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By Joseph G. Haubrich and Deborah Lucas

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"Toxic waste" refers to the riskiest derivative structures arising from collateralized mortgage obligations (CMOs). We use simulations to predict how this risk would manifest itself in various interest rate environments. We also look for evidence on the total dollar value of these securities, who holds them, and how much they hold. Very limited public information is available, but commercial banks are required to report on their holdings, and we investigate the extent to which the risk is concentrated in that sector.

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POLICY DISCUSSION PAPERS

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Introduction

Home mortgages may seem a rather pedestrian investment, but the mortgage financing industry has reached a level of maturity and development worthy of the most sophisticated financial engineer. Individual mortgages are bundled together and used as the collateral behind collateralized mortgage obligations (CMOs). CMOs are divided into tranches of various types, with names such as PACs, TACs, IOs, and sticky jump Zs. This proliferation segments the interest rate and pre-payment risk into different classes of instruments, creating a class of fairly safe assets with wide appeal. This of course also creates a class of risky assets, known collectively as toxic waste.[1]

To what extent is this toxic waste a problem? Held as a hedge, or by well-capitalized investors who understand the risk, it is not a concern. Held by unsophisticated investors who do not understand their exposure, or by institutions arbitraging regulatory requirements, it may be a problem.

Unfortunately, the extent of the possible problem has received little attention, either in the academic literature or the popular press.[2] Information on the total amount of risky CMO constructs is difficult to come by, and public information about the concentration and eventual disposition of those assets is almost non-existent. In this paper we take a first look at this aspect of the market, endeavoring to ascertain which portfolios hold risky CMO debt and the extent to which it poses a problem for investors and regulators.

In the next section we develop a simple pricing model that illustrates how the value of CMO constructs can change dramatically with interest rates. Then we examine the available data on the size and distribution of risky CMOs. Finally, we take a closer look at CMO holdings at commercial banks, a sector for which there is more detailed information and potentially greater regulatory concern.

The Risk in CMOs

Before attempting to track the ownership of risky CMO tranches, we present some examples illustrating the potential risks. Default risk generally is minimal, since most issuers either provide a guarantee of over-collateralize the CMO. The interest rate risk, on the other hand, can be enormous, particularly as there can be very complicated prepayment effects.

We construct a Monte Carlo model of stochastic interest rates and mortgage cash flows, and use it to illustrate the risk in the value of several common types of mortgage derivatives—Zs, IOs and POs. We consider the risks in a variety of interest rate environments, including one of rapidly rising interest rates. To preview the main results, we find that under conditions of typical interest rate volatility, the value of these derivatives is highly volatile. For instance, there is a significant probability that losses on toxic waste holdings will exceed the associated bank capital requirements, even with a 100 percent

1. See Haubrich (1995) for a basic introduction to CMO derivatives and Midanek (1995) for a history of the market. A detailed, but still high-level description of mortgage derivatives can be found in Oldfield (2000).

2. While there is also concern about the risk of Fannie Mae and Freddie Mac, and their holdings of toxic waste are an aspect of their risk, our focus is on the pass-through risk to other institutions.

risk weight. We also find that the effect of an unanticipated and unusually rapid increase in mortgage rates would be to increase the value of some types of derivatives (IOs), and decrease the value of others (Zs and POs).

Some Illustrations

In the model, stochastic interest rates induce stochastic prepayment rates, and hence variability in the timing, amount and present value of cash flows. More precisely, mortgage interest rates are assumed to follow a discretized Cox, Ingersoll and Ross (1985) process, with monthly shocks to annual rates described by:

$$(1)\quad r(t) = r(t-1) + s(r(t-1) - r^*) + (r(t-1))^{0.5}\sigma\varepsilon(t).$$

In equation (1), $r(t)$ is the mortgage rate at month t, r^* is the mean-reverting level of rates, s is the speed of mean reversion, σ is a volatility parameter, and $\varepsilon(t)$ is a standard normal shock. We impose an upper bound on interest rates of 30 percent to reduce the influence of outliers. The model is roughly calibrated to reflect recent market conditions. In the base case simulations, $s = 0.025/12$, $\sigma = 0.0378$, and $r^* = 0.07$. The assumed volatility is consistent with monthly mortgage rate volatility from January 1990 to July 2004.[3] The speed of mean reversion is from Tuckman (1995). The assumed long-run rate is lower than the average mortgage rate since 1990 of 7.7 percent, implicitly putting more weight on more recent conditions.

The prepayment rate[4] (PSA) varies inversely with the distance between current mortgage rates as given by equation (1) and the weighted average coupon (WAC) of the underlying mortgage pool. Consistent with mortgages issued in 2003, WAC = .05 in the base case, and $r(0) = 0.045$. The relation between prepayment rates and interest rates is nonlinear, and based on a linear interpolation of recent estimates from investment banks, reported in table 1.[5] In this simple model, prepayments along each path use this rule, invariant to the pattern of past prepayments.

