Who Bears Balloon Risk in Commercial Mortgage-Backed Securities?

A Tranche-by-Tranche Analysis

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Executive Summary

Little is known about the impact of balloon risk on the pricing of Commercial Mortgage-Backed Securities (CMBS) despite the $500 billion size of this market. To date, few CMBS investments have gone through a ten-year hold-to-maturity investment cycle to provide market participants with good empirical data. Additionally, several current market factors may contribute to future balloon risk in CMBS investment tranches that weren't in place when early CMBS investments were securitized, including: low commercial mortgage interest rates, low subordination levels, and interest-only or partial interest-only mortgage loans.

To determine who bears the balloon risk in CMBS investments we employ a two-step modeling process. In the first step, we use a double-trigger mortgage default model where property loan-to-value and debt service coverage are used to determine if and when a property falls into default, both during the term of the loan and in loan extension. After term default, balloon risk, and property cash flows levels are determined at the whole-loan level, property cash flows are then aggregated and allocated to the various CMBS investment tranches in step two.

Our findings are two-fold: (1) That balloon risk premiums, while modest in size at the whole loan level, are very important to the appropriate pricing of CMBS investments; and (2) Balloon risk premiums change across different pool and market assumptions and that the impact of these changes significantly and disproportionately affect the mid-level investment grade CMBS tranches.

The findings are based on three simulation models that have increasing levels of property escrows. These property escrows or reserves are established to reduce property cash flow volatility at the whole loan level and thus reduce term default risk. While term default is reduced and total credit risk premiums fall as property escrows are increased, balloon risk increases as weak properties that are "strung along" during the term of the loan cannot be refinanced at maturity. Additionally, these weak properties are allowed to further deteriorate in financial condition as they are being strung along creating increasing loss severity when default does occur. Therefore, while total credit risk of the whole loans is ***lower*** as escrows are increased, the credit risk to the mid-level investment grade CMBS tranches is ***higher***. As weak properties continue to make monthly debt service payments the non-investment grade tranches get paid on an ongoing basis, while the larger loss rates of later defaults is pushed up the subordination level to the investment grade tranches.

Additionally, changing subordination levels and interest rates at maturity critically impacts the mid-level investment grade tranches. Here again, small changes in whole loan total credit risk premiums significantly impact several of the investment grade CMBS tranches. Overall, we find that the mid-level investment grade tranches absorb a significant portion of the increase in total credit risk premiums that is attributable to balloon risk.

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Abstract

This paper investigates the impact of balloon risk on the valuation of Commercial Mortgage-Backed Securities (CMBS) investments. To date, much of the literature on the pricing of commercial mortgages underlying CMBS pools has focused solely on the effect of term default (i.e. default during the term of the loan), and ignores the possibility of a second type of credit risk, the borrower's inability to pay off the existing mortgage at maturity through refinancing (a.k.a. balloon risk). To estimate the impact of balloon risk on the pricing of CMBS investment tranches, we use a contingent-claims model that includes two default triggers: a cash flow trigger and an asset value trigger. After simulating whole loan cash flows, we place them in a CMBS framework to determine the impact of balloon risk on CMBS tranches. The results reveal that balloon risk is relatively small in absolute size at the whole loan level, however, under numerous simulation scenarios total credit risk and balloon risk "creeps" into the investment grade tranches and significantly impacts the pricing of these tranches.

I. Introduction

Global capitalization of Commercial Mortgage-Backed Securities (CMBS) currently exceeds $500 billion. As the market continues to grow, understanding the risk characteristics of CMBS investments becomes more and more important. Much of the research on commercial mortgages and CMBS has focused solely on the impact of default during the term of the loan (i.e. term default), and has paid little attention to the possibility of another type of credit risk: the borrower's inability to make the balloon payment at maturity through refinancing (i.e. balloon, or extension, risk). In an article entitled "Extension Risk Has Grown But Quantifying It Remains Elusive," the following is said about balloon or extension risk for 2004 vintage CMBS investments, "While we admit we are at a loss for forecasting future extensions we think that investors, particularly those managing buy and hold portfolios, **should at least consider the**

potential implications of loan extensions when determining relative value" (bold emphasis added in the article).[1] To date, few CMBS investments have gone through a complete 10-year hold-to-maturity investment cycle and none have gone through an investment cycle in an increasing interest rate environment, thus greatly limiting the empirical data available to test the impact of balloon risk on CMBS investments.

The relative newness of the CMBS market and the changing attributes of CMBS mortgage pools make it difficult for researchers to empirically address the issue of balloon risk. CMBS pools that have matured (i.e. pools that went to market prior to 1996) maintained different characteristics than those of more recent pools. For example, the average CMBS pool size for the 1987-1995 CMBS issuances was $144 million, different from the $1.1 billion average pool size in 2004 and the 1996-2004 average of $683 million; the average loan size for loans in CMBS pools has grown from $5.4 million in 1997 to $11 million in 2004; and the property type makeup of the pools has changed from being heavily weighted towards multifamily mortgages to being dominated by office and retail mortgages.

