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Derivative Mechanics: The CMO

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Collateralized mortgage obligations (CMOs), first introduced in 1983, are a form of financial derivative created to provide more stability and predictability for those investing in mortgage assets. Although some investors have profited handsomely from CMOs, others have lost millions of dollars. This article describes how CMOs work, looking at both their advantages and disadvantages, and explains how even savvy, seasoned market participants have gotten into trouble by investing in these interest-rate-sensitive financial instruments.

The current interest in financial derivatives sometimes appears to be driven by the same tastes that support police and doctor dramas on television: many crashes and a lot of blood. Though undeniably exciting, such shows do not teach you how to drive safely or how to administer first aid. Likewise, a concentration on the blowups of financial derivatives slights the more basic information needed for policy decisions or corporate risk management.

This *Economic Commentary* looks under the hood of one particularly important type of financial derivative, the Collateralized Mortgage Obligation, or CMO (sometimes known as a REMIC, or Real Estate Mortgage Investment Conduit[1]). CMOs have prominence both because of their wide use ($650 billion in 1994) and because of their role in a series of major financial setbacks. Wall Street professionals, including the investment bank of Kidder Peabody and mortgage guru Lew Ranieri's Hyperion Capital Management, lost money investing in CMOs. So did small towns and counties (some as close to home as Sandusky County and Jackson, Ohio), colleges, and even an Indian reservation.[2] To understand what went wrong, it is necessary to understand how CMOs work. This, too, has its own rewards, at least for those whose taste runs more toward the dazzle of gleaming machinery and the challenge of complexity.

Mortgage-Backed Securities

The story begins as ordinary mortgages become securitized, or bundled into a pool and then sold. It's a bit ironic that some of the most sophisticated financial derivatives ultimately depend on a very common, even mundane, instrument — the homeowner's mortgage. These mortgages provide the underlying collateral backing up the security.

The first type of mortgage-backed security, still quite common, is the "pass-through." Investors get a pro rata share of payments — some fraction of the monthly mortgage payments made by the myriad homeowners in the pool. Since each monthly payment includes both principal and interest, investors get a mixture of those elements "passed through" from the homeowners. This presents a problem in that the security has a very long maturity — it takes years until the last homeowner completely pays off the last mortgage and returns the full value of the principal. Since homeowners have the option to pre-pay their mortgages, pass-throughs also face the risk that payments may arrive on a different schedule than investors initially expected.

In the summer of 1983, market participants developed the CMO to solve these problems. CMOs break the mortgage-backed security into a series of bonds known as "tranches" (French for trench). Each tranche gets its share of interest payments, but the principal is repaid sequentially. That is, principal payments go exclusively to the first tranche until it is paid off, then to the second tranche until it is paid off, and so forth. This breaks the security into several shorter bonds (see figure 1). For example, an investor holding $10 million of a $100 million pass-through would not get all of his principal back until every mortgage had been paid off. The holder of a $10 million first tranche, by contrast, would get his principal back from the first $10 million paid. This structure makes CMOs *derivatives*: Their value depends on, or derives from, the value of the underlying mortgage pool.[3]

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Risk Remains

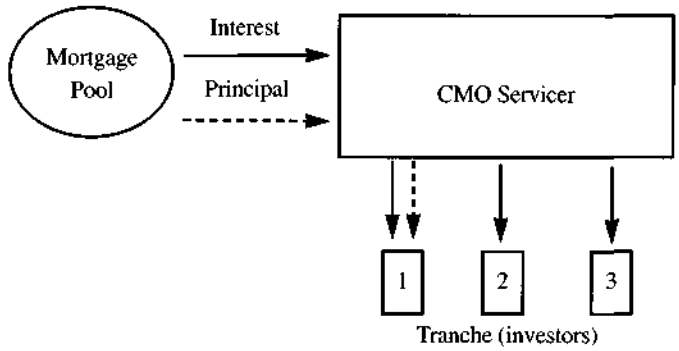
The standard CMO still exhibits two types of risk. Interest-rate risk exists because market rates can change, making the present value of the payment stream worth different amounts. Prepayment risk still exists, and it continues to make the maturity of the bond uncertain. For example, as interest rates fall, more people pre-pay their mortgages, so each tranche has a shorter maturity. As interest rates rise, fewer people pre-pay their mortgages, so each tranche has a longer maturity.

Why do people care about pre-payment risk? On the simplest level, slow prepayments mean that the investor does not get his money back as quickly, and the value of the bond declines. When interest rates rise, even ordinary bonds drop in price as the present discounted value of their payments falls. CMO tranches take another hit, because now their payments also come later as prepayment rates fall. Market participants refer to this as extension risk.

Extension risk has two additional downsides. One is that it subjects investors to reinvestment risk. Normally, investors holding a bond want interest rates to drop because it gives them a capital gain: The present discounted value of the cash stream is worth more. Bond prices rise as interest rates fall. But the pre-payment effect makes CMOs work somewhat differently. When interest rates rise, the CMO extends at exactly the wrong time, that is, when interest rates are high and investors would like to reinvest at the higher rate. When rates fall, the CMO tranche pays off quickly, again at the wrong time. The investor receives more principal today, when interest rates are down, and so must trade the high interest on the original CMO for lower interest on something else. This reinvestment risk offsets, and may dominate, the capital gain or loss stemming from a change in interest rates.

