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COLLATERALIZED MORTGAGE OBLIGATIONS (CMOs)

MORTGAGE MONEY CHEAPER BY THE SLICE?*

by

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COLLATERALIZED MORTGAGE OBLIGATIONS (CMOs): MORTGAGE MONEY CHEAPER BY THE SLICE?

I. INTRODUCTION

The collateralized mortgage obligation (CMO), which made its debut in June 1983, has in the past three and one-half years become the hottest new mortgage security. As of November 1985, $30 billion of CMOs (i.e., total principal amounts) had been issued by FHLMC (Federal Home Loan Mortgage Corporation), investment bankers, savings and loans, mortgage bankers, home builders, and mortgage conduits; by the end of 1986 approximately $80 billion of CMO's had been issued.

A CMO essentially combines some of the positive features of a mortgage passthrough security and a corporate bond. A CMO is a debt instrument collateralized by mortgage passthrough loans or individual mortgage loans. The major difference between a CMO and a mortgage passthrough security concerns the mechanism by which interest and principal is paid to the security holder. The traditional passthrough security pays a pro-rata share of interest and principal each month to the holder of the passthrough security. This reflects the fact that a passthrough certificate merely is an ownership of a fractional interest in a pool of mortgages.

The CMO structure radically alters this pro-rata distribution mechanism and substitutes a sequential retirement of bonds. A typical CMO has four classes or "tranches." The first three classes receive interest payments, with principal payments going first to the fast-pay class of bonds. After the first
class of bonds is repaid, principal payments are used to sequentially retire the remaining classes of bonds. The fourth class of bonds included in many CMO issues is an "accrual" or "Z" bond. Usually, the accrual bond does not receive any interest or principal payments until all previous classes of bonds are retired.

The advantages of the CMO structure are clear. The CMO has turned a long term monthly payment instrument into a series of semi-annual payment bond-like securities with short, intermediate and long maturities and average lives. It is claimed that the multiple-maturity class instrument reduces the uncertainty of cash flows for any particular maturity class, may allow an issuer to take advantage of a positively sloping yield curve, and provides the longer maturity classes with limited call protection. In theory, these features could broaden the range of potential investors in mortgage securities.

This paper attempts to assess the benefits of the CMO structure to the mortgage market. It starts with a theoretical examination of the benefits of unbundling cash flows. It then examines the details of the actual structuring of CMOs. Finally, the paper tests empirically the factors that explain the lower weighted average mortgage rates created by CMOs.

II. THE THEORY OF CMOs: THE UNBUNDLING OF CASH FLOWS

This section will discuss the theory of collateralized mortgage obligations. It is adapted from the "commodity bundling" literature, which discusses how firms often sell their goods in individual units as well as packaged bundles: sporting
and cultural organization sell individual event tickets as well as season tickets, restaurants offer a la carte items and complete dinners, and so forth. In a similar fashion, long-term mortgages can be construed as "bundling" short-term cash flows with long-term cash flows.

As discussed earlier, CMOs typically utilize current or discounted mortgages as collateral for a bond. Mortgage cash flows are used to pay principal and interest on the bond. Pre-payments on the underlying mortgages are passed through to the bondholders in order of maturity, i.e., paying all bondholders of the earliest maturity before paying longer maturity bondholders. However, by serializing the bonds, the issuer may be able to take advantage of a positively sloped maturity-yield curve; and different bondholders can obtain various maturities of debt instruments with varying degrees of call protection. Consequently, CMO instruments are priced according to where each of the "tranches" falls on the maturity-yield curve.

Abstracting from many of the details of CMOs, and for analytic convenience, a long-term mortgage backed bond can be viewed conceptually as a CMO with two tranches, a long bond (l) and a short bond (s). We assume that the marginal cost of supplying each tranche separately is independent of the overall bond(s) form(s); in essence, there exist no economic reasons for providing one form or the other from a "technological" view.

Second, the reservation price paid by a bond investor for a "packaged" bond comprising of one unit of each tranche would be the same as adding up the reservation prices for the sum of the
separate tranches:  \( R_b = R_s + R_l \) where

- \( R_b \) is the reservation price for a long-term mortgage bond;
- \( R_s \) is the reservation price for the CMO short-term tranche; and
- \( R_l \) is the reservation price for the CMO long-term tranche.

Recall that the CMO short tranche and the CMO long tranche bonds are created from the original cash flow generated from the portfolio of underlying long-term mortgages.

Third, we assume, as appears to be the case, that investors have preferred maturity habitats\(^1\), and, therefore, are willing to pay different amounts for bonds of different expected durations, controlling for risk.

