

**Commercial Mortgage Workout Strategy and Conditional Default Probability:  
Evidence from Special Serviced CMBS Loans**

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## **Abstract**

The existing literature in commercial mortgage defaults focuses on the process for loans in the current status to the default status. This study recognizes that commercial mortgage default is not a one-step process and examines a previously unexplored aspect in the whole default process, that is the stage between the initial delinquency to default. In the analysis of the conditional default risk during this stage, we distinguish the servicers' behavior from the borrowers' behavior and consequently break our empirical analysis into two parts. A multinomial logit model is applied to analyze the servicers' choice of workout options and a proportional hazard model is applied to analyze the borrower's default decision making process under time-varying conditions. Using the data sample that consists of 493 special serviced loans in 144 CMBS deals, we find that cash flow condition is the most significant factor in the servicers' decision making process. We also find that borrowers make default decisions based upon both the equity position in the mortgage and the cash flow condition in the space market. In addition, key real estate space market variables, such as market-level vacancy rates, also provide useful information in explaining commercial mortgage defaults. Finally, we find that special service seems to be functioning as it reduces the probability that a troubled loan will default.

**Keywords:** Commercial mortgage, default, delinquent, workout, loan servicing, hazard modeling

## I. Introduction

Commercial mortgage-backed security (CMBS) is an important asset class with aggregate outstanding balance of \$372 billion as of December 2001.<sup>1</sup> The major risks of CMBS investment include default risk, prepayment risk, extension risk, and liquidity risk. Contrary to residential MBS where prepayment risk dominates,<sup>2</sup> CMBS is much better protected from this risk due to prevailing commercial mortgage contractual clauses, such as enforced prepayment penalty, prepayment lockout, yield maintenance and defeasance. This study is mainly about the default risk. In particular, we focus on a previously unexplored aspect of this risk, that is the conditional default risk after problematic loans become special serviced.

Late 1980s to early 1990s saw extremely high commercial mortgage default rates across the country. The life insurance industry reported the highest outstanding foreclosure rate of 7.53% in the second quarter of 1992 (ACLI), and commercial banks reported the delinquent rate of commercial mortgages as 12.57% in the first quarter of 1991 (the Federal Reserve Board). These high default rates were certainly a consequence of the devastating commercial real estate market crash in the last business cycle, and this incidence has profoundly affected many financial institutions' confidence on the performance of commercial mortgages. Anecdotal evidences indicate that lenders and investors have become much more cautious in recent years. They have tightened underwriting standards, and have stepped up servicing effort to prevent the reoccurrence of the skyrocketing commercial mortgage default rates as experienced in the late 1980s to the early 1990s. As commercial mortgages have been increasingly securitized, investors in the CMBS market also pay particular attention to the default risk of collaterals and require various measures to be taken to mitigate the default probabilities and potential loan losses. One of these measures is to have a problem loan special serviced, which is to transfer the problem loan to a special servicer that has more expertise in handling problem loans than regular servicers.

Of the three types of servicers in a CMBS deal, the *master servicer* oversees the deal and monitors the timely collection and distribution of principal and interest payments at the deal level, the *subservicer* deals with borrowers directly and performs regular servicing routines such as collecting payments and bookkeeping, etc., and the *special servicer* starts to take over the servicing responsibility when a loan goes into serious trouble, usually when a loan becomes 30 to 60 days delinquent. Special servicers are often granted the power to decide the most effective workout strategy (e.g., decide whether to modify the loan term, to cure the delinquency, or to

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<sup>1</sup> Source: Institutional Real Estate Newslines, "Roulac Capital Flows Database."

<sup>2</sup> See, for example, Richard and Roll (1989), Schwartz and Torous (1989), and Quigley and Van Order (1990) for a discussion of prepayment risks in residential mortgage lending, and Downing, Stanton and Wallace (2001) for a more recent development in this field.

foreclose the property, among other options) with the ultimate goal as to maximize the expected net present value of the loans in problem. Because special servicers usually possess more expertise in managing delinquent loans, they charge a higher fee that is in the magnitude of 50 to 100 basis points for servicing delinquent loans and 150 to 200 basis points for foreclosure and liquidation (Han 1996). As a comparison, the regular annual servicing fee is in the range of 3 to 17 basis points (Han 1996 and Shilling 1995). In addition to the higher cost, a potential moral hazard problem may also arise as the special servicer may act in their self-interest rather than in the interest of CMBS investors (Fathe-Aazam 1995, Sanders 1999 and Riddiough 2000). As such, special servicers play a critical role in the CMBS market. Their business practice and their effectiveness in managing delinquent loans have significant impact on the collateral performance and consequently on the pricing of CMBS tranches, especially the lower-rated first-loss pieces.

This study concerns the performance of the loans that are special serviced. Because the outcome of loan servicing comes from the interaction between the borrowers and the servicers, and the distinction between the servicers' behavior and the borrowers' behavior is important, we seek to clarify this distinction in this paper. As a natural extension from this understanding, we first study the decision making process from the servicers' perspective, and then study the factors influencing loan defaults when they are special serviced. We consider the later as largely the borrowers' decision making process because few servicers would in favor of defaults. The link between the servicers' behavior and the borrowers' behavior is also established through a two-stage Hechman style estimation approach.

This paper benefits from many insights from earlier literature. As the first study on default risk assessment of commercial mortgages, Vandell (1984) hypothesizes that default could be due to the occurrence of either adverse cash flow or negative equity in the property. He recognizes the interactions between cash flow and equity conditions in affecting default risk. He also recognizes the importance to consider the timing of default and to incorporate the time-varying information about the property, market, and economic conditions. Kau, Keenan, Muller and Epperson (1987) and Titman and Torous (1989) start to apply contingent-claims approach to valuing commercial mortgages. Vandell (1992) carries out empirical study using aggregate commercial mortgage foreclosure experience and confirms the equity theory of default. He also attributes the possible high transaction costs as the cause of the under exercise of the default option.