Furthermore, the extended (or shortened) bond now has a new, different sensitivity to risk, with a five-year bond behaving differently from a two-year or 10-year bond. With a change in pre-payments, investors now hold a bond that reacts to interest rates in a manner unlike the original, so it may be less useful for hedging liabilities or fitting into their portfolio.

FIGURE 1 BASIC CMO STRUCTURE



SOURCE: Frank J. Fabozzi, ed., *The Handbook of Mortgage-Backed Securities* (footnote 3).

Fancy CMOs

To mitigate these risks, market participants created a new type of tranche—the accrual bond, or Z-bond. This bond gets neither principal nor interest until all previous tranches are paid off. The interest due accrues, and like a zero-coupon bond, it initially makes no interest payment. The Z-bond acts as a stabilizing influence on the other tranches. The interest that would otherwise go to the Z-bond tranche (recall that standard CMOs pay interest to all tranches) instead goes to the other tranches and counts as a principal payment. This constant flow of payments has a steadying effect, offsetting some of the variability from pre-payment. As pre-payments rise, the tranches pay off ahead of schedule and the Z-bond starts making payments earlier than originally anticipated. Because it is the last tranche, however, pre-payment fluctuations often average out by the time the Z-bond comes due.

Some investors wanted even more certainty about their bonds, so the market responded with PACS and TACS: Planned Amortization Classes and Targeted Amortization Classes, two fancier tranches. PACs provide principal payments according to a pre-specified schedule. They stick to this schedule as long as pre-payments stay in some broad range (for example, 50 to 350 percent PSA [see box]). Furthermore, the PAC is exempt from the serial paydown pattern of the tranches, so that other tranches may receive principal payments at the same time as the PAC. In effect, the PAC has priority over the other tranches through having first claim on the money available. For example, if PAC investors are scheduled to receive $1 million each month and the underlying mortgages produce $2 million, then $1 million can go to the "companion" tranche. If pre-payments fall so that the mortgages generate only $1.25 million, the companion tranche gets only $250,000. If pre-payments fall even more so that the mortgages generate only $800,000, even the PAC winds up short, although it receives the entire $800,000.

How, then, does a PAC provide protection against both high and low pre-payment? The issuer calculates the available cash flows in the protected range (known as the collar) and restricts PAC payments to that spread. Thus, to continue the above example, the 50 to 350 percent PSA range may have allowed for payments of between $800,000 and $4 million for the month in question, so the planned payment should fall within that range.[4]

It is important to note that although PACS are fairly safe bonds, the process of creating them necessarily shoves more risk into the other tranches. Companion bonds, which receive payments only after the PAC schedule is met, are particularly risky.

TACs offer a similar sort of protection, but only against pre-payments rising. The TAC has priority over other tranches and hence can keep to its schedule if pre-payments increase. If they drop off, however, the TAC has no protection. It is effectively a PAC with one side of the collar at the expected pre-payment rate, that is, 100 to 350 percent or 125 to 350 percent.

CMOs entail a second type of risk — default risk — because some people will not (or cannot) make their mortgage payments. To compensate, issuers over-collateralize CMOs. For instance, a CMO with a face value of $10 million may have mortgages backing it worth $11 million, for a 10 percent overcapitalization rate. This means that investors will get their money even if some homeowners default. What happens to this extra collateral if people do not default? Known as equity in the CMO, or the residual, it too can be bought and sold. Per usual in the mortgage-backed market, variations have developed, and it is now possible to invest in bullish, bearish, humped, stable, *De Minimus,* and smile residuals.

■ Exotic CMOs

Once market participants got the idea of splitting up the cash flows from a pool of mortgages, there was no stopping them. One innovation quickly spawned others, just as PACs and TACs spawned the companion classes that made them possible.

The market created IOs, or interest-only bonds, in which investors get interest payments as long as the underlying tranche gets principal payments. POs are the inverse, paying principal only.

Fancier still are the floaters, bonds whose coupon (interest payment) is linked to some interest-rate index, such as LIBOR or the 11th District Cost of Funds.[5] A standard floater may be quoted at something like LIBOR+1, meaning that the interest payment is 12 percent if LIBOR is 11 percent, and so forth. A superfloater responds to the index with a multiple greater than one. Thus, when the LIBOR rate moves from 10 percent to 11 percent to 12 percent, the interest rate on the bond moves from 10 percent to 12 percent to 14 percent. (Of course, the reverse is also true: A 2 percent drop in LIBOR sends the rate down 4 percent.) With an inverse floater, an increase in the index decreases the rate on the bond. And, yes, you can have a super inverse floater.

