1990 VALUATION ACTUARY
SYMPOSIUM PROCEEDINGS

Session 10

Panel: CMO and Other Asset Projections

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CMO AND OTHER ASSET PROJECTIONS

MR. RANDALL LEE BOUSHEK: I will be one of two speakers on the panel for this session. By way of introduction, I am an actuary with Lutheran Brotherhood, which is an $8 billion fraternal benefit society headquartered in Minneapolis. For more than three years I have been involved in the investment operations of Lutheran Brotherhood as manager of the mortgage-backed-security (MBS) and derivative-security portfolios. As such, I have responsibility for, among other things, the analysis, selection and trading of securities in our collateralized-mortgage-obligation (CMO) portfolio. I also wear the title of manager of investment research and technology. My colleague on the panel is David Hall. Dave is an actuary with the Hartford Life Insurance Companies, and he too is involved in the investment operations of his firm as director of portfolios and asset/liability management.

The format that we're going to use for our panel discussion is perhaps a little different then what may be typical for such sessions. Because this is intended to be essentially a teaching session, we thought we might be able to develop a more integrated and interesting approach by alternating our remarks rather than by each droning on uninterrupted. We hope we'll be able to accomplish this without tripping over each other both literally and figuratively.

Our topic is particularly timely. I concur with David Gardner's comments at the Luncheon Session that MBSs may well become the investment vehicle of choice for life companies in the 1990s. MBSs -- a generic term that by way of definition includes any investment vehicle ultimately supported by residential mortgage loans -- are delightfully complex investments that offer diversity, opportunity and risk to investment managers, and guaranteed migraines to accountants and actuaries. For a number of companies, MBSs in general, and CMOs in particular, already constitute a significant and increasing portion of their investment portfolios. At Lutheran Brotherhood, approximately one-third of our life company assets are invested in MBSs, primarily in about 150 CMOs, and approximately one-half of our net cash flow is applied to CMO purchases. Based on my conversations with Dave, I believe that both of these percentages are somewhat higher at the Hartford Life Companies. It would not surprise me at all to see companies with even higher levels of current exposure, or to see the life insurance industry in general increase its investment exposure to CMOs significantly through the next several years.

Before we dive into our agenda for this session, there are two prefacing comments that I would like to make, both of them in the nature of what we are not going to try to do. The first thing we are not going to try to do is to turn you all into CMO gurus. There is a considerable segment of the investment profession that does not yet fully understand CMOs. Every investment conference that I've ever attended invariably has sessions on CMOs that invariably involve a multitude of charts and graphs that invariably evolve into very technical discussions. We specifically want to try to avoid that with you. Our primary goal for this session is ultimately to discuss the challenges and issues involved in modeling CMOs for asset/liability management purposes. We are going to assume no prior knowledge of MBSs on your part, and thus we need to build a certain base of understanding about them before we can begin to talk about modeling them. However, we plan to keep this discussion very elementary.

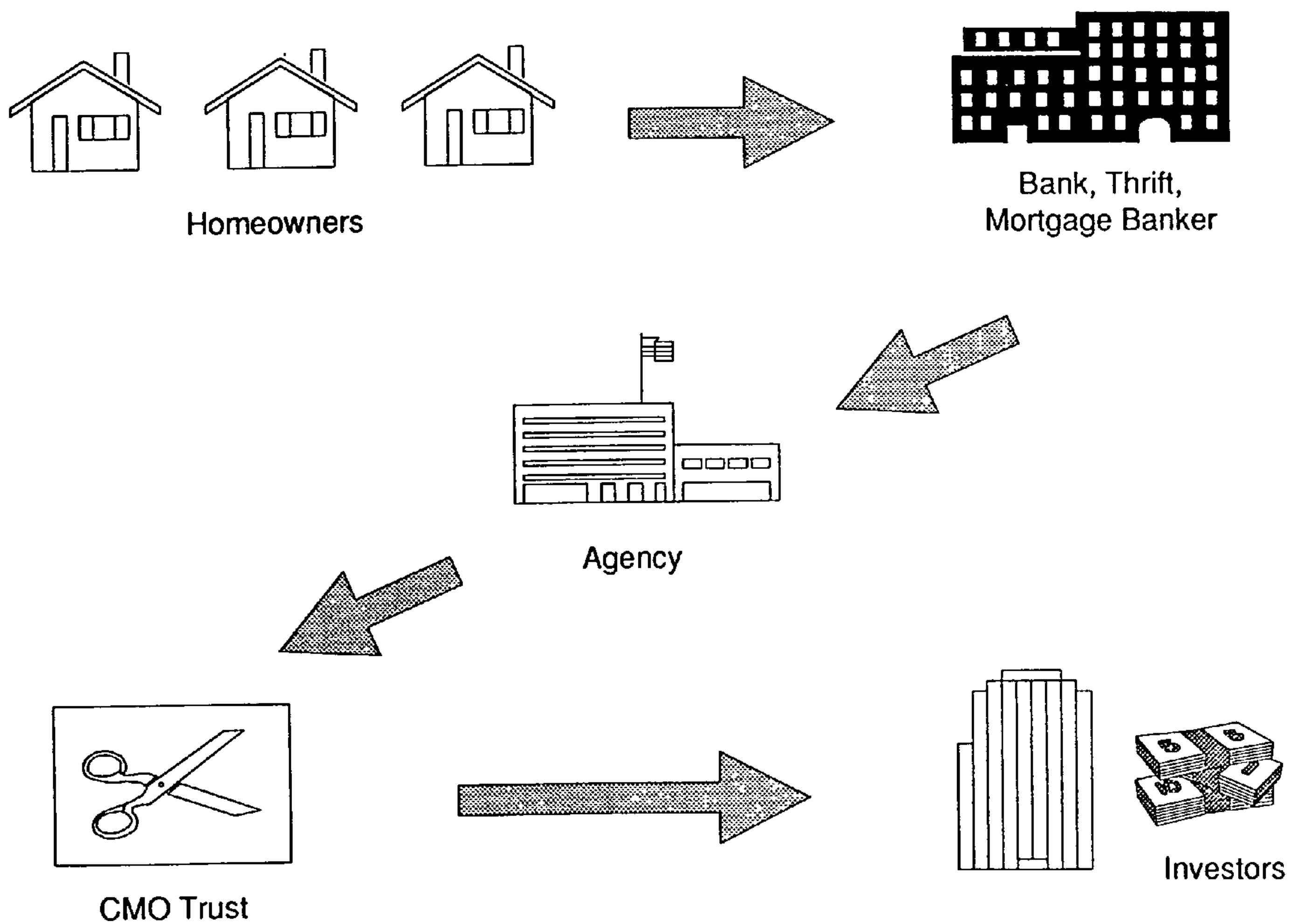
The second comment is that we are not going to discuss specific software packages for a couple of reasons. First, we do not want to be providing commercial air time for any particular package or vendor. Second, and perhaps more important, we do not want to slight any firm or individual or package that we are not familiar with, or that may or may not be well-suited to your particular needs. We obviously have our own experiences and opinions on software, but we'd like to reserve our comments on this for individual discussions after this session.

With that said, we can discuss the agenda that we plan to follow for this session. CMOs are essentially financially engineered creations. As such, they are at their core nothing more than a contrived but uncertain series of cash flows. In order for us to understand the engineering and how to model it, we need to start with an understanding of the raw material -- MBS cash flows -- and the primary determinant of that raw material -- the prepayment function. Consequently, Dave is going to begin this session with a discussion of the prepayment function. Following that, I'll spend some time talking about variations in CMO structures. There's no such thing as a generic CMO, and it's important that you understand just how much one CMO might differ from the next. After that we'll both provide brief comments on what we see as trends in the CMO market, which may ultimately impact you. Finally, we'll take turns giving you our perspectives on cash-flow modeling for CMOs.

Before I turn the floor over to Dave, I would like to address a very basic question that I often get when I talk about CMOs, namely, "Where do CMOs come from?" To answer this, I'd like you to refer to Chart 1. We're going to read this diagram from top to bottom and from left to right. At the upper left-hand corner are homeowners. We are homeowners or prospective homeowners who need to take out mortgages in order to purchase our homes. Those mortgages are provided variously by commercial banks, mortgage bankers, thrifts, or other types of financial institutions, which are depicted in the upper right-hand corner. These institutions package a number of such loans with others having similar characteristics and sell them to one of several governmental or quasi-governmental agencies, indicated in the middle of the diagram. These agencies go by the acronyms GNMA (Government National Mortgage Association), FNMA (Federal

CHART 1

EVOLUTION OF A CMO



National Mortgage Association), and FHLMC (Federal Home Loan Mortgage Corporation), and exist for the sole purpose of buying loan packages from primary lenders and thereby adding capacity to the residential lending market. The agencies combine several packages of loans with similar characteristics into something called a pool. Prior to 1983, proportionate interests in individual pools were sold directly to investors in the lower right-hand corner of the diagram as mortgage pass-throughs. Pass-through issuance did not terminate in 1983, and investors still can and do acquire newly issued pass-through pools. However, since 1983 the generic entity located in the lower left-hand corner of Chart 1 -- the CMO trust or special purpose corporation (SPC) -- has devoured the lion's share of new pass-through issuance, as well as an increasing share of outstanding pools. CMOs were first originated in 1983 by a few homebuilders and thrifts. The volume of originations grew slowly and steadily until 1986 and 1987, when the advent of the trust form of a CMO, and in particular something called REMIC (real estate mortgage investment conduit) legislation, gave it a tremendous boost. In a nutshell, REMIC legislation simplified the tax and regulatory aspects of CMOs and increased their appeal and availability to a significant number of investors. From that point the market literally exploded with growth. I've depicted the CMO trust or SPC in Chart 1 as a pair of scissors in a box. A CMO is really nothing more than a shell within which cash flows from various agency pools are sliced and diced and rerouted to investors.

MR. DAVID A. HALL: I suppose this means that a CMO is effectively a Veg-o-matic for mortgages. That is not a bad analogy.

