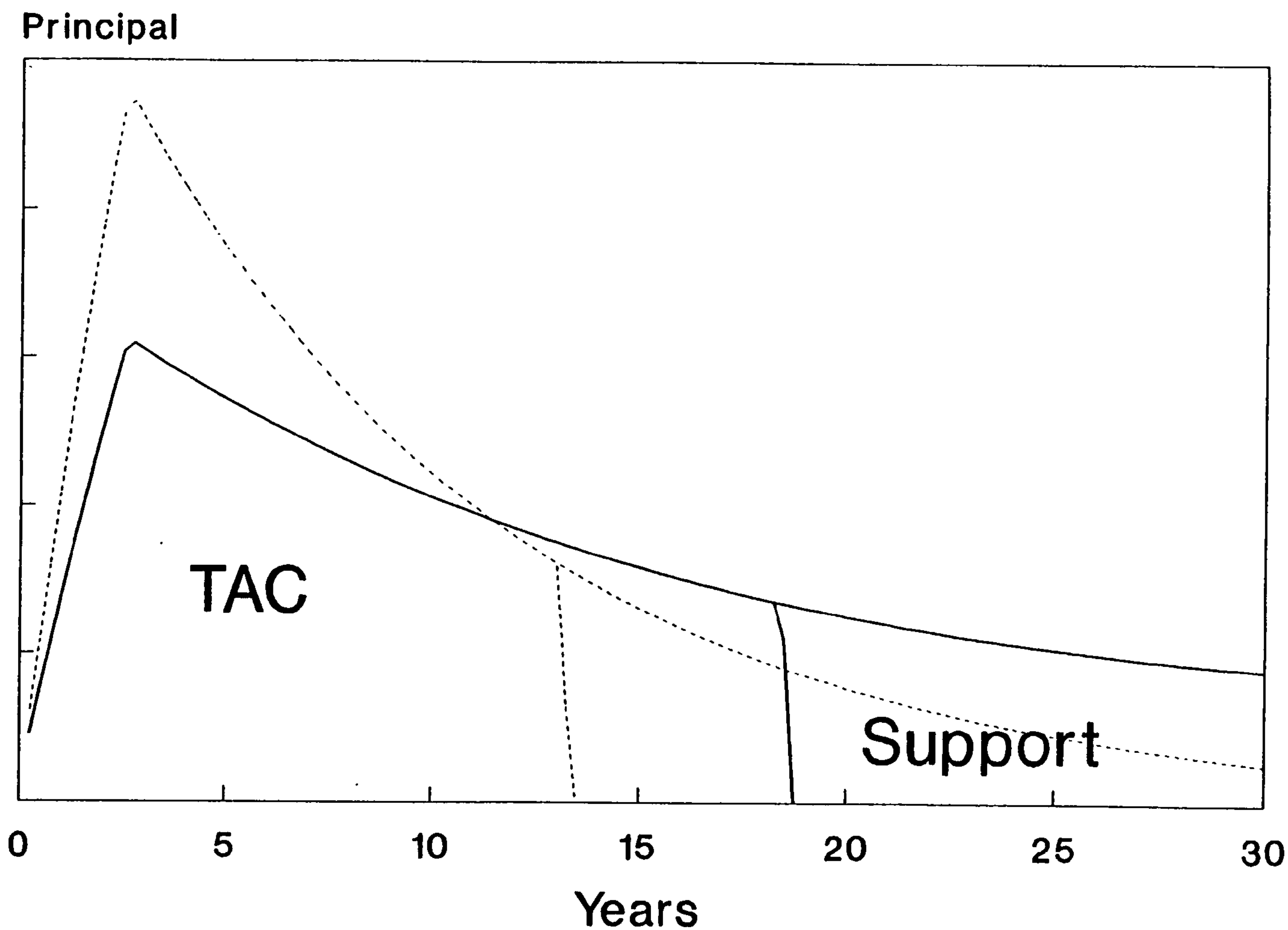
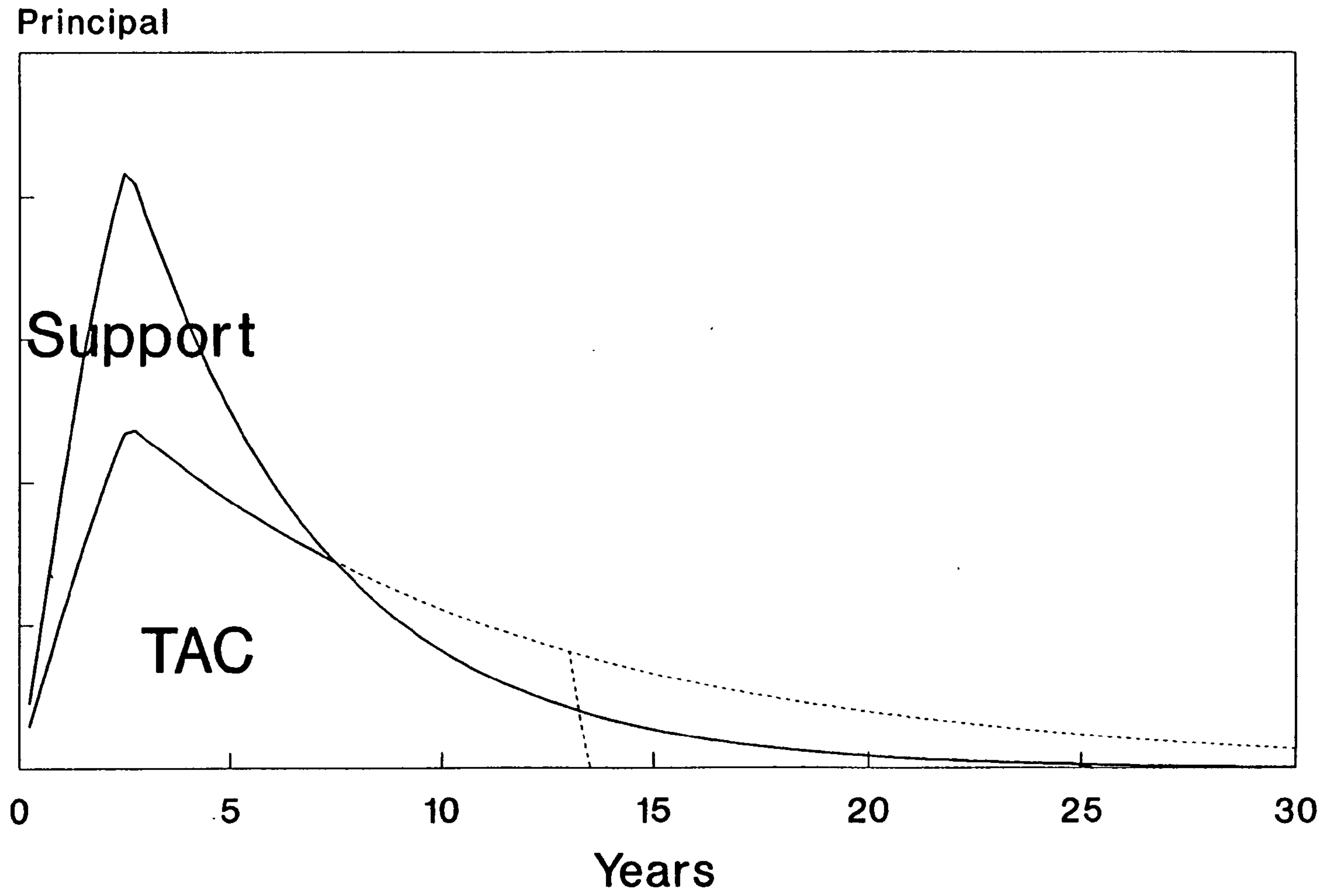