The cash flows for a given derivative security over its life are determined according to the rules for that security and the cash flows the underlying 30-year fixed-rate mortgage pool. In the case of Zs, no cash is received until all other classes of security holders are repaid in full. Deferred coupons are invested at the current monthly rate implied by the model, and paid out in full at the time of the first principal repayment to the Z class. Z's are assumed to comprise 10 percent of principal. IOs receive all coupon payments as

TABLE 1 PSA RATE SCHEDULE AS A FUNCTION OF INTEREST RATE CHANGES

Coupon	Issue year	Avg. –300*	Avg. –200	Avg. –100	Avg. –50	Avg. base	Avg. +50	Avg. +100	Avg. +200	Avg. +300
5	2003	1470	1400	667	262	170	150	131	111	102

*Avg – 300 indicates a drop in interest rates 300 basis points below the WAC on the mortgage pool.

3. This is derived from a monthly volatility of 1 percent, adjusted for the square root of the interest rate in the Cox, Ingersoll, and Ross (1985) formulation: $\sigma = (0.01/0.07)^{0.5}$.

4. Prepayment rates are expressed as percentages of the Public Securities Association standard conditional prepayment rate, or PSA. The conditional prepayment rate (CPR) is the annualized fraction of outstanding mortgages in a pool that get prepaid in a given month. The PSA schedule assumes the CPR increases from 0 in month 0 to 6 percent in month 30 (an increase of 0.2 percent per month), and is constant thereafter. For example, a PSA of 150 means that after month 30 the CPR is (6%)(1.5) = 9%.

5. BondMarkets.com monthly projection survey of PSA rates (August 16, 2004), for 5 percent, 30-year conventional mortgage issued in 2003. Participating dealers include: BS CITI CSFB DB GC GS LB. At 100 percent PSA, we assume 0.5 percent of outstanding mortgages are prepaid each month.

they arrive, and POs receive all principal payments. Cash flows are discounted at the realized mortgage rates along each Monte Carlo path.[6]

A histogram of the distribution of the present value of a Z residual, based on 2000 Monte Carlo runs and normalized by the average present value, is given in figure 1. The mean value is normalized to 1, and the coefficient of variation is 25 percent. However, the asymmetric distribution of the risk reduces the informativeness of variance-based measures of spread. In fact, if Zs are priced at their expected value, most of the time the investment will generate a sizable profit (the mode in figure 1 is well above the mean). The long lower tail, however, indicates that there is a risk of significant losses.

Figure 2 shows the distribution of present values for an IO, and figure 3 shows the distribution of the corresponding PO, again based on 2000 Monte Carlo runs, with all outcomes normalized by the average present value. The means of both normalized distri-

6. Discounting along the paths generated by equation (1) implicitly equates risk-neutral and actual probabilities, imparting some bias to the estimates.

FIGURE 1 Z VALUES

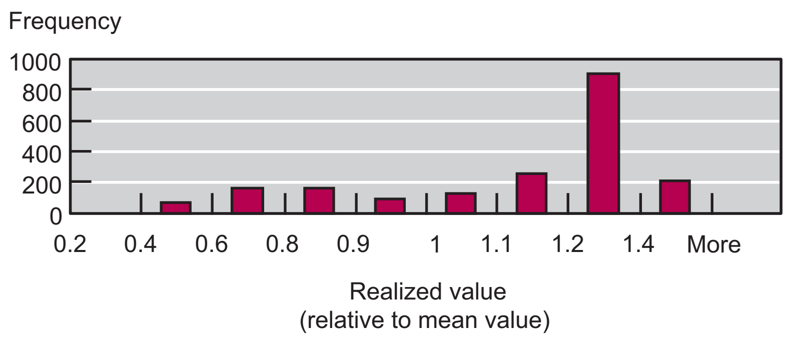


FIGURE 2 IO VALUES

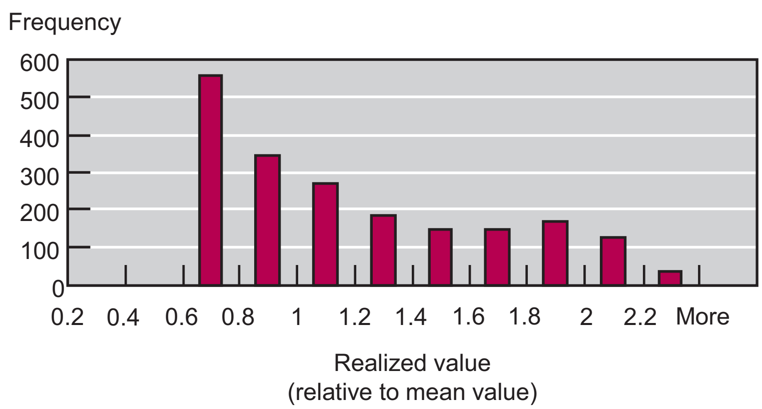
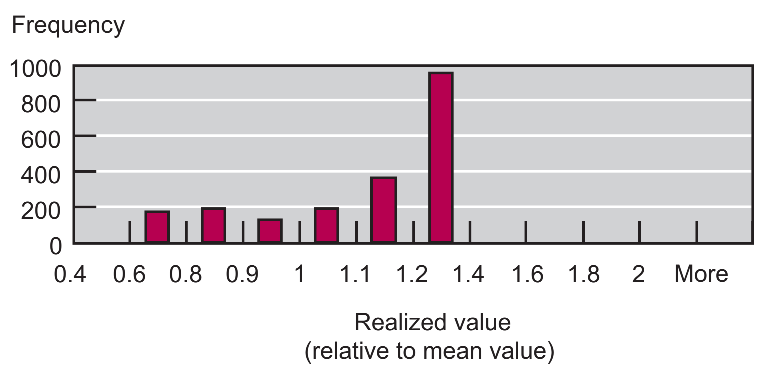


