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Recent Innovations in Collateralized Mortgage Obligations

by Richard Roll*

I. Introduction

Since the first Collateralized Mortgage Obligation (CMO), in June, 1983, most of the 347 issues have adhered to the classic form: fixed coupon bonds that receive payments of principal in a strict order of priority.[1] The outstanding bond (or "tranche") with the shortest stated maturity receives all distributed principal payments until it is fully redeemed.[2]

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[1] As of December 31, 1986. Total principal amount as of that date was $79.1 billion. This paper was completed in January, 1987.

[2] For a description of the classic form, see Richard Roll, Collateralized Mortgage Obligations: Characteristics, History, Analysis" (Goldman, Sachs & Co., Mortgage Securities Research), April, 1986.

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Structure

During the last 5 months of 1986, a number of CMOs have departed from the classic structure. Some of these CMOs have introduced a different priority of principal payment allocations where the longer-maturity tranches receive principal payments before oustanding shorter tranches are retired. Other CMOs have included tranches with nonfixed coupons, either coupons linked to a varying interest rate, or coupons that change in accordance with a prespecified schedule.

This paper offers analyses of these new CMO structures. A variable coupon tranche or a planned amortization tranche has an obviously distinct character; its risk attributes and value will differ from ordinary CMO bonds. The existence of such a tranche also has important consequences for the other, seemingly more familiar, CMO bonds in the same issue. Finally, these new structures influence the character of the residuals and alter the incentives of the issuer. We present a detailed explanation of these facts in the two major sections of this paper. Section II is devoted to CMOs with a Planned Amortization Class, or "PAC" Bond (the first of the two innovations). Section III discusses CMOs with a variable coupon tranche. Section IV discusses combinations of recent innovations, particularly, the use of stripped mortgage backed security technology in floating rate CMOs. Section V gives a brief summary.

II. Collateralized Mortgage Obligations with Planned Amortization Classes

As of the first week of December 1986, 12 CMO issues have contained at least one PAC bond. See Table 1.

CMOs and Prepayment Risks

A PAC bond is a CMO "tranche" that is protected in large measure from uncertainties in prepayments, the principal source of CMO risk. Virtually all CMOs have little risk of *default*, either because the underlying mortgage collateral is guaranteed or insured by private insurers or by the agencies,[3] or because there is excess collateral included in the mortgages backing up the CMO. Most CMOs have no protection, however, against prepayments by the underlying mortgages; in large part, these are passed directly through to the CMO bonds.

In a classic CMO structure, principal payments are allocated in strict order of priority to the outstanding bond with the shortest remaining *stated* maturity; the payments are used to reduce the remaining principal

[3] GNMA, the Government National Mortgage Association; FNMA, the Federal National Mortgage Association; and FHLMC, the Federal Home Loan Mortgage Corporation.

balance of that particular bond. As each CMO bond is retired, the next shortest maturity bond begins to receive the available principal payments, and so on, until only one tranche is left, the tranche that had the longest original maturity on the issue date of the CMO.

The *stated* maturities of the various tranches in a CMO are the *actual* maturities only when there are *zero* prepayments throughout the lives of the bonds and reinvestment rates are very low. At a zero prepayment rate, the scheduled amortization of the underlying mortgages is alone sufficient to pay off all the bonds no later than their stated maturities. But we have never witnessed a large pool of mortgages prepaying *at a zero rate* for an extended period, so CMO bonds, except the longest tranche in each issue, will probably be retired well before their stated maturity dates.

Because principal payments are allocated in strict accordance with stated maturity, it is often alleged that the shorter tranches of a classic CMO confer call protection (against early prepayment) on the longer tranches. However, this analysis is naive and misleading. It is true that the shorter-maturity classes are retired sooner when prepayments speed up, but so are the longer classes. The longer classes are pushed forward toward an earlier date when they will begin receiving principal prepayments in turn. Indeed, in the usual CMO structure, the underlying prepayment risk of the mortgage collateral is borne more by the longer CMO tranches than by the shorter tranches.

There are three reasons for this. First and most intuitively, a change in prepayment speed is not generally a calamitous event, but merely an alteration at the margin. An increase in speed from, say, 5% per year to 10% is considered substantial, but the *cumulative* effect of such a change in speed depends on the investment horizon. At a 5% speed, about 14% of the mortgages will prepay within 3 years and about 40% within 10 years. At a 10% speed, the figures are 27% percent in 3 years and 65% in 10 years. Thus, an increase in prepayment speed from 5 to 10% per year would necessitate the reinvestment of 13% more capital over a 3-year horizon, and 25% more capital over a 10-year horizon. These reinvestments would usually be made at a return *below* the original yield.[4]

Second, the prepayment option retained by the mortgage borrower is more valuable the longer its term. This is due to the greater possibility of interest rate movements in a direction favorable for the borrower the longer over which such a movement may take place. Thus, the shorter CMO tranches are effectively faced with a shorter term option over whose life downward interest rate movements are likely to be less substantial.

[4] Interest rates are likely to have declined. That is why prepayments have accelerated.

Table 1. CMO Issues and PAC Bonds

CHOs with PAC Tranches
14-Jan-87

#	ISSUE	ISSUE DATE COLLATERAL TOTAL SIZE % PAC BONDS	TRANCHE PRINCIPAL ($ 000,000)	COUPON	PRICE @ ISSUE	AVG. LIFE	@ ASSUMED PSA	PREPAYMENT BANDS (%PSA/AVG. LIFE)†	S/E*	SPREAD OVER UST (BASIS POINTS)
1	MDC MORT. FUNDING M-1	20-Aug-86	56,000	7.50%	99 26/32	2.40	175%			+120/2yr.
	MDC MORT. FUNDING M-2	100% FNMA	16,000	8.30%	99 22/32	5.60	175%			+170/5yr.
	MDC MORT. FUNDING M-3		56,000	9.25%	99 16/32	10.90	175%			+235/10yr.
	MDC MORT. FUNDING M-4	$198,300	60,600	8.05%	99 13/32	6.40	175%	0/9.0 50-375/6.31 500/6.51	S	+150/7yr.
	MDC MORT. FUNDING M-5	30.6%	9,700	9.50%	90 24/32	19.63	175%			+265/20yr.
2	MDC MORT. FUNDING O-1	04-Sep-86	87,300	7.75%	100	3.40	175%			+132/3yr.
	MDC MORT. FUNDING O-2	100% FHLMC 9	47,000	8.45%	99 24/32	7.90	175%	0/9.0 100-400/7.8 500/7.1	S	+155/7yr.
	MDC MORT. FUNDING O-3	$200,000	57,700	9.00%	97 28/32	11.00	175%			+220/10yr.
	MDC MORT. FUNDING O-4	23.5%	8,000	9.00%	78 24/32	20.80	175%			+260/20yr.
3	OXFORD ACCEPT. CORP III C-1	10-Sep-86	108,200	7.93%	99 31/32	3.40	175%			+130/3yr.
	OXFORD ACCEPT. CORP III C-2	100% FHLMC 9	46,000	8.69%	100	7.90	175%	0/8.64 25-300/7.93	E	+150/7yr.
	OXFORD ACCEPT. CORP III C-3	$200,000	35,000	8.95%	96 4/32	10.80	175%			+220/10yr.
	OXFORD ACCEPT. CORP III C-4	23.0%	10,800	8.95%	77 4/32	17.80	175%			+260/20yr.
4	MDC MORT. FUNDING P-1	11-Sep-86	87,900	7.95%	99 19/32	3.42	175%			+130/3yr.
	MDC MORT. FUNDING P-2	100% FHLMC	36,900	9.50%	98 16/32	10.93	175%			+220/10yr.
	MDC MORT. FUNDING P-3	$200,100	62,000	8.20%	99 19/32	5.64	175%	0/9.0 100-400/7.8 500/7.1	E	+120/5yr.
	MDC MORT. FUNDING P-4	31.0%	13,300	9.50%	83	18.63	175%			+255/20yr.
5	TMAC CMO TRUST 1-A	25-Sep-86	98,500	7.92%	99 31/32	3.40	175%			+115/3yr.
	TMAC CMO TRUST 1-B	100% FHLMC 9	50,000	8.89%	99 26/32	7.90	175%	175-300/7.924 350/8.01	E	+160/7yr.
	TMAC CMO TRUST 1-C	$200,000	41,750	8.95%	95 30/32	10.90	175%	400/8.21 500/6.88		+210/10yr.
	TMAC CMO TRUST 1-D	25.0%	9,750	8.95%	75 19/32	18.40	175%			+255/20yr.
6	RESIDENTIAL MORT. SEC. TRUST 1-A	01-Oct-86	48,600	7.92%	99 27/32	3.40	175%			+120/3yr.
	RESIDENTIAL MORT. SEC. TRUST 1-B	100% FHLMC 9	28,500	8.85%	99 30/32	7.90	175%	0/9.562 100-275/7.932	E	+160/7yr.
	RESIDENTIAL MORT. SEC. TRUST 1-C	$100,000	17,900	8.95%	96 2/32	10.90	175%	350/8.207 500/6.583		+215/10yr.
	RESIDENTIAL MORT. SEC. TRUST 1-D	28.5%	5,000	8.95%	77 27/32	18.20	175%			+255/20yr.
7	*MORGAN STANLEY CAPITAL TRUST D-1*	*02-Oct-86*	88,400	8.00%	99 28/32	3.50	175%			+117/3yr.
	MORGAN STANLEY CAPITAL TRUST D-2	*66% FNMA &*	54,100	9.50%	99 5/32	11.00	175%			+210/10yr.

	RESIDENTIAL MORT. SEC. TRUST 1-D	28.5%	5,000	8.95%	77 27/32	18.20	175%	[illegible]		+215/10yr. +255/20yr.
7	MORGAN STANLEY CAPITAL TRUST D-1	02-Oct-86	88,400	8.00%	99 28/32	3.50	175%			+117/3yr.
	MORGAN STANLEY CAPITAL TRUST D-2	66% FNMA &	54,100	9.50%	99 5/32	11.00	175%			+210/10yr.
	MORGAN STANLEY CAPITAL TRUST D-3	34% FNLMC	75,000	8.25%	99 24/32	5.40	175%	0/9.28 50-400/5.42 450/5.45	E	+121/5yr.
	MORGAN STANLEY CAPITAL TRUST D-4	$243,300	11,000	9.20%	99 28/32	10.90	175%	0/14.8 50-400/10.9 450/11.75	E	+169/10yr.
	MORGAN STANLEY CAPITAL TRUST D-5	35.3%	14,800	9.50%	82 12/32	19.20	175%			+260/20yr.
8	MDC MORT. FUNDING Q-1	06-Oct-86	84,300	7.85%	99 28/32	3.45	175%			+140/3yr.
	MDC MORT. FUNDING Q-2	100% FHLMC 9	13,000	9.00%	99 24/32	7.95	175%			+195/7yr.
	MDC MORT. FUNDING Q-3		36,500	9.00%	96 8/32	10.95	175%			+230/10yr.
	MDC MORT. FUNDING Q-4		57,000	7.65%	99 24/32	4.20	175%	0/7.29 50-450/4.2	E	+100/4yr.
	MDC MORT. FUNDING Q-5	$247,800	39,000	8.85%	99 28/32	9.76	175%	0/13.63 50-400/9.76 450/10.06	E	+160/10yr.
	MDC MORT. FUNDING Q-6	38.7%	18,000	9.00%	79	17.78	175%			265/20yr.
9	RESIDENTIAL MORT. SEC. IV-A	24-Oct-86	101,600	8.00%	99 24/32	3.44	175%			+135/3yr.
	RESIDENTIAL MORT. SEC. IV-B	100% FHLMC 9	46,000	8.85%	100	7.93	175%	0/8.84 50-300/7.97	E	+160/7yr.
	RESIDENTIAL MORT. SEC. IV-C	$192,000	37,150	8.95%	96 10/32	11.21	175%			+205/10yr.
	RESIDENTIAL MORT. SEC. IV-D	24.0%	7,250	8.95%	76 13/32	17.47	175%			+260/20yr.
10	KIDDER PEABODY ACCEPTANCE A-1	29-Oct-86	93,750	8.00%	100	3.37	175%			+130/3yr.
	KIDDER PEABODY ACCEPTANCE A-2	100% FHLMC 9	44,000	8.27%	99 29/32	5.88	175%	50-400/5.9	E	+140/5yr.
	KIDDER PEABODY ACCEPTANCE A-3	$200,000	51,750	8.95%	97 1/32	11.23	175%			+198/10yr.
	KIDDER PEABODY ACCEPTANCE A-4	22.0%	10,500	8.95%	77 7/32	18.05	175%			+255/20yr.
11	KIDDER PEABODY MORT. ASSETS II-A	30-Oct-86	92,400	7.45%	99 25/32	3.40	175%			+135/3yr.
	KIDDER PEABODY MORT. ASSETS II-B	100% FHLMC 9	44,000	8.20%	100	5.93	175%	0/7.93 50-300/5.93	E	+145/5yr.
	KIDDER PEABODY MORT. ASSETS II-C	$200,000	52,600	8.45%	97 26/32	11.19	175%			+200/10yr.
	KIDDER PEABODY MORT. ASSETS II-D	22.0%	11,000	8.45%	70 26/32	18.21	175%			+270/20yr.
12	MORGAN STANLEY CAPITAL TRUST E-1	19-Nov-86	199,000	7.25%	100	3.45	175%			+125/3yr.
	MORGAN STANLEY CAPITAL TRUST E-2	100% FHLMC 8.5	67,000	9.05%	99 28/32	11.00	175%			+190/10yr.
	MORGAN STANLEY CAPITAL TRUST E-3		161,000	8.00%	99 28/32	5.60	175%			+130/5yr.
	MORGAN STANLEY CAPITAL TRUST E-4		30,000	8.75%	100	11.07	175%			+160/10yr.
	MORGAN STANLEY CAPITAL TRUST E-5	$499,000	11,000	9.05%	100	14.77	175%			+166/10yr.
	MORGAN STANLEY CAPITAL TRUST E-6	44.3%	31,000	9.10%	85 2/32	18.98	175%			+250/20yr.
	MARKET SIZE		2,680,500							

* S—STATED IN THE PROSPECTUS; E—ESTIMATED FROM PRICE/YIELD TABLE

† The PSA standard (100%) is 6% annual prepayment rate after mortgages are 30 months old and (.5%)(t) annual rate for ages $1 \le t \le 30$.