CHART 25

Simple TAC Structure
165% PSA TAC Projected at 325% PSA



Randy's example this caused a significant negative convexity problem. But in this example, as we'll see, this can cause some very favorable results. This is because suddenly you are amortizing your discount over a very short period of time, rather than over a very long period of time.

The next table (Table 9) shows the effects of two seemingly slight modifications: seasonal variation and a single spike. This super PO that I'm using as an example here is not exactly the same as the one that was in the graph. The average life at issue is a little bit longer than the one you're seeing. So, the effective leverage is a little bit more, although behaviorally it is very similar. Just don't try to match up the numbers to the lines in the graph because they won't correspond exactly.

This is a security that was backed by FNMA 9.5% collateral. When I did this analysis, the assumed average prepayment speed for this was 165% PSA. At that speed, the average maturity of this super PO is almost 25 years. It'll trade at a big discount, something less than 50% of par value. Nonetheless, if we do get prepayment at 165% PSA, then the yield (which in this case is calculated as the internal rate of return of those cash flows) is only going to be about 3.76% (column B). This is significantly "through" (below) a comparable Treasury yield.

You can see (in column A) that, as speeds slow down, this tranche does extend moderately but not dramatically. Obviously, if you have to wait longer to get your money back and you're receiving no coupon income in the interim, the yield declines as well. At 100% PSA our yield is approaching the 3% level (column B).

On the other hand, as you begin to get some acceleration of prepayment, this tranche begins to jump forward very quickly. At 180% PSA (which is really a very marginal increase over 165% PSA), the security shortens from 25 years to 16 years as it begins to wrap around and jump to the head of the line, picking up all of the excess cash flows in those early years. With

TABLE 9

A Comparison of Super PO Performance

|— Static Model —|— With Seasonal Variation —|— Plus Spike in 3 Years —|

Base PSA	(A) Super PO Average Maturity	(B) Proj. IRR	(C) Super PO Average Maturity	(D) Proj. IRR	(E) Delta IRR	(F) Super PO Average Maturity	(G) Proj. IRR	(H) Delta IRR
100%	29.1	3.15%	29.1	3.16%	0.01%	28.6	3.22%	0.07%
125	28.4	3.23	27.6	3.30	0.07	26.6	3.52	0.29
150	26.8	3.43	25.4	3.75	0.32	22.1	4.38	0.95
165	24.6	3.76	21.6	4.78	1.02	10.2	14.86	11.10
180	15.9	7.94	11.4	19.30	11.36	2.8	37.54	29.60
200	2.4	42.38	1.9	53.18	10.80	1.9	53.39	11.01
250	1.3	78.77	1.2	81.52	2.75	1.2	81.52	2.75
300	1.0	103.21	1.0	105.10	1.89	1.0	105.10	1.89

STATIC MODEL:
Assumes uniform monthly prepayment experience at the designated multiple of the PSA prepayment model
- (A) Average projected maturity of a hypothetical Super PO with a 165% PSA prepayment threshold
- (B) Projected yield of the Super PO, calculated as the IRR of the projected cash flows

SEASONAL VARIATION MODEL:
Assumes a recurring annual cycle of six months at 75% PSA above the mean followed by six months at 75% PSA below the mean
- (C) Average projected maturity according to the seasonal model
- (D) Projected yield according to the seasonal model
- (E) (D) - (B)

THREE-YEAR SPIKE MODEL:
Same as seasonal model, but with an extra 75% PSA spike in prepayments for a three-month period at the beginning of year four
- (F) Average projected maturity according to the spike model
- (G) Projected yield according to the spike model
- (H) (G) - (B)

an average life of 16 years, the yield in this example goes up to almost 8%, comparable to a Treasury yield for a long-duration security.

And if we move up only another 20% PSA to 200% PSA, we've shortened all the way to 2.4 years. And now all of a sudden the yield looks like something you'd like to have in your portfolio (as opposed to something you'd like your competitors to have). Once it's shortened to 2.4 years, there isn't much more shortening that's going to happen as you get successively faster speeds. (The yield will continue to jump on up, to over 100% at 300% PSA, but you'll have it for only a very short time).