Vandell, Barnes, Hartzell, Kraft and Wendt (1993) were the first to use loan-level commercial mortgage data from a large life-insurance company. Empirical results confirm the dominance of loan terms and property value trends in affecting default. Ciochetti, Deng, Gao and

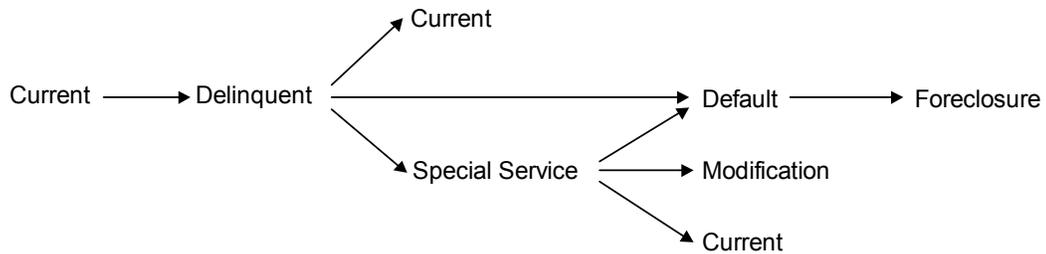
Yao (2002) use a similar data set (also from a major life insurer), and apply the competing risk framework developed by Deng, Quigley and Van Order (1996, 2000) in the residential mortgage market to commercial mortgages. Their findings confirm that the put and call options are highly significant in explaining commercial mortgage default and prepayment. Transaction costs are also found to be important in explaining mortgage termination. In particular, solvency conditions reduce default risk, and small borrowers default much more frequently. Goldberg and Capone (2002) incorporate both equity and cash-flow considerations (so called double-trigger) in default models. Their empirical analysis using data of multi-family loans purchased by Fannie Mae and Freddie Mac confirm the importance of double-trigger theory, that is, they find that models relying solely upon property equity may have a tendency to overstate potential default rates, and those relying only on cash flows understate default risk. Archer, Elmer, Harrison and Ling (2002) argue for the endogeneity in commercial mortgage underwriting in terms of LTV ratio, which would imply no empirical relationship between default and LTV because lenders would require lower LTVs for high risk mortgages. They examine 495 multifamily mortgages securitized by the Resolution Trust Corporation (RTC) and the Federal Deposit Insurance Corporation (FDIC) and find no evidence of LTV effect on default, while the strongest predictors of default are property characteristics, including property location and initial cash flow. Ambrose and Sanders (2003) are the first to conduct empirical study on CMBS loans.

While the aforementioned studies provide excellent theoretical guide and empirical evidence on the determinants of commercial mortgage defaults, they all focus on the default probabilities for loans from performing status to default status. Several studies, Riddiough and Wyatt (1994a, 1994b) and Harding and Sirmans (2002), start to consider theory of workout strategy of troubled debt and its implication on loan defaults and valuation, although none of these studies provide empirical evidence. Our study not only empirically analyzes servicers' workout strategic decisions but also analyzes the performance of troubled loans after they caught servicers' attention (i.e. being special serviced). Our study shares some similarity with the study by Ambrose and Capone (1998) on single-family mortgage default resolutions. While both recognize that default is not a one-step process, their study focuses on the step from initial default (90-day delinquency) to final foreclosure, ours focuses on the step from initial delinquent (first enter special service) to default. Another related study is Springer and Waller (1993) who examines lender forbearance and finds that the primary factors influencing the timing of the lender's foreclosure decision are the borrower's equity position and the erosion of that position with continuing delinquency. Capone (1996) also provides excellent review of the workout alternatives to foreclosure in the residential mortgage industry.

The rest of the paper is organized as follows: Section II discusses the default process in commercial mortgage lending; Section III describes the data used in this study; Section IV discusses the estimations and the empirical results; Section V is a conclusion.

## II. Default Process

There are several stages for loans in non-performing status. First, the borrower decides to miss a scheduled monthly payment and the loan becomes delinquent. Since default is generally considered as the exercise of the implicit put option embedded in the mortgage contracts<sup>3</sup>, the initial delinquency can be considered as the borrower’s tentative step to exercise the put option. Note the borrower still has lots of room to relinquish the put option exercise at this stage since it is relatively less financially stressful to make up the missed one-month payment. The special servicer usually steps in when the loan becomes 60 days past due, i.e. when the loan has missed two scheduled payments. The transfer of servicing function from the regular servicer to the special servicer is usually an indication that the loan is intentionally non-performing, i.e. the servicers determine that the missed payments are not due to inadvertent mistakes but rather due to the borrower’s deliberate action. The special servicer then decides the best workout strategy meanwhile the borrower continue to re-evaluate the financial situation in order to finalize the implicit put option. We define 90 days past due as default because this status shows the borrower’s determination to exercise his put option. While there could be jumps between these stages, the general process can be summarized as follows (Figure 1):



**Figure 1. The Default Process**

As mentioned earlier, the route from delinquent to special service is a common practice in the CMBS market although it is less so for life insurance companies and commercial banks. Archer, Elmer, Harrison and Ling (2002) provide more discussion on the post-default process of

<sup>3</sup> See Hendershott and Van Order (1987), and Ambrose, Capone and Deng (2001) for a discussion of put option theory and mortgage default.

commercial mortgages, while Ambrose and Capone (1998) and Ambrose and Buttimer (2001) provide theoretical and empirical analysis on post-default options for single-family mortgages.

This paper focuses on the process from delinquent to special service to workout outcomes. Note there are two perspectives to look at the process. The first perspective is from the servicers' point of view. After examining the financial condition of the collateral, the market condition, the borrower's own financial situation, and other relevant factors, the servicers decide the best workout strategy. We call this as the "expected" outcome. The major categories of "expected" outcome include foreclosure, modification, and return to current, among others. If the servicers expect the borrowers to default for a prolonged period, foreclosure is usually the best strategy. The "expected" outcome does not necessarily equal the actual outcome because the later is also determined by the borrower's behavior. This leads to another perspective that is from the borrower's point of view. We expect borrowers would still follow the rules of default put option when they are being special serviced. In fact, the borrowers could be more ruthless in this stage because they have already showed their intention to exercise the put option. Of course, cash flow condition may still play a critical role as found by some other studies. A rational borrower would be hesitant to complete the put option if there is still positive cash flow from the collateral, while negative equity must be the necessary condition for the borrower's final completion of the default put option.