Third, because the effective term of the option is greater for the longer CMO tranches, unexpected changes in the volatility of interest rates have a greater impact on their market values. An increase in volatility causes all mortgages to decline in price because it gives greater scope to possible refinancing at some unknown later date. The effect is more significant the longer the mortgage's term, because the number of possible refinancing dates is increased. This is reflected in longer CMO tranches by greater price reductions and a more substantial widening of quoted yield spreads over Treasuries when volatility increases.

Finally, even aside from the greater prepayment risk of the longer tranches, they are inherently more sensitive to interest rate movements, as is *any* longer term fixed-income security. The longest CMO tranches have an effective duration (i.e., an interest rate sensitivity) longer than any generic mortgage backed security, and their durations sometimes approach that of long Treasury zero-coupon bonds.

Increased investor sensitivity to these risks has produced an incentive to reengineer the CMO structure in order to provide a genuine degree of prepayment protection to at least some tranches. Thus, the birth of the PAC bond.

The CMO Structure with a PAC Bond

The PAC bonds have prespecified sinking fund payments that can be assured under a range of possible prepayments from the underlying mortgage collateral. Instead of prepayments first being allocated to the shortest outstanding tranche, as would be the case in a classic CMO, they are allocated on each bond payment date first in the amount necessary to pay the scheduled sinking fund payment, or "planned amortization," on the PAC.[5] After the PAC's planned amortization is satisfied, any remaining cash is allocated in the usual CMO order, to the shortest outstanding tranche.

During the early years of a CMO's life, the PAC has two major impacts on the shorter tranches. If prepayments *decrease* in speed, the earlier tranches are very likely to be extended in term, relative to the extension that would have occurred in an otherwise equivalent CMO without a PAC bond. An *increase* in speed probably has a smaller effect on the shorter tranches, since the PAC bond's scheduled payments are then easily satisfied.

The PAC bond stands in priority also in front of the longer classes. Thus, if prepayments are such that the shorter classes are retired before

[5] Scheduled *coupon* payments on all bonds have priority over unscheduled principal payments, including the planned amortization of the PAC. The PAC's scheduled principal payments usually begin fairly early, although not necessarily on the very first bond interest payment date.

the PAC, the longer classes begin to absorb prepayment risk. The scheduled amortization payments on the PAC are satisfied before principal is paid down on any of the remaining classes.

Although PAC bonds issued to date are well protected from prepayment risk, the protection is not absolute. Depending on the size of the PAC relative to the other bonds in the CMO, prepayments might be too slow or too fast for the scheduled PAC sinking fund. The PAC could conceivably be perfectly insulated against low prepayment speeds; the minimum prepayment is zero, and this still leaves scheduled amortization on the underlying mortgages that could exceed the coupon payments on all CMO bonds plus the PAC's planned amortization payments. To assure this result, however, the PAC would have to be a relatively small proportion of the entire CMO or else have a relatively slow planned amortization schedule.

Against high prepayment speeds, there is no *definitive* protection for a PAC. However unlikely it may seem, the underlying mortgages could conceivably prepay at such a high speed that all of the CMO bonds, and finally the PAC, would be paid off ahead of schedule. Notice that the PAC might become the last outstanding CMO bond. At extremely high prepayment speeds, the other bonds might be paid off even before the PAC's last scheduled date.

This implies a rather paradoxical result: very *rapid* prepayments by the collateral could actually *increase* the life of the PAC bond. If prepayment speed is rapid enough to pay off all the other CMO bonds before the PAC, then the PAC will probably not be retired on schedule because at least some of the mortgages in the collateral pool will not prepay. The PAC's actual payments will tail off to the maturity date of the last mortgage.[6]

In existing CMOs, however, the PAC bond is indeed very well protected, as prepayments would have to be unusually high or low to cause problems. Table 1 gives "prepayment bands" where the PAC meets its amortization plan on schedule, and these bands are quite wide for most issues.

The reduction in risk enjoyed by the PAC bond is obtained at the expense of an increase in the risk allocated to the other bonds. Thus, an important question for both the issuer and the investor is whether the gain in market value of the PAC is more or less than offset by a reduction in the aggregate market value of the other bonds. This is a difficult question to answer because the existence of a PAC bond has a complex effect on the other bonds in the CMO. It is really essential to perform a

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[6] Like most classic CMOs, however, there is usually a "nuisance" call provision that allows the originator to redeem the bonds when the remaining principal on the collateral pool falls below some small fraction of the original principal.

Table 2. Specifications for an Illustrative Five-Tranche CMO with a PAC Bond Third Tranche

Payment frequency: Quarterly
Settlement: 11/30/86 First payment: 3/15/87
Number of tranches: 5
Maturity of collateral: 340 months
Collateral market value: $102.70
Collateral coupon: 10.00%
Reinvestment rate: 3.00%
Issuing expenses: 1.00% of bond proceeds

	Tranche Configuration				
	1	2	3 (PAC)	4	5 (Z)
Coupons (BE)	8.50	9.10	8.30	9.40	9.45
Initial (%)	20.00	15.00	25.00	30.00	10.00
Stated maturity (years)	18.50	23.50	28.33	28.33	28.33
Price ($)	100.00	100.00	99.90	99.90	96.50

quantitative analysis of the CMO. Thus, we now turn to a numerical example of a prototypical issue.

A PAC Bond CMO: Illustrative and Quantitative Example

To illustrate the salient characteristics of a CMO with a PAC bond, consider the CMO whose structure is given in Table 2. This structure is intended to portray a typical PAC CMO, five tranches with a PAC third tranche, which enjoys a scheduled sinking fund *constant* payment equal to six times the first coupon.[7] If retired on schedule, the PAC would be fully paid off in the 75th month, just over 6 years after origination.

The PAC class represents 25% of the total CMO principal, a figure typical of existing isssues (see Table 1). Also, its coupon is somewhat lower than the coupons of the other bonds, even though its issue price is very close to par. This reflects the greater value of the PAC bond, i.e., its lower yield, because of its protection from prepayment risk. The other bonds are like most existing CMO bonds. The coupon of the underlying collateral was chosen so that the expected prepayment speed on the issue date was 200% PSA; most PAC CMOs have been issued at a similar assumed speed.

The effect of the existence of a PAC bond can be assessed by comparing such a CMO with an otherwise identical CMO without a PAC class. Thus, results are presented below for a CMO with characteristics just like those in Table 2, except that the third class is not a PAC

[7] The sinking fund is a constant dollar amount each quarter, not a percentage of the outstanding principal balance of the PAC bond.

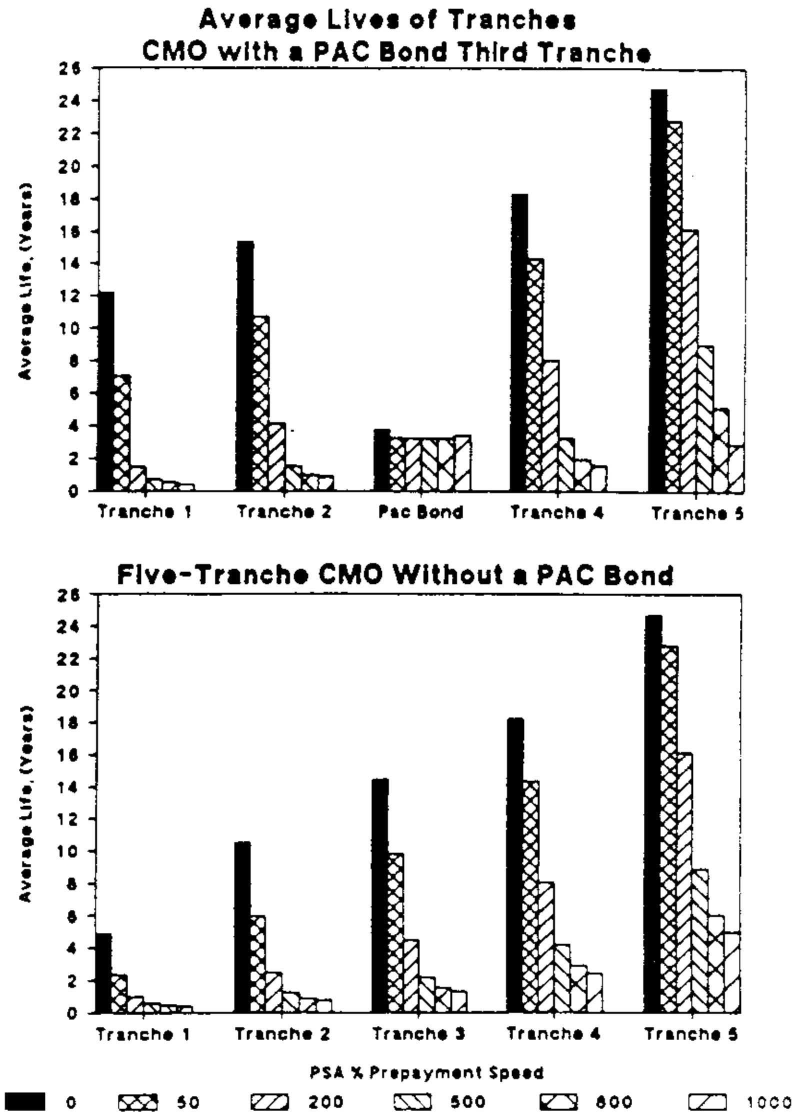

Figure 1. The average lives of the tranches in both CMOs for a variety of actual prepayment speeds.

bond; it is an ordinary CMO bond standing in the normal maturity priority rank.[8]

Figure 1 shows the average lives of the tranches in both CMOs for a variety of actual prepayment speeds. Perhaps the most striking feature

[8] Of course, this bond's issue price would be lower than the PAC bond's price.

of this figure is the stability of the PAC under a wide range of speeds. From 50 to 800% PSA, the PAC's amortization payments can be made on schedule, so the average life is identical.[9] At zero PSA and at speeds above 800% PSA, the PAC's schedule cannot be met, and its average life is longer. Notice that this lengthening of average life is hardly worth mentioning, especially by comparison with what would have happened to the third tranche of an ordinary CMO and also in comparison to the other bonds in either CMO.

The Effect of the PAC On the Other Bonds

The impact of the PAC on the other bonds is particularly apparent in the shorter classes when prepayments are slower than the original assumption of 200% PSA. At 0 and 50% PSA, for instance, the average lives of the first and second tranches are substantially lengthened by the presence of the PAC. At higher speeds, however, the PAC has little impact on the shorter tranches for the simple reason that prepayments provide more than enough cash to retire the bonds and to satisfy the PAC's scheduled amortization payments as well.

The net impact on the earlier tranches is dreadful. When interest rates increase, and prepayments slow down, these bonds are substantially extended. For example, the average life of the first tranche at zero prepayment speed is extended from 3.96 years without a PAC to 12.2 years when the CMO has a PAC third tranche (with the assumed characteristics). There is little offsetting benefit. When interest rates decrease, and prepayments speed up, the earlier tranches are retired almost as fast with a PAC as without one. Another example, at 500% PSA, the second tranche has an average life of 1.49 years with the PAC third tranche and 1.26 years with an ordinary third tranche.

The longer tranches (4 and 5) are also affected by the existence of the PAC bond, but only for higher prepayment speeds. Indeed, for speeds of 0, 50, and 200% PSA, there is no impact whatever on the cash flows to the fourth and fifth tranches. At 500% PSA and above, however, the PAC has a shortening effect on the average lives of the longer tranches. As an example, at 800% PSA the existence of the PAC shortens the average life of the fourth tranche from 2.88 to 1.93 years and it shortens the average life of the Z bond (the fifth class) from 6.06 to 5.11 years. Interestingly, at more moderate speeds, the influence of the PAC is felt more heavily by its neighboring class, in this case the fourth tranche.

The patterns of cash flows with and without a PAC are illustrated in Figure 2A–E. Each panel of Figure 2 shows the cash flows of a given

[9] Actually, the average life is slightly longer at 800% PSA, but the difference is too small to notice in Figure 1.

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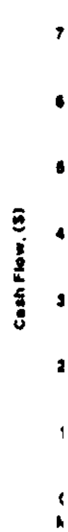


B

Coup

tranche for a variety of speeds with and without the PAC third tranche. These figures provide more information about the timing patterns summarized by the average life number. The first tranche, Figure 2A, shows a substantial influence of prepayment speed with or without a PAC third tranche, but the greatest extension attributable to the PAC

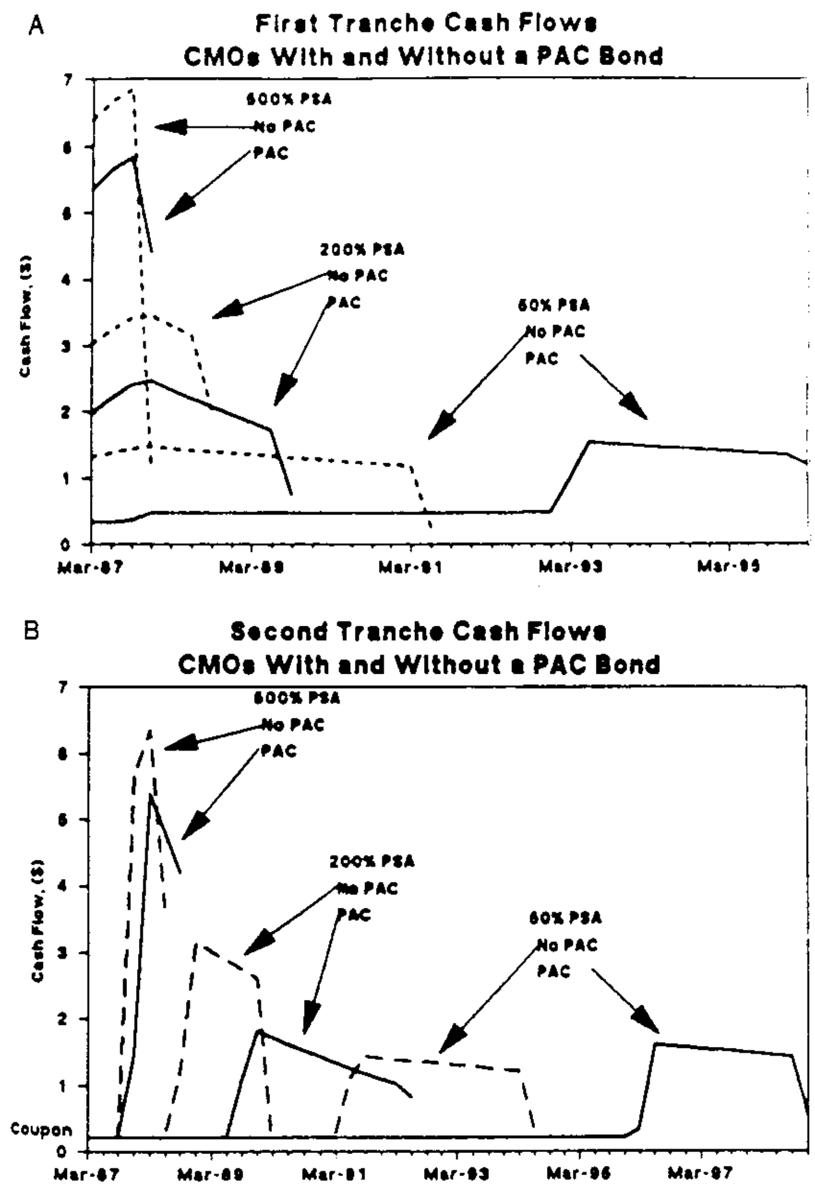


Figure 2. Patterns of cash flow with and without a PAC.