Several current market factors may contribute to future balloon risk in CMBS investment tranches. Low commercial mortgage interest rates (generally at or below 6.0%) and increases in property values over the past decade (with little if any appreciation in property income) provide a scenario where there is a reasonable chance that interest rates will rise and/or property values fall when commercial mortgages issued today mature in the coming decade, thus increasing the probability of balloon risk. That said,

[1] Merrill Lynch (2004), p. 2.

balloon risk today on loans issued in the mid-late 1990s is likely to remain low as current low interest rates allow for generous debt service coverage and/or lower loan-to-value ratios on appreciated property values permits relatively easy refinancing.

Another potential contributor to balloon risk for current vintage CMBS loan pools is the relatively low subordination levels. Pool subordination levels have fallen dramatically in recent years, with subordination rates for conduit/fusion transactions cut in half across all tranche levels since 1998 (see Table 1).

[Table 1]

Non-amortizing or partially amortizing loans are another potential contributor to balloon risk for current vintage CMBS pools. Prior to 2000, interest-only or partial interest-only CMBS loans were non-existent, conversely, in the fourth quarter of 2004, 50% of conduit CMBS loans were partial interest-only or full interest-only loans (see Exhibit 1).

[Exhibit 1]

While balloon risk in commercial mortgages may be a significant contributor to the overall risk of investing in commercial mortgage-backed securities, little research has focused to date on the impact of balloon risk on CMBS pricing. There are two primary reasons for the limited balloon risk research. First, as discussed earlier, there is limited data on balloon risk. Second, the complexity of simultaneously modeling term default risk and balloon risk (discussed in the next section) and then measuring the impact of these risks on CMBS investment tranches under changing market environments is a difficult task. The primary purpose of this study is to fill the gap by investigating the impact of balloon risk on the pricing of multi-class commercial mortgage-backed securities investments.

To determine who bears the risk in CMBS investments, we apply the commercial mortgage whole loan pricing model forwarded by Tu and Eppli (2003) to a CMBS framework. Specifically, we complete a series of simulation analyses that address the impact of balloon risk on various CMBS tranches under changing subordination levels, rising interest rates, employing interest-only loans, and using a range of refinancing and payoff scenarios at loan maturity.

Our findings reveal that balloon risk premiums, while modest in absolute size at the whole loan level, are very important to the appropriate pricing of CMBS investments. We also reveal that balloon risk premiums change across different pool and market assumptions and that the impact of these changes affects all but the highest rated CMBS investment tranches. As expected, we find that tighter subordination levels and increasing interest rates increase both the total credit risk premium and balloon risk premium for CMBS tranche investments.

Interestingly, balloon risk is not evenly shared among the different investment tranches. We find that balloon risk “creeps” up into investment grade CMBS tranches and disproportionately affects the lower-mid-level investment grade CMBS investments. While the size of the balloon risk premium relative to the term default risk premium is small, the balloon risk significantly increases the total credit risk premiums in the AA, A, and BBB tranches. We also find that changing underwriting standards and payoff probabilities at maturity have little effect on balloon risk.

In the remainder of the paper we present: an overview of the pricing methodology used to estimate term default and balloon risk; followed by a discussion of the model parameters and simulation results; and we close the paper with a summary of the paper's findings.

II. Methodology

As is the case with most all pricing models, we construct and simulate a model that is reflective of how the marketplace operates and use market information to parameterize the model. The proposed double-trigger default model, which considers both asset values and property cash flows as default triggers, is used in both the modeling of term default and extension default and reflects the practice of borrowers and lenders when facing a default decision.

The valuation model that we propose has two stages. In the first stage, a whole loan's cash flow stream is projected based on borrower default and extension behavior. In the second stage, after the cash flow streams for the mortgages in the CMBS pool are simulated, the cash flows are combined across all loans in the pool and allocated among the various CMBS investment classes. The value of each CMBS tranche is then calculated as the present value of the cash flow stream.

a. Modeling Whole Loan Term Default and Balloon Risk

In this study we use Monte Carlo simulation to assess the impact of balloon risk on total credit risk premiums for various CMBS classes.[2] In the Monte Carlo simulation model, a commercial mortgage's cash flow stream is projected based on borrower default and extension behavior. In each simulation path, three state variables: interest rate, property value, and property cash flow, are updated each month,[3] and the borrower makes the default decision based on the contemporaneous Loan-to-Value ratio (LTV) and Debt Service Coverage ratio (DSC).[4] If default occurs, the loan is foreclosed and the property will be sold. The sale price net of transaction costs will then be distributed to the CMBS pool. If default does not occur, the scheduled mortgage payment is made, and the default decision is considered for the next period based on a set of updated state variables.