Fourth, while we assume that in the capital market many issuers-institutions could create CMOs, at any point in time excess profits can be engendered (at least temporarily) for bond innovators.\(^2\)

In our quasi-monopolistic world, if one knew the reservation price for each bond investor for each type of maturity, the profit maximizing strategy would be simply Poguvisan first-degree price discrimination with respect to each bond sold separately. If, on the other hand, the issuer of the bond knew only the distribution of reservation prices in the population, or if there were legal reasons for preventing pure price discrimination, then the ideal bond pricing strategy would be somewhat more difficult to establish. Three options would appear open to the quasi-monopolistic issuer of CMOs.

1. The issuer could single price each of the maturities in the form of a CMO where the price for the short-
term tranche would be $P_s$ and the long-term tranche would be $P_l$. This strategy, as we shall see, makes sense if there is an upward sloping maturity yield curve.

2. The issuer could offer the two tranches packaged into one long-term mortgage-backed bond, priced at $P_b$. This would represent the "normal" passthrough mortgage security-bond, and is a form of pure bundling of all maturity cashflows.

3. The issuer could have a combination of CMOs and the more usual long-term mortgage securities, with a series of set prices $P_s$, $P_l$, $P_b$. This would be a mixed bundling strategy. Since the value of the bundle to the investor is no greater than the value of its components, mixed bundling is a distinct strategy only if the package is sold at a discount relative to its components.

The reservation price of each investor for each tranche can be represented as a point in Figure 1. If the bond issuer set tranche prices as $P_s$ and $P_l$ (Figure 1), the population of investors in bonds could be sorted into four subgroups: investors with reservation prices at least equal to tranche prices for both the long and the short tranches (area A in Figure 1); investors with reservation prices less than the tranche prices for both maturities (area C); and individuals with reservation prices at least equal to the offered tranche prices for one but not both tranches (areas B and D). Those in area A purchase both types of bonds (tranches); those in areas B and D
FIGURE 1

UNBUNDLING --

BOND RESERVATION SPACE

$R_1$, $R_s$ denote long-term and short-term bond reservation prices, respectively.

$P_1$, $P_s$ denote long-term and short-term bond prices in the marketplace, respectively.
purchase the long tranche and the short tranche, respectively; and investors in area C purchase neither tranche of the CMO.

If the CMO issuer were to adopt a "pure bundling" strategy for bonds, the population of investors would be sorted into only two groups: those whose reservation price for the bundle \( R_b = R_l + R_s \) is at least equal to the bundle's offering price, and those for whom the opposite is true. In Figure 2, the bundled bond price appears in tranche-reservation price space as a straight line with both intercepts equal to the bundled price \( P_b \), and, hence, with a slope of -1. Those in area A buy the bundle; implicitly by buying the long-term bond investors buy both tranches. Those in area B do not buy the bundled bond, investing in neither tranche.

Finally, if the bond-issuer adopts a mixed bundling strategy, investors are again sorted into four groups (Figure 3). These appear in Figure 3. Individuals in areas \( O P_1 X Y P_s \) invest in none of the bonds available. They are characterized by

\[
R_s \leq P_s, \ R_l \leq P_l \quad \text{and} \quad R_b \leq P_b
\]

Individuals southeast of \( P_s Y Z \) invest only in the short tranche (s). They are characterized by

\[
R_s \geq P_s \quad \text{and} \quad R_l \leq P_b - P_s
\]

The reason is that \( P_b - P_s \) represents the implicit price of the long-term tranche to an investor already prepared to buy the
FIGURE 2
PURE-BUNDLING
BOND RESERVATION SPACE
MIXED BUNDLING --

BOND RESERVATION SPACE
short-term tranche. For similar reasons, those investor
northwest of $P_1XW$ invest only in the long-term tranche CMO bond. They are characterized by

$$R_1 \geq P_1 \text{ and } R_s \leq P_b - P_s$$

The last group comprises those northeast of WXYZ, who invest in the "bundled" bond with all maturities of cash flow. They are characterized by