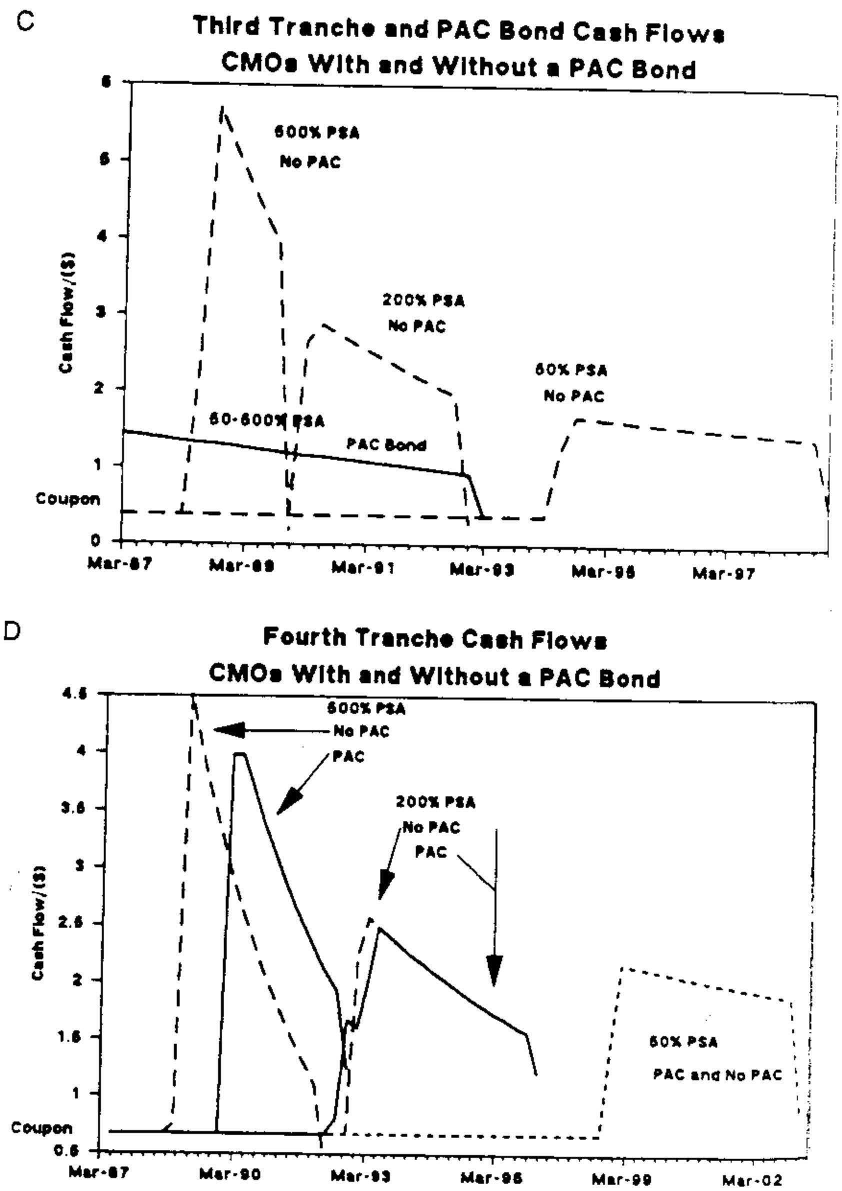


Figure 2. *(Continued)*

occurs at low speed. A similar conclusion is obtained for the second tranche from Figure 2B.

The third tranche, Figure 2C, displays a standard sinking fund pattern at all speeds considered for the PAC bonds, a pattern in marked contrast with the cash flow patterns that would be observed for a normal third tranche under the same variations in prepayment speed. The

E

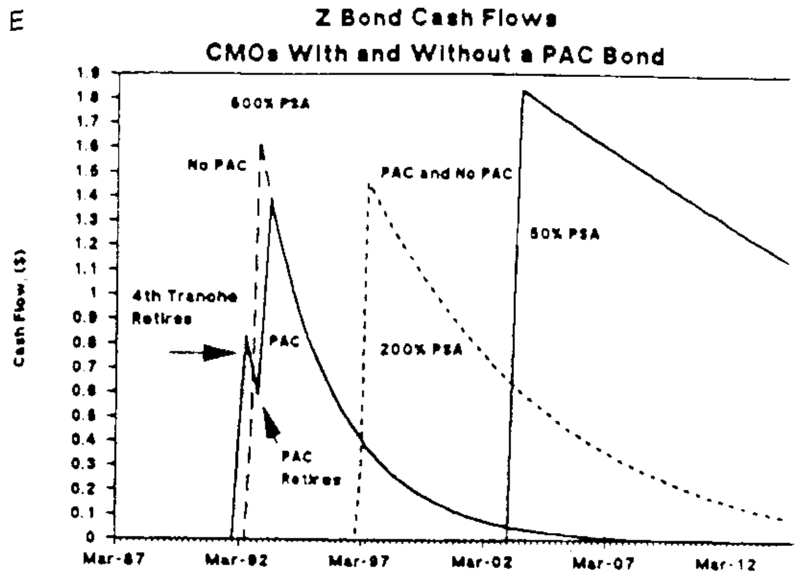


Figure 2. *(Continued)*

fourth and fifth tranches show little influence of the PAC at low speeds; indeed, the patterns are identical at 50 and 200% PSA for the Z bond fifth class, Figure 2E, and at 50% PSA and, during the later years at 200% PSA, for the fourth class.

When a PAC bond exists, there are curious kinks in the patterns of cash flows for these longer tranches at particular speeds (200% PSA for the fourth tranche and 500% PSA for the Z bond). The kinks can be traced to the successive retirements of the immediately earlier non-PAC tranche and then the PAC tranche. When the earlier non-PAC tranche retires, some principal begins to be allocated to the next non-PAC tranche, but the PAC's scheduled amortization payments are still being made. When the PAC is retired (a quarter or two later in these illustrations), the principal being received from the collateral and formerly allocated to the PAC now goes to the next non-PAC tranche. The result is a suddenly increased cash flow, then a decline for a quarter or so as the collateral pays down, then another sudden increase followed finally by a steady decline until complete redemption of the tranche.

The PAC Bond's Protection Under Prepayment Extremes

As mentioned above, the PAC bond is usually not totally protected against all possible prepayment speeds. Figure 3 illustrates the deviations possible for the illustrative PAC (for the CMO whose characteris-

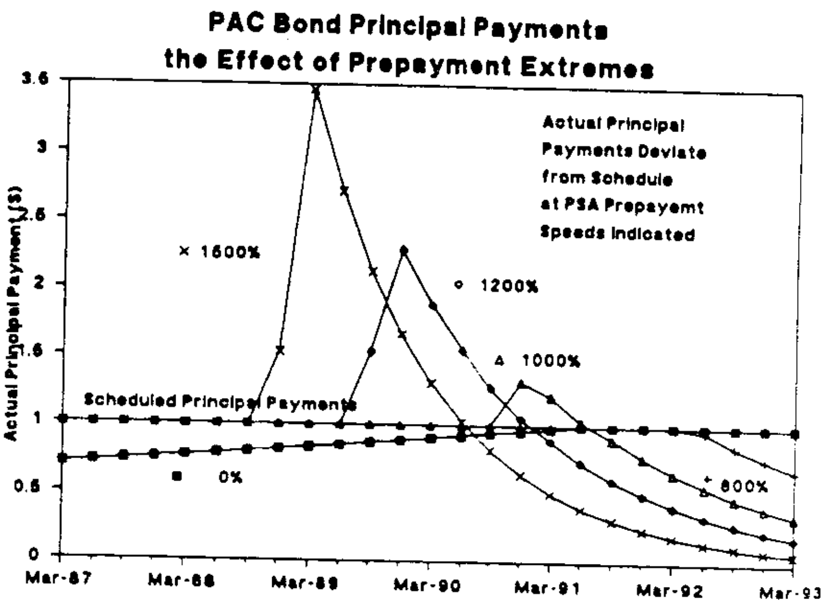


Figure 3. The deviations possible for the illustrative PAC.

tics are given in Table 2). The schedule can be maintained at all speeds from 50 to 750% PSA. At exceedingly low speeds, such as 0% PSA, there is a shortfall in the early years. Eventually, the shortfall is eliminated because the total coupon payments on the PAC bond itself decline over time as its principal is paid down.[10]

At exceedingly high speeds, there is a shortfall in the later years relative to the PAC's schedule. At 800% PSA, for instance, there is a small shortfall in the last four quarters. Also, the PAC is the only bond left outstanding in the later periods for these high-speed cases. For speeds of 1000% PSA and above, all other bonds are quickly retired and there is an excess of principal payments above the schedule during intermediate periods, followed by shortfalls in later periods as the collateral vanishes. These are extreme speeds; 1000% PSA, for instance, implies that 99% of the collateral prepays within 5 years. Such speeds may be observed on occasion, but are not very likely to continue for more than a brief period.

The characteristics of the PAC imply limits on the CMO structure. The PAC bond cannot represent too large a fraction of the total issue, else it would not enjoy protection except in a rather narrow range of prepayments. Also, the longer the protection is afforded, the smaller the

[10] At 0% PSA, no principal is being paid on any of the other classes.

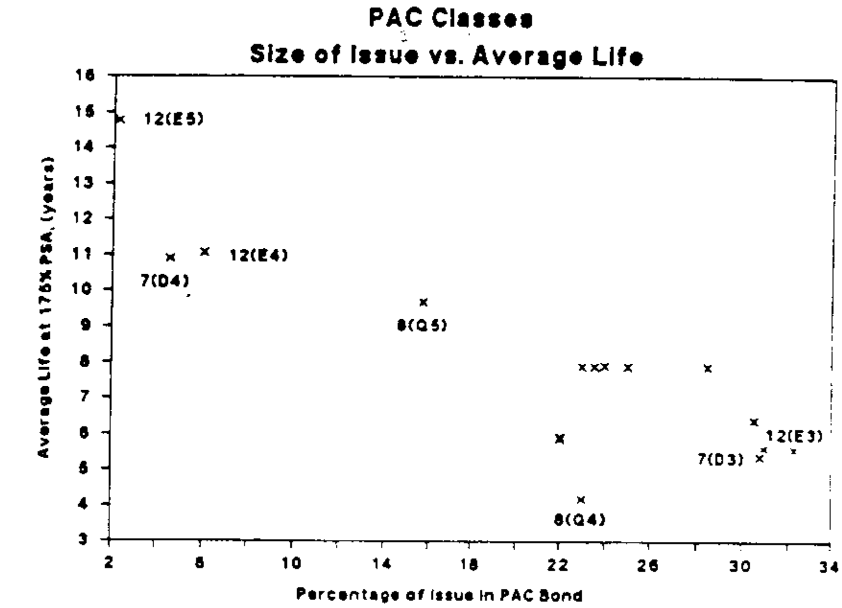


Figure 4. The relationship between the average life of the existing PAC bonds and the percentage that the bond represents of the total issue.

PAC bond can be relative to the entire CMO. These limitations can be traced in the structures of the existing issues. Figure 4 shows the relation between the average life of the existing PAC bonds and the percentage that the bond represents of the total issue. There are actually 16 PAC bonds in the 12 CMOs, and there is a complex interplay among several PACs in the same issue.[11] Nonetheless, Figure 4 shows a statistically significant negative relation between the average life of the PAC bond and the fraction it represents of the entire CMO.

The longer a PAC bond, the more likely it is to run into prepayment risk outside its schedule. Thus, although the original pricing for most PAC bonds provides for a relatively low yield at the assumed prepayment speed, the yield does increase with the anticipated term of the bond. Figure 5 shows the yield spread relative to a reference Treasury maturity chosen by the originator. The longer the PAC's schedule, the longer the maturity of the reference Treasury. The figure shows a clear and strong increase in yield spread with term. This is an unstated acknowledgment that the PAC class really does not enjoy *definitive* risk protection.

[11] In Figure 4, CMOs with more than one PAC are labeled with codes corresponding to the list of issues in Table 1. For instance, the point near the middle of the figure is labeled "8(Q5)." It is the second PAC bond, class Q-5, in the MDC Mortgage Funding issue, the 8th CMO that has appeared with a PAC.