My first topic is the prepayment function. I have some good news and some bad news. The good news is that there exists well over a quarter-century of data on prepayments that we can evaluate in attempting to model prepayment behavior. The bad news is that most of those data are obsolete and irrelevant. The fact is that no one has ever been successful at consistently and accurately forecasting prepayment rates for mortgage securities. But that is not necessarily the bad news. In fact, prepayment uncertainty is one of the fundamental factors upon which the entire CMO market has developed. Since prepayments are not effectively a diversifiable risk (as is also true of call risk), CMO structures have been created to reallocate this risk exposure. It is because of the uncertainty in prepayments that investors are paid to accept this risk. It is because this risk premium can be significant that insurers have been willing to be paid to accept this risk. And it is because insurers have accepted this risk that most of you are here, presumably hoping to glean some information to help you analyze how that risk integrates or disintegrates with your asset-liability structure. In this discussion of prepayment models, I will put forward several historical models, discuss the limitations of those models, mention some of the factors that influence prepayments, and highlight some evidence which supports my premise that prepayments must be regarded as a truly random variable.

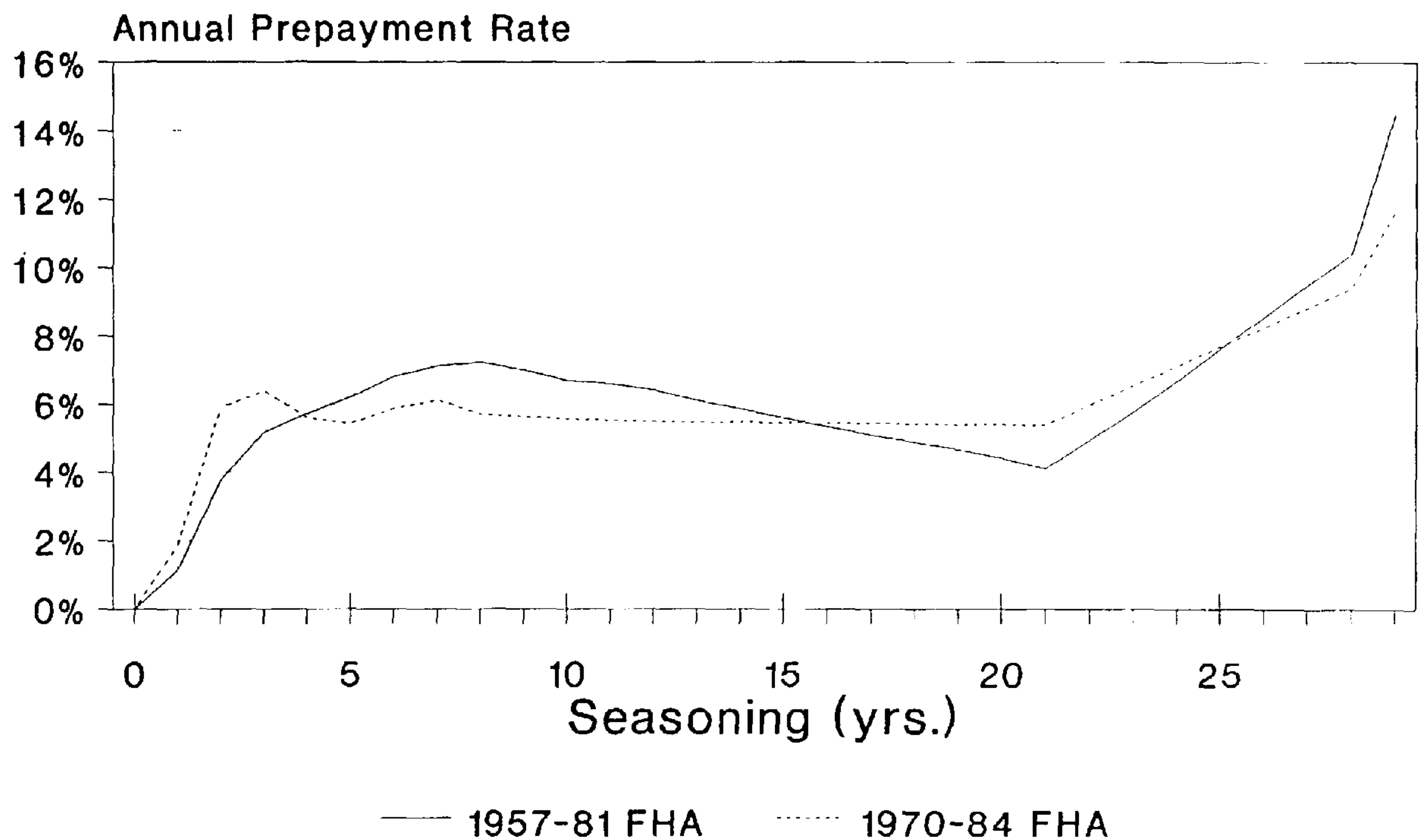
Let us begin by considering some of the sources of mortgage prepayments. The most obvious source is when a homeowner sells his property. In most cases, that generates the prepayment of his mortgage. (Some mortgages are assumable by the purchaser, and if this right is exercised, the sale would not generate a prepayment.) A default (in the context of federal agency mortgage pass-throughs) generates a prepayment, because the agency, usually FNMA, FHLMC, or GNMA pays off the investor in the event of a mortgage default. Casualty losses may cause prepayments. If a home burns down, the homeowner (or his insurer) will pay off the mortgage. Accelerated payments are a type of prepayment. This influence may be the least understood aspect of prepayment activity, but it is probably also very commonplace right now. What I am thinking of is the concept of tucking a little extra into your mortgage payment each month to attempt to pay down the balance a little faster than scheduled; that activity generates a partial prepayment each month. The last and perhaps most important source is refinancing. This derives from the homeowner's option to put the mortgage back to the issuer, presumably to refinance it at a more attractive rate.

Prepayments are likely to be "economical" from the standpoint of the homeowner. However, it is important to understand that many prepayments may be "noneconomical" from the perspective of the lender or investor. It may be that a mortgage is refinanced at a time when it is not to the detriment of the investor. For example, if a mortgage holder wishes to "take out" some additional equity, it may be more convenient (or even more inexpensive) to do that through a new first mortgage loan rather than by layering on a second mortgage. So a prepayment is not necessarily happening at a time which is against the economic interest of the ultimate investor.

Let us now consider one of the earliest models of prepayment activity, the Federal Housing Administration (FHA) Experience tables. Chart 2 shows prepayments from two different (although overlapping) time periods. They are based on 1957-81 and 1970-84 FHA experience as gathered by the U.S. Department of Housing and Urban Development. The graphs relate the annual prepayment rate (along the Y axis) to the seasoning (or age) of a mortgage (along the X axis). A prepayment rate is the percentage of mortgages that were outstanding at the beginning of a year that are not outstanding at the end of that year. As you can see, by the end of the first year approximately 2% of the mortgages were prepaid; by the end of the second year an additional 4% or more prepaid. This uptick obviously results from the selection factor. New mortgage holders typically do not sell their homes within months of buying these homes, and so there is an initial period during which prepayment rates tend to gradually increase (called the seasoning period). In these examples, annual prepayment rates increase through roughly seven years, then decline gradually until year 20, after which a more dramatic increase appears. This late increase probably represents the "nuisance factor." By this I mean that balances get to be so small that they are either refinanced to take out additional equity, or just paid off to eliminate

CHART 2

PREPAYMENT MODELS
FHA EXPERIENCE



Source: US Dept. of HUD

them. Note also that the later experience table seasons faster; that is presumably because that experience captures the period from 1981 to 1984, which was a period of pretty radically declining rates, dropping from highs in the upper teens all the way down to the lower teens. This period must have included a lot of rate-driven refinancing activity that was largely insensitive to seasoning influences. For example, if you had an 18% mortgage last year, and you are now able to refinance it at 14%, does it really matter how long you've been in the home? A lot of people exercised that opportunity pretty quickly.

What are the drawbacks of using this as a prepayment model? First, since it is based solely on the age of the mortgage, it fails to capture any other factors as determinants of prepayment activity. It averages many different coupons, which refer to the interest rates paid on the mortgage. The observed mortgages probably have underlying interest rates from 4% to 18%. Also, the table is based only on assumable FHA mortgages, it spans many different economic environments, and many of the measured trends may now be obsolete.

What other factors should we be considering in modeling prepayments? Seasoning clearly is important and is one factor that most models do capture, especially reflecting the preliminary "select period." Seasonality is also a factor. By seasonality I refer to the phenomenon that prepayment activity is usually higher in the summer than it is in the winter. In some CMO structures that is fairly inconsequential, but in some structures it can be very consequential. Changes in market interest rates are a primary determinant of activity, not only as it relates to refinancing activity, but also in the sense that when rates are low, housing turnover (and the resulting prepayment activity) has tended to be higher. There is also a product selection factor. New home buyers today have a wide selection of mortgage alternatives from which to choose. These include traditional 30-year fixed-rate mortgages as well as 15-year mortgages, seven-year balloon mortgages, and a wide variety of adjustable rate mortgages. It is likely that home buyers who expect to be moving fairly quickly will not opt to take out a 30-year fixed-rate loan. Instead, they may opt for an adjustable rate alternative, or perhaps even a seven-year balloon mortgage, since the need to refinance the mortgage in seven years may not be seen as too onerous if they do not expect to remain in that home for a full seven years. So product selection by the borrower is clearly an influential factor. This is one of the main reasons why much of the historical data are obsolete, because much of the data come from a time when 30-year fixed-rate mortgages were virtually "the only game in town."

"Burnout" is another factor to consider. In any pool of mortgages there are likely to be some mortgage holders who are very sensitive to their refinancing opportunities, some who are less sensitive, and some who just fail to catch on. With a brand new pool, you will usually notice that the first opportunity to refinance is greeted with a burst of prepayment activity, as those who are very sensitive to their refinancing opportunities take quick advantage. Prepayment activity will often remain high for some period of time after that, as those who failed to refinance right away gradually get around to it. But there very definitely is a burnout, or a period after which prepayment activity seems insensitive to refinancing opportunities. Believe it or not, there are still some GNMA 18% loans outstanding today, meaning that there are still some people who are paying 18.5% on their fixed-rate mortgages. I said earlier that all prepayment decisions made by mortgage holders are economic in their own frame of reference. I am not sure, though, that their decision not to prepay is always economic.