FIGURE 3 PO VALUES



butions equal 1; the coefficient of variation for the IO is 47.7 percent and 21 percent for the IO and PO, respectively. The very high risk of the IO is due to the disappearance of cash flows in the event of prepayments (whereas for the PO prepayment only affects the timing of the cash flows). Unlike Zs and POs, however, IOs have positive skewness

Losses and Bank Capital Requirements

As discussed below in the section on CMO holdings at commercial banks (Bank Risk), the rules governing the capital held against these securities by commercial banks are complicated. It is reasonable to assume that for many banks, particularly the smaller ones, toxic waste will be assigned a risk weight of 1, with a corresponding 8 percent capital requirement.

Under the base case assumptions, the Monte Carlo results suggest that an 8 percent capital requirement for these securities is often inadequate. For the Zs, losses exceed required capital 27.3 percent of the time; for the IOs, losses exceed capital a striking 54.8 percent of the time; and for POs losses exceed capital 24.9 percent of the time.

Larger banks may hold capital based on the more complicated rules for measuring market risk, although they may also follow the 8 percent rule if the securities are not held in a trading account. The market risk rule is based on value at risk (VaR) for a 10-day period and a 99 percent confidence level. Assessing the VaR for these securities is tricky. If historical price data were available (which it is not), it could be used to create a probability distribution of conditional price changes. The model used in the Monte Carlo experiments provides the conditional distribution of future interest rate and cash flow paths from a given starting point. How should this be used this to represent the distribution of changes in expectation over 10 days about the entire future path of cash flows and their present value?

The approach taken here is to compare the average present value of cash flows at the initial interest rate with the average present value for an adverse change in interest rates at the 99 percent level over 10 days. The 99 percent confidence interval for interest rates in the model, centered on the initial value of 0.045, is (0.0356, 0.0544). An adverse change for the IOs implies that rates fall to 0.0356, while for POs and Zs it implies that rates rise to 0.0544. For IOs, the VaR is 17.7 percent of the original price, for POs it is 8.8 percent of the original price, and for Zs it is 6.5 percent of the original price. Multiplying each by the factor of 3.5 implies a capital requirement far in excess of the 8 percent required for smaller institutions. To the extent that bank portfolios contain securities whose risk fully or partially offsets (for example, an IO plus a PO has risk identical to a whole mortgage), evaluating capital adequacy one security at a time overstates the risk.

Rapidly Rising Rates

Given the low interest rate environment of recent years and the expectation that rates could rise sharply, it is interesting to ask what would happen to the value of toxic waste if those expectations were realized or exceeded. As a test of this, we assume that the path of interest rates over 14 months follows the pattern of rates from October of 1993 to December of 1994. At that time, interest rates rose abruptly after a long period of gradual decline, climbing a total of 2.37 percent. The episode revealed the vulnerability of several major institutions to large and unhedged derivative positions, including Orange County and Proctor and Gamble. By way of comparison, home mortgage rates only rose 0.30 percent during the fed funds increases of 2004-2006.

To reproduce the 1994 experience, we assume those historical rate changes for the first 14 months of the simulations, with stochastic rates and their corresponding prepayment rates simulated in the Monte Carlo thereafter. We assume that security prices start at the average value predicted by the base case model, and that rates initially are at 4.5 percent. We then calculate the percentage change in the value of each security at the end of 14 months, assuming payments received along the way are reinvested and rolled over at current rates. For Zs, the average present value falls to 91.3 percent of the base case starting value. The average present value of POs falls to 94.7 percent of the base case starting value. IOs, on the other hand, significantly increase in value, to 179.5 percent of the base case. While these price changes are unlikely to threaten the viability of well-capitalized banks, they could have a significant adverse affect on poorly capitalized institutions with concentrated positions in these securities.

It is possible that the market is already pricing a more rapid increase in interest rates into mortgage derivatives than in the base case model. If so, the above calculations exaggerate the gains or losses likely to be realized. An alternative that takes this into account is to assume a more rapid rate of mean reversion to the long-run 7 percent rate than in the base case. To implement this, we recalculate the distribution of present values under the assumption that s, the mean reversion parameter, increases by a factor of 10 (going from 0.025 to 0.25 on an annual basis). This implies that rates on average are expected to rise by about 1 percent in the first two years the mortgages are outstanding, roughly consistent with implied forward rates. All other parameters are as before. Figures 4 to 6 illustrate the effect of faster mean reversion in rates on the distribution of present values. For the Zs, the average present value falls to 97.5 percent of the original base case. The value is depressed due to slower repayments as rates rise, and payments discounted at a higher average rate. For the IOs, value increases to 116 percent of the original base case. The dominant effect causing IO value to rise is that slower prepayments result in more coupon payments being received. For the POs, value decreases on average to 96.6 percent of the base case, as principal is returned more slowly and discounted at higher average rates.

Using this alternate base case, the losses to Zs and POs that would result from an interest rate experience like that in 1994 are considerable smaller—with values at the end of 14 months equal to about 99 percent of the modified base case values for both Zs and POs.