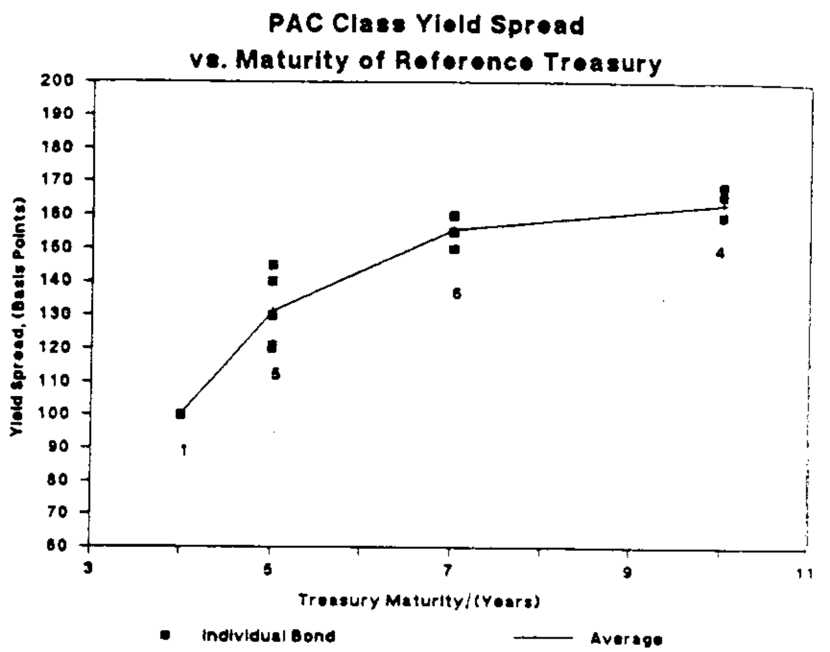


Figure 5. The yield spread relative to a reference Treasury maturity chosen by the originator.

The Effect of the PAC on the Residuals and on the Issuer

The PAC also has an influence on the other claimants, those who originate the CMO and those who retain or buy an interest in the residuals cash flows of the CMO. Figure 6 shows the cash flows to the residuals, assuming that the residual claimants receive all excess cash flow. Rapid prepayments are not good for residual owners (a well-known fact), but, perhaps surprisingly, the existence of a PAC class may actually be of some benefit. Figure 7 shows the residual yield, or internal rate of return on the initial investment, under different prepayment speeds with and without a PAC.

At high speeds, the residual yield is negative, but it is less negative with a PAC bond. If we examine the residual cash flows at high speeds, we see that they are slightly higher in the first few quarters without a PAC bond, but that this early benefit is outweighed by substantially lower residual cash flows in the intermediate quarters (cf. the lower curves in Figure 6). This is the result of higher coupons on the later tranches. With a PAC bond as a third class, the high-coupon fourth and fifth tranches must endure an earlier forced redemption when prepayment speeds are extremely high. To some extent, this ameliorates the negative residual yield.

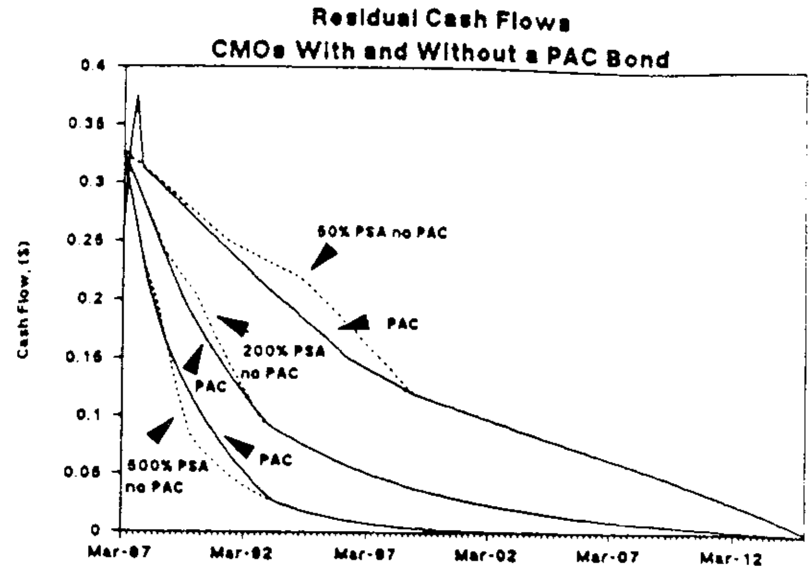


Figure 6. Cash flows to the residuals, assuming that the residual claimants receive all excess cash flow.

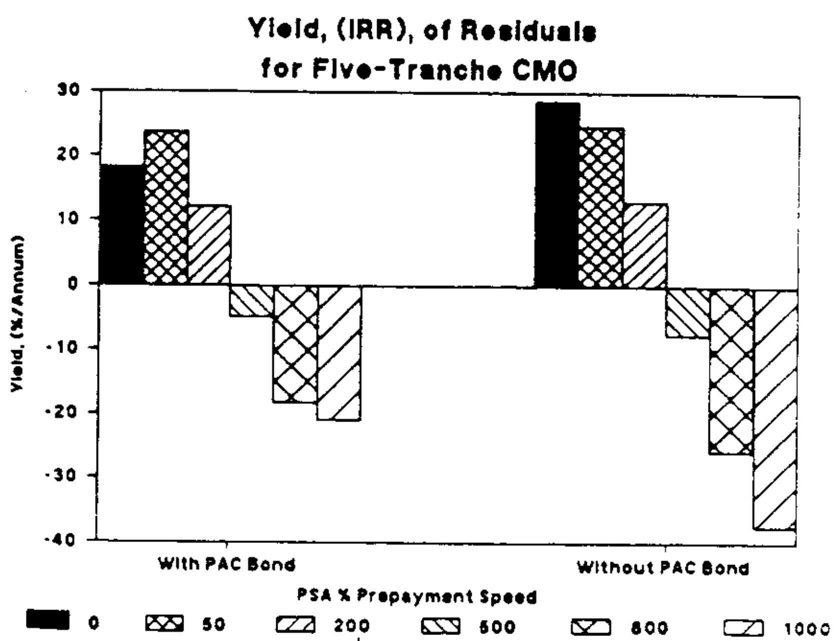


Figure 7. Residual yield or internal rate of return on the initial investment under different prepayment speeds with and without a PAC.

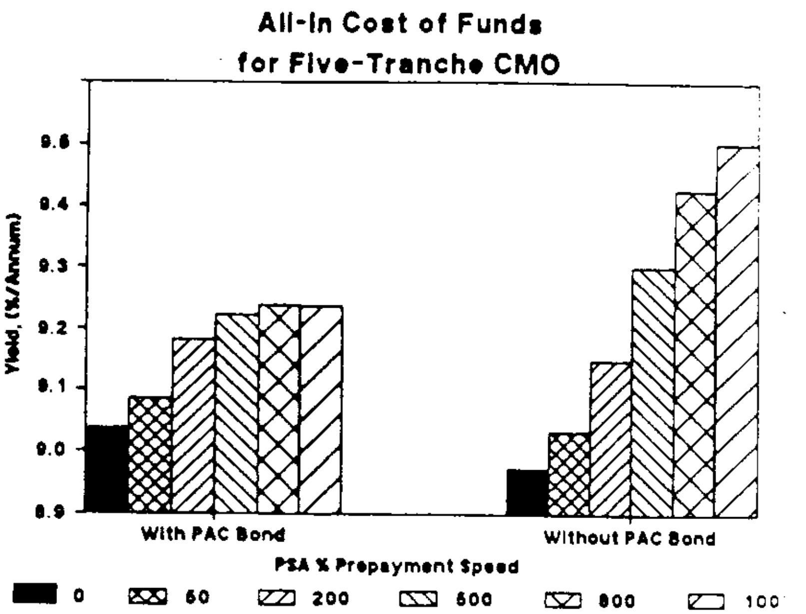


Figure 8. All-in cost of funds for CMOs with and without a PAC and for various prepayment speeds.

At extremely low prepayment speeds, the residual yield is somewhat lower with a PAC bond. The major impact occurs at speeds so low that there is a shortfall on the PAC's scheduled amortization. In such a case, there is no residual payment at all because there is not even enough cash flow to cover all the scheduled payments; interest on all bonds is paid, but too little cash is left to cover the PAC's sinking fund. At 0% PSA, for instance, there is no payment to the residuals in our illustrative CMO until the twentieth quarter.

The net impact of the PAC is to render the residuals less risky. With a PAC, the residuals have lower yields in slow prepayment environments, when they normally would have very high returns, but they also have higher yields in rapid prepayment environments, when they normally would perform very poorly. Perhaps this risk reduction provides an incentive to the issuer.

The "All-In Cost of Funds" is shown in Figure 8 for CMOs with and without a PAC and for various prepayment speeds. All-in cost measures net interest expense when the CMO is regarded as a means of financing of the underlying mortgage collateral. It is the internal rate of return of the interest payments on the bonds after accounting for issuing costs.[12] The PAC bond seems to have a small but beneficial impact on the all-in

[12] Issuing costs were assumed to be 1% in the present illustration.

cost of funds. The all-in cost is modestly higher at low speeds but considerably lower at high speeds. Like the residuals, the effective All-in Cost of Funds seems to be less subject to prepayment uncertainties with a PAC bond in the CMO.

The Bottom Line About CMOs with PAC Bonds

The existence of a planned amortization class in a CMO represents a reallocation of prepayment risk away from one group of claimholders, the PAC bondholders, and to another group, the bondholders of the other CMO tranches. Is it worthwhile?

It is worthwhile to the issuer when CMOs that include a PAC can be sold at higher risk-adjusted residual yields, or can bring greater proceeds, than CMOs without a PAC. This will only happen in the long run if investors value the gain in prepayment protection in the PAC more than the aggregate increase in prepayment risk in the other bonds.

Empirical evidence indicates that there was indeed a substantial gain to the first few issuers. The reduction in yield on the PAC was accompanied by little, if any, increase in yield on the other bonds. However, the later issues have been less successful in that the non-PAC tranches have sold at lower prices.

Investors now seem to be rightly charging a higher risk premium in the non-PAC tranches, particularly the shorter tranches. Investors in these bonds have sought fairly safe assets, at least relative to the underlying collateral. Many shorter tranches from ordinary CMOs have been purchased by thrift institutions in an attempt to lower their interest sensitivity (relative to the sensitivity obtained by their traditionally large position in whole mortgages). The PAC bond does not improve the attraction of short CMO tranches for such investors. Who, then, will buy these tranches? It requires an investor with a short horizon and a taste for more risk than has typically been available in money market-related fixed-income assets.

III. Collateralized Mortgage Obligations with Variable Coupon Bonds

Introduction

There have been 33 CMOs issued since September 22, 1986, that have included at least one floating rate class. See Table 3. With a few exceptions, the floater has been the shortest maturity tranche. Six of the CMOs have also included an *inverse* floating rate tranche. In all cases, the floating coupon has been linked to LIBOR;[13] the direct floaters have

[13] The London Interbank Offering Rate.

3. The 33 CMOs Issued Since September 22, 1986

FLOATING RATE TRANCHE CHOs SINCE FIRST ISSUANCE
05-Jan-86

ISSUE	ISSUE DATE COLLATERAL TOTAL SIZE	PRINCIPAL ($ 000s)	TYPE (1)	COUPON INDEX	MARGIN	
ARSON LEHMAN CMO INC. D-1	22-Sep-86	43,000	F	3 NO. LIBOR + 37 bp		1/9%,
ARSON LEHMAN CMO INC. D-2	100% FNMA 9	45,000		8.45		
ARSON LEHMAN CMO INC. D-3	$150,000	55,000		8.10		
ARSON LEHMAN CMO INC. D-4		7,000		8.95		
TEX ACCPT. CORP. O-1	24-Sep-86	37,000	F	3 NO. LIBOR + 31 bp		1/9%,
TEX ACCPT. CORP. O-2	100% GNMA 9 1/8	47,000		8.35		
TEX ACCPT. CORP. O-3	$120,000	20,000		9.00		
TEX ACCPT. CORP. O-4		16,000		9.00		
TRUST 9-A	26-Sep-86	164,500	F	3 NO. LIBOR + 25 bp		1/9%,
TRUST 9-B	90% GNMA 9;	86,500		7.75		
TRUST 9-C	10% GNMA 9.25	216,300		7.75		
TRUST 9-D	$499,900	32,600		7.75		
C MORT. SEC. B-1	29-Sep-86	184,000	F	1 NO. LIBOR – 25 bp		1/9%, 2
C MORT. SEC. B-2	100% FHLMC 9 &	188,000		7.80		
C MORT. SEC. B-3	FHLMC 9.25	28,000		8.95		
	$400,000					
LL LYNCH TRUST II-A	03-Oct-86	500,000	F	3 NO. LIBOR + 25 bp		
LL LYNCH TRUST II-B	50% FHMA 9.5;	158,000		8.05		
LL LYNCH TRUST II-C	50% FHMA 11.5	184,000		8.85		
LL LYNCH TRUST II-D (2)	$1,000,000	158,000		9.10		
ND ACCEP. CORP. IV 23-A	06-Oct-86	47,000	F	3 NO. LIBOR + 40 bp		1/8.5%
ND ACCEP. CORP. IV 23-B	100% WHOLE LOAN	88,500		9.375		
ND ACCEP. CORP. IV 23-C	(10.25% WAC)	42,500		9.20		
ND ACCEP. CORP. IV 23-D	$183,000	5,000		9.50		
IORTGAGE TRUST 5A-1	30-Oct-86	43,000	F	3 NO. LIBOR + 25 bp		
IORTGAGE TRUST 5A-2	20% FHLMC 9;	421,500		8.30		
IORTGAGE TRUST 5A-3	80% FHLMC 9.5	35,500		9.00		
	$500,000					
TRUST 13A	13-Oct-86	340,000	F	1 NO. LIBOR + 50 bp		
TRUST 13B	100% GNOME 9	150,000	I	14.6% – 2.163 × (1 NO. LIBOR - 8		
	$608,400					
TORS GOV'T SEC. CORP. 1-A	30-Oct-86	118,400	F	3 NO. LIBOR + 25 bp		1/8
TORS GOV'T SEC. CORP. 1-B	55% GNMA 9;	21,000		8.50		
TORS GOV'T SEC. CORP. 1-C	45% GNMA 11.5	61,000		9.00		
	$215,800					
ND ACCEP. CORP. IV 27-A	03-Nov-86	15,400		7.30		
ND ACCEP. CORP. IV 27-B	100% WHOLE LOANS	37,350	F	3 NO. LIBOR + 50 bp		1/8.5C
ND ACCEP. CORP. IV 27-C	(10.3% WAC)	70,600		9.30		
ND ACCEP. CORP. IV 27-D	$167,000	40,100		9.25		
ND ACCEP. CORP. IV 27-E		3,550		9.45		
RUST 14A	06-Nov-86	779,000	F	3 NO. LIBOR + 45 bp		
RUST 14B	50% FHMA 9;	280,000	I	12.5% – 2 × (3 NO. LIBOR - 6		
RUST 14C	50% FHA/VA GPN 9	130,000		5.00		
RUST 14D	$1,300,000	111,000		8.00		
IWESTERN ACCEPT. CORP. I-A	13-Nov-86	200,000	F	3 NO. LIBOR + 50 bp		
IWESTERN ACCEPT. CORP. I-B	100% FHLMC 9	100,000	I	23.189% – (1.838% × 3 NO. LIBOR		
	$300,000					
CAN PIONEER CMO TRUST 1-A	14-Nov-86	122,000	F	3 NO. LIBOR + 40 bp		
CAN PIONEER CMO TRUST 1-B	100% FHLMC 10	25,400		7.75		
CAN PIONEER CMO TRUST 1-C	$199,800	40,800		9.15		
CAN PIONEER CMO TRUST 1-D		11,600		9.15		
LYNCH TRUST IV-A	17-Nov-86	42,500		6.48		
LYNCH TRUST IV-B	100% FHLMC 11	320,900	F	3 NO. LIBOR + 50 bp		
LYNCH TRUST IV-C	$393,300	29,900	F	3 NO. LIBOR + 50 bp		