### **III. Data**

The special service loan data are gathered from Standard & Poor's Conquest CMBS deal library.<sup>4</sup> The data collection date is September of 2002, with loan status was recorded as of August 2002. We searched 144 CMBS deals, most of which are conduit deals. After collecting the records for 577 loans in the special service status, we took a closer look at the collateral information and found 74 loans that are either cross-collateralized or apparently backed up by the same borrower. Noticeable borrowers that have multiple loans include several hotel chains, retail chains, and restaurant chains, among others. We exclude these loans from our analysis due to the difficulty to analyze these business failures. We also excluded loans with missing data, and thus retained a final data set of 493 loans. Although there is still a possibility that we missed cross-connection between some of the loans in our final data set, we believe that the possible error would be insignificant and that the loans in our final data set are mostly independent therefore satisfying the data requirement for the following statistical analysis. In order to perform the

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<sup>4</sup> Courtesy access of Standard and Poor's Conquest CMBS deals library is through the University of Southern California.

Heckman style two-step analysis, we further collected the data of the performing loans from the same 144 CMBS deals. After excluding the records with missing data and cross-collateralized loans, we retain a total of 13,132 loans for the first stage estimation in the framework of the Heckman approach.

Table 1 shows the breakdown of the final data set of the special serviced loans by property type of the collateral. While mortgages of retail properties register the most percentage in terms of loan balance (31.6%), hotel, retail and apartment have similar percentage in terms of loan counts. A closer look at the average loan balance reveal that retail loans have slightly larger balance than the average, while office loans have the largest average balance among all property types. Apartment loans have the smallest average balance as one would expect, and warehouse loans rank the second smallest by balance.

**Table 1. Sample Loan Statistics by Property Type**

<b>Property Type</b>	<b>No. of Loans</b>	<b>Sum of Cutoff Balance</b>	<b>Average Cutoff Balance</b>	<b>% by No. of Loans</b>	<b>% by Cutoff Balance</b>
Apartment	118	\$377,842,605	\$3,202,056	23.9%	13.3%
Hotel	132	\$690,546,855	\$5,231,416	26.8%	24.3%
Office	62	\$660,493,930	\$10,653,128	12.6%	23.2%
Retail	131	\$898,368,902	\$6,857,778	26.6%	31.6%
Warehouse	50	\$216,746,746	\$4,334,935	10.1%	7.6%
<b>Total</b>	<b>493</b>	<b>\$2,843,999,036</b>	<b>\$5,768,761</b>	<b>100.0%</b>	<b>100.0%</b>

Table 2 shows the breakdown of the final data set by servicers' workout strategy. It is interesting to see that close to half of the sample loans do not contain information on servicers' workout strategy. This might suggest the difficulty in collecting complete CMBS data because CMBS deals have a diverse universe of originators, servicers, trustees, and investors, all of them have different reporting standards and requirements. Of the loans that have the information of servicers' workout strategy, about half are modified, with the remaining loans fall into three categories: foreclosure, return, and bankrupt.

**Table 2. Sample Loan Statistics by Workout Strategy**

<b>Workout Strategy</b>	<b>No. of Loans</b>	<b>Sum of Cutoff Balance</b>	<b>Average Cutoff Balance</b>	<b>% by No. of Loans</b>	<b>% by Cutoff Balance</b>
Foreclosure	48	\$265,017,274	\$5,521,193	9.7%	9.3%
Modified	122	\$811,761,552	\$6,653,783	24.7%	28.5%
Return	53	\$295,271,563	\$5,571,162	10.8%	10.4%
Bankrupt	36	\$186,395,154	\$5,177,643	7.3%	6.6%
Unidentified	234	\$1,285,553,494	\$5,493,818	47.5%	45.2%
<b>Total</b>	<b>493</b>	<b>\$2,843,999,036</b>	<b>\$5,768,761</b>	<b>100.0%</b>	<b>100.0%</b>

Real estate market data include occupancy rates for the hotel sector and vacancy rates for the remaining property types.<sup>5</sup> In addition, NCREIF Property Index is used to proxy for the market-level value indices and NOI indices.

## **IV. Empirical Analysis**

### *4.1 Multinomial Logit Analysis of Lenders' Workout Strategy*

Of the 493 special serviced loans in our sample, 217 loans have clear identification of servicers' workout strategy. Among these 217 loans, servicers intend to bring 52 loans back to "current" status, to foreclose 47 loans, and to modify the terms of the remaining 118 loans. Remember that servicers' intention does not guarantee the success of each strategy, in fact, loans could still fail to perform even though servicers intend to bring them back to "current" or have modified the loan terms. Since in this section we attempt to understand the reasons behind servicers' choice of a particular workout strategy over alternatives, we leave out the ultimate outcome of these strategies, which is a subject we shall return to in the next section concerning proportional hazard analysis. We focus on the effect of the measurable variables at the time loans enter the special service category on servicers' choice of workout strategy. These measurable variables are mainly related to loan characteristics and real estate market conditions. Unfortunately, we do not have enough information on borrower characteristics.

Following option pricing theory and mounting empirical evidence in the mortgage research literature, a loan's current equity level (measured by one minus the current loan-to-value ratio, i.e. LTV) has a dominant effect on the probability of the underlying collateral value dropping below the threshold (the par value of the outstanding principal amount) and hence to default. We expect servicers would more likely to foreclose high LTV loans since these loans are more likely to have their collateral value dropping even further. To cut the carrying cost and interest payment advance, the sooner the loans are foreclosed, the lower loss severity would be. For the loans with middle-tier LTV (that is, LTV is not too high so immediate foreclosure is justified and LTV is not too low hence there is no need for servicers to modify loan term<sup>6</sup>), we expect servicers would be more willing to modify the loan terms in order for them to stay "current". For this type of loans, a little bit payment reduction could be enough for the borrowers to remain solvent. Therefore we expect LTVs should be positively related to servicers' choice of foreclosure strategy and to a lesser extent to servicers' choice of loan term modification strategy.