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[2] The backward numeric approach is preferred by many academic researchers as it can explicitly measure the value of default options embedded in a mortgage. We decided to use the Monte Carlo simulation approach for two main reasons. First, we consider a double-trigger mortgage default model (i.e. one that considers both asset value and cash flow as default triggers), where three state variables are used to price a single mortgage: property cash flows, mortgage interest rates, and property values. When the model is applied to value a mortgage pool with *N* loans, (*2N+1*) state variables are incorporated. This type of valuation problem becomes intractable using a backward numerical method as its computation time increases exponentially with number of state variables. The second reason why we use a Monte Carlo simulation model is the backward numeric method does not generate monthly cash flows that can be distributed among the CMBS investment classes. Since the backward numeric method begins at the termination of the mortgage and works backward, the cash flows necessary to allocate to the various CMBS tranches are not available. As such, the forward-pricing Monte Carlo approach provides the only reasonable means of estimating a double-trigger, term default and balloon risk model that provides results that can be used to price a multi-tranche CMBS.

[3] See the Appendix for discussion of the stochastic processes governing the state variables.

[4] In the double-trigger default model, the borrower must incur a negative cash flow position and an adverse net equity level to consider default. In other words, a DSC of less than 1.0 and a LTV of

If a mortgage does not default during the loan term, we then model whether the mortgage can be refinanced at maturity. Using contemporaneous property value, mortgage interest rates and underwriting standards, we estimate the loan amount the borrower is able to refinance (i.e. the justified loan amount). If the justified loan amount is greater than the loan balance, the balloon payment will be made and loan is paid off. On the other hand, if the justified loan amount is lower than the balloon payment, the borrower is presumed to be unable to pay off the existing mortgage. In this case, the mortgage is assumed to take one of three paths: (1) the borrower will use his equity capital to make up the difference and pay off the loan; (2) the borrower will default; and (3) the borrower and the lender will negotiate an extension.

If the loan is extended, the borrower is assumed to continue to make periodic debt service payments and follow the same payment/default conditions during the term of the loan. At the end of each extended month, the mortgage may be paid off (if the justified loan amount exceeds the loan balance), in default (if both default triggers are satisfied), or extended again (otherwise) based on changing contemporaneous market and property conditions. Additionally, it is assumed that the mortgage can be extended for up to two years, at which point the borrower will be forced to liquidate the property and

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greater than 1.0 are both necessary conditions for default. For details on the simulation and pricing model see Tu and Eppli (2003).

terminate the existing mortgage if neither default nor payoff occurs during the two-year extension period.[5]

b. Distributing Commercial Mortgage Cash Flows to CMBS Tranches

After the cash flow stream for each of the *N* mortgages in the CMBS pool are simulated, the cash flows are then combined and allocated among various CMBS investment classes. While interest payments and principal repayments (including scheduled amortization and principal recovery when default occurs) are distributed top-down to CMBS tranches, lost interest and the reduction in the face amount of the principal (due to the shortfall between loan balance and principal recovery) is allocated bottom-up. The cash flow for each CMBS tranche is calculated monthly and the cash flow stream is discounted on a risk-neutral basis to determine the value of each tranche.[6] The credit risk premium of a CMBS tranche over the risk-free rate can then be calculated based on the tranche value.

III. Parameters and Estimation Results

After developing a CMBS pricing model that utilizes double default triggers and considers both term default and balloon risk, we must now populate the model with a set of parameters that are reflective of the behavior of the market participants. We source a range of academic journals, professional publications, and personal discussions with industry practitioners to populate our models with reasonable and

[5] While a range of mortgage extension fees and rules can be imposed that vary widely among the different mortgage loan agreements, our extension parameters are reflective of what many special servicers impose on mortgage loans that are extended beyond the mortgage maturity date.

logical parameters. While many of the details of the commercial mortgage market participants are not measurable, much less observable, we believe that we have used a series of commercial mortgage assumptions and default parameters that reflect the received academic and professional wisdom to appropriately price commercial mortgages and commercial mortgage-backed securities. After a discussion of the mortgage default model and extension parameters and assumptions, the simulation results are presented.

a. The Mortgage Default Model Parameters

Using the simulation model discussed in the previous section, we examine how term default risk and balloon risk affect the value of a ten-year commercial mortgage with a 30-year amortization schedule. To isolate the impact of credit risk on mortgage pricing, we assume a non-callable mortgage.[7] The two primary mortgage underwriting standards at loan origination are assumed to be the same at maturity: a 67% LTV and a 1.4 DSC.[8]

Most commercial mortgage underwriters require some level of cash reserves or escrows to mute cash flow volatility created by capital improvements, tenant build-outs,

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6 To ensure sufficient convergence to the true tranche value, a large number of simulation paths must be generated. We use 8,000 iterations in each of the simulation analysis.