MARGIN	CAPS [FLOORS] (YEAR/CAP)	PRICE @ ISSUE	AVG. LIFE	@ ASSUMED PSA	COLLATERAL
37 bp	1/9%, 2/10%, 3/11%, 4/11.5%, 5+/12%	100	2.4	175%	100% FHMA 9
		99 28/32	5.8	175%	
		91 31/32	11.2	175%	
		73 3/32	20.5	175%	
31 bp	1/9%, 2/10%, 3/11%, 4/11.5%, 5+/12%	100	2.8	100%	100% GNMA I & II 9 1/8
		100	7.7	100%	
		98 9/32	11.7	100%	
		78 7/32	20.4	100%	
25 bp	1/9%, 2/10%, 3/11%, 4/11.5%, 5+/12%	100	2.4	135%	90% GNMA 9; 10% GNMA 9 1/4
		97 8/32	5.7	135%	
		90 24/32	10.9	135%	
		62 24/32	20.8	135%	
25 bp	1/9%, 2/10%, 3/11%, 4/11.5%, 5+/12%	100	4.9	170%	100% FHLMC 9 & 9 1/4
		92 26/32	6.9	170%	
		76 20/32	18.9	170%	
25 bp	1+/11.25%	100	1.6	175%/583%	50% FNMA 9 1/2; 50% FNMA 11 1/2
		99 25/32	4.5	175%/583%	
		99 14/32	7.9	175%/583%	
		99 12/32	17.2	175%/583%	
40 bp	1/8.5%, 2/9.5%, 3/10%, 4/10.5%, 5+ 11%	100	2.4	140%	94% 30 YR WHOLE LOANS;
		99 26/32	7.8	140%	6% 6 YR WHOLE LOANS (10.2)
		91 20/32	14.7	150%	
		100	21.6	150%	
25 bp	.25/6.4%, .50+/11.5%	100	0.5	185%	20% FHLMC 9; 80% FHLMC 9 1/2
		99 31/32	5.6	185%	
		82 27/32	17.6	185%	
50 bp	1+/12%	99 18/32	6.4	150%	100% GNOME 9
LIBOR - 6%)	[1.75%]	109 27/3	6.4	150%	
25 bp	1/8.50, 2/9.5%, 3/10.5%, 4+/11%	100	2.7	110%/400%	59% GNMA 9; 45% GNMA 11 1/2
		99 13/32	7.9	110%/400%	
		96 8/32	16.9	110%/400%	
		99 30/32	1.2	150%	100% WHOLE LOANS (10.3% WAC)
50 bp	1/8.50, 2/9.5%, 3/10% 4/10.5%, 5+/1%	100	3.2	150%	
		99 27/32	7.8	150%	
		100	14.9	150%	
		78 11/32	23.5	150%	
15 bp	1+/12.5	99 24/32	5.9	150%	50% FHMA 9; 50% FHA/VA GPN 9
BOR - 6%)	[1.50%]	102 16/3	5.9	150%	
		85 28/32	5.9	150%	
		68 30/32	18.2	150%	
50 bp	.25/7.5%, .50+/13.5%	100	8.6	175%	100% FHLMC 9
NO. LIBOR)	[0%]	105 28/3	8.6	175%	
40 bp	(3)	100	3.3	195%	100% FHLMC 10
		93 24/32	7.8	195%	
		99 19/32	10.8	195%	
		83 2/32	18.2	195%	
		99 31/32	1.1	500%	100% FHLMC 11
50 bp	1+/11%	100	2.4	500%	
50 bp	1+/13%	100	7.7	500%	

: 3. The 33 CMOs Issued Since September 22, 1986 (*continued*)

FLOATING RATE TRANCHE CHOs SINCE FIRST ISSUANCE
05-Jan-86

ISSUE	ISSUE DATE COLLATERAL TOTAL SIZE	PRINCIPAL ($ 000s)	TYPE (1)	COUPON INDEX	MARG
ERILL LYNCH TRUST V-A	20-Nov-86	250,000	F	3 NO. LIBOR + 50 bp	
ERILL LYNCH TRUST V-B	100% FHLMC 9.5	250,000		6.00%	
	$500,000				
RUDENTIAL INSURANCE 1986-1	21-Nov-86	500,000	F	1 NO. LIBOR - 45 bp	
	100% GNMA 11.5				
	$500,000				
VR CMO TRUST 1-A	21-Nov-86	75,000	F	3 NO. LIBOR + 50 bp	
VR CMO TRUST 1-B	100% FHLMC 9.5	75,000		6.00%	
	$150,000				
L CMD TRUST SERIES D-1	21-Nov-86	103,000		7.00%	
L CMD TRUST SERIES D-2	100% FHLMC 9.5	21,000		7.00%	
L CMD TRUST SERIES D-3	300,000	120,000	F	3 NO. LIBOR + 50 bp	
L CMD TRUST SERIES D-4		40,500		7.00%	
L CMD TRUST SERIES D-5		15,500		7.00%	
IAC 1986-2A	21-Nov-86	72,600	F	3 NO. LIBOR + 50 bp	
IAC 1986-2B	100% FHLMC 9.5	27,400	I	25.11987% − (2.00959 × 3 NO. LI	
	$100,000				
IO TRUST 15-A	25-Nov-86	500,000	F	3 NO. LIBOR + 50 bp	
IO TRUST 15-B	100% FHLMC 9	188,340		5%	
IO TRUST 15-C	$1,000,000	69,300		5%	
IO TRUST 15-D		174,560		5%	
IO TRUST 15-E (2)		67,800		5%	
MORTGAGE TRUST 6A	01-Dec-86	185,000	F	3 NO. LIBOR − 50 bp	
	100% FHLMC 10.5				
	$185,000				
IO TRUST 16-A	01-Dec-86	296,750	F	3 NO. LIBOR + 50 bp	
IO TRUST 16-B	100% FHLMC 9	75,000	I	11.5% − 2 × (3 NO. LIBOR −	
IO TRUST 16-C	$667,500	48,250		5%	
IO TRUST 16-D		17,750		5%	
IO TRUST 16-E		44,750		5%	
IO TRUST 16-F		185,000		5%	
MORTGAGE TRUST 7A	03-Dec-86	240,000		3 NO. LIBOR − 50 bp	
	100% FHLMC 10.25				
	& FHLMC 10.50				
	$495,000				
FORD ACCPT. CORP., SERIES IV-A	03-Dec-86	225,000	F	3 NO. LIBOR + 50 bp	
FORD ACCPT. CORP., SERIES IV-B	(4)	30,000		8.40	
FORD ACCPT. CORP., SERIES IV-C	$325,500	35,000		8.70	
FORD ACCPT. CORP., SERIES IV-D		35,500		8.75	
MORTGAGE TRUST 7B-1	04-Dec-86	300,000	F	3 NO. LIBOR + 40 bp	
	100% GNMA				
	GPMs 11.5				
	$300,000				
MORTGAGE TRUST 8A-1	05-Dec-86	312,500	F	3 NO. LIBOR + 60 bp	
MORTGAGE TRUST 8A-2	100% FHMA 10	92,000		5%	
MORTGAGE TRUST 8A-3	$500,000	17,250		5%	
MORTGAGE TRUST 8A-4		72,250		5%	
MORTGAGE TRUST 8A-5 (2)		6,000		5%	
O TRUST 17A-1	05-Dec-86	150,000	F	3 NO. LIBOR + 50 bp	
O TRUST 17A-2	100% FHLMC 10.5	150,000	F	3 NO. LIBOR − 50 bp	
O TRUST 17A-3	$1,602,700	50,000		7.25%	
MSON MCKINNON MORT. ASSETS IVA	11-Dec-86	55,000		7.65%	
MSON MCKINNON MORT. ASSETS IVB	100% FHMA 9	31,000	F	3 NO. LIBOR + 50 bp	
MSON MCKINNON MORT. ASSETS IVC	$100,000	14,000	I	13% − [2.2143(LIBOR − 6.125%)	

MARGIN	CAPS [FLOORS] (YEAR/CAP)	PRICE @ ISSUE	AVG. LIFE	@ ASSUMED PSA	COLLATERAL
50 bp	1+/13%	100	8.3	175%	100% FHLMC 9 1/2
		86 17/32	8.3	175%	
45 bp		100	3.4	425%	100% GNMA 11.5%
50 bp	1+/12.75%	100	8.6	175%	100% FHLMC 9 1/2
		85 10/32	8.6	175%	
		97 25/32	3.4	175%	100% FHLMC 9 1/2
		90 17/32	7.8	175%	
50 bp	1+/13%	99 24/32	8.4	175%	
		86 22/32	10.9	175%	
		59 16/32	18.9	175%	
50 bp	1+/13%	100	8.7	175%	100% FHLMC 9 1/2
3 NO. 1	[0%]	106 2/32	8.7	175%	
50 bp	1+/13%	99 24/32	8.5	167%	100% FHLMC 9
		95 12/32	2.5	167%	
		85 8/32	5.8	167%	
		75 8/32	11.0	167%	
		59 20/32	21.6	167%	
50 bp	1+/11.5%	99 22/32	3.7	400%	100% FNMA 10.5
50 bp	1+/13%	99 19/32	8.5	167%	100% FHLMC 9
OR – 4.0	[0%]	99 13/32	8.5	167%	
		95 16/32	2.5	167%	
		85 8/32	5.8	167%	
		73 12/32	11.0	167%	
		60 8/32	21.6	167%	
50 bp	1+/11.5%	99 30/32	3.9	380%	100% FHLMC 10.25 & 10.5%
50 bp	1+/11%	NA	2.4	(4)	
		99 28/32	7.4	(4)	
		99 23/32	10.7	(4)	
		100	18.6	(4)	
40 bp	1/10.5%, 2+/11.25%	99 31/32	2.3	600%	
60 bp	1+/13%	99 20/32	6.6	225%	100% FNMA 10
		95 8/32	2.3	225%	
		85 30/32	5.4	225%	
		74 8/32	10.9	225%	
		58 9/32	23.9	225%	
50 bp	1+/11.5%	100	3.7	400%	100% FHLMC 10.5
50 bp	1+/11.5%	99 28/32	3.7	400%	
		99 14/32	3.7	400%	
50 bp		100	13.9	175%	
– 6.125		NA	13.9	175%	

le 3. The 33 CMOs Issued Since September 22, 1986 (*continued*)

FLOATING RATE TRANCHE CHOs SINCE FIRST ISSUANCE
05-Jan-86

ISSUE	ISSUE DATE COLLATERAL TOTAL SIZE	PRINCIPAL ($ 000s)	TYPE (1)	COUPON INDEX	MARGIN
MERILL LYNCH TRUST VI-A	11-Dec-86	200,000	F	3 NO. LIBOR − 50 bp	
MERILL LYNCH TRUST VI-B	100% FHLMC 11	115,000		7.00%	
	$315,000				
IERILL LYNCH TRUST VII-A	17-Dec-86	255,300	F	3 NO. LIBOR + 50 bp	
IERILL LYNCH TRUST VII-B	100% FHLMC 11	44,700		0%	
	$300,000				
ENTEX CMO CORP. A1	18-Dec-86	38,700	F	3 NO. LIBOR + 50 bp	
ENTEX CMO CORP. A2	100% GNMA 8.75	11,550		8.25%	
ENTEX CMO CORP. A3	$102,700	21,350		8.50%	
ENTEX CMO CORP. A4		26,400		8.50%	
ENTEX CMO CORP. A5		4,700		8.50%	
HEARSON LEHMAN CMO INC. F-1	31-Dec-86	112,480	F	3 NO. LIBOR + 62.5 bp	
HEARSON LEHMAN CMO INC. F-2	100% FHMA 9.5	27,460		7.301%	
HEARSON LEHMAN CMO INC. F-3	$200,000	17,030		8.042%	
HEARSON LEHMAN CMO INC. F-4		28,820		8.621%	
HEARSON LEHMAN CMO INC. F-5		14,210		9.266%	
3C MORTGAGE TRUST 9A	0.5-Jan-86	235,000		6 NO. LIBOR + 70 bp	
	100% FNMA 10.5				
	$235,000				
MARKET SIZE		12,274,100			

REIGN OFFERING
FLOATER; I = INVERSE FLOATER
T A Z PIECE
ST QUARTER − 7.25%
T 4 QUARTERS − 9%
T 4 QUARTERS − 10%
T 4 QUARTERS − 10.5%
REAFTER − 11%
MC 9's @ 160% PSA
MC 10's @ 200% PSA
MC 11.5's @ 500% PSA

all been expressed as LIBOR plus a fixed margin while the inverse floaters have generally been a linear, but not necessarily a proportional, function of *minus* LIBOR.

The curious innovation of an inverse floating rate CMO bond intimates an important aspect of all such issues: the underlying collateral consists of mortgages or mortgage-backed securities with *fixed* coupons. Thus, when the coupon on the floating rate tranche increases or decreases, there must be a corresponding decrease or increase in cash payments absorbed by some other claimants within the issue. If the CMO includes an inverse floating rate tranche, it can serve in this capacity, provided that it is of sufficient size and is inversely linked by the appropriate multiplier.