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<sup>5</sup> We are grateful for Property & Portfolio Research, Inc. (PPR), a Boston-based independent commercial real estate research consulting firm, for providing these real estate market data.

<sup>6</sup> Instead of loan term modification that is long term, servicers could offer forbearance, which is short term, to help borrowers overcome temporary cash flow problems for low LTV borrowers. See Capone (1996).

When borrowers are insolvent and run into trouble (that's the likely reason why they enter the special service category), the net operating cash flows are critical since it is the net cash flows that affect the immediate financial stress to the borrowers of commercial mortgages. Because commercial properties are very illiquid and involves substantial amount of transaction cost (both tangible and intangible), borrowers are very unlikely to dispose their properties quickly to meet the cash payment requirements even if the market value of collateral is higher than the mortgage principal amount. We expect the net operating cash flows (proxied by debt-service-coverage-ratio, i.e. DSCR) have a negative relationship with servicers' choice of foreclosure.

While commercial properties are illiquid assets, we should also realize that rational servicers would look forward. They would examine the property market condition in order to determine whether the performance of a particular collateral would get better or worse in the future, and whether the properties would be eventually sold at a higher price or a lower price. Because all these property market conditions ultimately affect the possibility of the borrowers' regaining financial solvency through either improved cash flows and/or profitable sales of the properties, we expect that higher rental growth rates in the real estate space market (proxied by the market-level NOI growth rates) and higher value appreciation rates in the property asset market (proxied by the market-level value appreciation rates) would have a negative relationship with servicers' choice of foreclosure<sup>7</sup>. Also, in an improving commercial real estate market, servicers are less likely to modify the loan terms so that the NOI growth rates and property value appreciation rates should have a negative relationship with servicers' choice of loan term modification.

We use the change of market-level occupancy rates as another variable proxying for real estate market condition. It is well known by commercial real estate participants, the vacancy rates (or the occupancy rates) serve as an excellent leading indicator of the future cash flows and property value growth potential<sup>8</sup>. If the occupancy rates in a market are getting higher, the servicers would expect improving cash flow and would be less likely to foreclose the property. We therefore expect a negative relationship between the change of occupancy rates and lenders' choice of foreclosure.

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<sup>7</sup> Note we implicitly assume that servicers do not intend to profit by foreclosing a property in a "hot" market in order to sell the property at a higher price than the principal loan amount. We believe this assumption is reasonable given that most servicers have no intention to take advantage of the temporary hardship of borrowers so that foreclosure is always the last and least preferred strategy of lenders facing defaults.

<sup>8</sup> It should be noted that vacancy rates are traditionally used in the commercial real estate studies in the sectors of apartment, office, retail and warehouse, while occupancy rates are preferred measure for hotel properties.

Empirical mortgage research literature has also identified the seasoning effect in loan default probability. That refers to the default seasoning pattern that default probabilities steadily increase in the initial years after loan origination and then level off between the third and the seventh year and then gradually decline (see Goldberg and Capone 2002 for recent evidence). We expect servicers would consider the seasoning of troubled loans in their decision making process. For both financial and psychological reasons, we expect servicers are more likely to tolerate payment delay and more likely to workout a modification strategy after the loans are in good standing for a long time period. We therefore expect a positive relationship between loan age and servicers' choice of modification strategy. Riddiough (2000) presents another possibility. He argues that borrower's bargaining power in renegotiating the loan may be reduced in the CMBS market because the special servicer may view financial distress as an isolated occurrence instead of an ongoing business relationship. This impersonal relationship between the borrower and the special servicer may restrict the ability to arrive at a mutually agreeable outcome. We empirically test this hypothesis in our statistical analysis.

Studies by Clauretie (1987), Ciochetti (1997) and Ambrose, Capone and Deng (2001) also documented the importance of state foreclosure laws on the probabilities of default. We separate states by two categories: judicial foreclosure and power-of-sale, the assignment of each state to these categories follows Ciochetti (1997).

In all, we identified seven variables that represent the various dimensions rational servicers are likely to take into consideration in making workout strategic decisions. Before turning to statistical analysis, we also performed a simple correlation analysis of these explanatory variables (reported in Table 3) and find mostly insignificant correlations between the independent variables. It suggests that the independent variables we choose indeed represent different dimensions that are likely to be orthogonal.

**Table 3. Correlation Matrix of the Variables Used In Multinomial Logit Analysis**

	LTV	DSCR	Value Growth (Market)	NOI Growth (Market)	Occupancy Change (Market)	Loan Age
<b>LTV (Loan)</b>	1.00					
<b>DSCR (Loan)</b>	(0.23)	1.00				
<b>Value Growth (Market)</b>	(0.16)	0.30	1.00			
<b>NOI Growth (Market)</b>	(0.14)	0.16	0.31	1.00		
<b>Occupancy Change (Market)</b>	(0.13)	0.26	0.22	0.11	1.00	
<b>Loan Age</b>	(0.17)	(0.05)	(0.15)	(0.02)	(0.05)	1.00
<b>Mean</b>	75.8%	1.28	-2.7%	-6.0%	1.21	40.5
<b>Standard Deviation</b>	38.1%	0.56	6.3%	15.4%	0.32	20.8
<b>No. of Observations</b>	217	214	217	217	217	217

Once the potential explanatory variables are identified, we further assume a loss severity function where lenders maximize a linear utility function  $U_j$  over  $j$  workout strategies:

$$U_j = \alpha_j + \beta_j X + \gamma_j Z + \varepsilon_j, \quad j = 1, 2, 3. \quad (1)$$

where  $X$  is a vector of loan and property characteristics (LTV, DSCR, and loan age),  $Z$  is a vector of real estate market variables. The possible workout strategies in our case are: (1) foreclosure, (2) modification, and (3) return to “current”, which are all conditional on the mortgage being specially serviced. The workout strategy  $j$  is chosen whenever the servicers expect the lowest future loss severity conditional upon that strategy. For example, if the servicer finds that the real estate market is drastically improving, he would neither foreclose the loan nor modify the loan term. Instead, he would simply push the borrower to make timely payments so that he wouldn’t realize any loss. Although the expected loss severity function is unobservable, we do observe the choices servicers made under varying conditions, and these choices directly reflect the least loss severity expectations for the servicers. We therefore model the probability of each workout strategy  $P_j$  as a multinomial logit function<sup>9</sup>:

$$\Pr(P_j = 1) = \frac{e^{\alpha_j + \beta_j X + \gamma_j Z}}{\sum_{k=1}^3 e^{\alpha_k + \beta_k X + \gamma_k Z}}, \quad j = 1, 2, 3. \quad (2)$$

The expected sign of the coefficients are explained earlier in the section. The multinomial logit analysis is performed using SAS CATMOD procedure. Table 4 shows the results from the maximum likelihood estimation with “return to current” as the base case.