7 Commercial mortgage pricing studies have generally presumed non-callable mortgages (see Titman and Torous, 1989; Riddiough and Thompson, 1993; Childs, Ott and Riddiough, 1996). Most commercial mortgages have lockout periods and strict prepayment penalties in the form of defeasance and yield maintenance prepayment penalties.

8 These parameters are consistent with the issuer reported LTV, DSC, and other reported terms in 2004 Fitch CMBS conduit presale reports (see www.fitchratings.com).

and other expected cash flow variances.[9] As such, when a property's contemporaneous debt service coverage ratio slips below 1.00, the borrower is able to delay or reduce the frequency of term default by funding the property cash flow shortfall with the reserve account. Three models are employed in the simulation analysis to illustrate the effects of including the cash flow default trigger on CMBS pricing.[10] We first simulate credit risk premiums using a single-trigger, asset value-only model default model (**Model 1**). The other two models assume that the borrower has sufficient reserves to fund a one-month (**Model 2**) and three-month (**Model 3**) cumulative debt service shortfall in the previous twelve-month period, where a one-month shortfall is equal to one month's debt service. The possibility of the borrower funding debt service out of a reserve account for the cumulative amount of one to three months of debt service appears entirely reasonable.[11] Models 2 and 3 are double-trigger default models that include a contemporaneous LTV trigger and a contemporaneous cash flow trigger where both trigger conditions must be met for the property to be considered in default.

Once a property is in default the mean time to foreclosure is 12 months; the asset recovery rate is 90% with a standard deviation of 5%; and a carrying cost per month of 0.5% of the loan balance. Again, these foreclosure assumptions hold for both term

[9] For example, see the *Fitch Commercial Mortgage Presale Report, GE Capital Commercial Mortgage Corp., Series 2003-C2*. The summary statistics on page 2 reveal that 82% of all mortgages in the pool have capital reserve requirements and 87% have upfront or ongoing expense reserve requirements.

[10] The following base case parameters are used for all three models: a flat yield curve (r_0 = 7.5%, κ = 25%, θ = 7.5%, and σ_r = 8.0%), a property return volatility of 15%, a zero correlation between property value and interest rate, and an initial property payout rate of 7.8%. These assumptions are consistent with Esaki, L'Heureux and Snyderman (1999) and Esaki and Goldman (2004).

default and extension default. The base case CMBS subordination levels are averages for the 1998-2004 period.[12] For each parameterization 8,000 Monte Carlo paths are conducted.

b. Estimation Results-The Base Case

To isolate the impact of balloon risk on credit risk premiums, we begin by presenting credit risk premiums ***without*** including the effects of balloon risk in Table 2. Using the Model 1 asset price-only single default trigger model (i.e. contemporaneous LTV) whole loan credit risk premiums are 81 basis points. Including a second cash flow trigger in Models 2 and 3 the whole loan credit risk premiums decline to 79 and 64 basis points respectively. Also, as expected, the B tranche credit risk premiums fall from 1436 basis points for Model 1 to 997 basis points in Model 3 when the borrower has the ability to fund temporary debt service shortfall of three months.

[Table 2]

Interestingly, for the AA and A traches the credit risk premium is ***higher*** for Model 3 than for Models 1 and 2. Initially these results seemed counter-intuitive, i.e. that a whole loan with a lower risk premium has higher risk premiums for the investment grade tranches. However, after a closer look at our simulation results these findings are

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[11] With a 6.50% mortgage constant, the cost of keeping the option open is 0.54% and 1.625% of the loan amount at origination in the one-month and three-month reserve account cases respectively.

[12] CMBS subordination levels have fallen dramatically over the 1998-2004 period. As 2004 subordination levels are at all-time lows, we felt that an average subordination level over a relevant

reasonable and can be explained as follows: Weaker or underperforming loans originated under Model 3 requirements are kept current using a cash flow reserve account and without that reserve would otherwise have defaulted. By "stringing along" these weaker loans, the asset is able to fall into a worse financial position, thus creating larger losses at the time of foreclosure.[13] As the B piece investor maintains property cash flows for a longer period of time, the risk premium of default is shifted from the B tranche to more highly rated tranches.

Table 3 presents the total credit risk premiums for CMBS tranches across the three default models and then separates the impact of balloon risk on CMBS pricing. Comparing the Table 3 with Table 2 is instructive. First, the increase in whole loan risk premiums when including balloon risk versus the term default-only models is 4-7 basis points across the three models, with the largest increase in credit risk premiums coming in the Model 3 results. The larger increase in credit risk premiums for Model 3 is as expected as weaker loans are able to make it to maturity without defaulting and then at maturity are forced to extend.