Geography influences prepayments. California loans have typically prepaid faster. Certainly, any area of the country where economic activity or housing turnover is high will generate faster prepayment activity. Demographics will influence prepayments. Homeowners who are in one economic strata may have very different prepayment activity than those in another. So clearly, there are a wide variety of factors to be considered in modeling prepayments.

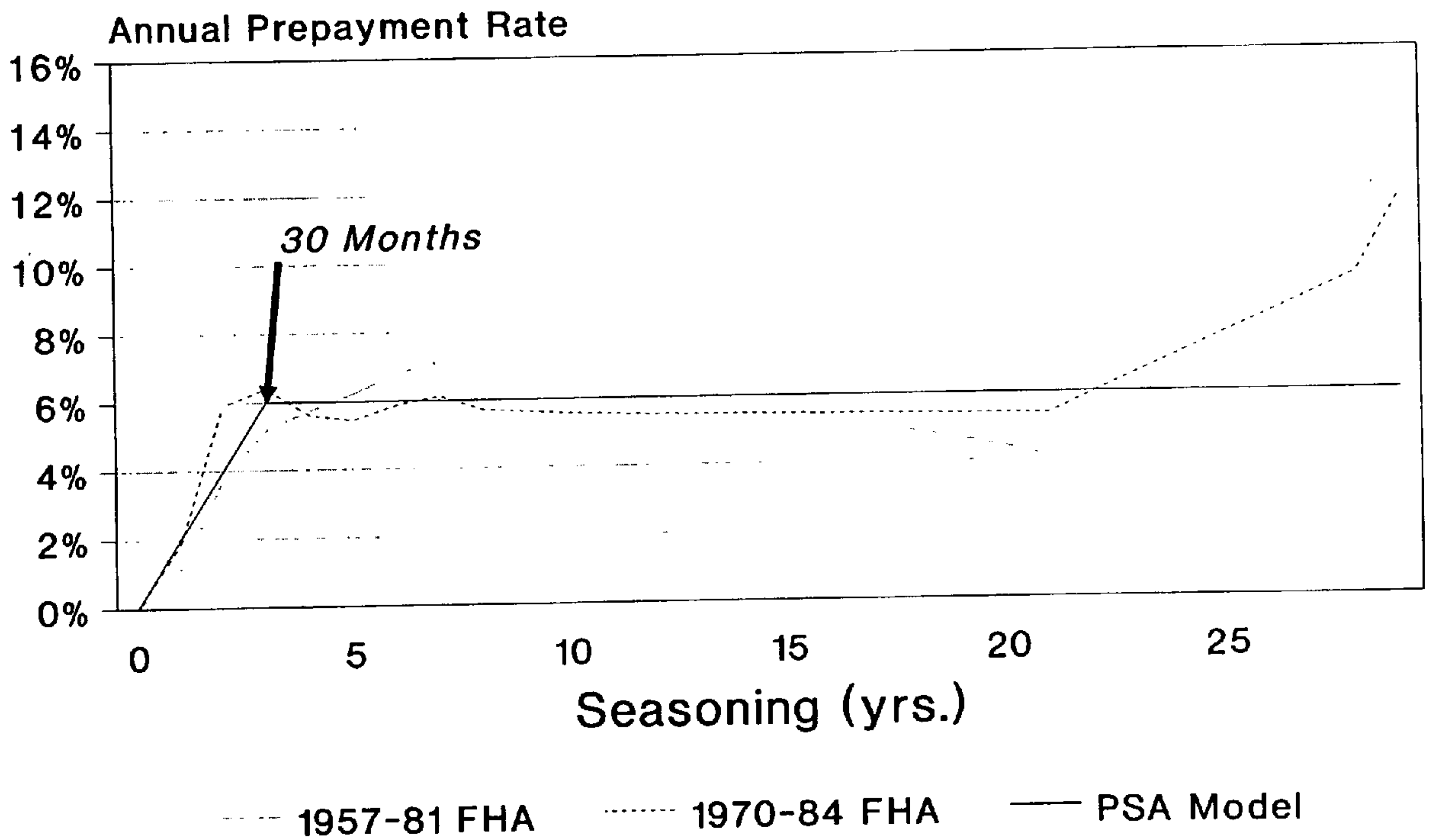
As it turns out, the FHA experience table is not used very much, not only because of some of the limitations that I have discussed, but also because it is a complicated, nonlinear scale. The most prevalent model is the Public Securities Association (PSA) Model. The

PSA is an association which promulgates standards for quoting yields and settlement procedures for publicly traded securities. Chart 3 shows the PSA Model compared to the two FHA tables. It consists of a 2.5 year seasoning period during which (annualized) prepayment rates increase linearly each month from .2% to 6%. This is followed by a level 6% prepayment rate from month 30 to the end of the mortgage term. This is the model that is typically used as a basis for quoting yields and projecting prepayment profiles on CMO securities and has been the standard since about 1985. PSA did want to capture that initial seasoning period, because for shorter tranches of mortgage securities, this seasoning influence can be very critical to the yield and average maturity calculation. It was felt that a standard was needed that would capture this influence, but that was also simple enough that it could be easily understood.

Usually prepayment rates are quoted as a percentage of the PSA model. The rates in Chart 3 represent 100% of PSA model. For 200% of the PSA model, one would double all the rates, and in fact one can use any percentage of PSA from 0% up to very high multiples. For most mortgage securities today, quoted speeds would tend to be from a low in the 50% to 75% PSA range for lower-coupon GNMAs, up to 500% to 600% PSA for higher-coupon conventional mortgages.

CHART 3

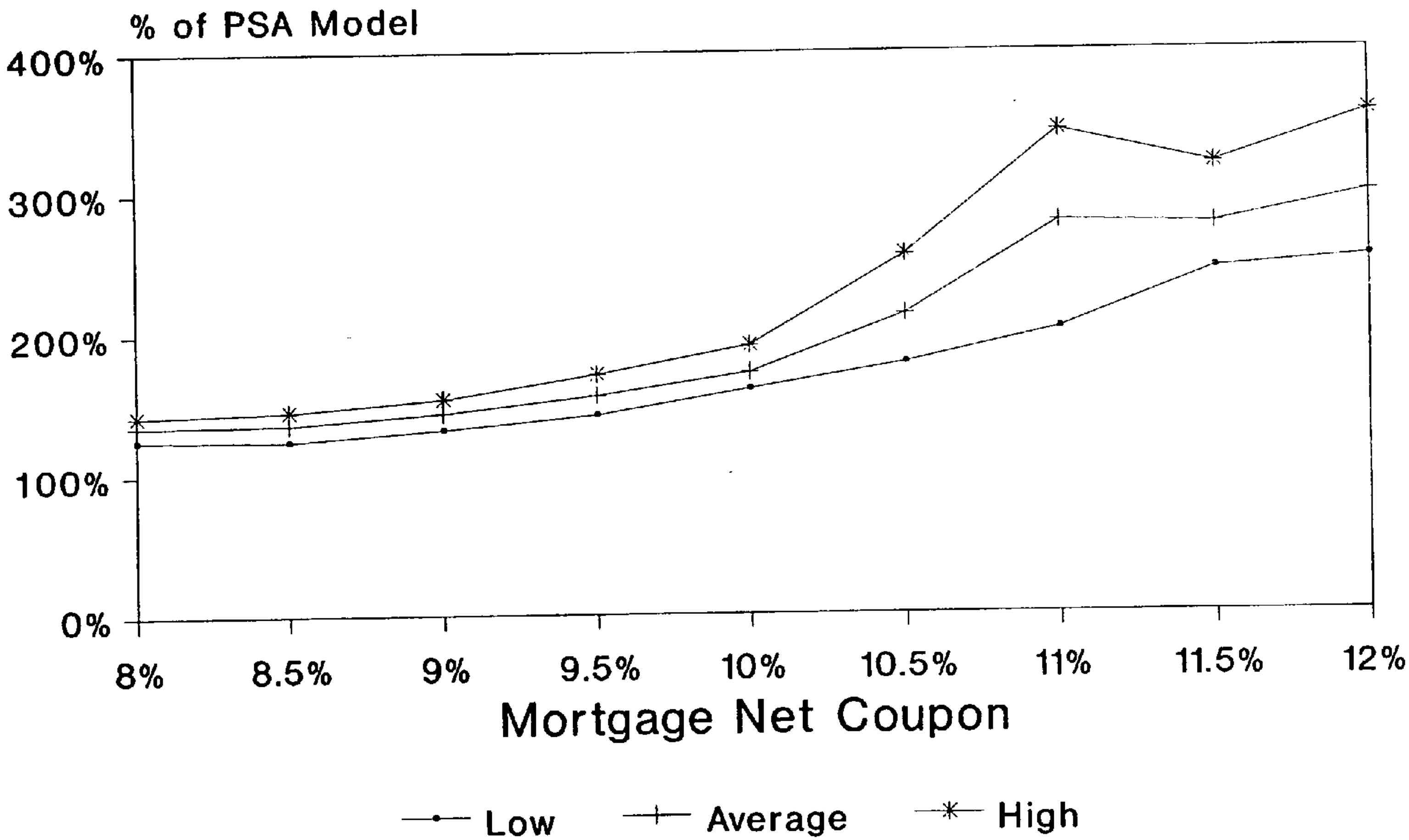
PREPAYMENT MODELS
FHA EXPERIENCE VS. PSA MODEL



While the PSA model is usually regarded as a benchmark, I would like to illustrate the current level of uncertainty in prepayment speeds. Chart 4 shows the current median, high, and low mortgage prepayment speed projections for ten major Wall Street broker-dealer firms. These projections are for the most recent production FNMA and FHLMC 30-year mortgages. The prepayment rates are from about 130% to 140% of PSA for the deepest discount mortgages, and they increase as the mortgage coupon rises, as one would expect. The top line shows the highest prepayment rate projected by any of the ten firms, and the bottom line shows the slowest speed. Not much variation exists for the discount securities, where there is only about plus or minus 10% in expectations of prepayments between the high range and the low range relative to the median. Moving out to 11% coupons, we find a much wider range of plus or minus 25% relative to the median speed. These are based on models that are developed by firms that obviously have a lot of manpower and horsepower to devote to modeling prepayment activity, and yet they are obviously coming up with widely varying projections of what prepayment rates will be experienced. If different Wall Street firms arrive at such a wide variety of answers, it is unlikely that we as actuaries are going to do a much more refined job. I think you should resign yourself to the concept that there is an element here that is going to have to be regarded as random, an element that you are unlikely to be able to capture, and thus you should be technically (and emotionally) equipped to deal with significant variability in mortgage prepayments.