**Table 4. Multinomial Logit Analysis of Workout Strategy**

Parameter	Foreclosure				Modified			
	Estimate	Standard Error	Chi-Square	Pr > ChiSq	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	-3.0108	1.3441	5.02	0.0251	-1.8902	1.0741	3.1	0.0784
LTV (Loan)	1.0368	0.6403	2.62	0.1054	0.4908	0.6053	0.66	0.4175
DSCR (Loan)	0.5506	0.4310	1.63	0.2014	0.4471	0.3383	1.75	0.1863
Value Growth (Market)	-2.4174	4.1440	0.34	0.5596	-3.6360	3.4628	1.1	0.2937
NOI Growth (Market)	-5.1921	1.7572	8.73	0.0031	-1.4455	1.3784	1.1	0.2943
Loan Age	0.0048	0.0124	0.15	0.7017	0.0214	0.0100	4.58	0.0324
Occupancy Change (Market)	0.7282	0.7683	0.9	0.3433	0.6926	0.6174	1.26	0.2619
Foreclosure Law (Judicial)	0.4359	0.2206	3.9	0.0482	0.1063	0.1801	0.35	0.5552
Log Likelihood Value:	-198.80							

<sup>9</sup> Among many others, similar multinomial logit analysis has been used by Campbell and Detriech (1983) in examining the termination of residential mortgage default, and by Ambrose and Capone (1998) in modeling the conditional foreclosure probability of single-family mortgages.

It is interesting to note that only three explanatory variables show up as significant in affecting lenders' workout choice. The negative relationship between market NOI growth rates and foreclosure strategy is strongly supported by the logit analysis. The magnitude of the impact of market NOI growth rates on servicers' workout strategy is also confirmed. Everything else being equal, in a real estate market where rents are increasing (NOI growth rate is positive), servicers prefer to bring the loans back to "current" and are least likely to foreclose on that property. The negative coefficient of market value growth rates appear to support our hypothesis, however the insignificance of covariate in both foreclosure and modification also seem to suggest that servicers pay more attention to cash flow variables (NOI growth rates) than to property value variables (value growth rates), possibly because cash flow is tangible and easily measurable at the time of decision making while property value is subject to error-prone value appraisals and less accurate in practice. Another real estate market proxy, the change of market occupancy rates, has the wrong sign and is insignificant. The possible reason is that the market vacancy rates (occupancy rates) exert indirect influence on loan performance through affecting the cash flows of underlying collateral, servicers have no immediate need to understand the more complex real estate market if they have property cash flow information at hand.

The significant positive relationship between loan age and servicers' choice of loan term modification strategy suggests that servicers do seem to be more tolerable to borrowers who have been performing for a long period.

Two loan-specific financial variables, LTV and DSCR are not significant, with LTV has the correct sign and DSCR has the incorrect sign. This is possible because the loans must have some type of idiosyncratic problems (could be some type of trigger events as in residential mortgages) before they enter the special service category. Since both variables are largely estimated from market-level indices, they may not reflect the true financial conditions for these properties. In other words, both LTV and DSCR in our model are imperfect proxies. Another possibility could be that, even if we correctly estimated LTV and DSCR, servicers might still pay more attention to the general market condition rather than focusing on individual property performance. Because rational lenders would focus more on the possibility of curing the problem in the future, which is mostly dependent upon the general market condition, rather than on backward looking at the past financial situation that brought the loans into special service.

We find significant positive impact of judicial foreclosure law on servicers' choice of foreclosure strategy. This seems puzzling at the first look, because judicial foreclosure is more costly than power-of-sale, one might expect the servicers not to prefer foreclosure in the states where judicial foreclosure is required. However, as suggested by Riddiough and Wyatt (1994b),

servicers may not want to reveal their unwillingness to foreclose in these states because doing that would encourage more defaults. Actually, as shown from the statistical results, servicers may purposely become tougher in states with judicial foreclosure laws in order to discourage future defaults.

The significant coefficients of both intercepts suggest that, either our model misses some explanatory variables, or servicers prefer foreclosure the least and prefer the “return to current” strategy the most. We think both are equally likely reasons, while the later explanation seems to corroborate with the lenders’ rationale as we examined earlier.

In summary, the results of multinomial logit analysis appear to suggest that special servicers make workout strategic decisions based largely upon the real estate space market condition – proxied by market-level NOI growth rates. This is understandable since space market condition (rental growth and NOI growth rates) are easily observable and measurable. The forward-looking component of current space market condition is also helpful in the decision-marking process. We also find that servicers are more willing to modify loan term for more seasoned commercial mortgages and are more likely to foreclose loans in states where judicial foreclosure is required.

#### *4.2 Proportional Hazard Analysis of Default Probability of Special Serviced Loans*

Before we turn into the proportional hazard analysis of default outcomes of special serviced loans, recall we define loans being “bad” as the “90 days late” in mortgage payment or worse, so “bad” also includes “foreclosure” or “REO”<sup>10</sup>. Since loans enter special service due to various payment problems, we consider “30 days late” and “60 days late” as “good” in our sample. Hence “good” loans in our sample include “current” loans and those loans in minor delinquency. Among the 493 special serviced loans in our data sample, 183 are identified as “bad” since they became “90 days late” or worse by the end of the data collection date, and 310 still remain in “good” standing by the end of the data collection date. We stamp these 310 loans as censored observations. Because special-serviced loans are counted as non-performing status in many industry reports, it is important to realize that not all special-serviced loans end up in default and the percentage of non-defaults is actually not trivial<sup>11</sup>.