[Table3]

It is also interesting to note that the balloon risk premiums are largest for the Model 3 simulations for all investment tranches except the AAA tranche, which does not incur

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analysis period may be more reflective of the market and allows us to later test the impact of changing subordination levels on the pricing of CMBS investment tranches.

[13] The financial condition of some of the loans may improve, and the reserve will be restored. However, for those loans that eventually default, the loss rate becomes much more severe.

any credit risk premium across the three models. These results are important as what can be considered safer underwriting procedures (i.e. increasing property escrows) increases balloon risk premiums across all investment tranches. And, as these weaker loans that have been kept current until maturity further deteriorate in credit quality, loss rates on these loans increase, thus pushing credit risk up the subordination levels. With a 4-7 basis point increase in whole loan total credit risk premiums that is attributable to balloon risk, the A, BBB, BB, and B investment tranches had total risk premiums creep up 13-84 basis points.

c. Simulation Results-Comparative Analyses

One of the benefits of a forward-pricing Monte Carlo simulation model is that we are able to change model parameters to reflect alternative states of the property and capital markets and simulate the impact of these market changes on CMBS investments. Specifically, we are interested in assessing the impact of balloon risk on total credit risk when critical parameters are changed. Here we will focus on the impact on total credit risk and balloon risk of: (1) Lower subordination rates; (2) Higher mortgage interest rates at maturity; (3) Interest-only loans; and (4) Changing underwriting standards and loan extension assumptions.

1. The Impact of Lower Subordination Levels on Credit Risk Premiums

The base case credit risk analysis presented in Table 3 presumes average subordination levels for the period 1998-2004. Table 4 presents simulation results using 2004 subordination levels (See Table 1 for 2004 subordination levels).

Subordination levels in 2004 are approximately one-half the subordination levels of 1998 and to date are at all-time lows.

[Table 4]

The whole loan credit risk premiums in Table 3 and Table 4 are identical, as the CMBS structure in our model has no impact on whole loan credit risk premiums. That said, tranche credit risk premiums change dramatically. Total credit risk premiums extend well into the AA tranche, with AA credit risk premiums ranging from 57 to 97 basis points across the three models. These simulated total credit risk premiums exceed market risk spreads (i.e. those reported in February 2005) by a considerable margin for all but the AAA tranche.

Balloon risk premiums are two to five times higher for the AA, A, and BBB tranches in Table 4 relative to the base case presented in Table 3. However, it should be noted that the balloon risk premiums relative to the total credit risk premiums maintain approximately the same relationship where balloon risk accounts for approximately 10-20% of the total risk premium in both Tables 3 and 4. Also worth noting is the difference in balloon risk premiums across the three models. Consistent with the base case results Model 3 balloon risk premiums in Table 4 are two to three times higher for Model 3 relative to Model 1, with sizeable balloon risk premiums creeping well into the investment grade tranches, with the AAA tranche being the lone exception.

2. The Impact of Higher Interest Rates on Credit Risk Premiums

Employing a moderately upward sloping (i.e. 100bp increase from a two-year to a ten-year U.S. Treasury security) or a steeply upward sloping yield curve (i.e. 200bp increase from a two-year to a ten-year U.S. Treasury security) increases total credit risk premiums. The whole loan total credit risk premiums for a moderately upward sloping yield curve, which are presented in Panel A of Table 5, are approximately five basis point higher than the flat yield curve assumption used in the base case (Table 3). The increase in the whole loan total credit risk premium and the balloon risk premium from using this yield curve is distributed somewhat evenly across the individual CMBS tranches.

[Table 5]

Employing a steeply upward sloping yield curve, which suggests significantly higher interest rates in the future, dramatically increases total and balloon credit risk premiums over the base case. For the investment grade tranches, not including the AAA tranche, total and balloon credit risk premiums are two to three times higher in Panel B of Table 5 relative to Table 3. For the non-investment grade tranches the impact of a steeply upward sloping yield curve is more muted. Here again, the effect on total credit risk and balloon risk of higher interest rates in the future most significantly impacts the mid-range investment grade tranches and does not as strongly impact the BB and B investment tranches. Consistent with the lower subordination simulations in Table 4, there is a considerable balloon credit risk creep into the BBB, BB, and A investment tranches.

3. The Impact of Interest-Only Loans on Credit Risk Premiums

The impact of interest-only loans on the credit risk premiums of CMBS tranches is complicated. At the whole loan level, as amortization lowers loan balance over time,[14] the possibility of default is reduced if LTV is the only default trigger. However, when property cash flow is also taken into account, an interest-only loan may actually have lower default risk due to the higher initial DSC. In our simulations, the mortgage with 30-year amortization schedule (the base case) has an initial DSC ratio of 1.40, while an interest-only loan with the same LTV has an initial DSC of 1.58. As a result, the term default risk premiums are higher for interest-only loans in Models 1 and 2, but lower in Model 3.