The leverage of this deal, in effect, is around that 165% PSA threshold; that leverage being occasioned by the existence of the TAC schedule that is picking up the first 165% PSA.

It's difficult, especially for actuaries, to look at the possible purchase of a tranche like this when its base case yield might be stated as something around 3.75% (regardless of what it's doing outside that range). But what I want to try to bring out in this example is why this type of analysis can be very misleading.

Again, we have used a level-projected prepayment speed throughout the duration of this security. This is not only an average prepayment speed of 165, but also this is an every month prepayment speed at exactly 165% of the PSA model.

I'm going to use two different prepayment models, using these same mean PSA speeds, to show how variability in prepayment speeds around that mean can cause dramatic differences in projected performance. The "seasonal prepayment model" is what I'll call the first variation.

Looking now at Columns C through E of Table 9, this model is one that tries to capture the fact that prepayments tend to be faster during the warm months (the period through the summer and into the fall) and slower during the cold months (the period starting from December through the late spring months).

While this model still uses as its base an average prepayment speed of 165% PSA, it is really using an annual cycle of six months at 75% PSA higher than the mean, followed by six months at 75% PSA lower than the mean.

So what I'm really doing here is projecting for six months at 240% PSA, followed by six months at 90% PSA, back to 240% for six months, back to 90% for six months, and so on.

The average is still something like 165% PSA. But as you can see, we've now added 100 basis points of yield (as calculated by the internal rate of return measure), just by incorporating some seasonality. This is because I'm now getting some cash flows to jump forward through this seasonal effect, which wasn't occurring when using level prepayments.

The impact is much more dramatic if I use that same seasonal model around 180% PSA. Again, this would be oscillating between 255% PSA in the fast months and 105% PSA in the slow months. Then the yield jumps to 19%. Under the static model you receive only an 8% yield in that scenario (level 180% PSA).

At the extremes, the different prepayment models don't result in much variance. At 100% PSA we really haven't gotten much benefit at all because we were too slow for the variability to ever kick in, and at fast speeds the seasonality didn't really matter because we're getting excesses all the time anyway. But in this middle range, this "at-the-money area," that variability could have a fairly dramatic impact on projected performance.

Column E shows the yield increase using the seasonal model. It's very dramatic in the slightly accelerated prepayment range. However, this model still gives you only a 1% pickup in your base case. So you've now got a security with a base case yield of 4.75%, which I'm sure still doesn't get you excited.

Now let's make one more adjustment to our prepayment model, and this I'll call my spike model. The spike model is developed by starting with the seasonal model, and adding to it an additional 75% PSA for only a three-month period occurring at the end of the third year. So my mean speed has increased a bit, but only because I'm assuming there's a slight burst of prepayment activity (of an extra 75% of the PSA model) that happens at the beginning of the fourth year.

Here are the results using that scenario (column G). At 165% PSA this tranche has dramatically shortened, as that one burst of prepayments in the beginning of the fourth year has really dramatically affected the overall return. And now, in fact, the internal rate of return on the security has jumped all the way up to 15%, a yield which I'm sure you'd all be very happy to own.

Again, at the very extremes it hasn't had much of an effect, but within the range of expected prepayments it has very dramatically affected performance. A burst of prepayments of that nature could happen for any number of reasons; it's a very marginal prepayment burst, well within the normal standard deviation of what you might expect even in an unchanged environment. This shows the yield difference (compared to the static model) caused by using the seasonal model with a one-time three-month spike. The incremental yield pickup in this range is staggering.

The moral of the story is this: By looking at only level deterministic static models of prepayment activity, the yields on many types of leveraged prepayment securities (such as a super PO or any type of support tranche) can be dramatically understated. And in the instance of a super PO, that generally means missing some of the benefits of the security. If you're looking at a support class with a full coupon on it, that probably means you're missing some of the negative aspects of the security.

But the main message I want to impart is that in the real world these securities behave much differently (or have the potential to behave much differently) from what they do if you project them under a static model.

MR. BOUSHEK: I'd just like to amplify one or two of Dave's points.

We talk about PAC tranches, and the variability that a PAC tranche can exhibit even when prepayments occur entirely within the band. There exist many tranches that bear the name of PAC, but which are really junior PACs or PAC-IIs. Your companies may have them in their portfolios. These tranches not only exhibit the same type of sensitivity to different cash-flow patterns within the PAC band, but also, because they are a combination of a PAC tranche and a support tranche, they exhibit significant extreme variations when you get even very slightly outside of those collars as well.

The other comment is that Dave was exhibiting the very positive, beneficial aspects of this super PO. That occurs because this companion tranche or this support tranche has a fixed par and is bought at an extreme discount. I contrast that with the accrual Z that was the support tranche I was using. A Z tranche, unlike a PO, is quite often purchased near par. Therefore, it does not provide a yield kick if prepayments accelerate.

I'd like to look at two different types of tranches that are not what you might call your bread and butter tranches for asset/liability matching, but which are tranches that can be added to a portfolio (and may be found in your own portfolios) that actually serve to reduce certain kinds of portfolio risk.

The first case study we'll be looking at is a portfolio that is most vulnerable to a steady deterioration attributable to rising interest rates. Our objective for this portfolio is to reduce its duration without selling securities and without sacrificing yield in a stable environment; the possible solution is an IO tranche out of a CMO.

First, I need to discuss briefly the difference between an IO strip (in other words a trust that has nothing but an IO and a PO in it, and an IO (or an "IO-ette," as the market uses the term) that is incorporated into a CMO that includes other types of tranches. An IO strip has a notional principal amount; namely, the other half of the deal. There's no coupon that's associated with that notional principal, and the price is simply a discounted present value of those interest cash flows. An IO tranche from a CMO REMIC trust is a little bit different. Under REMIC legislation in the 1986 Tax Reform Act, one of the requirements for any CMO tranche is that it had to have a nominal amount of principal included in that tranche. Therefore, an IO-ette from a CMO actually has a little bit of principal associated with it. (Only recently has that situation changed, and the PSA has now decided to allow IO strips to be created without a nominal principal amount).