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<sup>10</sup> Defining defaults as 90-days-late or more is consistent with many other studies, e.g. Archer et al. (2002). Loans that are delinquent for 90 days or more are also called “serious delinquency” in the mortgage industry. Foreclosure becomes a viable option only until this stage. See Capone (1996) for details.

<sup>11</sup> We should not conclude from our sample data that the majority of special serviced loans would not default because our data sample is censored.

Once the problem loans are transferred to the special servicer, the special servicer must decide the most effective (least cost) solution to the problems. The decision must be made repeatedly until the loans terminate or drop out of the special service category. The loans may remain in special service for varying length of time. If the loans remain current while they are special serviced, that would imply the effectiveness of special service. While the results certainly depend upon various conditions, the ideal goal of special service is to cure the problems of the loans and make them current (to maximize the present value for the lenders/investors). The special servicer also makes decisions regarding whether to modify the loan term would be the least-cost alternative. The survival probability of special serviced loans is a function of various characteristics, observable at the time when loans became special serviced and during the special service period.

We apply the Cox proportional hazards model to analyze the probability of loans becoming “bad” since they enter the special service category. The Cox model has recently become the most popular technique in mortgage performance studies (Green and Shoven [1986], Schwartz and Torous [1989] are among the first to apply hazard model, and Deng, Quigley and Van Order [2000] presents more recent applications with increased realism and sophistication). The model was primarily developed and extensively used in the biomedical sciences to predict survival of patients (e.g., patients who have had heart transplants or cancer diagnoses) based on patient and treatment characteristics. Because mortgage default (becoming “bad”) can also be considered as a survival failure, the model has been conveniently borrowed by mortgage researchers to estimate the effects of explanatory variables on the commercial mortgage’s time to default. In particular, the model estimates the probability that a mortgage with certain characteristics will default in a given period given the fact the mortgage is still alive at the beginning of the period, which is also called the conditional probability of default. Cumulative default probability can then be easily computed from the conditional default rate (CDR).

Assuming the probability density function of duration of the loan to first default at  $t$  is  $f(t)$ , and the cumulative probability distribution is  $F(t)$ , the hazard function is defined as the probability density of default at time  $t$ , conditional on its being active before time  $t$ :

$$h(t) = \lim_{\Delta \rightarrow 0} \frac{\Pr(t < T < t + \Delta | T \geq t)}{\Delta} = \frac{f(t)}{1 - F(t)}. \quad (3)$$

This hazard function,  $h(t)$ , represents the conditional default probability in the next period given that loan was current at time  $t$ . The proportional hazard assumption of Cox (1972) assumes a vector of covariates,  $z_i(t)$ , either time-constant or time-varying, affect the baseline hazard

function,  $h_0(t)$  proportionally in exponential form. Thus the hazard function for subject  $i$  at time  $t$  can be specified as:

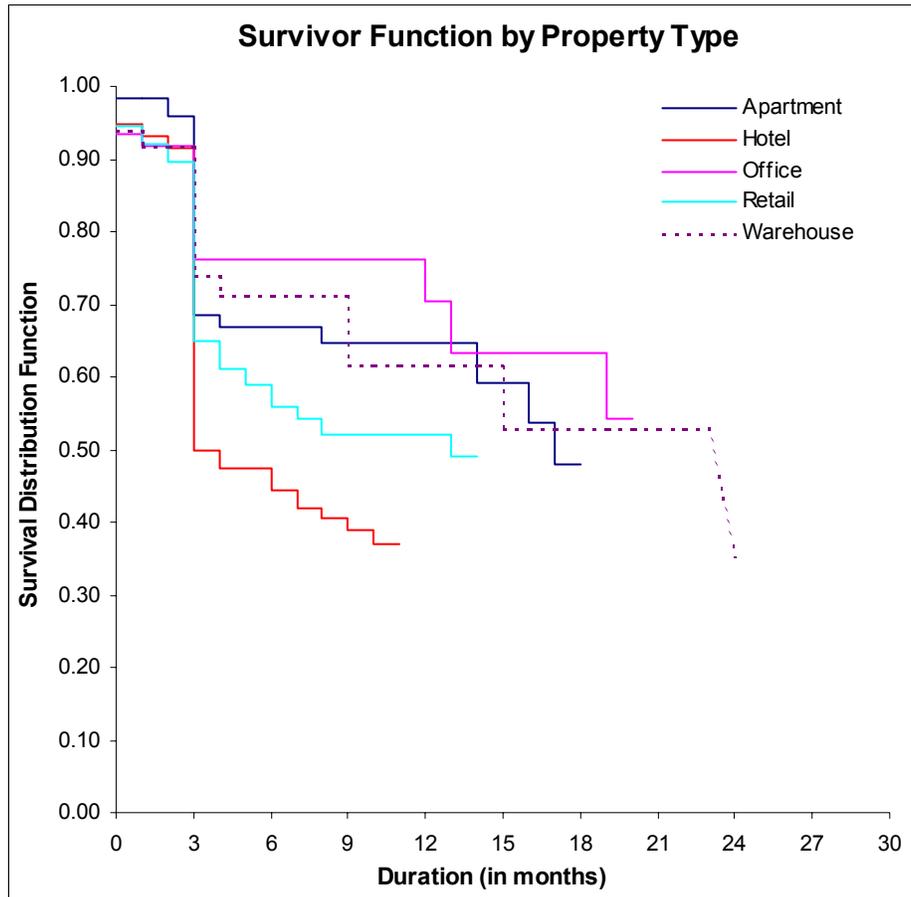
$$h(t_i; z(t_i)) = h_0(t_i) \exp(z(t_i)' \beta), \quad (4)$$

where  $\beta$  is the vector of constant coefficients. Note that the baseline hazard function is the hazard rates over the time for average loan in the sample, and the proportionality factor is the exponential function of the time varying or time constant covariates  $z$  and the coefficient vector  $\beta$ .