If the CMO does not include an inverse floating tranche, the absorption could be provided by the residuals, but they have only a

MARGIN	CAPS (FLOORS) (YEAR/CAP)	PRICE @ ISSUE	AVG. LIFE	@ ASSUMED PSA	COLLATERAL
50 bp	1+/13%	100	3.2	467%	100% FNLMC 11
		98 26/32	3.2	467%	
50 bp	1+/12.5%	99 31/32	3.1	467%	100% FNLMC 11
		81 8/32	3.1	467%	
50 bp	NA	100	3.7		100% GNMA 8.75
		99 26/32	7.8		
		99 6/32	10.9		
		100	15.9		
		80 4/32	24.0		
2.5 bp	1+/13%	100	9.0	165%	
		94 22/32	2.5	165%	
		86 5/32	5.7	165%	
		74 29/32	11.0	165%	
		61 4/32	21.3	165%	
0 bp	1+/11%	99 22/32	4.2	400%	

limited capacity unless there is substantial "overcollateralization." In the classic CMO, the original market value of the residuals is, at most, only a few percent of the market value of the bonds.[14] Overcollateralization implies that fewer bonds are issued than the maximum possible amount; the investment in residuals is correspondingly greater, and it probably has a lower expected return but additionally may be less risky.

The CMO issues with floating rate tranches have lessened the mandatory extent of effective overcollateralization by imposing limits, or "caps," on the floating rate.

[14] In the classic CMO structure, the principal amount of the bonds is usually very close to the "bond value" of the collateral. The bond value is the maximum amount of bonds for which interest and principal is covered by the cash received from the collateral, even under the worst possible conditions for prepayments and reinvestment rates.

As Table 3 shows, there is not a single uncapped floater in the lot; and many of the floating rate tranches are capped rather close to current rates. Of course, a cap decreases the value of the floating rate bond, because there is always a chance that market rates will rise above the cap during the bond's lifetime. The margin over LIBOR can be regarded as compensation for the cap, because AAA-rated short-term bonds without a cap could presumably be sold at a rate equal to or less than LIBOR.

The nonfloating CMO tranches are affected by the presence of the floater. If interest rates increase, more of the cash received from the collateral will have to be allocated to interest payments on the floater, so there will be less cash remaining to pay interest on the other bonds. Ordinarily, this decrease in available cash will be exacerbated because prepayments on the underlying collateral slow down when interest rates rise. Just when more cash is required, less is likely to be available.

The Structure of CMOs with a Floating Rate Tranche

To assure that there will always be enough cash to pay the interest on all bonds, many of the CMOs have been structured so that the underlying interest payments from the collateral will be sufficient to cover interest payments on all the CMO tranches *when the floating rate is at its cap,* and at a zero prepayment rate. Because the cap on the floater is usually higher than the coupon of the collateral, the coupons on the nonfloating tranches must be correspondingly lower.

For example, consider a deal with homogeneous-coupon collateral, say CMO Trust 15 (the twentieth issue in Table 3). The collateral is 100% Freddie Mac 9% mortgage-backed securities. The face amount of the floating rate tranche is $500,000,000 and the *aggregate* face amount of the nonfloating tranches (B–E) is also $500,000,000. There is no Z bond, so all stated coupons on every tranche must be paid on a current basis. The floater is capped at 13%, i.e., 400 basis points above the collateral coupon. The nonfloating tranches all have coupons of 5%, 400 basis points *below* the collateral coupon. Thus, if the 3-month LIBOR + 50 bp rises to 13% before any bond is retired, there will be exactly enough interest received from the collateral to pay the promised coupons on all of the bonds.[15]

This type of structuring permits the issuer to calculate the "bond value" of the collateral without reference to the maximum floating rate. To receive a AAA rating, the collateral can be valued at par, even though the coupon on the floater can conceivably rise above the coupon on the

[15] When the issue contains an accrual tranche (a "Z bond") or when there is nonhomogeneous collateral, the structuring is a bit more complex; yet the basic principle remains that the total interest collected from the collateral in the worst of circumstances must be adequate to pay the coupons due on all of the outstanding bonds.

collateral. (In the usual CMO structure, the bond value of the collateral would be below par to the extent that the maximum coupon on any of the CMO tranches is above the coupon of the collateral.)

An interesting consequence of this structure is that the redemptions mandated by prepayments are independent of the level of rates; they are not affected by the coupon of the floating rate tranches. Thus, when comparing a CMO without a floater to an otherwise equivalent CMO with a floater, the principal retirement schedule is virtually identical.

Because the nonfloating tranches generally have lower coupons than the coupons that would be typical for a CMO without a floating rate tranche, their initial market prices are often substantially below par. Notice in Table 3 that many of the longer tranches were issued at prices in the $80s, $70s, and even in the $50s. This is a marked contrast with the classic CMO, most of whose bonds have original issue prices quite close to par.

As a result, the nonfloating tranches of a floating rate CMO will be more bullish securities and will display a much greater degree of interest sensitivity, relative to classic CMO tranches. When interest rates decline, these low-coupon tranches will increase in market value for a double reason: (1) there will be a price rise from the rate decline itself, and (2) there will be an additional price rise because prepayments are likely to increase, thus returning the discount from par at an earlier date. Of course, when interest rates increase, these bonds can be expected to fall in price more precipitously than the usual CMO bonds, again for the double reason of the rate rise and the concomitant prepayment speed *decrease*.

The nonfloating tranches of a CMO with a floating rate tranche are more risky than their counterparts in CMOs without a floater.

The impact on the riskiness of inverse floating classes and on the residuals is less clear. When interest rates increase, the cash flows to such assets decrease; so we might at first conclude that there would be a terrible decline in market value. However, the inverse floating classes are originally sold at prices well above par and the residuals are effectively super high premiums, because they have no principal whatever. This implies that an increase in interest rates could actually have a beneficial influence on their market values, because it is very likely to induce a reduction in the prepayment rate of the collateral; i.e., the premium of the inverse floating class could be lost less rapidly and the cash flow to the residuals could last longer.

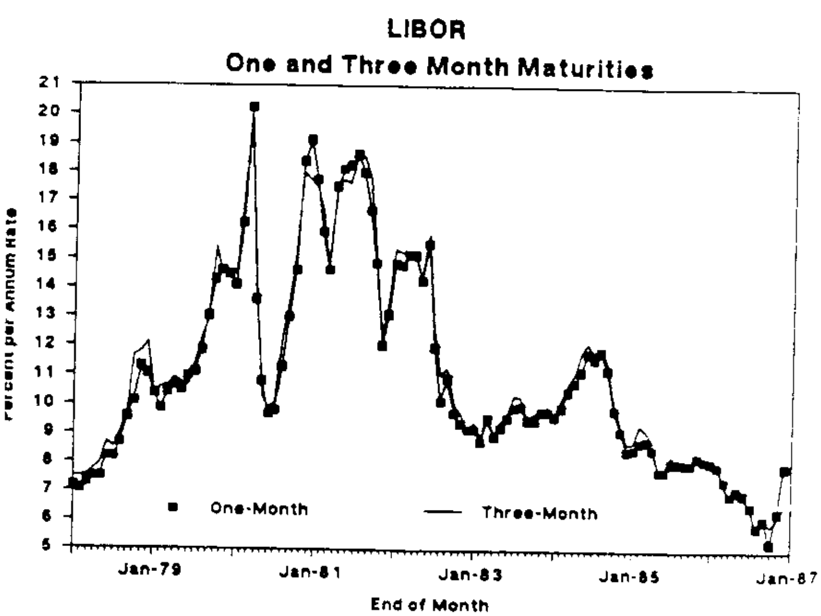
A decline in interest rates would generally increase prepayments, so again there are offsetting influences, higher current interest but shorter lives. It would seem that the inverse floater *could* be less risky than a nonfloating, otherwise equivalent (high coupon) CMO bond. Similarly, the residuals from a CMO with a floating rate tranche could be less risky than the residuals from a CMO with the classic structure. The key word here is "could." Without further detailed analysis, it is hard to know whether the riskiness of any particular issue increases or decreases.

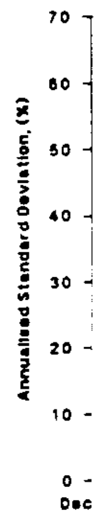
The critical question of analysis is whether any increase in the market value of the floating rate tranche, plus any increase or decrease in the market value of the residuals and/or the inverse floating rate tranche, is offset by a possible reduction in the aggregate market value of the nonfloating tranches. To provide some insight into this question, we now turn to the behaviors and interactions of floating rates, prepayments, and cash payments to the various classes of the CMO. To prepare the way, however, we must first digress to examine the actual behavior of LIBOR, to which all of the floating rate tranches have been linked.

[T]he Behavior of the London Interbank Offering Rate LIBOR

The month-end values of the 1- and 3-month LIBOR are shown in [F]igure 9 for the period commencing in January 1978 and ending with the [l]atest available month. LIBOR is closely related to other dollar-denomi[n]ated rates, and it has experienced substantial variation over time. In [1]980, it reached a level of 20%, but it has been well below the 10% level [f]or the past 2 years. As the figure reveals, there is a close association [b]etween the 1- and 3-month rates.

Figure 9. The month-end values of the 1- and 3-month LIBOR.





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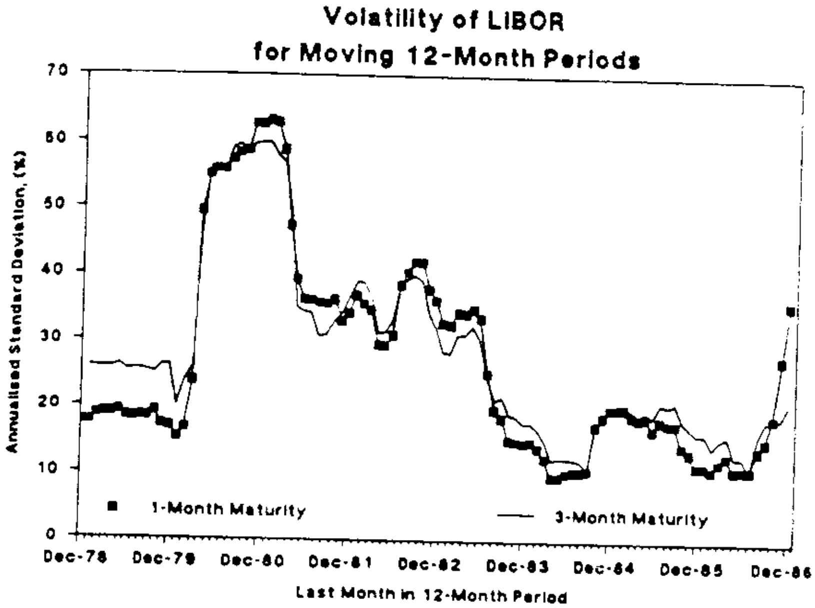

Figure 10. Standard deviations of monthly percentage changes.

The volatility of LIBOR is important for pricing the caps on floating rate CMO tranches, because the chance of reaching a cap during the term of the bond depends on the likely swings in LIBOR. Our preferred measure of volatility is the standard deviation of monthly percentage changes.[16] Figure 10 gives this number for the 1- and 3-month LIBOR, calculated from moving 12-month periods over the available sample. The first period, for instance, gives the volatility during the 12 months from February 1978 through January 1979; (the first month is lost in calculating the first percentage change).

The annual standard deviation has hovered between 10 and 20% for the past several years, after having declined from a much higher level in the early 1980s. The last few months have witnessed a substantial increase in volatility, particularly in the 1-month maturity.

Although the plots of LIBOR's level in Figure 10 do not show any obvious predictability, there is in fact a modest degree of dependence from month to month in LIBOR's changes. The correlation between

[16] A monthly percentage change is defined as the movement in the LIBOR during a month, divided by the level at the beginning of the month. For instance, an increase from 5 to 5.5% in a given month is a monthly percentage change of +10%; 100[(5.5–5.0)/5.0]. The continuously compounded monthly percentage change is given by 100 $\log_e$ (5.5/5), or 9.53%. We use the continuously compounded definition in all of the empirical results below.

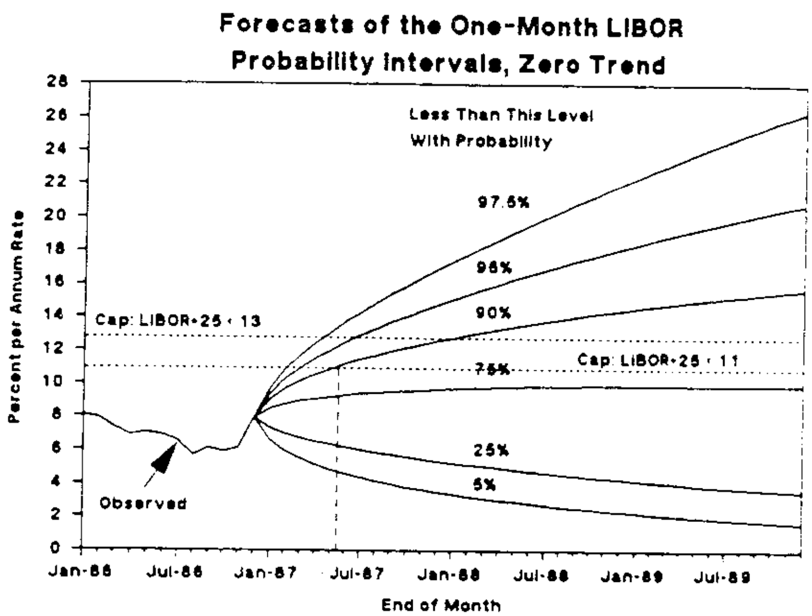

Figure 11. Probability intervals for the forecasted levels of 1-month LIBOR over the next 3 years.

successive percentage changes in LIBOR is around 0.20, and this correlation is statistically significant. Thus, when forecasting the volatility of LIBOR into the future, this intertemporal dependence has to be taken into account.[17]

Using the most recent 12-month period to estimate volatility, and taking into account LIBOR's propensity to display correlation in successive changes, Figures 11 and 12 give probability intervals for the forecasted levels of the 1- and 3-month LIBOR over the next 3 years (a period chosen to correspond to the lives of many of the floating CMO tranches). The actual observed path of LIBOR during 1986 is shown on

[17] If s is the standard deviation of the monthly percentage change in LIBOR, p is the first-order autocorrrelation coefficient, and there is no higher-order serial dependence, the standard deviation over an N-month forecasting period would be:

$$\{s^2[N + 2(N - 1)p]\}^{1/2}.$$

For example, if s = 15% and p = .2, the volatility for a 12-month horizon (N = 12), would be 56.5%. If serial dependence had not been taken into account, the 12-month volatility would have been estimated as only 52.0%. The LIBOR series are available on a daily basis, but we have used the month-end numbers, for two reasons. First, the reset on floating rate bonds is usually accomplished at most once a month. Second, the daily LIBOR series display a modest but annoying amount of additional serial dependence and (weekly) seasonal dependence.