CHART 4

DEALERS' PREPAYMENT ESTIMATES
FNMA/FHLMC AS OF 10/4/90



Source: Bloomberg Financial Markets

I want to mention one more aspect of prepayment variability, a phenomenon called "idiosyncratic prepayment risk." This is a term that I believe was first coined by the mortgage research analysts at Morgan Stanley & Co. It refers to the variations in prepayment speeds which are commonly observed among different pools of otherwise similar collateral. Chart 5 illustrates data for three different FHLMC deals that were all issued within a two-month period from November 1988 to January 1989. Two of the deals are a billion dollars in size, and the other is a half billion dollars in size. The weighted average coupon (WAC) that is paid by the mortgage holder, is very close to 10.2% for each deal. The weighted average final maturity (WAM) of the collateral is also very similar among the deals, about 27.5 years currently. Let us look at the last 12 months of actual prepayment experience. Expressed as a percentage of the PSA model, these three deals prepaid at 116% of PSA, 180% of PSA, and 130%. Thus we observe wide variations of prepayment experience on very large aggregations of seemingly similar collateral. The implication of this is that even if one could accurately model the prepayment behavior of the market in aggregate, one should still expect to find significant variability from deal to deal, even for very sizable deals as demonstrated by this example.

How would I sum up this discussion? Prepayments can be modeled, but a meaningful model must accommodate a significant degree of seemingly random variability. To be

CHART 5

IDIOSYNCRATIC PREPAYMENT RISK

	FHLMC 21	FHLMC 22	FHLMC 30
Issued:	11/88	12/88	1/89
Size:	$1 Bil.	$0.5 Bil.	$1 Bil.
WAC:	10.205%	10.222%	10.159%
WAM:	27.5 yrs.	27.7 yrs.	27.3 yrs.
Prepaid:	116% PSA	180% PSA	130% PSA

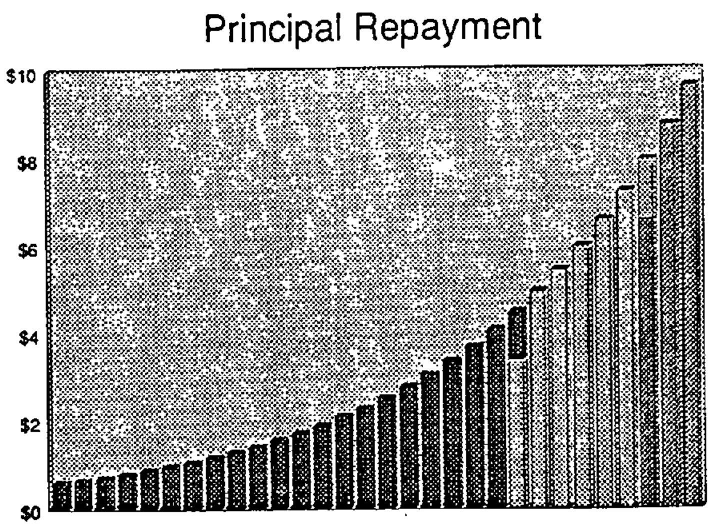
comfortable with the analysis of CMO tranches, one must accept that a level of prepayment uncertainty is inevitable.

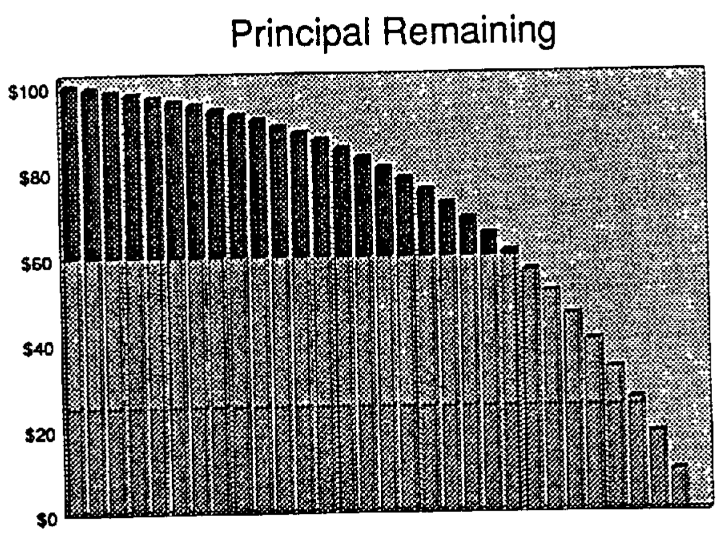
MR. BOUSHEK: I'm going to talk a little bit about variations in CMO design, which I subtitle as "All CMOs are Not Created Equally." I intend to cover this section in three pieces, beginning with a graphical look at an early, simple CMO, followed by a discussion of differences in collateral and finally a discussion of differences in structure.

Please refer to Chart 6. What I have constructed here is a very simple 3-tranche CMO. In CMO-speak, a tranche is simply one slice of cash flows. The graph on the left shows year-by-year the amount of principal that's paid off on an MBS. Ignoring the different shadings for now, this is the pattern of the return of principal for a collection of pass-through pools priced at 0% PSA, i.e., assuming that all homeowners in all the pools pay their loans exactly on schedule. The graph on the right, which uses a different scale, shows year-by-year the remaining amount of principal outstanding that generates interest for the next period. The shadings in the graphs represent the simple sequential tranching of the principal cash flows within this pure vanilla CMO. In this particular case, the first 40% of total principal cash flows are assigned to one class of investors, the next 35% to another class (us), and the final 25% to a third class. A key underlying premise of CMOs is that the sum of the parts have to add up to the whole, and that should be evident in this

CHART 6

3-TRANCHE CMO
0% PSA





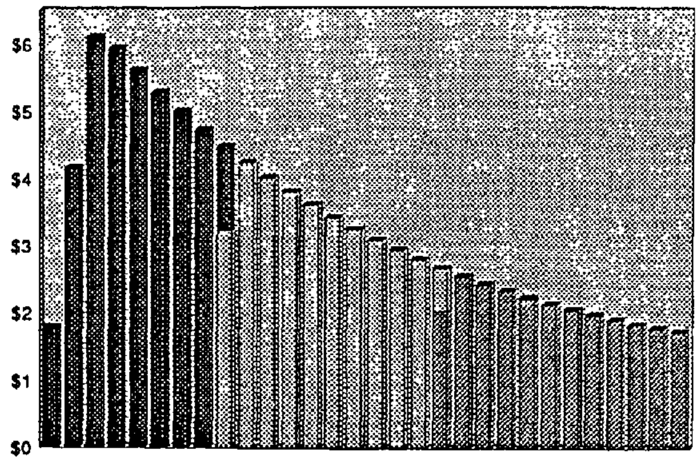
example. In the left-hand graph you can see that if all these homeowners pay their loans off exactly on schedule, our second tranche will start paying down in year 22 and will continue until we get that last little sliver in year 28. In the right-hand graph you can see that the amount of principal that we have left outstanding that will generate interest for us remains level for 22 years and then declines as we begin to receive our repayments of principal.

Now, instead of assuming 0% PSA prepayments, what if I assume that prepayments will be received at 100% of the PSA model? In other words, what if aggregate loan repayments grade into an annualized rate of 6% of outstanding principal by the thirtieth month after origination of the loans and remain at that rate thereafter? The radically different shape to our expected cash flows is shown in Chart 7. Again, if we ignore the shadings for a moment, you can see the dramatic impact of this assumption on the aggregate principal cash flows and remaining balances of the underlying loans. Much more principal is paid up front, and much less principal remains outstanding. If you focus now on what happens to our 35% of those cash flows, you can see that we have shifted from receiving principal cash flows in years 22 through 28 to now receiving our principal back in years nine through 18. For this example, I have assumed that our CMO was created out of GNMA 9.5% pools, which are a collection of Veterans Administration (VA)/FHA 10% 30-year loans.

