In Brief
Economic Capsules

Collateralized Mortgage Obligations: Do They Reduce Cash Flow Uncertainty?

The collateralized mortgage obligation (CMO) has become a very popular instrument in the secondary mortgage market: over $9.5 billion of these securities have been issued since the first offering in June 1983. Like standard mortgage pay-through securities, the cash flow generated by the CMO mortgage collateral pool is used to provide for interest and principal repayment. However, the conventional wisdom is that the CMO structure creates two advantages over the standard pay-through bond.

First, CMOs offer a wider variety of expected maturity dates and thus may appeal to a broader spectrum of investors Second, they "offer a more predictable principal repayment schedule."[1] If both propositions were true (and there were no alternative means in the market to accomplish the same ends), one would expect the CMO to lower mortgage rates by making mortgages more marketable in the secondary market.

But the second proposition is not necessarily true Although the CMO structure does lead to a more diverse selection of expected maturity dates, our research indicates that the timing of the cash flows cannot be more predictable for all CMO investors.[2] In fact, we show that under a variety of conceivable circumstances the timing of the payment stream for many CMO investors will be considerably less certain than with a standard pay-through bond. Furthermore, under some scenarios, *all* CMO investors may receive less predictable cash flows.

Uncertainty about the timing of payments on any mortgage or pay-through security (including CMOs) arises from the borrower's option to prepay the mortgage at any time (usually with little or no penalty).[3] With a pay-through bond, these prepayments would be passed onto the holder of the security, effectively reducing the instrument's duration—a measure of its average life. Investors generally view this duration uncertainty as a disadvantage, since it could leave them vulnerable to some unexpected interest rate risk.[4]

While all investors in a standard pay-through security receive a pro rata share of *each* of the payments, CMO investors get a pro rata share of only a specific *segment* of the total mortgage payments. By design, the CMO mortgage pool is divided into two or more maturity classes. Initial principal payments (both prepayments and regular repayments) from the total pool are paid to investors in the shortest maturity class only, until their entire principal has been repaid Principal repayments to investors in any subsequent class are made only when all of the shorter maturity classes are fully paid off

Therefore, while all investors in standard pay-through securities share the same randomly timed payment stream, CMO investors can choose among classes with different expected cash flow patterns, ranging from very short to very long periods. However, the variability around those expected

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[1] *Real Estate Finance Today*, "Lack of Consensus May Delay CMO Guidelines" (May 1984), page 9

[2] For a proof of this assertion, see Arturo Estrella and Andrew Silver, "The Collateralized Mortgage Obligation A Statistical Analysis of Its Cash Flows", Federal Reserve Bank of New York Working Paper, forthcoming

[3] We are abstracting here from any other payment uncertainty, such as default risk

[4] Interest rate risk is the risk that net worth may decline due to a change in interest rates To avoid this, investors may in principle adjust their portfolios so that the ratio of the duration of liabilities to the duration of assets equals the ratio of assets to liabilities However, when the duration of an asset is uncertain, as in the case of a mortgage with a prepayment option, it is not possible to adjust so precisely For a further explanation of duration and interest rate risk, see Richard W McEnally, "Duration as a Practical Tool for Bond Management", *Journal of Portfolio Management* (Summer 1977), pages 53-57

Duration Statistics for a Simulated Collateralized Mortgage Obligation

Security	Prepayment rates* FHA Mean†	FHA Variance‡	Flat Mean†	Flat Variance‡	Increasing Mean†	Increasing Variance‡	Decreasing Mean†	Decreasing Variance‡
Mortgage pool	5 73	038	5 51	043	6 50	020	4 71	051
CMO class								
1	2 47	084	2 02	092	3.83	150	1 44	037
2	4 64	137	4.37	172	6 16	057	3 08	129
3	6 28	102	6 11	098	7 08	017	4 82	156
4	7 40	020	7 24	027	7 57	004	6 50	102
5	7 87	001	7 84	002	7 88	000	7 73	009