A popular estimation approach is *Cox's Partial Likelihood* specification, which only requires the existence of a common stationary baseline hazard function,  $h_0$ , for all subjects. The Cox approach estimates the coefficients for the proportional factors based on rank and order statistics (hence called *Partial Likelihood*). So  $\beta$  can be identified without parametric restrictions on the baseline function since  $h_0(t)$  is concentrated out as a nuisance number. Note the proportional hazard model is parametric in the specifications of proportional change while the baseline hazard function can be either parametric or non-parametric.

Before proceeding to the Cox hazard model, we first examine the empirical survivor functions from the unadjusted sample by property type. Figure 2 shows that survival probabilities vary substantially by property type. The graph clearly suggests that hotel loans are the most likely to become default, followed by retail loans. Only about 37% of the hotel loans are still alive by month 12 since they are special serviced. Retail loans also have high default rates. The performance of apartment, office and warehouse loans looks similar considering the sample size. This observation seems to reflect the recent property market conditions, that is, during the recent economic slowdown, the hotel sector was hit the hardest due to reduced traveling, and the retail sector was also hit very badly due to heightened competition and increased bankruptcies of many retailers.

We also examine the summary statistics both at the time loans first enter the special service status and at the time loans either become “bad” or censored at the end of the data collection date. Table 5 shows the aggregate statistics. There appears to be big differences between “bad” loans and “good” loans in terms of average LTV and the market-level occupancy rates. There is also slight difference in the initial coupon rates, “bad” loans have relatively higher coupon rates, yet the difference is not that big. The differences of year-to-year value appreciation, DSCR, the NOI (year-to-year) growth rate, and property-level cutoff occupancy rates are also as expected, but the differences do not appear to be as pronounced as in LTV. We did not find meaningful differences between the two categories in terms of loan age and annual loan payment, which we use as a proxy for the financial obligation of the borrowers.



**Figure 2: Survival Functions by Property Type**

Table 6 reports the summary statistics by property type. It is striking to notice that the big differences of LTV come mainly from retail, hotel and apartment sectors. The difference of LTV does not appear to be significant in both office and warehouse sectors. The major difference of DSCR comes from apartment and office sectors while not in the others. The differences of NOI and value growth rates are not significant in all the sectors. Closer observation of Table 6 also suggest that the marked performance differences between property types could be explained by more fundamental variables, for example, the whole hotel sector appears to have suffered the greatest cash flow drain (the biggest negative NOI growth) and largest value decline (more than 10% value decline on annual basis). We also notice that “bad” retail loans have exceedingly high LTV based on our estimation. These observations lead us to suspect that more fundamental variables rather than property type determine the default probabilities.

**Table 5. Descriptive Statistics**

Variable	At the Date Loans Were First Transferred To Special Servicer			At the Date Loans either Went "Bad" or Were Censored		
	Loan Status		Total	Loan Status		Total
	Bad <sup>a</sup>	Good <sup>b</sup>		Bad	Good	
<b>Loan Age</b>	41.9 (18.1)	42.9 (20.7)	42.5 (19.8)	45.5 (18.1)	50.9 (19.9)	48.9 (19.4)
<b>LTV</b>	83.2% (53.5%)	68.9% (19.6%)	76.1% (56.0%)	81.9% (53.1%)	67.7% (19.8%)	73.0% (36.5%)
<b>DSCR<sup>c</sup></b>	1.24 (0.72)	1.31 (0.61)	1.29 (0.65)	1.22 (0.71)	1.29 (0.59)	1.26 (0.64)
<b>Value Change (year-to-year)</b>	-4.8% (7.0%)	-2.9% (7.3%)	-3.6% (7.2%)	-5.0% (7.2%)	-3.6% (6.2%)	-4.1% (6.6%)
<b>NOI Change (year-to-year)</b>	-7.4% (18.8%)	-4.4% (18.9%)	-5.5% (18.9%)	-8.0% (15.4%)	-4.8% (12.3%)	-6.0% (13.6%)
<b>Cutoff Occupancy<sup>d</sup></b>	88.2% (14.7%)	92.2% (11.4%)	90.8% (12.8%)	77.3% (22.6%)	83.7% (19.2%)	81.3% (20.8%)
<b>Market Occupancy<sup>e</sup></b>	77.9% (14.6%)	83.5% (11.8%)	81.4% (13.2%)	78.0% (14.1%)	83.3% (11.1%)	81.3% (12.5%)
<b>Annual Payment</b>	511,935 (481,950)	531,071 (788,483)	523,977 (690,414)			
<b>Initial Note Rate</b>	8.50% (0.86%)	8.26% (0.84%)	8.35% (0.85%)			
<b>No. of Loans</b>	183	310	493	183	310	493

Note: Standard deviations are in parentheses

<sup>a</sup> "Bad" is defined in this table as having entered "90 days late" or worse condition.

<sup>b</sup> "Good" is defined in this table as having not met the definition of "Bad".

<sup>c</sup> DSCR: Debt-service-coverage ratio.

<sup>d</sup> Cutoff Occupancy is the occupancy data obtained directly from the loan files.

<sup>e</sup> Market Occupancy is the market-level occupancy data supplied by PPR.

**Table 6. Descriptive Statistics At the Date Loans either Went "Bad" or Were Censored**

Property Type	Apartment		Office		Retail		Warehouse		Hotel	
	Bad	Good	Bad	Good	Bad	Good	Bad	Good	Bad	Good
Standing										
<b>Loan Age</b>	37.8	49.1	41.5	44.8	44.7	56.4	41.5	45.0	51.0	54.1
<b>LTV</b>	74.5%	65.5%	62.3%	65.0%	97.6%	69.3%	60.5%	64.4%	83.1%	72.6%
<b>DSCR</b>	1.15	1.33	1.36	1.50	1.42	1.33	1.39	1.44	1.03	0.94
<b>Current Occupancy</b>	89.9%	88.9%	86.7%	86.1%	86.2%	87.2%	96.1%	96.8%	58.9%	62.3%
<b>Market Occupancy</b>	92.7%	91.7%	82.8%	83.8%	87.1%	86.6%	90.8%	89.7%	61.4%	62.8%
<b>Value Change (year-to-year)</b>	1.2%	0.6%	-2.3%	-4.5%	-2.0%	-1.7%	0.9%	-1.0%	-11.8%	-12.8%
<b>NOI Change (year-to-year)</b>	-5.5%	-6.9%	0.5%	3.4%	-3.1%	-1.4%	2.1%	-0.5%	-16.8%	-15.1%
<b>Initial Note Rate</b>	8.25%	8.05%	8.07%	8.27%	8.35%	8.28%	8.24%	8.22%	8.87%	8.57%
<b>Annual Payment</b>	361,078	256,252	524,574	1,012,517	538,691	672,653	571,392	348,614	535,961	484,225
<b>No. of Loans</b>	29	89	16	46	51	80	16	34	71	61

Note: All the variables are measured at loan level except Market Occupancy.