The example we're going to be looking at does include a nominal principal amount. Therefore, you can state a coupon against that principal amount, and a price (that is, the price of that principal amount), as opposed to the discounted cash-flow value of the interest payments.

The particular example I'd like to use is FNMA REMIC 91-109 tranche J, described in Table 10. The collateral for this tranche is FNMA 9%, with a 9.70% gross WAC and a 354-month weighted average maturity (WAM). These are relatively new production mortgages.

TABLE 10

Case Study 1
IO-ette Analysis: FNMA 91-109-J

COLLATERAL:	FNMA 9% 9.70% gross WAC 354 month WAM
TRANCHE:	$100,000 par value 1009.50% coupon 5178.57 price $5.2 MM investment
KEYS:	CMO tranche (60 bp for liquidity) single digit gross WAC unseasoned loans

The particular tranche that we're going to look at has a nominal principal par value of $100,000. It has a stated coupon of 1,009.5%, and a price of 5178 ($5,178 per $100 par). These values may at first appear a bit unusual, but that is because we're dealing with a very small amount of principal relative to the interest flows that are going to be generated. The net aggregate investment for this instrument is a little over $5 million given the price that's associated with it.

Second, the single-digit gross WAC is a prepayment protection. There is a psychological barrier of prepayments at 10%. If your gross loan rate on the loans is underneath 10%, you have a certain additional amount of built-in prepayment protection. This is essential for an IO.

Third, you also have relatively new production loans. There are a number of IO/PO trusts outstanding; but most of them are quite seasoned, and they do exhibit relatively faster prepays than collateral that comes out of a newly created CMO that is basically made up from new production loans. If you're going to own an IO, you definitely want to own unseasoned collateral.

Chart 26 shows the cash flows of our IO-ette strip under four different prepayment assumptions. In the upper left-hand corner we've got a 0% PSA assumption. At 0% prepayments, that is the cash-flow pattern on our IO strip. The upper right-hand corner would show prepayments at 75% of PSA. The lower left-hand graph would be at 175% of PSA. And the lower right-hand graph, 350% of PSA. This shows the various cash-flow patterns that would be associated with this IO; and you can see the dramatic changes in the aggregate number of dollars you ultimately get back, due to changes in that prepayment assumption.

Now, in analyzing this instrument we're looking at a number of scenarios that are instantaneous shifts to various PSA speeds that are level throughout the projection. In other words, we're projecting at 150% PSA from day one on, or at 175% from day one on.

Table 11 shows the cash-flow duration under different speeds. (Average life is a concept that applies to principal, so there's no point in showing average life on the principal. Instead, we'll use the cash-flow duration number as a proxy for the timing on the receipt of cash flows.)

TABLE 11

Case Study 1
IO-ette Analysis: FNMA 91-109-J

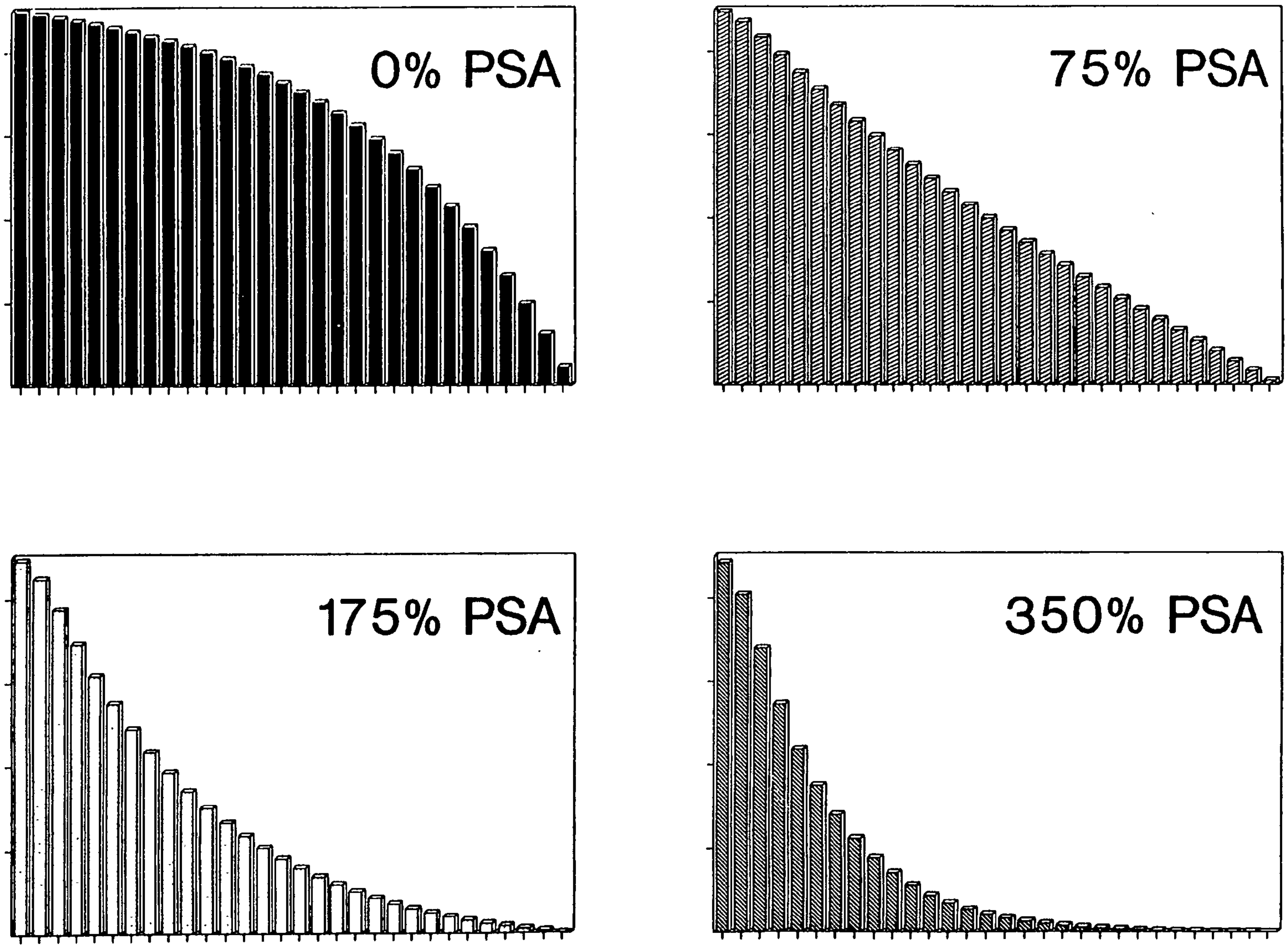
	CF Duration Yrs)	Yield (IRR)
0% PSA	7.49	18.80%
75% PSA	6.04	14.53
135% PSA	5.16	11.17
150% PSA	4.98	10.33
160% PSA	4.86	9.75
175% PSA	4.69	8.89
225% PSA	4.20	5.97
350% PSA	3.33	-1.26