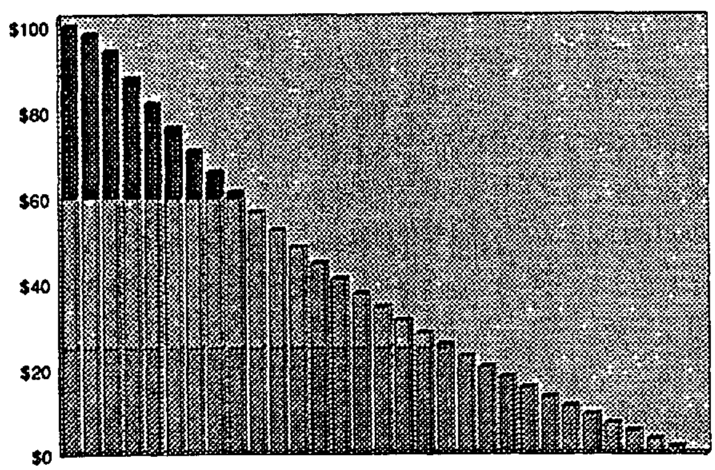
CHART 7

3-TRANCHE CMO
100% PSA

Principal Repayment



Principal Remaining



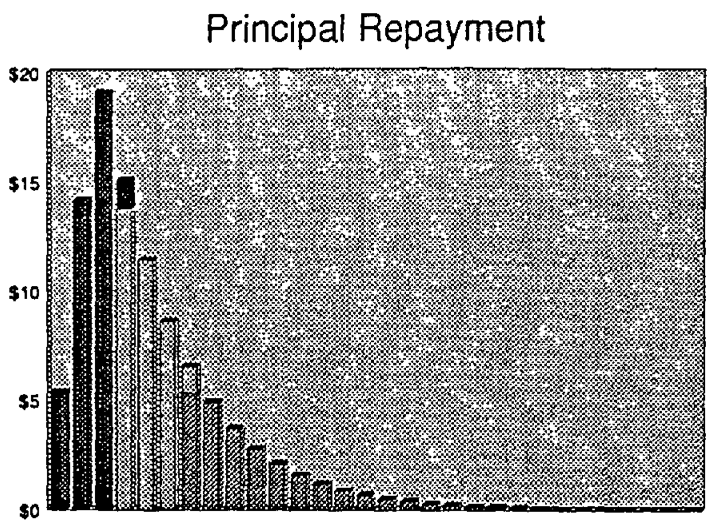
This 100% PSA might be called our current best guess as to future prepayments for this type of collateral.

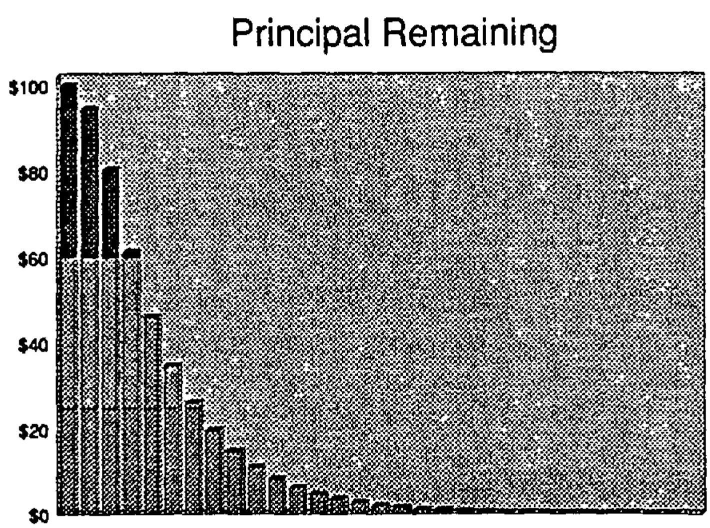
Finally, suppose that interest rates drop dramatically and we decide that 100% PSA is an unrealistic assumption. Believing that several homeowners might now be tempted to pay off their loans by refinancing at a lower interest rate, we decide that 400% of PSA is a more appropriate assumption. This means that by the thirtieth month after origination we expect principal repayments to be coming in at an annualized rate of 24% of outstanding principal each month. In this case, the shape of our graphs change even more dramatically, as shown in Chart 8. Looking directly at our shaded tranche, we now expect to get our principal back not in years 22 through 28, not in years nine through 18, but rather in years four through seven.

As complicated as they may seem, these few graphs show you what CMOs used to look like in the "good old days." This is the simplest, most pure vanilla form that a CMO can take. I'm not sure I could even illustrate with a set of graphs some of the more complex CMOs currently available in the market. Regardless of the degree of complexity, however, one point should be clearly obvious from any graphical depiction of a CMO, namely, that the cash flows of a single CMO tranche cannot be considered or projected in a vacuum apart from the other tranches.

CHART 8

3-TRANCHE CMO
400% PSA





I promised that I would restrict my use of graphs to a minimum, so I'd like to move on from here to a nongraphical discussion of differences in the collateral (the pass-through pools) that goes into various CMOs. In Chart 9 I have listed various characteristics that impact the general shape of the bars in the graphs we were looking at. Dave talked about some of them. One that he did not really discuss was one that I have labeled as packaging, namely the agency and program that the pass-throughs emanate from. There are significant differences here. GNMA, for example, buys only VA and FHA mortgages. That implies a certain class of borrowers and a certain type of mortgage, including among other things an assumability provision. These two things significantly influence how we model prepayments. FHLMC and FNMA, on the other hand, buy nonguaranteed conventional mortgages up to a certain size limit that conform to certain standards. These pools are often geographically concentrated, include nonassumable loans, and consequently must be modeled with different assumptions. The various agencies also buy loans under different programs -- 30-year and 15-year, straight payment, graduated payment and balloon. Each of these must obviously be modeled differently, and CMOs have been created out of every one of them. In fact, some of the earlier CMOs included mixtures of pools from various agencies and various programs.

There are also differences in coupons. Dave talked about the WAC. Some of the early CMOs included pools with a wide range of pass-through coupons (and thus underlying loan

CHART 9

DIFFERENCES IN COLLATERAL

- PACKAGING:
  Agency/Program/Issuer
- COUPON:
  Gross/Net/Average/Range
- SEASONING AND REMAINING TERM:
  Average/Range
- CREDIT QUALITY
- PREPAYMENT HISTORY

rates), ranging perhaps from as low as 8% to as high as 14% in a single deal. To model this collateral as a single loan with an average interest rate equal to the WAC of the collateral is obviously incorrect and would be comparable to modeling the mortality of a cohort ranging in age from 20 to 60 as a cohort all age 40.

I plan to talk about credit quality a little later on. Suffice it to say that the majority of outstanding CMOs have been created out of federal agency pass-throughs, which have either the direct or implied credit support of the U.S. government and are therefore rated AAA. If you recall Chart 1, however, we could draw a line directly from the loan originators to the CMO slicer without going through a governmental agency. Such a process does exist, and an increasing number of CMOs have been created in this way, constituted from what is generally referred to as whole-loan collateral. These CMOs include not only prepayment risk but also an element of credit risk, which I will discuss more fully under our segment on market trends.

The last area I want cover, and really the meat of this segment, is differences in CMO structure. If you will recall, we started this segment with graphs of a simple 3-tranche pure vanilla sequential CMO. At last count I can now identify 28 different types of CMO tranches, all more complex than the simple sequential vanilla tranche and all more intricately intertwined with other tranches in the same deal. Given the rich lode of raw material to mine, Wall Street has unleashed a tremendous amount of financial engineering power to find creative, and profitable, ways to slice and dice MBS cash flows within a CMO. The result is an amazing and expanding array of alternative CMO structures, each designed to capture a different market arbitrage and/or meet a different client need.

In general, I can group my 28 tranches into eight primary tranche types. In the beginning was the vanilla tranche, also called the straight sequential or clean payer tranche. This is the type of tranche we discussed in the examples earlier. The first real innovation in CMO design came in 1986 with the advent of controlled amortization tranches. This family of tranches gets preferential treatment when it comes to dividing up cash flows within a CMO. The two most common forms of this tranche are PAC (planned amortization class) and TAC (targeted amortization class) bonds. Very briefly, in a PAC tranche the CMO issuer guarantees that as long as prepayments fall consistently between some prepayment speeds X and Y (the PAC "collar"), the holder of the tranche will receive principal repayments according to a fixed predetermined schedule. However, if prepayments come in outside of that collar, the guarantee no longer holds. A TAC tranche is sort of a half-PAC. Instead of a collar, the CMO issuer sets an expected prepayment speed and guarantees that as long as actual prepayments exceed this level, the holder of the TAC tranche will for as long as possible receive repayments as if prepayments had come in at the expected level.

If prepayments come in slower than expected, the tranche performs just like a vanilla tranche.

A fundamental law of CMO creation is that the sum of the parts has to equal the whole. If one tranche in a CMO gets preferential treatment on repayments, it follows that another tranche somewhere in the deal must get the shorter end of the stick. Such support or companion tranches absorb the volatility that other tranches are shielded from. These tranches come in various forms and go by various names, some complimentary and some not so complimentary. They typically carry much higher yields as compensation for the greater risk. Some companion tranches actually begin life as preferred amortization tranches, receiving support from some tranches but ultimately providing support to others when their own support tranches are extinguished.

Accrual tranches are often referred to as Z-bonds. An accrual tranche is essentially a payment-in-kind bond for a period of time, as interest is paid in the form of compounding additions to the principal balance rather than in cash. At some point in time, depending on how actual cash flows emerge, an accrual tranche quits building par value and begins paying down both principal and interest. Accrual tranches were first found typically at the tail end of a CMO, but now can be found at various maturities within a deal. Accrual tranches quite often double as support tranches, but PAC Zs also exist. One of the more interesting forms of the accrual tranche is the jump Z, which begins life as a long-dated bond but jumps ahead of other tranches to claim a priority on principal prepayments if either interest rates or actual prepayments cross a given threshold level, or "trigger."

Index tranches vary from one another and from other tranche types primarily in the way that they distribute interest to investors. The most common type of index tranche is a floating-rate CMO, which typically pays a coupon tied to a short-term-yield index. The index most commonly used is LIBOR (London InterBank Offered Rate), a standard short-term benchmark in foreign markets. However, I have seen CMOs indexed off of just about everything. We own CMO tranches that are indexed off the ten-year Treasury yield. Most recently I have seen a proposed CMO tranche that had interest payments indexed off the yield on a high-yield bond index. Principal repayments, too, can be indexed to an external measure. For example, it is possible to set up a tranche that has a priority claim on prepayments if interest rates are at or below a certain level. Returning again to the fundamental requirement that the sum of the parts must equal the whole in a CMO, it follows that any indexed tranche in a deal must be offset by a tranche or tranches whose cash flows are inversely affected.