Z-bonds have also gotten more complicated. One innovation is the jump Z. That's where a Z tranche can jump to the head of the tranche line. For example, the Z tranche is last in line unless interest rates rise above 10 percent, at which point it moves up and becomes the tranche getting the principal payments. We have a sticky jump Z if the Z stays in that position. We have a non-sticky jump Z if the Z moves back to the end of the line when interest rates fall below 10 percent. And the market has adopted even more complicated Z-bonds, such as the toggle Z.

Exotic CMO constructs can make it easier for the unwary to get into trouble. As with any interest-rate-sensitive financial instrument, if an investor does not properly hedge, changes in interest rates will imply big changes in asset value. Exotics only make these changes happen faster. Thus, when interest rates fall, interest received by superfloaters falls even more, and their value (and corresponding resale price) drops. In the past, some investors consciously took an exposed position, knowing the consequences if their interest-rate predictions proved wrong. Others did not realize how fast or how far CMO prices could change. Still others failed to account for the complicated effects of pre-payment risk. Of course, guessing wrong and not understanding your investment are two classic ways to lose money.

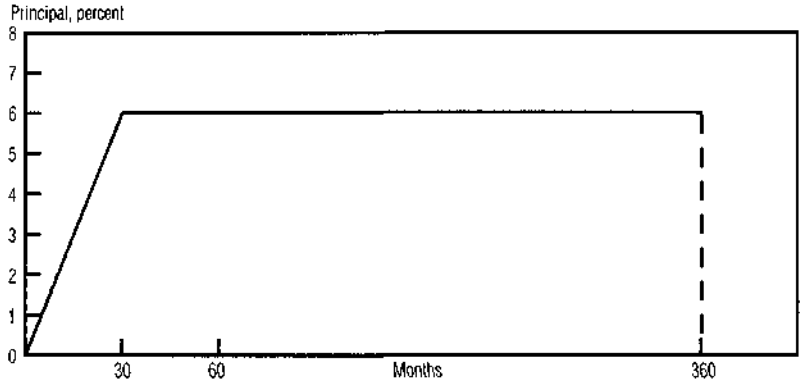
■ Conclusion

This brief overview perhaps paints the CMO market as one vast poker game, so it is particularly important to point out the social benefits of CMOs. Mortgage-backed securities, by bringing investors into the mortgage market, reduce housing costs for all mortgage holders. The major innovations in the market have allowed investors to reduce their risk, decreasing the chance of bankruptcy and further lowering costs to homeowners.

MEASURING PRE-PAYMENT SPEED

Market participants measure pre-payment speed as a percentage of PSA, the Public Securities Association pre-payment model. The model assumes that pre-payments start at zero at the beginning of the mortgage and rise linearly to 6 percent at 30 months (see figure 2), where they remain constant until the end, at 360 months. 150 percent PSA means that pre-payments rise to 9 percent at 30 months (150 percent of 6 percent = 9 percent), remaining constant thereafter, and 50 percent PSA means that pre-payments rise to 3 percent at 30 months, remaining constant thereafter. Some investors have developed their own, more complicated models.

FIGURE 2 PSA PRE-PAYMENT MODEL



SOURCE: Author's calculations.

Initially, investors who wished to buy mortgage-backed securities faced a variety of problems. A pure pass-through security had a longer maturity than many investors liked. All mortgage-backed securities entailed not only interest-rate risk and default risk, but pre-payment risk as well. A sequence of ingenious innovations helped investors both protect against and speculate in these risks.

Readers need not plan on adding sticky jump Zs to their portfolio, but looking under the hood of CMOs may help investors understand—and later avoid—financial crashes.

Footnotes

1. A provision of the Tax Reform Act of 1986 created REMICs. The provision changed the tax liability of particular types of CMOs issued by private firms, as opposed to those issued by public agencies such as the Government National Mortgage Association, or Ginnie Mae. For more details, see Robert Gerber, "Adjustable-Rate Mortgages: Products, Markets, and Valuation," in Frank J. Fabozzi, ed., *The Handbook of Mortgage-Backed Securities*, 3d ed., Chicago: Probus Publishing Co., 1992, pp. 155–96.

2. For interesting journalistic accounts of these episodes, along with some additional information on the mortgage-backed securities market, see Michael Carroll and Alyssa A. Lappen, "Mortgage-Backed Mayhem," *Institutional Investor*, vol. 28, no. 7 (July 1994), pp. 81–96. See also Lillian Chew, "Backing Down," *Risk*, vol. 8, no. 1 (January 1995), pp. 20–25.

3. This article makes no attempt to offer investment advice. For more details on the CMO market and bonds, consult Frank J. Fabozzi, ed., *The Handbook of Mortgage-Backed Securities*, 3d ed., Chicago: Probus Publishing Co., 1992.

4. For other months, the payments will differ. For high pre-payment rates, a lot of money will be available early on, then less in later months when most people have already paid off their mortgages. The reverse is true for low pre-payment rates.

5. LIBOR is the London Interbank Offered Rate, or the rate that large international banks charge each other for short-term loans. The 11th District Cost of Funds is an index produced by the 11th Federal Home Loan Bank District. Adjustable-rate mortgages are often tied to this index.

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