(OA Duration: -14.2 years)

Note the variability in the cash-flow duration across those scenarios, and more important, the variability in the yield. You will note that an IO can return a negative yield. If prepayments

CHART 26

IO-ette Cash Flows: FNMA 91-109-J



accelerate sufficiently, you simply do not get enough cash flows back to recover your cost in the instrument. But, assuming that an increase in interest rates correlates with a decrease in the PSA assumption for mortgage prepayment speeds, you can see the contribution of this IO to the yield of the portfolio.

This example, remember, assumes that your portfolio is reasonably well call protected, and does perform well in a falling rate scenario (which is where the hedge then begins to work against you).

There's one other thing I'd like to point out in Table 11. I've used cash-flow durations for the individual scenarios. However, the option-adjusted duration for this instrument (which is the market-price-sensitivity measure) is a negative 14.2 years in the base case, for an up and down 50 basis point move. This is often hard to understand. It's the option-adjusted (or "effective") duration of an instrument that should be used for duration-matching purposes. The cash-flow duration for an IO will be positive for any scenario that you run. But the option-adjusted duration of an IO is extremely negative, for all but extreme changes in interest rates.
My second case study takes a look at somewhat the reverse risk. Here we start with a portfolio that's reasonably well-protected against a rise in interest rates, but is very vulnerable to even a modest decline in interest rates. Perhaps it is a portfolio supporting a guarantee, and we are near that guarantee level and cannot afford to have the yields on the assets decline much at all.

Our objective in this particular case is to supplement the returns of the portfolio without taking creditor counterparty risk. This eliminates high-yield bonds, swap options and floors. I also do not want to count on MBS prepayments accelerating. This eliminates super POs.

The possible solution here is something that's called a "modified inverse floater." The structure of this particular tranche (Table 12) is an inverse floater modified with an IO. Now, an inverse floating-rate instrument is simply an investment instrument that has a coupon that changes inversely to the change in some type of index. Most inverse floating-rate CMO tranches are indexed to the London Interbank Offered Rate (LIBOR), which is basically a European short-term rate. As LIBOR goes down, the coupon goes up. As LIBOR goes up, the coupon goes down.

TABLE 12

Case Study 2
Modified Inverse Floater Analysis

STRUCTURE:	Inverse floater with partial IO, indexed to the 10-year CMT
COLLATERAL:	FHLMC gold 9% 9.65% gross WAC 354 month WAM
TRANCHE:	$155,000 par value 409.47% initial coupon 3231.67 price $5.0 MM investment
FORMULA:	1214.1876 - (108.89268 x 10-yr CMT) with a 0% floor

This particular tranche is indexed to the 10-year constant maturity Treasury, instead of to LIBOR. So, this particular instrument is indexed to 10-year rates, rather than to short-term interest rates. It includes elements of an IO, which help to offset some of the risks that are otherwise inherent in an inverse floater.

As you'll notice at the bottom of Table 12, one of the elements of a leveraged inverse floater is this somewhat convoluted formula to determine the coupon rate on the bond. I'm not going to spend a lot of time with it other than to say that this is the formula that's used in this particular deal to specify the coupon associated with this particular bond.

In analyzing this type of an instrument, we have to look at a matrix (Table 13) that has various prepayment assumptions down the column, and various changes in the 10-year Treasury interest

TABLE 13

Case Study 2
Modified Inverse Floater Analysis (INV/IO)

Yield (IRR)

PSA	-200	-100	-50	0	+50	+100	+200	AveLf
300	18.01%	13.59%	11.30%	8.93%	6.45%	3.84%	-2.04%	13.8
275	18.47%	14.32%	11.86%	9.56%	7.15%	4.60%	-1.13%	14.8
225	19.18%	15.02%	12.88%	10.67%	8.38%	5.97%	0.55%	17.3
200	19.45%	15.38%	13.29%	11.14%	8.92%	6.57%	1.31%	18.7
175	19.68%	15.69%	13.65%	11.55%	9.38%	7.10%	2.08%	20.2
155	19.82%	15.69%	13.88%	11.82%	9.70%	7.47%	2.49%	21.5
135	19.94%	16.05%	14.07%	12.05%	9.97%	7.79%	2.92%	22.8
110	20.04%	16.20%	14.26%	12.27%	10.23%	8.10%	3.36%	24.5
90	20.36%	16.21%	14.34%	12.37%	10.35%	8.25%	3.58%	25.4

rate across the top. The last column shows the average life under the various PSA assumptions. There is definitely a correlation between movements in interest rates and changes in prepayment assumptions, but it is not automatic. Therefore, we have to bracket those assumed correlations.