Stripped tranches involve only a single element of cash flow -- principal or interest -- or a disproportionate allocation of interest. The PO (principal only) family of tranches pays no interest and only returns principal to the investor. Ultimate return of a fixed amount of dollars is guaranteed, but with uncertain timing. The IO (interest only) family of tranches pays no principal but rather only interest based on a notional amount of principal outstanding. Here, both the timing and amount of ultimate cash flow is uncertain -- the longer that the notional principal behind the tranche remains outstanding, the more payments the holder receives. Obviously, both IO and PO tranches are sold at a significant discount to the actual or notional amount of initial principal outstanding. Variations on this theme include tranches designed with partially stripped coupons (e.g., 6% coupon off of 10% collateral) priced at a big discount, and tranches designed with excess coupons (e.g., 14% coupon off of 10% collateral) priced at a big premium, designed to appeal to certain investors.

A capped tranche includes a guarantee of final payment by a given date regardless of actual prepayments. In one sense, all CMO tranches are "capped" by a zero prepayment assumption. However, suppose you have the opportunity to buy a PAC tranche with a payment window between years eight and 12 as long as prepayments come in within the PAC collar, with an ultimate final maturity in year 25 if there are no prepayments at all. You would like to own this bond, except that your liability requirements are such that you need all principal repaid on this investment by no later than the fifteenth year. A creative CMO issuer can provide that guarantee to you -- at a cost -- by giving you a priority allocation of cash flows, if necessary, at the expense of other tranches in the deal. Some capped tranches also include a "lockout" provision that provides a guarantee against repayment of principal prior to a given date. For obvious reasons, capped tranches are often referred to as "stated final" bonds. Many of these bonds have been created specifically for GIC writers.

Finally, there are the leftovers, or residual tranches. When all the slicing and dicing is done, the remaining bits and pieces form the residual interest. In the early days of CMOs, residuals represented essentially the equity interest in the deal retained by the issuer. Now, however, nearly all CMO residuals are securitized and sold to investors, often as hedge vehicles, and the composition of the residual is an important consideration in the structuring of any deal. Residuals come in all kinds of flavors, with all kinds of tax and accounting ramifications. Life companies are ordinarily not big players in this particular segment of the CMO market.

In addition to basic differences in structure, one CMO or CMO tranche can often be distinguished from another by the presence of options. Some CMO tranches contain a put provision, allowing holders of the bond to demand repayment in full from the issuer at certain times and under certain conditions. Most CMO trusts also have a cleanup call provision that enables the issuer of the CMO to repay all outstanding principal after year x or after y% of the collateral has been repaid. This provision has little or no impact on short maturity tranches, but can be important to longer-dated tranches. It has often been ignored by CMO buyers, and given the relative youth of the CMO market there is little experience to date on its exercise. However, I believe that the cleanup call option will become much more important in the valuation process as time goes on.

To finish this segment of our presentation, I'd like to illustrate just how far CMOs have come since the simple 3-tranche vanilla example that we looked at earlier by looking at two CMOs that we own in our portfolio. The first one is FHLMC REMIC Trust 112. There are other CMOs with more tranches in them, but I thought the composition of this particular CMO was rather interesting. Included in its design are nine PAC tranches, eight of which have different PAC collars; an inverse floater, which is the flip side of a floating-rate bond; a super floater, which is a leveraged floating-rate bond; two pure support tranches; an IO-ette; and two residuals. I thought about trying to graph this CMO, but decided I couldn't cost-justify the effort. What I think is interesting about this example is the potential performance of the PAC bonds. Quite often, individuals or vendors will dismiss the difficulties of modeling a PAC tranche by asserting that one PAC is the same as the next, except for collateral, coupon and collar, and therefore PACs can be modeled generically. That's only true as long as prepayments never fall outside the PAC collar. If they do, the performance of the tranche then becomes very dependent upon how the rest of the deal has been designed. I doubt that any of us could surmise how the PAC tranches in this deal might act if prepayments slowed down or speeded up in plausible extremes; yet, this is exactly what we must know in order to manage our asset/liability risk. And just to show you that it doesn't take a lot of tranches to create complexity, I'd also like to look at FNMA REMIC Trust 88-29, which is a much older deal. This CMO has only six tranches, but they include a PAC, a support TAC, two floaters (with different indices), a PO and a residual. Again, I doubt that anyone else could project how the PAC tranche in this CMO might look under reasonable extremes without projecting cash flows for all tranches in the trust.

MR. HALL: I would like to make a few brief comments on recent trends. CMO yield spreads have been very fluid in 1990. During the first part of 1990, we witnessed yield spread tightening in tranches that had lower volatility and more stability. For example, three-year PACs traded as tight as 60 basis points over comparable Treasuries, five-year PACs as tight as 70 over Treasuries, and ten-year PACs even narrowed into the 80 over Treasury range. The more volatile tranches widened substantially because the traditional investors in those classes either pulled away or went insolvent. Support tranches, depending on their structure, traded as wide as 200 to 300 over Treasuries in some instances, and typically there were not many buyers even at those levels, at least for the most "ugly-looking" tranches. Super POs, though, trade at levels anywhere from a base case yield of 4% to something moderately above Treasuries, again depending on their structure. At the other end of the spectrum, inverse floaters have recently commanded the highest yields. As Randy alluded, those are the flip side of floating-rate tranches, and they typically trade at new issue yields of anywhere from 12 to 16%, depending on a number of factors.

More recently, yield spreads on even the more stable CMO tranches have been widening somewhat. I think this has been primarily in sympathy with the spread widening that has occurred in the corporate market and the asset-backed market. In order to induce buyers to continue to invest in CMO tranches, these securities must provide yield spreads that bear some reasonable relationship with other high quality alternatives. It is difficult to see where the trend is ultimately headed, but it is important to understand that there is a lot of fluidity in CMO yield spreads. In fact, it is not even entirely appropriate to say (although I just did) that three-year PACs trade at 70 off, because while highly protected three-year PACs may be trading at 70 off, alternative structures, which could still legitimately be called three-year PACs, could be trading as much as 25 to 35 basis points wider. So you find significant variability, and it is very difficult, if not misleading, to generalize.

Next I will mention a brief chronology of the structuring fads which have been in vogue. If you are evaluating your CMO portfolios, it can be useful to understand when a deal was issued, as this can provide a clue to how it was structured. The very early deals are of the type that Randy showed in his chart, referred to as plain vanilla sequential deals, ABCD, or ABCZ, the latter if the final tranche is an accrual tranche. Other early deals were IO/PO strips where the interest and the principal were separated into two different classes. The next innovation that found favor was the scheduled sinking fund concept (i.e., PACs and TACs) where, instead of paying sequentially, tranches paid down simultaneously with different priorities for the emerging cash flows.

In 1986-87, floating-rate CMOs became very popular, especially as a way to structure the support tranches, because you could establish a sizable piece of the support with floating rate coupons, thereby eliminating much of the concern about prepayment volatility. Those deals typically included Super POs, as well, and generated a residual that was typically bought at a very high yield with a very volatile return profile. Many of those residuals went into the savings and loans, and many are now coming back out of the savings and loans, being auctioned virtually weekly by the Resolution Trust Corporation (RTC). Incidentally, a number of those are now going into insurance company portfolios at yield levels that appear to be pretty attractive, even when hedging costs are considered.

Next, the trend went to multiple-tier PACs, sometimes called Type 1 and Type 2 PACs, or Tier 1 and Tier 2 PACs. These are PACs with different levels of prepayment protection, or different levels of seniority over cash flows. Finally, 1990 has been the year of customization. We have seen a number of deals that have upwards of 20 tranches in them, that have a lot of small, very unique tranches that have been custom built for clients that were looking for a certain type of profile. These include PAC IOs (interest only strips off of PACs), tranches with unique indexing features, bonds that have enhanced convexity features, or unusual liquidity characteristics. A number of accrual PACs have been built this year for insurance company portfolios. These can be a higher yielding alternative to zero-coupon bonds, and thus I am sure that many GIC writers have some of these in their portfolios.

While the simplest deals are typically the oldest deals, there has been a bit of a trend in 1990 once again to issue plain vanilla deals. This was a response to the developing "complexity overload," as some investors just wanted to return to the ABCD structure because it was simple. So 1990 has seen the return of the simple deal as well as an expansion of the more complex structures.

Randy will now discuss some of the credit-risk-related aspects of the nonagency CMO market.

MR. BOUSHEK: I'd like to talk just briefly about credit risk in CMOs. I mentioned earlier that there is a form of CMO that is not comprised of GNMA, FNMA or FHLMC pools with their explicit or implicit government guarantees. Whole-loan CMOs contain packages of mortgages that come directly from a bank or savings and loan or mortgage banker. The only "guarantee" on the ultimate return of principal to investors in these CMOs is the quality of the underwriting of the loan originator. To make these deals more attractive to investors, issuers often add credit enhancements sufficient to get an AA or AAA rating from the bond-rating agencies. There are a number of ways to do this. For example, one common approach is to secure a guarantee from the originator or a letter of credit from a third party to cover all losses up to something like 10% of the issue. A second approach is to purchase insurance coverage from a third-party provider. A third way is to create a subordinated tranche that will absorb any losses up to the amount of its outstanding balance. Obviously, the holder of this tranche must be compensated for greatly increased risk by a much higher initial yield.

There are three main asset/liability considerations that you need to be aware of in dealing with whole-loan CMOs. The first is that such bonds require reserving not only for C-3 risk, but also for C-1 risk. A number of CMOs bearing the Citicorp name have as their credit enhancement a guarantee from Citicorp. As long as Citicorp was rated AA, tranches from those CMOs were rated AA. When Citicorp was downgraded earlier this year to A, the rating on a number of those tranches was downgraded to A because of the decline in the strength of the guarantee. The second consideration is prepayment modeling. Whole-loan CMOs are generally created out of loans that don't fit FNMA or FHLMC guidelines, which for the most part means they have much larger outstanding balances. This implies a much different type of borrower, with different characteristics that have to be considered in modeling the prepayments. Also, delinquencies or defaults often need to be modeled separately from other prepayments, because this particular source of prepayment can result in different allocation of the cash flows in the CMO. The final consideration is tranche modeling -- assessing the impact of subordinated tranches on the redirection of cash flows in the trust, even in the absence of defaults.