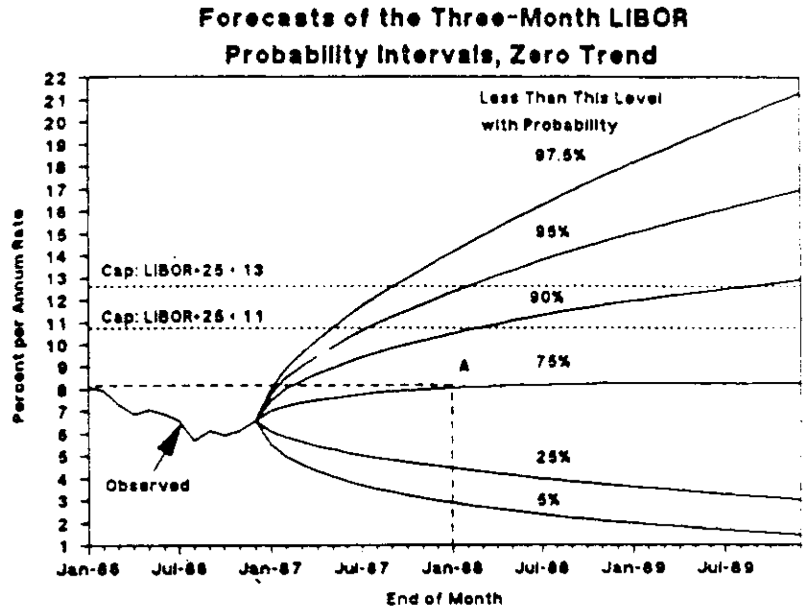

Figure 12. Probability intervals for the forecasted levels of 3-month LIBOR over the next 3 years.

the left side of the figures and then rays are projected from the December 1986 terminal rates.

Each ray is labeled with a probability. On any future date, this is the probabililty that LIBOR will be less than or equal the value given by the level of the ray on that date. As an example, consider point A in Figure 12. At the end of January 1988, the probability is 75% that the 3-month LIBOR will be less than 8.04%, and, of course, the probability is 25% that the 3-month LIBOR will be above 8.04%.

The calculation of these forecasts was based on the assumption that LIBOR has zero drift,[18] and also on the assumption that the long-term volatility would be equal to the actual volatility during the past 12 months, with a correction for serial dependence.

The greatest utility of these pictures is their visual representation of the probability of exceeding a cap. For instance, some of the actual caps are at 11 and 13% (see Table 3). These would correspond to LIBOR levels of 11 and 13% *less the margin* on the floating coupon over LIBOR. Thus, if the floating rate were the 1-month LIBOR plus 25 basis points capped at 11%, the cap would become effective when LIBOR reached 10.75%.

[18] The expected value of its percentage change is zero.

In each figure, two cap/margin combinations are indicated by horizontal lines. By observing where these lines intersect the probability rays, one can deduce the likelihood of encountering a cap on any particular date over the next 3 years. For example, the lower cap/margin line in Figure 11 is for a floating rate equal to the 1-month LIBOR + 25 basis points capped at 11%. The 90% probability ray intersects this level in May 1987. Thus, subsequent to May 1987, the probability is at least 10% that the cap will be effective. Remember too that this assumes no upward drift in LIBOR. If an increase in LIBOR were expected, the probability of hitting the cap would be correspondingly higher.

The general impression given by these figures is that the caps have a good chance of becoming effective sometime during the next 3 years. Caps at or below 11% would seem to have almost *one chance in four.* Some of the bonds are capped at 8.5 or 9% during the first year. For the 1-month LIBOR-linked issues, these caps have almost even odds of becoming effective.

Cash Flows and Returns for a Prototypical Issue Under Realistic Interest Rate and Prepayment Conditions

To provide some insight into the effect of the floating rate CMO innovation, this section presents detailed numerical results for cash flows, yields, and other relevant data for a prototypical issue and for a companion CMO issue without a floating rate but with otherwise similar characteristics. Results are presented under realistic, but simulated, interest rate conditions.

The LIBOR is simulated using a volatility equal to LIBOR's observed volatility and using three different assumptions about drift: upward, level, and downward. Mortgage rates on the current coupon also vary over time and are correlated, but not perfectly, with LIBOR. The variation in mortgage rates induces interest-sensitive prepayment behavior in the underlying collateral, as determined by the proprietary *Goldman, Sachs prepayment model.* Table 4 gives details of this specification.

Both CMOS have three tranches and have GNMA 9.5% coupon collateral with a remaining term of 322 months. The first tranche in the floater CMO is linked to the 3-month LIBOR plus 40 basis points, capped at 11%. It represents one-half of the principal amount of the three bonds. Notice that the other two bonds have fixed coupons lower than the collateral and that the interest received from the collateral is exactly equal to the *initial* aggregate coupon on the three bonds if the floater is at its cap. Actually, since the third tranche is a Z bond, there will be some excess cash flow even without *any* prepayments.

The corresponding CMO without a floating rate tranche differs primarily by having a fixed coupon on the first tranche which is initially

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Table 4. Illustrative CMOs

CMO Structure

Payment frequency: Quarterly
Settlement: 2/28/87 First Payment: 4/15/87
Number of tranches: 3
Maturity of collateral: 322 months.
Collateral market value: $104.50
Collateral coupon: 9.50%
Assumed reinvestment rate for bond value calculation: 3.00%
Issuing expenses: 1.00% of bond proceeds

Floating Rate CMO-Tranche Configuration

Tranche	1	2	3
Beginning coupons (BE)	6.40	7.50	8.50
Initial (%)	50.00	25.00	25.00
Maturity (years)	8.50	15.50	26.8
Price	100.0	97.0	95.0

Nonfloating Rate CMO–Tranche Configuration

Tranche	1	2	3
Beginning coupons (BE)	7.60	8.30	8.50
Initial %	50.00	25.00	25.00
Maturity (years)	8.50	15.50	26.8
Price	100.0	100.0	95.0

Interest Rate Scenario

Actual reinvestment rate: 5.50%
Initial LIBOR + margin rate: 6.40%/annum
Standard deviation of percentage/changes in LIBOR: 20.00%/annum
Initial current coupon mortgage rate: 8.30%/annum
Standard deviation of % changes in mortgage rates: 11.00%/annum
Correlation with LIBOR: 0.80
Trends in Rates
Upward: 50 basis points in first year, same relative increase later
Level: Zero change, on average
Downward: −50 basis points in first year, same relative decrease later

higher than LIBOR and by a higher coupon on the second tranche. Since there is no floating rate tranche in this issue, the coupons can be set, as they are traditionally, at a level which allows the bonds to be sold near par. An exception is the last tranche, a Z bond, which is usually sold at a moderate discount.

The effect of randomness in interest rates is captured by allowing LIBOR to vary randomly and by imposing a correlation of .8 between the percentage change in LIBOR and the percentage change in the current coupon mortgage rate. The interest rate scenarios were generated randomly and are depicted in Figure 13. Notice that there are three different scenarios that differ by the trend in rates. The upward trend

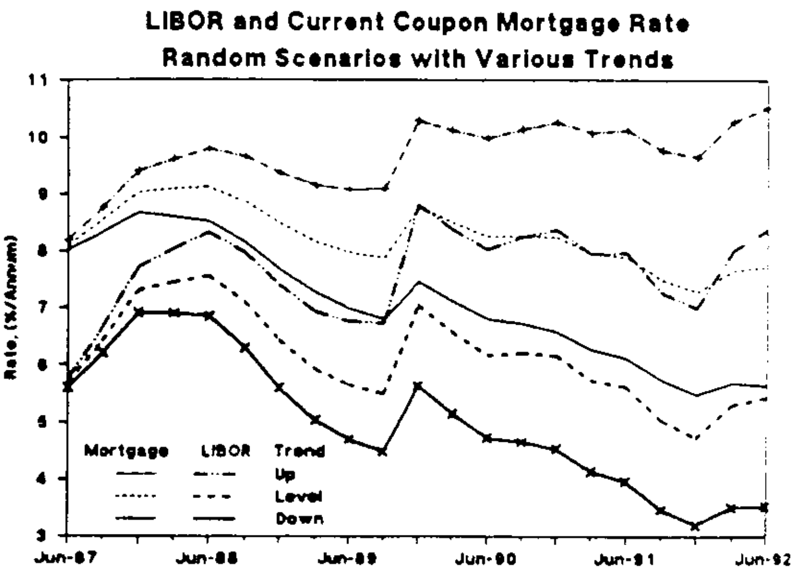


Figure 13. Interest rate scenarios generated randomly.

was specified as an *expected* increase in LIBOR of 50 basis points relative to its initial level in the first year.[19] The downward trend was specified as an *expected* decrease of 50 basis points. The level scenario has no expected change.

The total volatility of mortgage rates plus the correlation with LIBOR determines the movement in mortgage rates given a movement in LIBOR. A given change in LIBOR elicits a less pronounced movement in mortgage rates, generally in the same direction. Mortgage rate movements are less pronounced because, as is typical for mortgages, rate volatility is considerably less than short-term money market rate volatility. The illustrations use a mortgage rate volatility of 11% per annum (in contrast to LIBOR's 20% volatility). The relative trends in mortgage rates were the same as LIBOR trends, +50 bp, 0 bp, and −50 bp during the first year and the same percentage trend in later years.

Table 5 presents results comparing various characteristics of the

[19] An expected change of 50 basis points, relative to a beginning LIBOR level of 6%, implies an average percentage increase during the first year of about eight (continuously compounded). The same average percentage change is carried into years beyond the first under each of the three scenarios. The average is what would be expected over many replications of random scenarios, but any given scenario, including those used as illustrations here, can differ from the average. Due to the realistic randomness in the illustrations, the LIBOR actually increased over 100 basis points during the first year under both the upward and level drift cases. Over the first 5 years, however, the actual drifts in all illustrated scenarios happened to be quite close to the expected drifts.

Table 5. Results for Illustrative CMOs Under Different Interest Rate Trends

Interest Rate Trend	Upward		Level		Downward	
CMO Issue[a]	F	N	F	N	F	N
Tranche No. 1						
Duration (years)	2.22	2.21	1.78	1.77	1.52	1.51
Yield (%/annum BE)	7.613	7.396	6.784	7.358	6.300	7.325
WAL (years)	2.46	2.46	1.91	1.91	1.60	1.60
Maturity Month	63	63	42	42	33	33
1st principal payment month	3	3	3	3	3	3
1st interest payment month	3	3	3	3	3	3
Tranche No. 2						
Duration (years)	5.57	5.47	3.86	3.82	2.95	2.93
Yield (%/annum BE)	7.959	8.174	8.181	8.141	8.407	8.111
WAL (years)	7.13	7.13	4.50	4.50	3.29	3.29
Maturity Month	111	111	63	63	45	45
1st principal payment month	63	63	42	42	33	33
1st interest payment month	3	3	3	3	3	3
Tranche No. 3						
Duration (years)	15.81	15.81	8.12	8.12	4.73	4.73
Yield (%/annum BE)	8.749	8.749	9.050	9.050	9.488	9.488
WAL (years)	20.04	20.04	9.04	9.04	4.80	4.80
Maturity Month	322	322	279	279	125	125
1st principal payment month	111	111	63	63	45	45
1st interest payment month	111	111	63	63	45	45
Residuals						
Duration (years)	2.82	3.26	2.12	2.70	1.59	1.90
Yield (%/annum BE)	28.148	23.933	23.477	13.205	12.831	−5.076
All-In Cost of Funds						
Yield (%/annum BE)	8.456	8.464	8.490	8.611	8.577	8.785

[a] F = CMO with a floating rate first tranche. N = comparable CMO without a floating rate tranche.

tranches in the CMOs with and without a floating rate class, under the three illustrated interest rate scenarios. Also given are results for the residuals and for the All-In Cost of Funds.

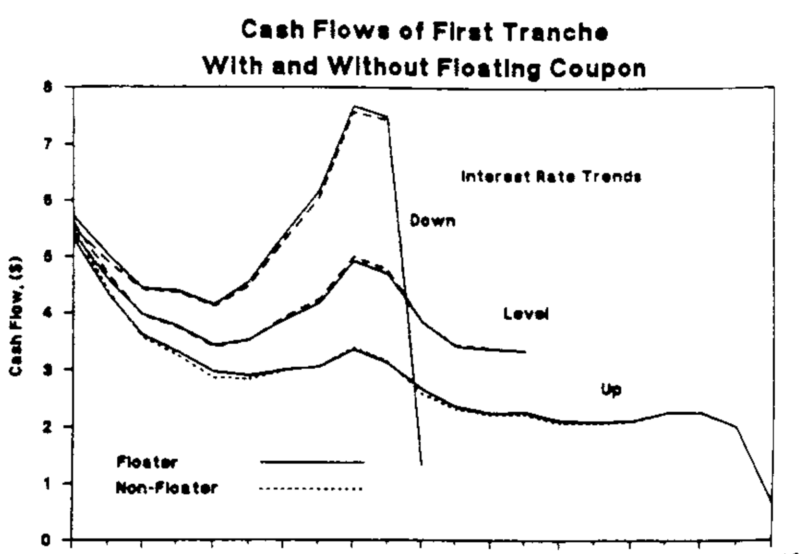
Looking first at the time paths of cash flows, we see that the presence of a floating rate tranche in the CMO has no impact at all on the average lives (WAL) of the various tranches. For example, the first tranche has an average life of 2.46 years under an upward rate trend, whether or not its coupon floats with LIBOR. The explanation for this result derives from the calculation of "bond value" in the CMO. Since the collateral pays interest sufficient for all of the bond coupons even when the floater is capped, the bond value is always par. Thus, any prepayments received from the collateral are used to pay down principal on the bonds at exactly the same rate, regardless of the floater's coupon at the moment the cash is received.