Let's assume that this type of an instrument has a base case assumption of 175% PSA. In a zero-change-in-interest-rate environment, you can see a base case yield of 11.55% (in the middle of the table); and if you look across to the far right-hand column, you can see that the average life in the base case is 20.2 years.

As interest rates change, and we go from the center to the left-hand side of the table, for each 50-basis-point change in interest rates you can see roughly a 200-basis-point increase in the yield associated with this vehicle. This is evidence of the 4-to-1 leverage in the coupon. Similarly, as interest rates increase, you can see the coupon and the yield on this instrument significantly declining. However, because this instrument also has elements of an IO, there is also some benefit to "up" interest-rate scenarios, if those are correlated with declines in prepayment assumptions (which is what you would anticipate).

The diamond in this table represents the primary region of potential returns for this investment. Our goal was to augment the yields of the portfolio in a declining-rate scenario, which we do even if we get an acceleration of prepayments in this particular deal.

The virtue of this particular tranche is a reasonable degree of stability and the combination of IO and inverse working together to give a nice profile of potential returns for the instrument.

MR. HALL: The two case studies I will discuss will relate to a super PO (extending the analysis that we used before), and a "tiered super floater."

When we were initially trying to decide how to organize these sessions, this session was originally entitled, "Practical Asset/Liability Matching Using CMOs." One of the comments that came back was "Why in the world would you want to use CMOs for asset/liability matching?" That wasn't really what we were trying to get at, so we changed the name to, "Practical Asset/Liability Management for CMOs." But what we're really getting at in some of these last case studies is practical asset/liability management using CMOs, and we're trying to illustrate some examples of why you would want to use CMOs for that purpose.

For the first case study, let's assume you're given a closed block of immediate annuities which include no nonforfeiture benefits. This could be structured settlements or retired life annuities or something in that vein.

Assume that you have an asset portfolio invested in mortgage pass-throughs and CMO classes that are moderately impacted by prepayment variability. The principal risk is that your scenario analysis indicates you're vulnerable to a rapid decline in interest rates, especially if this scenario induces significant mortgage refinancing activity.

The risk management tool we're going to use is a super PO. Since we're dealing principally with long-duration securities in this example, I'm going to use a single reinvestment-rate assumption rather than trying to model an entire yield curve. In my reinvestment-rate assumption we'll use a base case reinvestment rate of 8%, and then pop up and pop down scenario analysis in the rising and falling scenarios.

And although actuaries typically like to work with present values, what I'm going to work with are "horizon values," which are future values or accumulated values. In effect, the horizon value is a value achieved by taking all the cash flows arising from a portfolio of assets or liabilities and accumulating them to a terminal date (which in this example is 25 years forward) at the specific reinvestment rate, to develop a terminal horizon value for a portfolio.

I'll begin by working independently with the assets and the liabilities. Then we'll add them together. Clearly, to the extent that the cash flows are offsetting, the two reinvestment assumptions will effectively cancel out each other when you get to the terminal date. But we'll work with them independently for the time being.

The numbers for this example are shown on Table 14. Because you have to start somewhere, I've started with the liability portfolio, which in this scenario (8% reinvestment yield) has a horizon value of $1,000 (column C). This obviously has a beginning value of something considerably less than $1,000.

And as you can see, although there is no cash-flow variability on the liabilities, the introduction of higher or lower reinvestment rates causes the horizon value of this portfolio of liabilities to increase as interest rates rise and to decrease as interest rates fall, owing strictly to the impact of compounding those cash flows out at higher or lower rates. This is shown in column C.

Let's now work back to columns A and B and look at the asset portfolio. I'm showing average maturity (or average life) of the portfolio, since that's a frequent way to describe the performance of a mortgage portfolio.

On our base case assumption (with reinvestment rates at 8%), we have about a 7.7-year average life portfolio. As rates rise, because of the prepayment variability, we expect it to extend somewhat; and as rates fall, we expect it to shorten somewhat. The amount of shortening I have here would indicate that there are some support tranches within this portfolio, although it is not a highly leveraged prepayment portfolio and probably is not that unrepresentative of many company portfolios.

Again I'm accumulating the cash flows from this portfolio out to the terminal date at the same reinvestment rate that we used for the liabilities. If you consider that the liability cash flows do not withdraw any profit margins, then at the end of time what I'm illustrating is that you have built $53 million of profits or surplus. If you want to assume that your liability cash flows have included a profit requirement, then at the end of 25 years this asset portfolio has developed

TABLE 14

Adding a Super PO to Control Prepayment Risk

Reinv. Yield	(A) Asset Average Maturity	(B) Asset Horizon Value	(C) Liability Horizon Value	(D) Surplus Horizon Value	(E) Super PO Average Maturity	(F) Super PO Horizon Value	(G) Adjusted Asset Value	(H) Adjusted Surplus Horizon Value
11%	10.7	1,845	1,657	188	16.7	787	1,686	29
10	9.5	1,540	1,463	77	15.2	840	1,435	(28)
9	8.6	1,277	1,212	65	14.2	833	1,210	(2)
8	7.7	1,053	1,000	53	12.4	867	1,025	25
7	4.1	820	851	(31)	4.9	1,288	890	39
6	2.8	640	729	(89)	1.3	1,310	741	12
5	2.0	496	626	(130)	0.8	1,059	580	(46)

(A) Average projected maturity of a mortgage-related portfolio for each reinvestment scenario
(B) Projected value of asset portfolio, including reinvestment, after 25 years
(C) Comparable projected value of liability portfolio, including expenses and required profit, after 25 years
(D) (B) - (C), which might be interpreted as the projected value of excess surplus
(E) Projected average maturity of a hypothetical super PO
(F) Projected value of super PO cash flows, with reinvestment, after 25 years
(G) Adjusted portfolio replaces 15% of original portfolio with super PO
(H) Comparable value to (D), based upon adjusted portfolio (G) and liabilities (C)

excess surplus of $53 million. The way you deal with profits in this analysis is not important. You'll all have your biases as to how you want to do that.