$$R_s + R_1 \geq P_b, \ R_s \geq (P_b - P_1) \text{ and } R_1 \geq (P_b - P_s)$$

The bundled bond is invested by those who not only get sufficient yield from purchasing the full range of maturity, but also do not have a necessarily preferred habitat; and do not require limited call protection from expected and unexpected mortgage repayments. A profit-oriented bond issuer may choose among each of the three pricing strategies for bonds -- pure bundling, CMO tranches (unbundling of cash flows), and mixed bundling. Each of the strategies has advantages and disadvantages which relate to the term structure of yields in the marketplace as well as the extent of term-duration investor habitats. If the underlying mortgage instruments for bond issuance are taken as given, then, the nature of the cash flows available for issuing bonds are predetermined. The revenue maximizing institution-bond dealer would issue bonds which would generate the largest net proceeds. Abstracting from flotation and other costs, bundling (i.e., passthrough mortgage bonds)
versus unbundling (i.e., CMO bonds) will maximize proceeds depending upon the term structure of interest rates and the duration-habits of investors:

\[ P_b < P_1 + P_s \] if the term structure of yields is upward sloping, controlling for risks

\[ P_b = P_1 + P_s \] if the term structure of yields is flat, controlling for risks

\[ P_b > P_1 + P_s \] if the term structure of yields is downward sloping, controlling for risks

However, as we have seen above, mixed bundling can also be attractive depending upon the underlying distribution of reservation prices. If there exists investors who strictly purchase long, short, or "normal" mortgage-backed bond portfolios, then, depending exactly on the distribution of each of the types of investors, a mixed bundling strategy may produce the largest revenue.\(^3\)

In the longer run, if bond issuance is competitive, as one would expect, then the underlying cash flows (i.e., the mortgage interest rates) cannot be taken as given. In particular, if quasi-rents are earned by CMO issuers, one should expect a downward pressure on mortgage interest rates to restore competitive margins.

In sum, each of the three pricing strategies for bonds has potential revenue advantages over each of the other two. If individuals have preferred habitats in terms of duration-maturity and the term structure for market yields is upward sloping, CMO
type instruments will produce the highest revenue generation and the lowest overall interest cost. This, of course, requires both the term structure to be upward sloping and the existence of a pool of individual investors that have relatively inelastic demand for each of the tranche-maturity habitats. Finally, in the longer run, the quasi-rents earned by CMO issuers are likely to vanish through the forces of market competition. At the margin, one would expect CMOs to drive down mortgage interest rates vis-a-vis other market interest rates.

III. STRUCTURING OF CMOs

A. Tranche Payment Mechanics, Prepayments and CMO Risk

The concept behind the CMO structure is suprisingly simple. The collateral backing CMO multiple class bonds has been primarily single-family GNMA, FHLMC, and FNMA PCs. A few issuers have exclusively used single-family conventional loans, multi-family loans, or commercial mortgages as collateral. The major drawback of traditional mortgage passthrough securities has been the unpredictable cash flows associated with prepayments of the underlying mortgages.

Under the usual CMO structure this uncertainty is substantially changed by the creation of a sequential payment multi-class set of securities. In the classic four tranche CMO, as mentioned earlier, interest is paid on the first three classes of bonds, with no interest paid on the accrual or Z class of bonds. Any cash flow in excess of that required to pay interest to the first three classes of bonds is used to retire outstanding bond principal in a strict order of priority, with the shortest
stated existing tranche receiving all available principal payments until it is fully redeemed. Then the next shortest tranche is redeemed until it is fully paid off, and so forth. Since the underlying collateral generates a monthly cash flow and the CMO bondholders are paid semi-annually, reinvestment income is also used to sequentially retire the bonds.

The accrual or Z class of the CMO is a deferred interest obligation which is a zero coupon bond until the early bonds classes are retired. After that time the accrual bond receives payments representing interest and principal on the original principal balance plus the compounded accrued interest.

Prepayment assumptions are critical in pricing the CMO, and evaluating the risks associated with each tranche. In July 1985, a new prepayment benchmark, the PSA (Public Securities Association) Standard Prepayment Model, was adopted by the CMO market, replacing the somewhat archaic FHA experience model. The PSA prepayment rate curve (100% PSA) starts at .2% per month, per year in the first month outstanding and increases .2% per month, per year, for the first 30 months, and then remains at a constant 6% per year for the life of the mortgage. The PSA curve looks similar to the FHA curve for the first 30 months, with the exception that it avoids the year end jumps that characterize FHA experience. After the 30th month, PSA more closely approximates the markets pricing of seasoned mortgages.

Because principal payments are allocated in strict accordance with the stated maturity, it is often alleged that the shorter tranches of the classic CMO engender limited call protection against early prepayments for the longer tranches.
Finally, CMOs continue to evolve to meet new market niches. For example, guaranteed minimum repayment schedules on FHLMC CMOs have further reduced payment uncertainty. "Guaranteed" minimum reinvestment rates and distribution of excess cash flow also have enhanced the value of certain CMO issues.