Market Data

The mortgage market in the United States is large: As of the third quarter of 2005, the value of mortgage debt outstanding was $11.50 trillion, of which $8.82 trillion was residential mortgages (one to four family residences). This compares with federal debt in private hands of $3.86 trillion and total assets of domestically chartered commercial banks of $7.73 trillion for the same time period. (*Federal Reserve Bulletin*, tables 1.54, 1.41 and 1.26.)

FIGURE 4 Z VALUES, ACCELERATED MEAN REVERSION

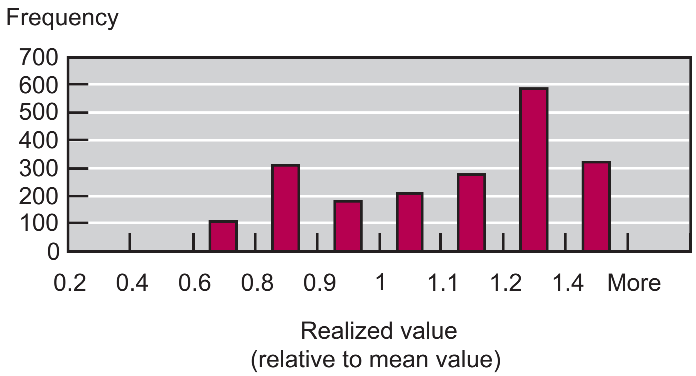


FIGURE 5 IO VALUES, ACCELERATE MEAN REVERSION

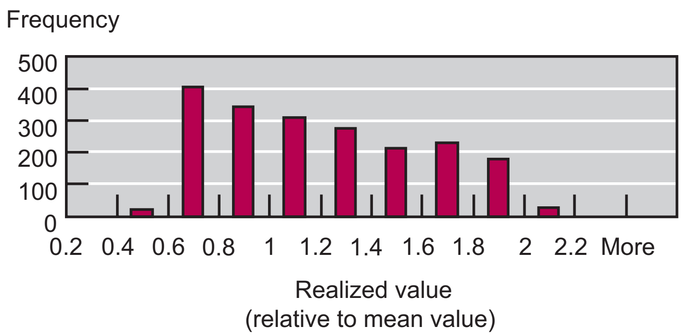
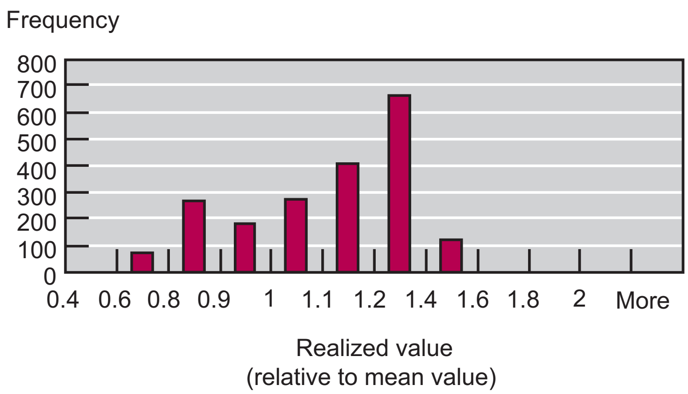


FIGURE 6 PO VALUES, ACCELERATED MEAN REVERSION



Much of the mortgage debt is securitized: $4.69 trillion of the total mortgage debt, and $4.22 trillion of the residential mortgages, most of it securitized by the major government sponsored enterprises: Ginne Mae did $474 billion, Freddie Mac did $1,148 billion, and Fannie Mae did $1,787 billion, leaving $842 billion to the private mortgage conduits. Not all of these are CMOs/REMICs (Real Estate Mortgage Investment Conduits). The *Mortgage Market Statistical Annual* (2004) reports that as of the fourth quarter of 2003, agency-backed CMO/REMICs were at $955 billion. Interestingly, they report total mortgage securities at $4,207 billion, while the *Federal Reserve Bulletin* reports 2003 pool and trusts as $4,692 billion).

How Much Toxic Waste?

Of the CMO/REMICs out there, how much is extremely risky and should count as toxic waste? This is a difficult question to answer. The mortgage debt outstanding number is a stock measure, and as such it combines securities issued in many different years. Furthermore, a major characteristic of CMOs is that tranches may be of short or variable duration. To our knowledge, there is no accurate aggregate estimate of the number or value of outstanding tranches. There is somewhat more information on the flow variable, CMO issuance.

One source for this is Bloomberg, with the ICMO function. The "Deal Structure" part of this splits the CMO tranches issued in a particular month into eight classes: PAC (Planned Amortization Class), AD (Accretion Directed), Z (accrual), FLT (Floater), INV (inverse floater), IO/PO (Interest Only/Principal Only), SUB (Subordinate), and Other (all others, but mostly standard sequential pay classes). What exactly counts as toxic waste is a matter of judgment, but a reasonable definition would be Z+INV+IO/PO+SUB and this is the definition we use here. Accretion-directed bonds, PACs, and to a lesser extent, floaters, are designed to be safe, and most of the other, as generic sequential pay bonds, will also be relatively safe (see Amerman, 1996, for a discussion). The Federal Reserve's *Trading and Capital-Markets Activities Manual* (section 4110.1, p. 12) states that "prepayment risk is concentrated within a few volatile classes, most notably residuals, inverse floaters, IOs and POs, Z bonds, and long-term support bonds." As an example, in April 2000, Bloomberg lists 46 CMO issuances that total $16.6 billion, with toxic waste of $3.0 billion, most of it ($2.4 billion) as IOs and POs.