Having discussed the prepayment function, variations in CMO design, and trends in the CMO market, we can move finally to the subject of modeling these creatures. CMOs are financially engineered creations. Some people tend to put that in the same category as Frankenstein's monster. I tend to disagree, although I may have a biased viewpoint. I think CMOs offer real value to investors, although I acknowledge that they are extremely complex. I'll give you my thoughts on CMO modeling first, and then ask Dave to do the same.

Historically, there has been a number of challenges that have arisen in modeling MBSs. The first challenge was to model pass-throughs. Agency pass-throughs were first modeled as 12-year bullet (single maturity) bonds. This works fine until they start paying down materially or until projections are needed for various interest rate scenarios. In response to these problems, the dynamic prepayment model was developed. Actually, there was a step in-between, namely the advent of the FHA experience model that Dave discussed earlier. Nearly all major Wall Street firms and their institutional clients now have at their fingertips models that dynamically adjust MBS prepayments to changes in a scenario projection.

The next major challenge was the need to isolate and model a vanilla CMO tranche. One of the first attempts at doing this, away from Wall Street, was to treat the tranche as a serial maturity corporate bond with maturities matching expected principal repayments under a best guess prepayment assumption. This approach works fine until prepayment experience begins to differ from expectations or until projections are needed for various interest rate scenarios. A second simplistic approach was to model the tranche as a combination of positive and negative pass-throughs. With some effort, this approach can accommodate a straight vanilla sequential CMO, but nothing else. More recently I have seen models that have advanced to the point of being able to dynamically model a vanilla sequential CMO. Some of these even have the capability to handle a very simple PAC structure within the deal.

The current challenge -- and the one that I consider most daunting -- is isolating a tranche in a flavored CMO. I always cringe when I hear the generic claim that such-and-such model handles CMOs. Very few models have advanced to this stage. There is no such thing as a generic CMO, and in my view any true dynamic model must somehow access a database containing issue-specific information. Away from Wall Street, I don't know where any such database exists. Wall Street firms, because of their role in creating and trading these instruments, have developed tremendous modeling capabilities and would seem to be natural vendors of a CMO projection model. Several Wall Street firms have entire staffs of people dedicated solely to reverse engineering the CMOs of other firms for inclusion in their own database. Unfortunately, most Wall Street models are geared to security valuation and yield analysis, not portfolio management or dynamic scenario cash-flow projection. Still, the database is there and ready to be tapped.

I have been advocating development of a client modeling system for two years with the Wall Street firms that we do business with, trying to impress on them the potential size of the market that exists in the insurance industry for such a product. I really believe that they are missing a great entrepreneurial opportunity, leaving a gap that will ultimately be filled by third-party vendors that will reverse engineer CMOs for themselves. Thus far I haven't met with a lot of success, but the message is definitely getting more attentive audiences. Depending on the nature of your investment division's relationship with various Wall Street firms, there are certain services that some brokers are now willing to provide. For example, there are at least four firms that have offered to take my portfolio of CMOs and provide me with a one-time analysis of aggregate cash flows and portfolio performance under a simple set of three scenarios -- level, rates up 100 basis points and rates down 100 basis points. This is helpful to me as a portfolio manager, but does little for my corporate actuaries. Asking for segmented cash flows for 20 to 40 randomly generated scenarios, however, is beyond the scope of a relationship request.

There are a few other challenges that exist in modeling CMOs as well. One particular challenge is modeling an "in-force" CMO. It's relatively easier to model a new CMO right out of the chute than it is to project a CMO that's been on your books for a few years. To project a seasoned CMO tranche, you need to know every cash flow that's come in up to that point in order to figure out where every tranche in the deal currently stands. This is a process called factor updating. Another challenge is market valuing CMOs if they must be sold to raise cash in a model projection. A third challenge is modeling the indices that payments on any indexed tranches are based on.

I think there are four basic options in modeling CMOs. The first is in-house development. I don't mean to put that option down, because there are a number of situations where it may be viable, but I think it is much more difficult than many people will admit. The second is actuarial asset/liability models that handle CMOs in some simplified fashion. I do caution that whenever you look at a model that purports to handle CMOs, find out just how it does so. The third option is to capitalize on relationships with Wall Street, which is viable only to a point, or perhaps contract with the Street for services. The fourth -- and in my opinion optimal -- alternative is an asset-only model that interfaces a database of specific CMO issues. There is at least one promising product currently being tested that does just that, and I suspect others are on the horizon.

In assessing how you're going to model CMOs for asset/liability purposes, I think you need to ask yourself a series of questions. What kinds of tranches do I own? What other types of tranches exist in the CMOs that I own tranches in? How extreme are my scenarios? If I own PAC tranches and I'm only going to test moderate scenarios, I probably don't need a lot of modeling capability. How frequently do I need to model? How important are variations in CMO cash flows to my results? How accurate are my liability models? How big are CMOs as a percent of my cash flow? What similar needs does my investment portfolio manager have? And finally, what kinds of resources -- money and people -- do I have available to tackle this issue?

MR. HALL: There are a number of important considerations when choosing an approach to modeling CMOs. First, you need to assess your manpower resources. If you hope to develop an in-house model, you will need to devote significant time to the process of designing and programming the system. Beyond that, you should be aware that the effort needed to maintain and update the system may also be substantial. Wall Street has aptly demonstrated that there are almost unlimited permutations for reallocating cash flows, and you can also be sure that new methods will be developed. In fact, any CMO system should be extremely modular in architecture so that updates can be conveniently integrated without risk of disrupting other areas of program logic.

You must next ascertain which database sources you may access. I believe that there are now several services that provide factor and prepayment information for CMOs. Check with your investment accounting or treasury services departments; it may be that your investment systems already receive feeds from such a database. If your CMO holdings are small, you may be able to manually maintain this data. However, carefully evaluate this option, for CMOs will likely become more pervasive in fixed income portfolios over the next decade, and today's small position may mushroom into a much larger holding very quickly.

If you think you have both the manpower and the database issues resolved, you should still pause to assess whether you really have sufficient market familiarity to develop a credible system. CMOs are very complex instruments with many subtleties, and it is unrealistic to expect that a system can be designed based solely on information gleaned through a study of literature on the subject. The market is not nearly as "black and white" as it may appear in print, and some hands-on experience with this market is critical if you are to avoid a number of naive, academic presumptions. Clearly, you should involve some member of your portfolio management or trading operations. (If you don't believe that those areas have the required expertise, then you may be better off not knowing how your CMO holdings are likely to perform. Ignorance is bliss.)

Once you have crossed all of these decision thresholds, look around for a viable system from an outside vendor. Many firms are working feverishly towards incorporating CMO analytics in their fixed-income systems. While I am not aware of any firm that currently has a fully functioning system available, I do know of a number that are moving down the right path. It very well could be that more external alternatives will be available by early to mid-1991. Even if an outside system can't provide every feature you desire, the cost/benefit trade-offs of accepting a partial bird-in-the-hand may be compelling.

Let us assume that you have chosen to engineer your own CMO model. What main engines should it contain? I like to think of a good CMO model as having four principal components: a collateral model, a prepayment model, a "traffic cop," and a market-pricing module. I will discuss each of these items.

Since a CMO is only a controlled distributor of collateral cash flows, it is intuitively important that any modeling system must be fully capable of modeling the cash flows of the collateral. Issues to consider include:

- Should you model the behavior of each individual pool, or may pools be aggregated? In particular, is it appropriate to use average coupon and maturity characteristics, or must some of the actual distributions of those characteristics be captured?

- Can the model adequately deal with such nontraditional (but certainly not unique) features as graduated payments, adjustable coupons, scheduled balloon payments, and prepayment lockout periods? CMOs have been issued which incorporate all of these collateral oddities, and more.

- Are reinvestment assumptions necessary? Early CMOs paid interest and principal only semiannually or quarterly, and internal reinvestment assumptions are critical to accurately modeling those deals. Even monthly-paying CMOs may incorporate some internal reinvestment if the CMO payment date does not coincide with its collateral payment dates.

- How will collateral experience be updated? How will emerging prepayment experience be measured? If you track collateral at the individual pool level, then you may be able to interface with factor tapes to update collateral balances, but if you (more likely) deal with aggregations, some other means may be required.

Although it is perhaps implicit in the collateral modeling function, I prefer to regard prepayment modeling as a separate issue. Collateral modeling addresses the capability to model the peculiar features of various types of mortgage collateral. Prepayment modeling addresses the rationale that will be used to project the emerging behavior of those mortgages.

I earlier discussed a number of factors which influence prepayment activity. Models can be and have been constructed by incorporating dependant variables such as seasoning, coupon, seasonality, loan type, geography, and loan history. Depending on the purpose of your CMO model and the nature of your portfolio holdings, some factors may be critical, while others may be less significant. For example, if your holdings are predominantly PAC tranches, then your model may not require sensitivity to seasonal prepayment patterns, as these influences will largely affect only the support tranches. Also, while the relative spread between the collateral coupon and current mortgage rates is typically a primary determinant of prepayment activity, collateral that has already been exposed to at least one period of refinancing opportunity will probably react more sluggishly to subsequent interest rate declines when compared with collateral that has yet to experience such an opportunity. This "path dependent" modeling feature, while complex to measure, can nonetheless wield a powerful influence in projecting cash flows over extended time horizons.