But the point I want to show is that in spite of the fact that our cash flows lengthen or shorten, being able to reinvest these flows at higher rates or lower rates causes the terminal values to rise when rates rise and to be less when rates fall.

Of course, looking at the asset side independently, without looking at the liability side, doesn't give us much information. Now I'll net the two. Column D shows the horizon value of surplus (or excess surplus). This is positive in our base case scenario, becomes more positive as rates rise, and becomes less positive and then negative as rates fall.

This type of profile is symptomatic of two types of risk. There probably is some duration mismatch in this portfolio. It would appear that the assets are slightly shorter than the liabilities. There's also some convexity mismatch here, because the rate at which our horizon value increases is slower than the rate at which our horizon value decreases.

So, what do we want to do to fix this problem (on the assumption that you consider this to be a problem)? The type of security I want to look at is a super PO. In my earlier case study I exhibited ways of evaluating the behavior of a super PO.

Now I'm going to try to show why one might want to have one of these low-yielding securities in a portfolio, and what it can do for a portfolio. Incidentally, the super PO that I'm using now is different from the one I used in the prior example. This is a live deal, (although I don't recall the name and number of the CMO).

Assume that I have a portfolio with the same starting value, but consisting entirely of this super PO tranche. As you can see in column F, the yield give-up for buying this type of security is such that at the end of your horizon date you have less than $1,000.

In my base case assumption, I'm assuming that the super PO really hasn't kicked in any of its prepayment effect. So this is symptomatic of the yield give-up or the cost of that prepayment option that I'm paying for in this security. Interestingly, though, as interest rates rise, I have somewhat of a flat horizon value. What's happening here is that the extension is enough to wipe out the impact of being able to reinvest at higher rates during that scenario.

Conversely, as reinvestment rates fall, I have a very dramatic gain in horizon value. The ability of this super PO to jump forward dramatically as interest rates fall significantly overwhelms that reinvestment impact, at least to a point.

You can also see in this example that, as rates get down into the 5% threshold, we have shortened about as much as we're going to, and the additional shortening that we get by going from a 6% scenario to a 5% scenario is not enough to overcome reinvestment at a 1% lower rate.

Thus, we have a very asymmetrical surplus pattern. This security has very strong positive convexity within one range of prepayments or interest rates, but the convexity at lower rates becomes negative. This is one way of illustrating some of the effects of that convexity.

Obviously, I don't want to have a whole portfolio of this security, because it doesn't match up well and it doesn't give me any profit. In fact it gives me a net loss over time; fortunately, I don't need a whole portfolio of this. What I've chosen to use is a portfolio in which I have replaced 15% of my initial portfolio with a like amount of the super PO.

Columns G and H on Table 14 are an 85:15 weighting of the two asset portfolios. As you can see my base case excess surplus has come down slightly but still meets my threshold, and I have significantly leveled out the amount of excess surplus that I have at the end of the period of time.

I still have some pop-up and pop-down positives and negatives (in column H). When I started working with this, I thought about trying to make a neater solution, but then I realized that's not necessary. The real world doesn't give you neat solutions, and sometimes you have to deal with these very erratic types of patterns.

What you can see here is a situation where, if you're willing to trade off some excess income in scenarios that are very favorable, you can use a type of CMO structure to cover your risk (or a significant part of your risk) in other scenarios.

I'd summarize this particular case study with the following point: Super POs very clearly offer highly leveraged prepayment variability protection. A little bit goes a long way.

For this type of usage you're going to need to find a super PO that offers a relatively long duration (or average life) in a base case, but that also has very significant positive convexity (or an ability to accelerate very quickly as interest rates fall).

In this instance I've used a one time pop-up or pop-down scenario model; but if you remember what I said in the earlier section, that type of model tends to understate the likely performance of this type of security. So, although in this model I've used a super PO to fairly effectively control risk, I'm probably understating the actual benefits introduced to this portfolio by using this very simplistic type of modeling approach.

In general, super POs can offer very good risk control against mortgage prepayment risk. This is because they kick in based upon nothing other than mortgage prepayments, and therefore they don't require precise correlation between reinvestment rates and prepayment rates for their risk control properties to be effective.

The risk that I was hedging was that of prepayments accelerating as rates fell. If prepayment rates accelerated without rates falling, then I really didn't have a problem; the super PO gives me extra benefit that I don't need. On the other hand, if interest rates fall, but I don't get prepayment acceleration, then the super PO won't do much for me; but as it turns out, I wouldn't need much help because my portfolio would be performing all right.

The caveat is that if your declining-rate risk is associated with the call exposure of corporate securities, then a super PO may not be the appropriate instrument because prepayment rates and corporate call exposure may lack the tightness of correlation that you need for that type of risk control.

Now I'll go on to my second case study. In this instance we're given a block of universal life or single premium deferred annuity (SPDA) business, a classical type of policy that offers the option to surrender at book value less a nominal surrender charge. The asset portfolio is invested in intermediate-term, fixed-income securities.

Our scenario analysis indicates that the principal risk in this portfolio is associated with an upward spike in interest rates especially if it's accompanied by a yield curve inversion. Obviously, this is due to the disintermediation risk associated with that type of scenario.

The risk management tool I'm going to use is called a tiered super floater.

The collateral is FNMA 9%, 30-year mortgages, and fairly new issues. The tiered super floater is a Type II PAC class which is structured to be protected from the range 130% to 190% PSA. It supports a Type I PAC within this deal. It is supported by other Type III PACs and by regular support classes within this deal.