Figures 7 and 8 plot the time series flow of total toxic waste value and toxic waste value as a fraction of total value from Bloomberg. One possible concern about our measure is that it on occasion exceeds 50 percent. Can there be that many highly risky CMO constructs? As it turns out, for the three months where the fraction exceeds one-third, in two of them (May 1995 and October 1999) the high number results from components about which we have the most confidence that they are risky: Zs and Subs. Usually, these are much lower; the median of their sum is only 4 percent. In the other (July 1996) the cause was a high level of IO/POs, which also are generally regarded as high risk.

Another source on the extent of toxic waste arises from regulatory concern about the risk in bank portfolios. In 1992, the Federal Reserve Board issued a *Supervisory Policy Statement on Securities Activities* that defined the "high-risk mortgage securities" deemed unsuitable investments for banks. This became known as the FFIEC test, and CMO bonds that passed (deemed not high risk) became known as FFIEC-qualified. Those deemed high risk had to be carried in the institution's trading account or as assets held for sale. In practice, a mortgage-derivative product that met any of the following three criteria was deemed high risk:

- **Average Life Test**: expected weighted average life greater than 10.0 years
- **Average Life Sensitivity Test**: expected weighted average life extends by more 4.0 years if the yield curve shifts up 300 basis points or shortens by more the 6.0 years if the yield curve shifts down 300 basis points (both shifts sustained and parallel).
- **Price Sensitivity Test**: the estimated change in the price of the security exceeds 17 percent with a shift in the yield curve of 300 basis points.

FIGURE 7 | IO VALUES, ACCELERATE MEAN REVERSION

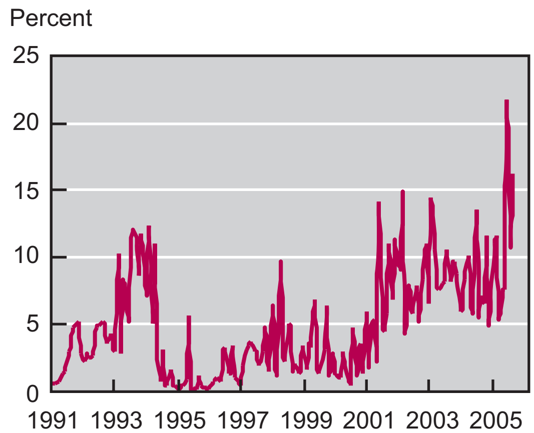
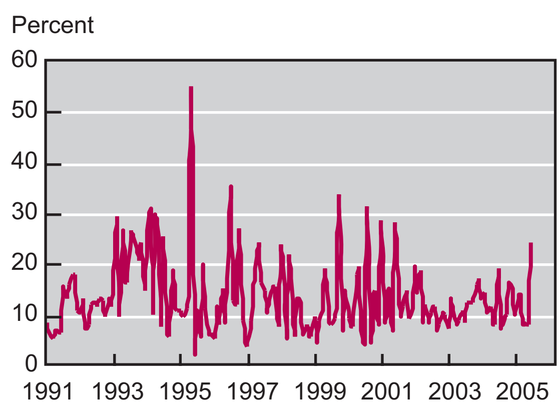


FIGURE 8 | PO VALUES, ACCELERATED MEAN REVERSION



This regulation also led to a revision of the FFIEC *Call Reports*, having banks report the amount of high risk mortgage securities they held. In April 1998, the constraints were rescinded, and shortly thereafter banks stopped reporting.

Bloomberg reports some aggregate FFIEC test results for CMOs in the "Bloomberg universe."[7] For May 16, 2000, this had a value of $2,728.2 billion, of which $884.4 was a solid pass and $1,110.2 was a solid fail. For May 3, 2004, out of a total market value of the Bloomberg universe of $3,753 billion, $1,301 billion were solid pass and $1,053 billion, or 28 percent, were solid fail. Should a fail count as toxic waste? In some sense it is an objective criterion, in that regulators deemed these securities high risk for banks.

Who Holds CMOs and Their Constructs?

Who holds the risky CMO constructs—the exotic tranches, the toxic waste? That question is not so easy to answer. Anecdotally, much goes to private partnerships and hedge funds, entities with little regulation a few reporting requirements (Passmore, et al., 2002). A preliminary step is to establish which investors hold CMOs in their portfolios, though the distribution of risky CMO constructs may differ. Furthermore, concentration matters: a sector's aggregate holdings may be low, but that does not preclude an unhealthy concentration in a few firms. Table 2 lists the mortgage-related security holdings by investor type for year-end 2003 reported in the *Mortgage Market Statistical Annual* (MMSA).

Notice from table 2 that the three largest holders of CMOs appear to be commercial banks, life insurance companies, and foreign investors (with Fannie Mae, and presumably Freddie Mac, although they are not listed by MMSA, in close fourth place). Details on holdings of foreigners is exceedingly difficult to come by, and we will have little more to say about them. According to recent press reports, however, foreign holdings of mortgage-

7. Some measure of the coverage of the Bloomberg universe can be gained by noting that excluding re-REMICs, Bloomberg lists $836.8 billion in CMOs as of June 30, 2000. Compare this with the $690 billion for mid-year 2000 from the *Mortgage Market Statistical Annual* so Bloomberg appears to cover much of the market.