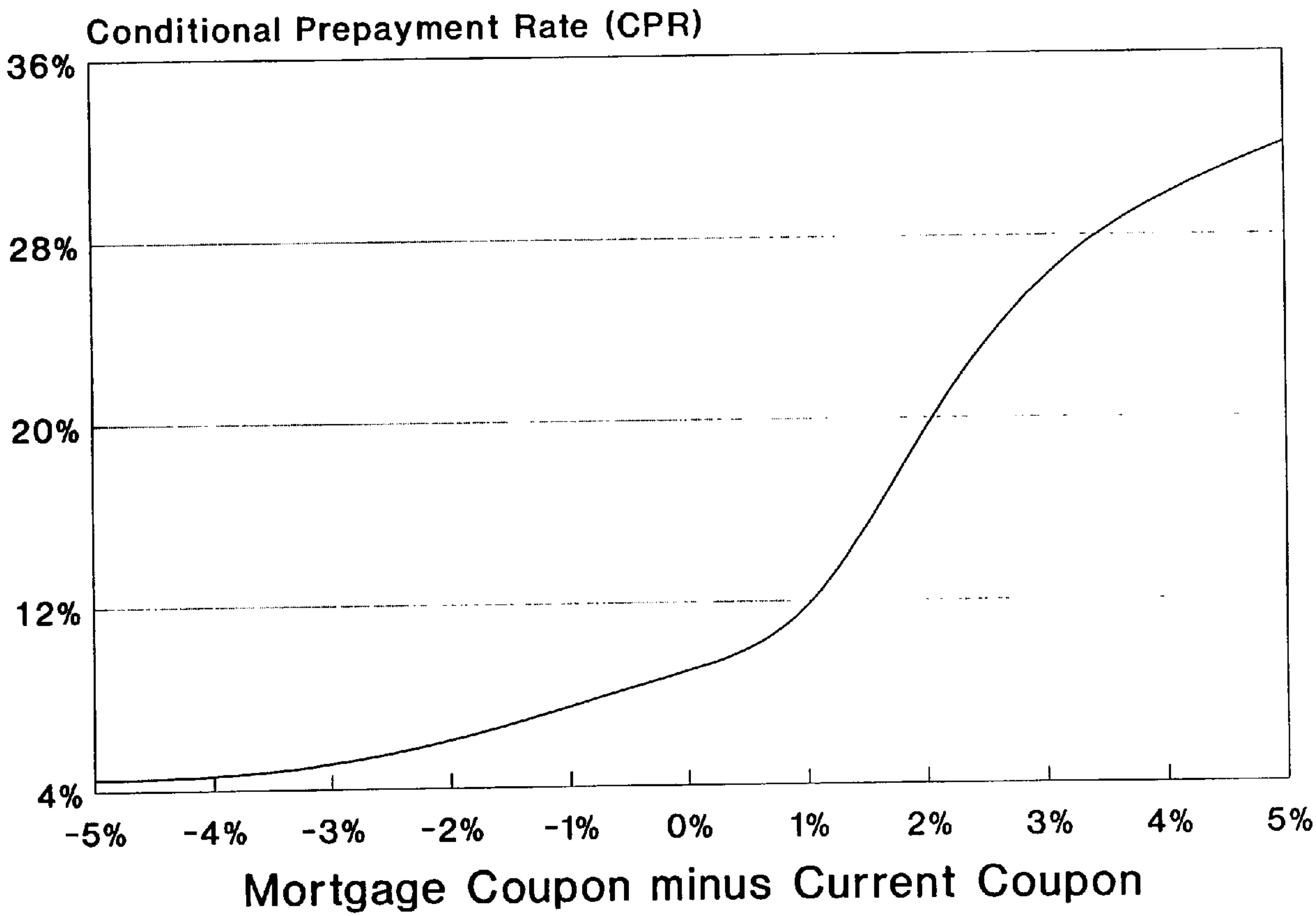
Another consideration in building a prepayment model relates to the concept of making the model stochastic, as opposed to deterministic. Will the model assume that a predetermined prepayment rate will result from a given mix of determinants, or will these determinants only give rise to a distribution of possible prepayment rates, presumably with a determinable mean and standard deviation? Recall my earlier remarks on idiosyncratic prepayment risk. A wide variety of prepayment rates can manifest from quite similar collateral. While most CMO models that I have seen do not capture this type of behavior variability, this very well may be more prevalent in the developing wave of CMO analytical systems. Further, certain types of CMO tranches may be particularly susceptible to idiosyncratic variability, such as super POs and jump-Z tranches.

Chart 10 illustrates a common type of prepayment function for mortgage models. In this example, annualized prepayment rates are determined as a function of the difference between the mortgage coupon and the current coupon. As the mortgage coupon falls well below the current coupon, prepayment rates decline gradually. As the mortgage coupon begins to exceed current rates by 100 basis points, prepayment rates increase markedly. This trend continues until the differential becomes so great that the marginal impact of wider differences fails to generate much more prepayment activity, and the ultimate prepayment rates begin to plateau. Although it is a rather simple model, models of this type are quite popular, and do capture much of the behavior needed to value the raw option embedded in mortgages. As a caveat, the actual rates depicted in this example should not be construed as having any current significance, although I do believe that they are typical of what some recent models would incorporate.

The third and perhaps most interesting feature of a CMO model is the tranche selector. This is the logic that determines to which tranche a specific cash flow should be directed. I like to think of this function as a "traffic cop" that stands in the center of a cash-flow stream and directs the various bits of principal and interest to their proper outlets. It is this function in particular that my earlier comment on modular system architecture contemplated. Metaphorically, this is Wall Street's playground. This is where you will find

CHART 10

SAMPLE PREPAYMENT FUNCTION



countless variations in rules and algorithms for determining where each of the cash flows of a mortgage will ultimately come to rest.

In developing a fully functional traffic cop, you will require the development of innumerable sinking-fund schedules for PACs, TACs, and other scheduled payment derivatives. Although these may be keypunched by an ambitious clerical staff, you will likely find it sufficient (and ultimately more enlightening) to approximate these schedules through a process called "reverse engineering," in effect attempting to reconstruct an entire deal given only some of its parameters. Through this process, one can gain a much deeper understanding of what makes a CACMO "tick," thereby gaining a better appreciation of how various parts of a deal interact. In fact, in order for a traffic cop to do its job, it must know where each tranche in the deal stands at each payment date, since most deals involve interdependent tranches. In essence, it is not sufficient to merely know the paydown status of the tranche in which you have interest: the status of most, if not all, of the other tranches in the deal must also be known. This brings with it a monumental data management problem, that of capturing all of the various paydowns of each tranche in each deal in your portfolio. Again, unless your portfolio is very small, you will want to explore means of purchasing these data from vendors.

If the purpose of your CMO model is to "stress test" a portfolio, as would be the case in the case of a Regulation 126 scenario analysis, it is important to capture the behavior of stable tranches (such as PACs) as they break through their protection barriers. Although many deals direct excess PAC cash flows from "front-to-back" once all support tranches are exhausted, still a number of deals have unusual excess payment priority allocations, ranging from "back-to-front" to what may appear to be random patterns, generally emanating from a deal in which a particular tranche was engineered to appeal to a specific investor. Capturing all deal-specific rules such as these is important if one is to recognize the degree of call risk which is inherent in a portfolio.

Finally, I wish to speak briefly about direct call features in CMOs. Most recent deals have a "nuisance call," or "cleanup call" provision, which grants either the issuer or the residual holder the right to terminate a deal when the collateral reaches a balance of 1% of its initial size. At that time, the collateral would be sold, and all remaining principal balances would be paid off, as in a traditional bond call. In most circumstances, a 1% cleanup provision would be unlikely to contribute much to the value of a CMO tranche. However, many older deals, and some recent deals, have much more liberal call provisions, wherein the residual holder may call a deal when the collateral pays down to 20%, or when a specified date is reached, or when a certain tranche begins to pay down. Some of these features can be quite critical in assessing value and modeling performance. However, it is also important to understand the likely motivations for a residual holder to call an issue. It may not always be that a call is detrimental to the investor who is prepaid. In particular, a PO holder would always prefer to be called at par. Further, it is also true that some calls that would be detrimental to a tranche investor would also be detrimental to the residual holder. If you can analyze the call economics from the perspective of the party that controls the call, you may find that your call risk is greatly diminished because your economics are similar to that of the caller.

Finally, let me comment on the market pricing function. Many models project cash flows for an intermediate horizon, and then attempt to assign a terminal market value to any assets still remaining at the end of the projection period. For noncallable bonds, this terminal value is generally the discounted value of any remaining cash flows, using a yield rate that is the sum of the initial market yield plus any change in market rates which has occurred. For callable bonds, the market value must also reflect the change in the value of the call option. This value can usually be accurately projected, since we have years of actual experience in valuing traditional bonds with options that range from deeply in the money to deeply out of the money.

Modeling the terminal values of many CMO tranches can be somewhat problematic, however. Not only does the prepayment option embedded in the collateral move in or out of the money, but also the risk profile of many tranches can change dramatically over time. PAC tranches change into vanilla tranches once their support has prepaid. Highly volatile short-maturity support tranches sold at prices near par can become very positively convex if the collateral pays slowly and interest rates rise. In short, it is insufficient to merely reproject remaining cash flows and discount them at a market yield that reflects only yield changes since pricing. Rather, it is necessary to reevaluate the risk profile of the security, and then estimate the yield at which the market might value such a security. This can be quite subjective if the security fails to resemble any currently available type of security. Yet, this problem would be quite commonplace if attempting to value a CMO portfolio in a scenario where Treasury yields drop 500 basis points.

Actuaries love to collect and analyze data, and then to build models that purport to capture the relevant behavior of the subject under study. In our discussion, although we have provided and alluded to significant amounts of data, one of the central messages I would like to conclude with is that the CMO market can be almost as artful as it is scientific. Significant uncertainty must be accommodated, and value judgments often must be based as much on intuition as on fact. To me, this is one of the charms of the market, rather than a detraction. If CMOs could be fully reduced to facts and absolutes, then not only would the market be less interesting, but also much of it would not even exist. It is the opportunity to extrapolate from existing data and make informed guesses as to the relative value and performance of various CMOs that has allowed the market to thrive on innovation. Models will never be totally correct. But they can capture sensitivities and lead to improved understanding of the dynamics of our business. It doesn't get any better than this!

1990 VALUATION ACTUARY
SYMPOSIUM PROCEEDINGS

Session 11

Open Forum: Exhibit 9

Exhibit 9
William F. Bluhm

Health Liabilities and Reserves
Paul R. Fleischacker

A Technique For Estimating the Liability for Incurred But Unpaid Claims
Benjamin H. Mulkey