*One of our prepayment assumptions represents the actual FHA experience from 1970 to 1983 See Thomas N Herzog and Dominick C Stasulli, "Survivorship and Decrement Tables for HUD/FHA Home Mortgage Insurance Programs as of December 31, 1983", U S Department of Housing and Urban Development (March 1984) A second schedule assumes a flat expected prepayment rate of 6 percent (of the remaining outstanding mortgages) per year over the 30 year period—the average of all the annual FHA rates Finally, two sets of more strongly tilted rates are used One increases linearly from 1 1 percent in the first year to 10 9 percent in the twenty-ninth, and the second decreases linearly from 10 9 percent to 1 1 percent Once again, the average rate is 6 percent in both cases

†In years

‡In years squared

patterns depends on the variability of the repayments in which the investors share The investor in a CMO class shares the cash flow from just a portion of the mortgage pool, a portion segmented by the timing of payments One would thus expect that the repayment period for a CMO class probably would be less spread out than for a standard pay-through security This would tend to reduce the variability of the payments and is probably behind the conventional conclusion that CMOs provide a more predictable repayment schedule

Another factor, however, tends to increase the variability Prepayments which come in at unexpected times have a much larger impact on the duration of a CMO class than of a standard pool. This is because in a standard pool, deviations from expectations are averaged over the entire pool, while CMO deviations are averaged over only a segment of the pool

So it is not clear, *a priori,* whether the duration of the repayment schedule would tend to be more predictable with a CMO class than with a conventional pay-through security The answer depends on the relative magnitudes of the two opposing factors described above, which in turn depend on the probability distribution of the timing of the prepayments. What is clear, however, is that not all of the CMO classes can have more predictable cash flows At best, the uncertainty can be shuffled from class to class.[5] At worst, the uncertainty for all classes is greater than that for the pool.

To illustrate these points, we examined the effects of uncertain prepayments on the duration for a variety of possible distributions Prepayment experience will vary with interest rates, generally, higher interest rates lead to slower prepayment rates Thus, the exact distribution may vary if the CMO is offered at different points in the interest rate cycle

We measure the uncertainty regarding cash flow timing by the variance of the duration, which quantifies the dispersion around the expected duration.[6] The method of Monte Carlo simulations was used to estimate the means and variances of the duration for a standard pay-through security and CMO classes based on the same underlying mortgages In each simulation, the basic pool consisted of 100 independent 14 percent 30-year mortgages, and the CMO was assumed to have five classes (each with the same initial principal)

The mean and variance of the duration for each distribution are presented in the table for the mortgage pool and for each of the five CMO classes The results indicate that.

[5]To shift the uncertainty, issuers could direct all or part of the initial prepayments to classes other than that with shortest stated maturity Alterations of the conventional CMOs along these lines have not yet become commonplace in the market, although at least one variant was offered in early 1984, in a private placement (See Bondweek, "Lepercq Structures CMOs to Protect Short-term Investors" [March 19, 1984], page 1) As with conventional CMOs, however, any alteration would leave at least one class of investors with greater uncertainty than with a standard pay-through security For a proof of this assertion and an example of an alternative structure, see Arturo Estrella and Andrew Silver, *op cit*

[6]Instead of looking at the deviations from the mean duration, one can look at the dispersion around any "desired" duration This amounts to attributing a specific form to investors' preferences regarding duration In our basic simulation (five CMO classes, FHA prepayment rates), the pool was preferable to all CMO classes for some of the desired durations See Arturo Estrella and Andrew Silver, *op cit*

- the claim that the CMO provides a wider *selection* of expected durations is correct, but

- the claim that duration is more *predictable* for the CMO classes is incorrect in most cases.[7]

CMO classes, then, offer a variety of combinations of expected durations and variances For some investors, certain classes may provide both a more appealing expected duration and more payment timing certainty than a standard pay-through bond Other investors, however, may find that a CMO class offers more desirable expected cash flow timing only at the expense of higher variability Thus the total cost of issuing a CMO instead of a standard pay-through security can be lower only if the premium relinquished by the group which benefits from the CMO exceeds the premium required by the group which is made worse off

[7]There are conceivable situations in which *all* of the classes would have a higher variance than the pool For example, with two CMO classes an interest rate of eight percent and annual prepayment rates decreasing linearly from 7 4 percent to 4 6 percent, the class variances are 130 and 107, while the pool variance is 098