TABLE 2 CMO HOLDINGS, (BILLIONS OF DOLLARS, BY INVESTOR TYPE, YEAR-END 2003)

Investor type	CMOs	Percent of assets
FDIC commercial banks	263.1	3.46
S&Ls	45.5	3.09
Federal credit unions	12.9	2.11
FHL banks	40.0	4.86
Pension funds[1]	42.5	0.65
Life insurance companies	155.0	4.11
Fannie Mae & Freddie Mac	N.A.	N.A.
Foreign investors[2]	182.0	N.A.
MBS dealer inventory	18.0	N.A.
(Sub)total	709.8	

1. year-end 2004 estimate.
2. No longer reported; 2001 estimate.
Source: *Mortgage Market Statistical Annual*, 2004; and FNMA 10-k, 2004.

backed securities have been growing rapidly. A small amount of information exists about life insurance companies, but little of that is centralized. The best data exist for commercial banks, though even there the breakdown of portfolios is sketchy.

Life Insurers

Although as table 2 shows, life insurers are major investors in CMOs, detailed portfolio data are difficult to come by, particularly because insurers are regulated at the state level. One rating agency, at least, occasionally reports more detailed information. Weiss Ratings reported on what they termed the "riskiest types of CMOs…multiclass, nondefined, mortgage and asset-backed securities," putting these holdings among the nation's life and health insurers at $105 billion at the end of 1998 and $123 billion at the end of 1999. Anecdotal evidence suggests that at least some life insurers overinvest in risky CMO constructs. The most prominent example is the failure of Coastal States Life Insurance, which was seized by the Georgia Department of Insurance in January 1993. Coastal States had invested heavily in mortgage-backed securities, and its portfolio of CMOs had a book value nearly $9 million less than what the company reported (Knowles, 1993).

Banks

Banks hold many CMOs, and this raises two concerns. First, under current capital requirements, it may be advantageous to hold the riskier forms of any given asset class to increase return on equity. Secondly, the expense of bank failures may be borne by the public because of the safety net.

How much toxic waste do banks hold? At the end of December 1998, banks held a total of $7.50 billion of FFIEC-risky mortgage securities. This excludes what they held in their trading accounts (as it includes only RCON 8781 in the call report data). Even adding all the CMOs in the trading accounts (RCON 3535 and 3536) only brings the number up to $14.2 billion. While banks hold some risky CMO residuals, in general, they account for a modest portion of the total. But do some individual banks hold too much?

Bank Risk

Bank capital requirements are designed to differentiate between different instruments according to risk and, to a large extent, are directed at credit rather than interest rate risk. Accordingly, for risk-based capital purposes, any sort of mortgage-backed security falls into one of several broad categories. Agency CMOs get generally favorable treatment. Securities backed by Ginne Mae, Freddie, and Fannie get a 20 percent weight (though passthroughs from Ginnie get a zero weight). Privately-issued CMOs have a weight dependent on the weights of the underlying assets, and thus often get a risk weight of 50 or 100 percent. Instruments viewed as risky, such as strips, get a 100 percent weight. The criterion for a 100 percent weighting is "any class of an MBS that can absorb more than its pro rata share of loss without the whole issue being in default"[8]

While the most obvious form of regulatory arbitrage may be banks amassing risky CMO constructs, which, for some reason, get a 20 percent weight, that is not the only possibility. Roughly speaking, banks must hold eight percent capital against their risk-weighted assets. As shown above, it is entirely possible that eight percent capital is not enough, given the risk of some CMO constructs. Thus, even with a 100 percent risk weighting, holding some CMOs may constitute regulatory arbitrage.

Since 1998 however, there has been another capital requirement on market risk for banks with large trading activity. These banks must increase their credit-risk-weighted assets by a "market-risk-equivalent" factor based on the value at risk (VaR) of the bank's trading account (and commodity position).[9]

In organizing the data on bank CMO holdings, we take two approaches. The first looks for particularly high concentrations of CMOs or risky CMOs. The other looks into the determinants of CMO holdings, the factors influencing the CMO component of bank portfolios. The hope is to uncover the reasons (evading capital requirements, etc.) that lead some banks to a high, or inappropriate, level of holdings.

Here we should be precise about exactly what we are reporting. CMOs listed in the call reports are in two sections, the portfolio (RC-B) and the trading account. For the measure of total CMOs, we report the sum of the portfolio measures (RCON A561 and RCON A562) and the trading account measures (RCON 3535 and RCON 3536). For a narrow measure of risky CMOs, we report those held in the portfolio that failed the FFIEC test, RCON 8781 (technically, the maximum of RCON 8781 and RCFD8781). An alternative would be to report RCONA562, which includes other mortgage-backed securities with an expected average life of over three years, and although this gives perhaps too broad a measure of what is risky, it has the advantage of still being reported. Our broader measure adds in RCON 8781 plus mortgage-backed securities other than pass-throughs held in the trading accounts (RCON3535 and RCON 3536). Trading account assets are not necessarily risky, but they are where regulations mandated that risky CMOs be housed. Table 3 lists these definitions for easier reference.

8 *Commercial Bank Eamination Manual,* Nov. 1998, section 3020.1, p. 14. This is essentially the language in Regulation H, 12 CFR 208 appendix A.