However, the yields on the first two tranches *are* influenced to a minor extent by the presence of the floating coupon. This carries over to a minor influence on the duration of the tranches. Notice that the yield on the first tranche is between 7.3 and 7.4% under all interest rate scenarios when its coupon does not float. In contrast, a floating coupon on the first tranche produces substantially higher yield in upward trending rate environments and substantially lower yield in downward trending environments. The yield is also lower in level rate environments because floating rate bonds can be sold at par with lower initial coupon levels than fixed rate bonds.

The effect of the floating rate feature is dwarfed, however, by the impact of prepayments. Because prepayments speed up when rates fall and slow down when rates rise, there is a dramatic difference in the cash flow patterns of the first tranche under the three illustrated scenarios. Figure 14 presents a graph of these cash flows. The influence of the floating coupon is minuscule compared to the influence of prepayments.

Even though the cash flow yield in Table 5 is not very sensitive to trends in interest rates, the actual holding period return to the nonfloating first tranche, over any investment horizon, would be sensitive to the cash flow pattern. When rates decline, the first tranche pays down very quickly, whether or not it has a floating coupon, and this cash could be reinvested in an equivalent new security only at rates lower than the

Figure 14. Graph of cash flows.



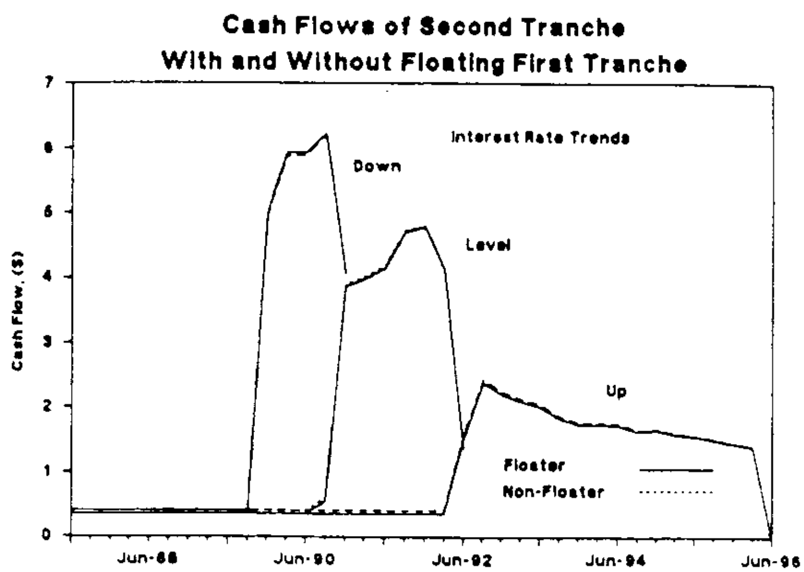
initial coupon of the tranche. But when rates increase, prepayments decline and holders of the nonfloating tranche would have less cash available to take advantage of higher reinvestment rates. The net effect on the nonfloater is to lower its expected holding period return below its original anticipated cash flow yield. This is a major advantage of the floater; *its* coupon resets when rates increase. The reset is tantamount to reinvesting the entire principal at the new higher rate. The nonfloater, in contrast, would still be mainly invested at the lower *original* rate in such circumstances.

The second tranche is influenced to some degree by the presence of the floating rate feature on the first tranche. Notice in Table 5 that the cash flow yield of the second tranche is slightly above 8.1% under all interest rate trends when there is no floater. With a floating rate first tranche, however, the yield on the second tranche increases as rates decline. This is caused by the necessity of selling the second tranche at a discount from par (in order to assure sufficient cash to pay all promised coupons even when the floater rises above the coupon of the collateral).

Figure 15 shows the cash flow patterns of the second tranche. Like the first tranche, the impact of the floating feature is hardly perceptible compared to the impact of prepayments. And for the same reasons, the second tranche's holding period return would be below its original cash flow yield.

The third tranche, a Z bond, is not influenced at all by the presence of the floater. Its original coupon and price were the same in the two

Figure 15. Cash flow patterns of the second tranche.



CMOs, and because the principal payments also followed the same schedule, the floating feature per se has no effect.

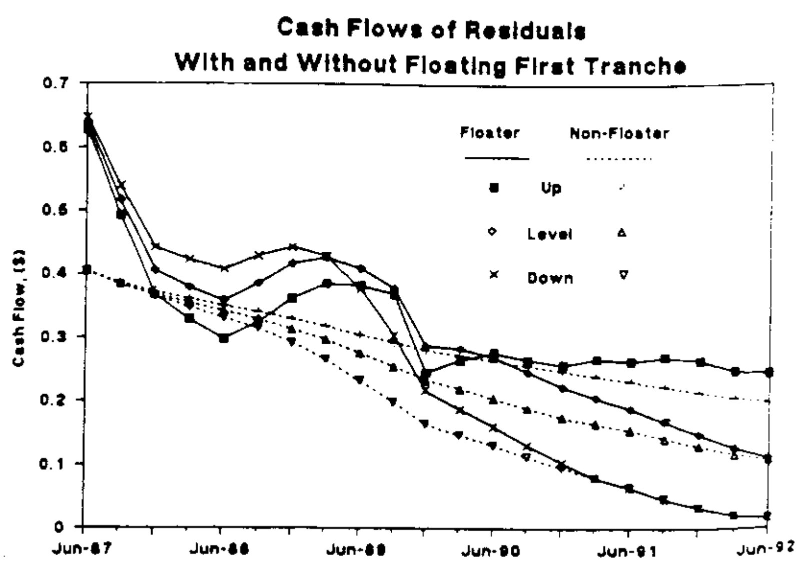
Again, however, prepayments have a big impact. The Z bond's average life shortens from 20 to 4.8 years as rates change from an upward to a downward trend.

The floating rate feature thus has relevance mainly for the floater itself. A floating tranche displays only very minor differences in its own cash flow pattern, relative to a similarly sized fixed rate tranche, but holding period returns are not as affected by the adverse prepayment selection experienced by nonfloating tranches. The influence of the floater on the other bonds in the issue is relatively insignificant, particularly when contrasted with the influence of prepayments.

There is, however, one other claimant in the CMO, the owner of the residuals, who is quite affected by the presence of the floater. Table 5 shows a material difference in the durations and yields of the residuals under various rate scenarios with and without a floating rate first tranche in the CMO. Figure 16 shows the cash flow patterns of the residuals during the first 6 years.

The residual yield is greatly reduced by lower interest rates and more rapid prepayments, with or without the floater; but this reduction is significantly attenuated by the floater's presence. Under each interest rate trend, the residuals have a higher yield when the first tranche has a floating rate coupon. This is partly due to the initially lower coupon on the first tranche when it floats. The attenuating effect of the floater on

Figure 16. The cash flow patterns of the residuals during the first 6 years.



the residual's yield when rates decline can be ascribed to another factor: viz., the *inverse* floating rate nature of the residual "coupon." Note in Figure 16 how the cash flows of the residuals increase when rates decline, e.g., between June 1988 and June 1989, and note also that the residual cash flows are lower in upward trending rate environments in the early months, when the floating tranche has not yet been paid off.

In terms of holding-period returns, the residual yields are a bit misleading. The residual owner experiences a double reinvestment impact when interest rates and prepayments change. When rates decline, the owner receives extra cash for two reasons: the floating coupon on the first tranche declines, releasing more excess cash flow, *and* prepayment rates accelerate, releasing even more cash. But reinvestment of all this cash must be accomplished at lower prevailing market rates. When rates increase, cash inflows are reduced substantially, and thus less reinvestment can be accomplished at higher interest rates. The overall result is a large difference between the yield on the residuals and the actual holding period return over any investment horizon; the difference is exacerbated by the presence of a floating coupon on one or more of the CMO tranches.

Finally, the All-In Cost of funds is influenced to only a modest extent by the presence of the floater (see Table 5).

The Bottom Line for CMOS with Floating Rate Tranches

In summary, the innovation of a floating rate coupon on tranches within a CMO has an innocuous effect on the nonfloating bonds. The cash flows of the floating tranche, and perhaps of other tranches whose coupons must be altered, are changed by minor amounts. The main benefit is less adverse prepayment selection for the floating rate tranche.

Residuals from CMOs with floating tranches are impacted to a greater degree than are the bonds. At first, it would appear that the floater brings a benefit to the residuals; the cash flow yields are more stable under different interest rate environments. However, when one considers reinvestment risks, the benefit becomes doubtful. The residuals with a floating rate tranche tend to throw off more cash at the most inopportune moments, when reinvestment rates are low. This creates a bigger gap between their original anticipated yield and the expected return earned over any investment horizon.

IV. Combinations of Innovations: Derivatives of Derivative Securities

The PAC and floater innovations discussed in Sections II and III were illustrated with simple examples in order to highlight their salient features. However, these "generic" innovations are only special cases and CMOs containing both features, or CMOs that borrow from other recent innovations in mortgage-backed securities, might be interesting to some issuers or to some investors. There is nothing to prevent the issurance of a CMO that contains both a PAC and a floater, or even a floating PAC!

One of the most innovative of the CMO innovations borrows from another recently invented non-CMO product, the stripped mortgage-backed security, or SMBS. The SMBSs were first issued in July 1986 by FNMA. In contrast to traditional CMOs, which cut up mortgage cash flows along the maturity dimension, SMBSs cut up mortgage cash flows by separating the interest and principal payments, allocating different fractions to the SMBS tranches, but retaining the same fractions over time.

For example, the first tranche of an SMBS might receive 50% of the principal payments from the mortgage collateral, but ⅔ of the interest payments, while the second trance would receive the complement (50% of the principal and only ⅓ of the interest). This effectively creates a relatively high-coupon and a relatively low-coupon mortgage-backed security, each of which has a prepayment speed governed by the coupon of the collateral. The SMBS uncouples the traditional relation between coupon and prepayment speed.[20]

Some of the recent CMOs have essentially employed the SMBS concept to first create a high-coupon class and a corresponding low-coupon class from underlying medium coupon collateral, and then have used the low-coupon SMBS as "collateral" for a traditional CMO. Meanwhile, the high-coupon SMBS was divided into a floater and an inverse floater. This structure has the advantage that it permits a higher cap on the floater while avoiding potential overcollateralization.

To illustate, consider the particular CMO we have already discussed in Section II, CMO Trust 15, the twentieth issue in Table 3. The collateral has a 9% coupon. One-half of the CMO bonds have 5% coupons while the other half is a floating tranche whose coupon is capped at 13%. Even at the cap, interest receipts from the collateral are sufficient to pay the promised interest on all of the bonds. However, if the floating tranche had been designated as the "first" CMO tranche to receive all principal payments, in accordance with traditional CMO maturity structuring, it would soon be retired. After the floater's retirement, the CMO would be substantially overcollateralized because a 9% mortgage pass-through rate represents a large spread over the 5% coupon on the remaining tranches.[21]

[20] For a more complete description of SMBSs, see Richard Roll, "Stripped Mortgage-Backed Securities", (Goldman, Sachs & Co., Mortgage Securities Research), October, 1986.

[21] Remember that the "bond value" of the collateral is the *lesser* of (a) the present value of mortgage cash flows discounted at the highest CMO bond rate, and (b) par. In this case, the bond value would be par, an amount likely to be substantially in excess of the market value of the remaining tranches.

To avoid this potential overcollateralization, CMO Trust 15 does *not* allocate principal payments first to the floating tranche. Instead, 50% of any principal payment is allocated to the floating tranche and the other 50% is allocated to the shortest outstanding nonfloating tranche. Thus, the final stated maturity of the floater is the same as the stated maturity of the longest nonfloating tranche (trance E). Because the floater will remain unredeemed exactly as long as the longest discount coupon tranche, there is less potential for overcollateralization in future periods. The floater's average life is equal to the weighted average life of the other tranches.

Such a structure is identical to performing the following operation: First, construct a 5% coupon and a 13% coupon SMBS from the underlying 9% collateral by allocating half of the principal to each SMBS class, while allocating 5⁄18 (27.77%) of the interest to the first class and 13⁄18 of the interest to the second class (thereby creating a 5 and a 13% SMBS). Second, with the 5% SMBS as pseudo-collateral, issue a standard CMO, consisting of four tranches with fixed coupons and whose principal allocations are ordered by stated final maturity. Third, with the 13% SMBS as pseudo-collateral, issue a floater with a cap equal to the coupon on the (pseudo) collateral. As long as the cap is not binding, there will be an inverse-floating interest-only excess cash flow, which can be allocated to the residual claimant.

A CMO structured in this manner combines many of the most desirable features of recent innovations, but it is still subject to the cardinal risk of mortgages and mortgage-related securities, prepayments. An SMBS/Floater has cash flows that differ somewhat from a non-SMBS/Floater, but a plot of the two cash flows against time, allowing for interest rate variability, reveals that the CMO structure is even here much less important than the underlying collateral's prepayment risk.

V. Conclusion

Recent innovations in CMOs have been fascinating and ingenious. A planned amortization tranche, or PAC, allows a finer division of prepayment risk among the various CMO bonds, but it may have a major disadvantage; viz., it allocates more risk to the shorter tranches, and those tranches may be attractive to the most risk-averse investors.

The CMOs with floating rate tranches permit the sale of mortgage-related products in nontraditional markets, such as the money market both domestically and abroad. Because most mortgage collateral used thus far in CMOs has been fixed rate, the floating rate tranche must be capped and the nonfloating tranches must have relatively low coupons. This may render the nonfloating tranches somewhat more price sensitive to interest rate volatility. The floater, however, has the benefit of being subject to prepayment risk only if rates are near its cap.

The CMOs that combine the floating rate feature with characteristics of other recent innovations, such as the stripped mortgage-backed security, offer certain structuring advantages; in particular, the necessity of lower coupons of the nonfloating tranches may be obtained without as much potential over collateralization in later years.

Residuals from CMOs with floating tranches, and without an inverse floating tranche, have more stable yields than residuals from traditional CMOs. However, their holding period returns are adversely influenced to a greater extent by prepayments.