While including the cash flow default trigger reduces the “probability” of term default, the lender’s loss when default does occur become much more severe. The combination of lower default probability and higher loss severity shifts part of the default risk from lowest subordinate tranches to investment grade tranches. The simulation results reveal that with Model 3, the term default risk premiums for non-investment grade tranches either decrease or stay the same; in contrast, the risk premiums on all investment grade tranches increase.

For investment grade CMBS tranches, the impact of interest-only loans on balloon risk is similar to that on term default risk: the balloon risk premiums are significantly higher

[14] Consider a 10-year loan with 30-year amortization schedule and 6% interest rate, the outstanding loan balance at maturity is 83.69% of the original loan amount.

for tranches AA, A and BBB. On the other hand, balloon risk premiums on B-pieces become lower. An interesting, and somewhat surprising finding is that loan extension may actually increase the return on subordination tranches when less stringent default assumptions are applied. A possible explanation is that when a loan is extended, investors in junior tranches who otherwise would not receive full payoff can continue to receive periodic payments as well as benefit from the possibility of full principal recovery (if the loan can be refinanced during extension).

Overall, the findings reveal that interest-only loans shift the credit risk from subordinate tranches to investment grade tranches.

[Table 6]

4. The Impact of Changing Underwriting Standards and Loan Payoffs at Maturity on Credit Risk Premiums

Property underwriting standards change over time, Table 7 presents simulation results where LTV and DSC ratios at maturity (i.e. at refinance) differ from those at origination. To assess the impact of changing LTV and DSC ratios we use both more stringent and less stringent underwriting standards at maturity than origination. Overall we find negligible changes in total risk premiums and balloon risk premiums for the whole loans as well as for the total risk premiums and balloon risk premiums for the different CMBS tranches across a reasonable range of LTVs and DSCs.

[Table 7]

In the base case analysis we assume that all loans that meet contemporaneous underwriting standards for refinance are refinanced. Of the loans that do not meet contemporaneous underwriting standards we assume there is a 20% chance that the borrower will use his equity to pay off the loan, a 20% chance that the borrower will default, and a 60% chance that the loan will be extended. Borrower and lender behavior is difficult to project, but we thought it might be instructive to look at different payoff probabilities at maturity.[15] Table 8 presents the simulation results using a range of payoff levels of 0%, 40%, and 60% for those loans that do not meet contemporaneous underwriting standards.

[Table 8]

The 0% and 40% payoff scenarios return total credit risk premiums and balloon risk premiums that are marginally different from the base case. When assuming a 60% payoff of loans that do not meet contemporaneous underwriting standards, balloon risk premiums drop by approximately 50% across all tranches for all three models.

IV. Conclusion

In this paper we use Monte Carlo simulation to measure the impact of balloon risk on the pricing of CMBS investments using a double-trigger default model. Overall, we find that balloon risk makes up a relatively small portion of total credit risk at the whole loan level. However, balloon risk becomes a significant portion of total credit risk when pricing individual CMBS tranches, especially when the Model 3 more restrictive cash flow trigger is employed, as weaker properties that use cash flow reserves to prevent from defaulting during the term of the loan are more vulnerable to balloon risk at maturity. This increase in balloon risk significantly and disproportionately impacts the A, BBB, BB, and B rated CMBS tranches.

Additionally, changing subordination levels and interest rates at maturity critically impacts the investment grade tranches. Here again, small changes in whole loan total credit risk premiums significantly impacted several of the investment grade CMBS tranches. Specifically, employing reasonable changes in subordination levels and interest rates at mortgage maturity increase the total risk premiums for the A and BBB tranches 28-229 basis points using the Model 3 results. Similarly, balloon risk premiums using the Model 3 results for the A and BB are 14-34 basis points higher, while the non-investment grade tranches were marginally impacted. Overall, we find that the mid-level investment grade tranches absorb a significant portion of the increase in total credit risk premiums that is attributable to balloon risk.

[15] We credit Martha Peyton for this suggestion.

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Appendix

Three state variables are specified in the contingent claims model: interest rate, property value, and payout rate. Consistent with studies in the mortgage pricing literature,[16] the interest rate variation is assumed to follow the Cox-Ingersoll-Ross mean-reverting process:

$$dr = \kappa(\theta - r)dt + \sigma_r \sqrt{r} dz_r , \qquad \text{(A-1)}$$

where κ is the speed of reversion parameter, θ is the long-term reverting rate, $\sigma_r \sqrt{r}$ is the standard deviation of changes in the current spot rate, and dz_r is a standard Wiener process. A variety of shapes of the yield curve can be described by using a different initial interest rate, r_0.