9. The market-risk-equivalent assets are defined as 12.5 (the reciprocal of 8 percent) times the larger of the the 60-day average VaR (99 percent level, calculated on 10 days) times a factor between three and four and the previous day's VaR, plus an additional charge for specific risk.

TABLE 3 CALL REPORT DEFINITIONS

Variable	Call mnemonic	Description
Total CMOs	RCON A561 + RCON A562 + RCON 3535 + RCON 3536	Portfolio plus trading account
Risky CMOs (narrow measure)	Max (RCON8781,RCFD8781)	Portfolio, failing FFIEC test
Risky CMOs (broad measure)	Max (RCON8781,RCFD8781) + RCON3535+RCON3536	Narrow measure, plus MBS other than pass-throughs in trading account

Table 4 lists the ten banks that hold the most CMOs for the fourth quarter of 2005. Because we have a more detailed breakdown for risky CMOs in 1998, we also report those figures in table 5. Similarly, table 6 lists the ten banks with the largest ratio of CMOs to total assets for the fourth quarter of 2005, and table 7 lists the ten banks with the largest ratio of CMOs to total assets for the fourth quarter of 1998.

The portfolios with a high concentration of CMOs are rarely large in an absolute sense: Only one bank in tables 6 and 7 is among the top-ten CMO holders for the quarter. But the concentration seems quite impressive.

Table 8 lists the ten banks with the most risky CMOs (under the broad definition). Not surprisingly, several of the largest CMO holders are also among the largest holders of risky CMOs. Compass and North Fork appear among the top-ten CMO holders. Some others, however, concentrated their holdings more in risky CMOs.

TABLE 4 LARGEST CMO HOLDINGS AMONG BANKS, 2005

Name	CMOs (thousands of dollars)	Percentage of total assets	Percentage of capital
Commerce Bank, NA	14,551,881	41.89	724.96
Merrill Lynch Bank	7,930,545	13.14	138.34
Countrywide Bank, NA	4,946,132	6.76	92.56
Merrill Lynch B&T	4,460,239	42.47	583.85
Fifth Third Bank	3,700,011	7.77	75.17
Charles Schwab Bank, NA	3,424,178	50.13	619.49
New York Community Bank	2,684,223	10.48	132.87
Branch B&T, Virginia	2,577,437	11.45	162.71
HSBC Bank USA, NA	2,339,228	1.66	24.03
Associated Bank, NA	2,251,297	10.31	150.99

TABLE 5 LARGEST CMO HOLDINGS AMONG BANKS, 1998

Name	CMOs (thousands of dollars)	Percentage of total assets	Percentage of capital
Washington Mutual	5,009,473	15.43	279.77
Compass Bank	4,487,579	27.22	390.55
Morgan Guaranty Trust, NY	2,892,712	4.61	27.98
North Fork Bank	2,454,078	23.23	347.44
National City, MI/IL	2,060,031	10.39	119.36
Apple Bank for Savings	1,849,563	34.45	478.41
Investors Savings Bank	1,546,131	39.05	625.57
Citizens Bank, MA	1,502,782	25.05	390.22
Citizens Bank, RI	1,440,246	24.17	358.34
First Union N.B.	1,438,575	0.70	10.02

TABLE 6 RATIO OF CMO HOLDINGS TO TOTAL ASSETS, 2005

Name	Percentage of total assets	Percentage of capital
First Signature B&T	91.03	1127.99
HSBC Trust (Delaware), NA	85.66	86.18
Frontier State Bank	77.75	1075.74
Washita State Bank	75.84	1078.65
Firstbank North	55.64	879.81
Firstbank, Arvada	55.19	902.73
Firstbank, Douglas County	53.90	851.25
Fiserv Trust	53.37	578.89
Firstbank, Evergreen	52.23	802.01
Firstbank, Parker	51.99	893.74

TABLE 7 RATIO OF CMO HOLDINGS TO TOTAL ASSETS, 1998

Name	Percentage of total Assets	Percentage of capital
First National Bank, Okeene	59.22	184.92
Lincoln Trust Company	56.87	591.49
Bank of Beulah	47.87	512.44
Rochester Bank	45.91	347.68
First Trust Corporation	45.72	607.45
Citizens' and People's Bank, NA	42.27	416.04
Merrill Lynch B&T	41.24	339.66
Firstbank, Parker	39.26	360.52
Investors Savings Bank	39.05	625.57
Firstbank, Parker	51.99	893.74

TABLE 8 LARGEST HOLDERS OF RISKY CMOS, 1998

Name	CMOs (thousands of dollars)	Percentage of total assets	Percentage of capital
Compass Bank	1,681,433	10.20	146.33
First Midwest Bank, NA	391,596	7.75	116.15
Lafayette American Bank	192,725	7.63	127.37
North Fork Bank	190,622	1.80	26.99
Harris Savings Bank	150,157	6.02	93.66
Southside Bank	127,740	14.60	236.60
National City, MI/IL	127,419	0.64	7.38
Citizens Bank NH	94,771	2.09	36.30
Citizens 1st Bank	90,076	21.49	162.26
Community Bank, NA	85,452	5.07	90.64

Table 9 lists the ten banks with the largest ratio of risky CMOs to total assets. Southside and Compass stand out as banks with a position in risky CMOs that is large both absolutely and relative to their assets.