Table 15 shows the average maturity of the security under a range of PSA speeds. If we get level prepayment scenarios with speeds from 130 to 190%, it has a 2.5-year average life. As prepayments accelerate, it doesn't shorten dramatically. This is because it's at the front of the deal, and there's enough support to keep it from collapsing dramatically. On the other hand, if you get through the 130% threshold, it behaves very much like a support tranche. This is because it is supporting a Type I PAC. You can see that it extends very dramatically at speeds through (below) 130% PSA.

TABLE 15

Tiered Super Floater
Principal Allocation Characteristics

FNMA 9% 30-year collateral

Type II PAC Class (130% - 190% PSA)

Prepay Speed	Average Maturity (years)
115% PSA	9.1
125% PSA	3.2
130%-190% PSA	2.5
245% PSA	2.3
315% PSA	1.9

The coupon characteristics of the security are shown on Table 16. It's a floating-rate security with a leverage factor of 5.37. The coupon formula is 5.37 times LIBOR minus 40.7375%. However, this security has a stipulated minimum coupon of 6.25% and a maximum coupon of 13.5%. This means that this formula operates only in the range of LIBOR from 8.75% to 10.1%. The table indicates that for LIBOR in excess of 10.1%, the coupon is capped out at 13.5%. As you grade down from 10.1% to 8.75%, you get this 5.37 to 1 leverage as LIBOR changes. And if LIBOR is at 8.75% or below, we have bottomed out at 6.25%, and the coupon will stay at that level.

I'm assuming that this particular security has an offering price of 99.96, just slightly under par, and yields 6.35% on a bond equivalent basis. This was an actual offering made to us several months ago at that yield. For reference, on that particular date LIBOR was 5.5%. The two-year Treasury yield was about 6%. The three-year Treasury yield was 6.3%. And the five-year yield was 6.9%. So, you can see that you're getting a yield which exceeds short-term

TABLE 16

Tiered Super Floater
Coupon Characteristics

Coupon = 5.35 * LIBOR - 40.7375%

minimum coupon = 6.25%

maximum coupon = 13.5%

Formula operates in range 8.75% <= LIBOR <= 10.1%

LIBOR	Coupon
10.1% and above	13.50%
10.0%	12.96
9.5%	10.28
9.0%	7.59
8.75% and below	6.25

rates, is fairly comparable to intermediate-term Treasuries, but is probably somewhat below what the typical asset for this portfolio would be expected to yield at issue.

What's the reason for using this type of security? We stated that we want protection if interest rates rise. Here we have a security that has a fairly low effective duration. You can see that although it has about a 2.5-year average life, as interest rates rise, ultimately our coupon begins to kick in and provide some extra return. And it's that impact as the coupon option begins to come closer and closer to being at the money, which gives the security some option value as rates rise.

Although there is some significant extension risk in this security (since it could extend dramatically if we get just moderate slowdowns of prepayment), we actually find in this security that this could be very favorable. This is because, if this extension occurs at a time when the coupon formula is active (in other words, when the coupon is beginning to rise at a rate of 5.37 to 1), we may find that we're very happy to have the security extend! If interest rates were to go up into the 10% range, and we have a 9.1-year security with a 13.5% coupon, we probably aren't going to feel very bad about having to keep that security for nine years as opposed to only 2.5 years.

So, although support types of principal prepayments are normally associated with something that's not attractive, the reverse can be true: if you have unusual coupon characteristics (either in the case of a PO or in the case of floating-rate securities or leveraged, floating-rate securities), the interaction of the average life drift and the coupon activity can actually create some very favorable effects. Thus, the security would have a fairly low effective duration (meaning its actual market price volatility would be fairly low, at least for a moderate change in interest rates).

I believe it has positive convexity (very difficult to prove). And certainly as rates begin to rise the convexity would begin to turn around, because the cap effect would begin to dampen the ability of that security to hold its value.

The out-of-money cap corridor (this range of 8.75% to 10.1% LIBOR) is well-positioned to offset the asset/liability risk that we're trying to protect ourselves from -- that of abruptly rising rates (or particularly those associated with an inverted yield curve). And since LIBOR is a short-term index, it will correlate with a yield curve inversion.

Again, I mention that the principal extension risk could be favorable if the coupon formula is active at that point. As the way you're paying for this attractive feature of the security, there might be some yield give-up versus a more traditional type of security. You're still not having to give up a tremendous amount of yield. If you were to buy these raw-option features, they would have no yield at all. So here you're able to get some option characteristics in your portfolio at a very, very modest yield give-up.

To conclude these two case studies, I would say that leveraged CMO structures can mitigate many types of asset/liability risk exposures; and when I say "leverage" I'm talking about leverage either in the principal allocation process caused by the existence of PAC and support classes, or coupon variability, or both.

Customized asset classes can be constructed to solve even the most unusual asset/liability problems. This is a classic example of a way that you can be creative and innovative in trying to solve some of the peculiar risk profiles that may be embedded in your portfolios.

In conclusion, we've tried to show a number of different types of CMO tranches, illustrate a number of different ways to evaluate or project their performance, and suggest a number of reasons why these types of securities may be beneficial (or detrimental) for your asset/liability management purposes.

Our larger objective has been to illustrate some of the processes one could use to evaluate or illustrate some of the benefits of these processes or the limitations of those processes.

MR. BOUSHEK: I do want to address one question that was presubmitted to us. I'll repeat that we have a very strong bias toward modeling CMOs with some type of a system that accesses reverse engineered deals. However, if you are in a situation where that is not a viable solution, and you must work with some type of a generic model, remember that in any CMO, A+B+C must equal 1.0, so simple algebra produces A=1-B-C.

For example, if you need to model a companion tranche, and you cannot do it, perhaps you can model it as a sequential minus a PAC (although I would wonder that, if it models the PAC, somehow it must also model the companion tranche for you). So, using negative tranches is one alternative to assist, but again I would strongly emphasize the importance and the need for being able to access some type of a live, reverse engineered database, for accurately modeling CMOs.