Property values are assumed to follow a lognormal diffusion process:

$$dP = (\alpha_P - \beta_P)P\,dt + \sigma_P P dz_P , \qquad \text{(A-2)}$$

where P is property price, α_P is the expected total return on the property, β_P is the continuous property income payout rate, σ_P is a volatility parameter of property returns, and dz_P is a standard Wiener process. To estimate the credit risk premium of commercial mortgages we apply the risk-neutral valuation principle, where the risk-neutral property price process is specified as:

[16] For example, see Titman and Torous (1987), Kau, et. al (1990), Childs, Ott and Riddiough (1996), and Ciochetti and Vandell (1999),

$$dP = (r - \beta_P)Pdt + \sigma_P Pdz_P \, , \qquad \text{(A-3)}$$

and r is the riskless spot rate. It is assumed that there exists an instantaneous correlation between changes in property prices and interest rates, ρ_{Pr}.

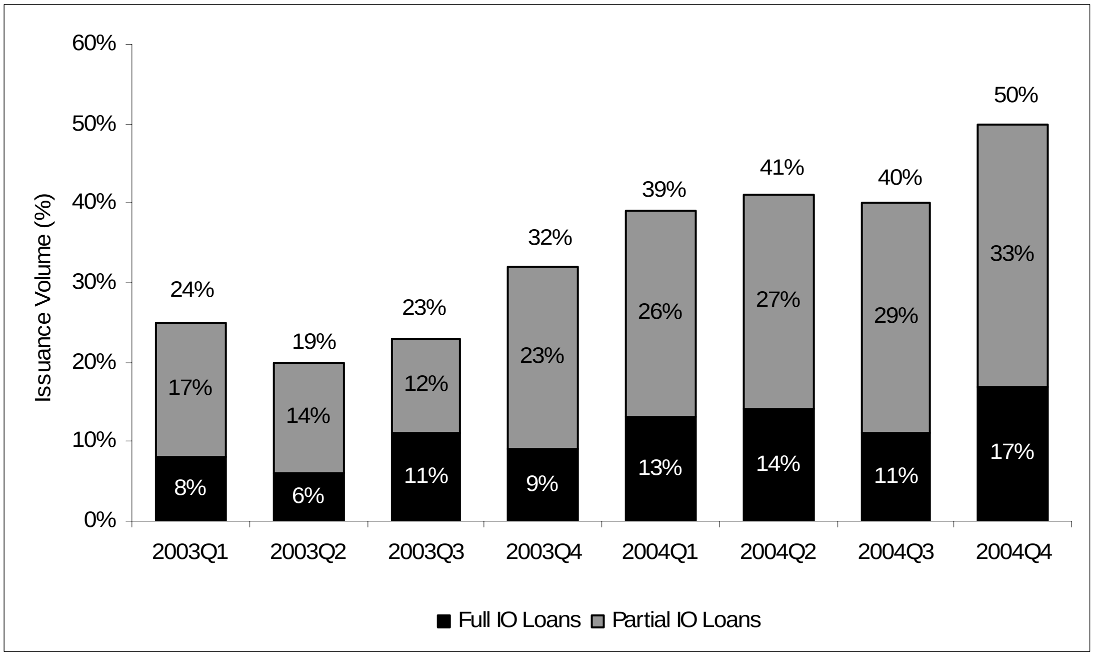
The third stochastic variable in our mortgage pricing model is property cash flow. Monthly property cash flow is determined by multiplying the property value by the property income payout rate, which is modeled as a function of contemporaneous market interest rates. Since interest rate and payout rate are correlated we specify the payout rate as a linear function of interest rates plus a random volatility measure:[17]

$$\beta_P = a + b \times r + \varepsilon \, , \qquad \text{(A-4)}$$

where β_P is the property income payout rate, r is the interest rate, a and b are estimated parameters, and ε is the residual. It is also assumed that there is an autocorrelation term ρ_ε between ε_t and ε_{t-1}.

[17] Since data on commercial property income payout rates is not available, we estimate the relationship between payout rates and interest rates using property capitalization rates as a proxy. A regression of capitalization rates on mortgage contract rates is estimated using ACLI data, a similar approach is employed by Goldberg and Capone (1998, 2002).

Exhibit 1 Interest-Only Loans in Conduit CMBS



Source: Credit Suisse First Boston

Table 1 Subordination Levels of CMBS Tranches

CMBS Tranches	AAA	AA	A	BBB	BB	B
Subordination Levels in 1998	29%	24%	18%	13%	6%	3%
Subordination Levels in 2001	21%	17%	13%	9%	4%	2%
Subordination Levels in 2004	14%	12%	9%	5%	2%	1%

Source: Morgan Stanley (2004).