One thing to notice in table 9 is the relatively quick drop-off in holding concentration. Few banks hold much more than 10 percent of their assets as risky CMOs. The top banks show surprisingly high concentrations, though. In eight of sixteen quarters for which we have these data, at least one bank is holding more than one-quarter of its total assets as risky CMOs. The peak is nearly 43 percent. Possibly, these are just special-purpose vehicles and not "real banks." If they are conduits for mortgage firms or securitization, there may be less of a problem, if management knows the relevant risks.

TABLE 9 LARGEST HOLDERS OF RISKY CMOS BY PERCENT OF ASSETS, 1998

Name	CMOs (thousands of dollars)	Percentage of total assets	Percentage of capital
Kentucky-Farmers, Catlettsburg	36,602	30.55	101.64
Citizens 1st Bank	90,076	21.49	162.26
Southside Bank	127,740	14.60	236.60
Watertown Savings Bank	56,269	10.99	121.60
South Shore Bank of Chicago	85,216	10.86	195.42
Compass Bank	1,681,433	10.20	146.33
First United Security Bank	36,965	8.29	76.22
First Bank Richmond, NA	36,281	8.16	92.31
First National Bank, Chillicothe	6,040	8.12	113.79
First National Bank, Okeene	5,246	8.11	25.34

TABLE 10 TOBIT VARIABLE DESCRIPTIONS, 1998

Variable	Description
Intercept	
Dum1	Dummy for size. 1 if total assets < $50 million
Dum2	1 if total assets between $50 and $100 million
Dum3	1 if total assets between $100 and $500 million
Dum4	1 if total assets between $500 and $1000 million
Dum5	1 if total assets between $1 and $5 billion
Caprat	Ratio of bank capital to total assets
Hotrat	Hot funds to total assets
Bhc	Dummy for bank-holding-company affiliation
Tass	Log of total assets
Chrat	Ratio of total charge-offs, net recoveries, to total assets
Nlrat	Net loans and leases to total assets
Netmar	Net interest margin
Tsprd	Spread between 30-year T-bond and 3-month T-bill
Baasp	Spread between Baa portfolio and 3-month T-bill
Offrat	Ratio of off-balance-sheet activities to total assets

Tobits

Which factors lead a bank to invest in CMOs? As a natural beginning to answering this question, we conduct a Tobit analysis. The procedure controls for zero holdings and includes standard control variables in addition to variables related to risk, such as the capital ratio, net interest margin, and charge-offs. The full set of variables is listed in table 10. The idea is to test the hypothesis that riskier banks have a higher propensity to hold risky CMOs (as a share of assets).

Table 11 reports the results for the period where we have the most detailed data (1994:Q1 to 1998:Q4). Notice that most coefficients are highly significant. The size dummies are mostly significant and positive. Since the excluded group is banks with total assets above $5 billion, this result indicates that smaller banks tend to hold more CMOs as a fraction of total assets, the exception being the smallest banks with assets below $50 million. The charge-off ratio enters negatively, which suggests that banks investing in risky CMOs are not particularly risky on other dimensions.

The capital ratio has a negative coefficient, suggesting that a higher capital ratio implies lower holdings of CMOs. This is consistent with the story that some CMO holdings might be for gaming capital regulations. However, the effect is rather small. Increasing the capital ratio of the bank by one percentage point (say from 8 percent to 9 percent) should decrease the percentage of CMOs in the bank's portfolio by 0.03 percent (see

TABLE 11 TOBIT: RISKY(BROAD) CMO/TOTAL ASSETS, 1998

Noncensored: 3,194
Censored: 38,504

Variable	Estimate	STD Err	Pval
Intercept	–0.1818207	0.012523	0.0001
Dum1	–0.3501799	1332.627	0.9998
Dum2	0.01513873	0.004572	0.0009
Dum3	0.01094492	0.003285	0.0009
Dum4	0.0050788	0.002777	0.0674
Dum5	0.00109907	0.002368	0.6426
Caprat	–0.0318325	0.009439	0.0007
Hotrat	0.01525661	0.0026	0.0001
Bhc	0.00101018	0.00087	0.2457
Tass	0.01111653	0.000746	0.0001
Chrat	–0.1418837	0.061826	0.0217
Nlrat	–0.0364996	0.002168	0.0001
Netmar	0.08664372	0.007874	0.0001
Tsprd	–0.002567	0.001157	0.0264
Baasp	0.00552368	0.00146	0.0002
Offrat	–0.0159142	0.002578	0.0001

Maddala, 1983, section 6.6). Since a big change in bank capital of 3 percent would decrease the risky CMO percentage by only one-tenth of one percent, this does not appear to be highly important.

Conclusion

Although we find no smoking gun in call report data, CMO constructs can be dangerous. That became obvious ex post when interest rates rose dramatically in 1994. Then, the losses from CMO constructs made the headlines, with multimillion-dollar losses at Askin Capital Management, Piper Jaffray, the Louisiana State Retirement Plan and Yamachi Securities, among others (Canadian Institute of Actuaries, 1996). Unfortunately, the institutions that have assumed this risk in recent years are opaque, and it is impossible to determine whether and where there are concentrated exposures. At a time when interest rates are again rising, understanding who is exposed to such risk is a question investors—and taxpayers—should ponder.

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