B. CMOs Issuers

In terms of issuers, in the first year of activity, FHLMC issued over 25% of CMO volume. Since then, however, a wide variety of new issuing entities have come to market. For example, up until recently CMOs have been particularly attractive to financing subsidiaries of homebuilders as they allow the use of the installment sale method for tax purposes. Thus the homebuilder can book a gain on the sale of the home for accounting purposes, but pays taxes as the mortgage loan is repaid. The new tax reform act of 1986 closed this tax deferral avenue.

Thrift institutions and commercial bankers at first were generally not issuers of CMOs because of regulatory and rating problems, which over the last two years or so have been resolved. The new tax law, with the introduction of REMICs (Real Estate Mortgage Investment Conduits), has both simplified and enhanced the attractiveness of issuing CMOs by financial institutions. Also, S&P originally refused to rate CMOs issued by either FDIC-insured or FSLIC-insured institutions because of the uncertainty surrounding the regulators' handling of the mortgage collateral backing a CMO in the event a thrift or bank was placed in receivership. Since a CMO is usually issued by a single purpose
finance subsidiary incorporated solely for the purpose of issuing these securities it would normally be considered bankruptcy-proof. The rating service wanted to make sure the interests of CMO bond holders were preserved regardless of what happened to the federally insured institution issuing the mortgage-backed debt or CMO. Thrifts insured by the Federal Savings and Loan Insurance Corporation became eligible for S&P rating more than a two and one-half ago when FSLIC offered assurances that a properly established CMO subsidiary would not be "collapsed" in the event of receivership. The recent large CMO issues by several thrifts indicate that this market is likely to expand substantially as long as economic advantages remain.5

IV. AN EMPIRICAL TEST OF ECONOMIC ADVANTAGES OF CMOS

The ultimate success of the CMO instrument depends on its ability to provide an attractive yield to investors and cost minimization to issuers. Our previous discussion has indicated that the CMO in a theoretical and empirical framework appears to add value to the traditional pass-through security. In this section we attempt to document and explain the extent to which CMOs have reduced the weighted average cost of mortgage credit. The first CMO issue by FHLMC in mid-1983 was an enormous success in terms of lowering mortgage interest rates. The three tranche issue had spreads of 40, 54, and 85 basis points, respectively, over treasuries with similar coupons and average lives. The weighted average yield was 85 basis points lower than the comparably priced FHLMC PC. While the first issue showed a large apparent economic benefit, it was probable that the initial
large arbitrage gain might erode over time.

The CMO instrument has been developed in the context of the larger mortgage security markets. The CMO is, therefore, a by-product of competitive market forces where economic entities constantly seek profitability niches. Of course, in the longer run, competitors will replicate successful instruments and "bid-away" any arbitrage profits. In this sense, one can look at the CMO market as following a diffusion process. The relative profitability depends upon how long the originators of CMOs can keep this market niche, which depends upon market size, costs of flotation, market acceptability, and the innovation or education-learning curve of the market.

In order to test the economic gain of CMOs a simple empirical model was constructed.

A. **Dependent Variable**

The basic dependent variable is the yield spread between a GNMA passthrough security and a comparable coupon CMO. This variable measures the efficiency or changes in market efficiency as explained by changes in yield differentials. Figures 4 and 5 plot the yields and yield spreads for the two CMOs we will analyze: the Salomon CMO and the Norwest CMO. These data show generally over time an increasing spread, which implies an increasing value of the CMOs vis-a-vis the comparable GNMA instruments.

B. **Independent Variables**

As independent variables, we attempted to capture the two variables that make the CMO valuable relative to the GNMA
passthrough. The two major advantages of the CMO securities relative to passthrough securities are the ability to take advantage of a positively-sloping yield curve, and the ability to protect against prepayment risk. We use the spread between the 30 year Treasury bond rate and three month Treasury bill rate as a measure of the steepness of the yield curve (STPNESS). We use the one month lagged actual prepayment rates as a proxy for expected prepayment risk (PREPAY(-1)).

Two additional variables are used to attempt to capture specific supply and demand factors. The first, the ratio of CMOs to GNMA new issuances is meant to capture any relative supply-demand shifts in the two markets. The second is a dummy for the EPIC issues in the late summer and early fall of 1985.