Table 2 Credit Risk Premiums of CMBS Tranches (without Balloon Risk)

	AAA	AA	A	BBB	BB	B	Whole L.oan
Model 1	0	4	24	99	389	1436	81
Model 2	0	7	34	124	421	1353	79
Model 3	0	12	41	119	350	997	64

Table 3 Credit Risk Premiums of CMBS Tranches (including Balloon Risk)

Total Credit Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	5	28	114	422	1486	84
Model 2	0	8	41	144	464	1409	84
Model 3	0	16	54	150	412	1081	71

*Balloon Risk Premiums (bp)**

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	1	4	14	33	51	4
Model 2	0	2	7	20	43	57	4
Model 3	0	4	13	32	62	84	7

* The balloon risk premium is the difference between the total credit risk premium above and the credit risk premium (without balloon risk) in Table 2.

Table 4 The Impact of Lower Subordination Levels on CMBS Tranches

Total Credit Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	1	57	136	371	874	1621	84
Model 2	2	79	170	414	898	1479	84
Model 3	3	97	176	379	758	1091	71

Balloon Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	8	16	32	47	45	4
Model 2	0	13	23	40	57	54	4
Model 3	1	23	35	58	75	97	7

Table 5 The Impact of Different Shapes of Yield Curve on CMBS Tranches

Panel A Moderately Upward Sloping Yield Curve

Total Credit Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	11	47	169	532	1661	91
Model 2	0	18	73	206	569	1512	91
Model 3	0	27	74	183	454	1090	75

Balloon Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	2	7	18	39	48	5
Model 2	0	4	13	27	55	67	7
Model 3	0	9	19	40	74	104	10

Panel B Steeply Upward Sloping Yield Curve

Total Credit Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	17	73	234	674	1860	98
Model 2	0	28	103	269	667	1595	96
Model 3	1	28	82	198	472	1111	77

Balloon Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	3	8	25	46	45	6
Model 2	0	7	22	43	74	73	10
Model 3	0	10	27	53	92	133	15

Table 6 The Impact of Interest-Only Loans on CMBS Tranches

Term Default Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	20	78	236	645	1697	107
Model 2	1	42	115	267	575	1251	91
Model 3	1	28	69	150	354	738	59

Total Credit Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	22	84	245	633	1597	113
Model 2	1	58	143	298	595	1219	103
Model 3	1	48	101	198	409	786	73

Balloon Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	3	6	8	-12	-100	7
Model 2	0	16	27	31	20	-33	11
Model 3	1	20	33	49	55	48	15

Table 7 The Impact of Different Underwriting Standards for Refinancing on CMBS Tranches (Base Case: LTV = 0.67, DSC = 1.4)

LTV = 0.65, DSC = 1.45

Total Credit Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	5	29	119	420	1484	84
Model 2	0	9	44	150	458	1403	84
Model 3	0	17	57	157	409	1067	71

Balloon Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	1	4	14	34	48	4
Model 2	0	2	8	20	41	56	4
Model 3	0	5	14	32	62	88	7

LTV = 0.70, DSC = 1.35

Total Credit Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	6	30	117	422	1487	85
Model 2	0	10	43	147	462	1407	84
Model 3	0	18	58	154	408	1073	72

Balloon Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	1	3	14	33	44	4
Model 2	0	2	7	20	42	52	5
Model 3	0	5	15	32	60	90	8

LTV = 0.72, DSC = 1.30

Total Credit Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	6	31	120	423	1482	85
Model 2	0	9	45	148	463	1403	85
Model 3	0	20	61	158	414	1074	73

Balloon Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	1	4	13	31	41	4
Model 2	0	2	8	20	41	53	5
Model 3	0	6	15	33	63	88	8

Table 8 The Impact of Different Payoff Assumptions on CMBS Tranches (Base Case: 20% Payoff)

Probability of Payoff=0%

Total Credit Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	5	32	127	446	1504	87
Model 2	0	9	48	160	485	1428	87
Model 3	0	19	65	172	435	1090	75

Balloon Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	1	6	18	43	53	5
Model 2	0	2	10	27	54	66	6
Model 3	0	7	20	43	78	104	10

Probability of Payoff=40%

Total Credit Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	5	28	117	436	1497	85
Model 2	0	8	42	148	474	1412	85
Model 3	0	15	54	155	412	1070	72

Balloon Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	1	3	10	27	33	3
Model 2	0	1	6	17	34	41	4
Model 3	0	3	11	28	50	68	6

Probability of Payoff=60%

Total Credit Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	5	26	106	402	1465	82
Model 2	0	7	37	135	438	1385	81
Model 3	0	13	48	134	375	1025	67

Balloon Risk Premiums (bp)

	AAA	AA	A	BBB	BB	B	Whole Loan
Model 1	0	0	2	7	18	21	2
Model 2	0	1	4	10	23	30	2
Model 3	0	2	7	16	31	47	4