C. Empirical Results

This relatively simple model is tested using OLS (Ordinary Least Squares) regression for 1983 - 1985 monthly time series data for the two major CMO issues plotted earlier. The results, equations (1) and (2), strongly support the hypothesis that the fundamental characteristics of CMOs account for a substantial portion of their relative value. As the regressions below show, a steeper yield curve and a greater prepayment rate$^8$ enhance the value of the CMO security relative to the comparable GNMA passthrough. Each 100 basis points in the steepness of the yield curve provides a 14 basis point reduction in the CMO weighted yield relative to the yield on GNMA$s$. Similarly, an increase in the prepayment rate leads to a statistically significant increase in the relative yield spread.
(1) Yield GNMA - Yield Salomon CMO =

\[-.238 + .143 \text{ STPNESS} + .125 \text{ PREPAY} (-1) - .173 \text{ EPIC} \]

\[
(1.07) \quad (1.83) \quad (3.18) \quad (1.01)
\]

\[
R^2 = .442 \quad F = 7.07 \quad n = 24 \quad 1983:12-1985:11
\]

(2) Yield GNMA - Yield Norwest CMO =

\[
.948 + .149 \text{ STPNESS} + .155 \text{ PREPAY} (-1) - .183 \text{ EPIC} \]

\[
(3.94) \quad (1.81) \quad (2.72) \quad (1.02)
\]

\[
R^2 = .394 \quad F = 5.34 \quad n = 21 \quad 1984:3-1985:11
\]

The relative volume variable is statistically insignificant and has been deleted; the EPIC dummy variable\(^9\) exerts a negative though statistically insignificant impact on the relative value of the CMO.

D. A Caveat on Empirical Results

While these empirical results may appear strong, an empirical problem may arise because the implied diffusion process may take some time to reach its asymptotic equilibrium limit. If one uses contemporaneous data from an existing stochastic diffusion process, before it has reached its final structural position, that is, while the data are incomplete, the empirical analysis may be flawed; and this leads to a range of estimation problems related to truncated samples.

It could be argued that the CMO diffusion process is still occurring, so that our data set is truncated, therefore, not normally distributed. As a result, multivariate statistical methods, such as OLS estimations, could be biased.
V. CONCLUSION

This paper has shown that CMOs, in a theoretical context, have a substantial value to the mortgage markets. While our empirical work is preliminary it appears to confirm our theoretical discussion. More work on this most recent financial innovation is clearly warranted.
FOOTNOTES

1. It is claimed that the CMO has been very successful in attracting "non-traditional" investors to the mortgage market by offering a broader maturity range of investments with less repayment uncertainty and/or enhanced call protection. For example, insurance companies purchase heavily in the 4-6 year weighted life tranches (presumably to match against GIC money). Pension funds have been heavy purchasers of all CMO classes, but have been especially active in the long end of the market. It seems that CMOs have been accepted by "non-traditional" investors. See Jehle (1985) and Roll (1986).

2. These will not be long-term profits; more likely, these profits to issuers will be associated with ephemeral CMO market niches, which will fade in future offerings as the remainder of the market "catches on." Therefore, in the longer run, one would expect that the issuer of CMOs (to the extent there are no new innovations) will earn normal profits instead of quasi-monopolistic profits.

3. In the longer run, if bond issuance is competitive, as one would expect, the underlying cash flows (i.e., the interest rates at which mortgages are issued) cannot be taken as given. In particular, if quasi-rents are earned by CMO issuers, one should expect a downward pressure on mortgage interest rates to restore competitive margins.
4. Virtually all CMOs have little risk of default, either because the underlying mortgage collateral is guaranteed or insured by private mortgage insurers or by quasi-government agencies, such as GNMA, or because there is sufficient excess mortgage collateral. Most CMOs have no protection, however, against prepayments of the underlying mortgages; in large part, these are passed directly through to the CMO bonds.

5. Technically, the reinvestment rates are not always guaranteed; but are assumed to be so low in order to meet S&P Rating Standards and/or the excess collateral is relatively large to insure excess cash flows that are included in the bond holder yield computation.


7. For the Salomon CMO, the underlying mortgages securities are GNMA 11.5% and, hence, are used to generate the Salomon CMO dependent variable spreads. For the Norwest CMO, the GNMA 12.0% corresponds to the underlying mortgage securities, and is used to create the Norwest CMO dependent variable spread.

8. We use the actual prepayment rate on GNMA mortgages, lagged one month, as the measure of "expected" prepayment because it is the most recent addition to the prepayment "information set" available to market participants. We tried alternative forecast specifications of prepayment without improving the explanatory power of the model.
9. EPIC dummy variable is defined to be unity if the month date is August 1985; zero otherwise. Several alternative specifications were chosen for the EPIC dummy variable without improving the model's explanatory power.
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