The biggest advantage of proportional hazard model over the regular multinomial logit model is that we can examine the dynamic of the time-varying decision making process. In so doing, we should incorporate time-varying explanatory variables in the proportional hazard model to capture the time-dependent financial conditions of the commercial mortgages and time-dependent real estate market conditions. This is a very nice feature because we know that borrowers constantly evaluate their financial situation and constantly monitor the market condition before they make the decision to either continue the mortgage payment or to withhold the payments. We incorporate the following time-dependent explanatory variables: *PeriodicLTV*, which is calculated based on the estimated property value and the calculated unpaid mortgage principal balance at each point in time before they either become “bad” or are censored. The property value is estimated by first taking the initial appraised property value in the loan file and then applying the market-level value growth rates moving forward period to period. In cases where the loan file contains a recent property value, we compare that value to the initial value, if two values are the same, we assume that the recent value is simply a carry-over from the initial value and is disregarded<sup>12</sup>. If the recorded recent value is different from the initial value, we then assume either lenders or property owners re-appraised the property and we take that value as the new value at the current value recording date. We then continue to apply market-level value growth rates to this new value going forward period to period. The variable, *ValueGrowthMkt* is the market-level year-to-year value appreciation rates. Because the market-level value indices we used are NCREIF indices that are known to be sticky and affected by the infrequent appraisals, we feel it is the best choice to use year-to-year change as a proxy for the market property value change. Since most properties in the NCREIF index are re-appraised at least once a year, the year-to-year market value change should have overcome some of the weakness in this market value index. The variable, *NOIGrowthMkt* is also the market-level year-to-year NOI growth rates. We use the variable, *VacancyChangeMkt* to represent to leading indicator of the space market condition, which is also measured as the year-to-year vacancy change. Because we saw from Table 6 that hotel sector experienced the largest value and NOI decline while the other property sector performed relatively better, we test an alternative model including a dummy variable *HotelFlag* that takes value 1 if the collateral is hotel and takes value 0 if otherwise. As in the previous section, we use a dummy variable *JudicialForeclosure* to indicate the states that have judicial foreclosure laws.

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<sup>12</sup> It is quite common that property owners only appraise the property value once in a long while. Even in the institutional real estate industry, property owners don’t re-appraise very often.

Finally, we follow Lekkas, Quigley and Van Order (1993) and Ambrose, Capone and Deng (2001) by including an inverse Mills ratio as an additional explanatory variable in the hazard model to correct the sample selection bias. This Heckman-style approach consists of two steps. The first step is to estimate a simple binary probit model of commercial mortgages falling into the special serviced pool using the full sample that consists of the event history of both performing and non-performing loans, and the second step is to add the inverse Mills ratio from the first-stage probit model as a covariate into the second stage hazard model. The Mills ratio is calculated as  $f/(1-F)$ , where  $f$  is the probability density function and  $F$  is the cumulative density function. Heckman (1976) shows that including the inverse Mills ratio in the second-stage estimation corrects the sample selection bias and provides more consistent estimates of the behavioral parameters. The Heckman two-stage approach is the appropriate estimation when dealing with truncated samples (in our case, non-special serviced loans are truncated).

Amemiya (1985) pointed out that the inverse Mills ratio can be explained as hazard rate. Therefore by adding the inverse Mills ratio in the second-stage estimation, the model also explore the possible correlation between the efforts of special service screening process and the default risk of the special serviced loans.

Tables 7A and 7B show the results of Cox proportional hazard model using SAS PHREG procedure. Model 1 in Table 7A shows the estimation without *inverse Mills ratio*. The coefficients behave mostly as we expected, and the significance level is much higher than that from the multinomial logit model. The most significant variable is *PeriodicLTV*, suggesting that the equity effect is dominant in affecting borrowers' decision to continue or withhold the payments. Higher LTV leads to more defaults, which is exactly as option pricing theory would suggest, and appears to conform with what we have observed in other mortgage default studies, both residential and commercial. Two other variables, *NOIGrowthMkt* and *VacancyChangeMkt* are significant at the 10% and 5% level respectively, suggesting that market-wide cash flow increase makes default less likely, and that the market-wide decline in vacancy rates has a positive effect on the borrowers' willingness to continue the mortgage payment and therefore reduce the default probability. *JudicialForeclosure* does not show up as significant, suggesting that borrowers do not consider foreclosure laws in their default decision. In other words, our results do not provide significant evidence to the hypothesis by Archer, Elmer, Harrison and Ling (2002) that states "judicial" states should have higher default incidence, reflecting a tendency for mortgagors to risk default more readily if foreclosure is more difficult to effect. *HotelFlag* is significant at the 10% level, probably because the hotel sector experienced the largest value decline in the last few years therefore captures a large chunk of the variation in

**Table 7A. Proportional Hazard Model Analysis Results**

Variable	Model 1				
	Parameter Estimate	Standard Error	Chi-Square	Pr > ChiSq	Hazard Ratio
PeriodicLTV	0.613	0.20	9.85	0.002	1.85
ValueGrowthMkt	0.235	1.86	0.02	0.900	1.26
NOIGrowthMkt	-0.927	0.51	3.30	0.069	0.40
VacancyChangeMkt	0.320	0.16	3.93	0.048	1.38
JudicialForeclosure	0.216	0.18	1.52	0.218	1.24
HotelFlag	0.427	0.26	2.72	0.099	1.53
inverse Mills ratio					
-2 Log Likelihood Value:		981.2			
Schwartz B.I.C.		1012.4			

*ValueGrowthMkt*, which does not appear to be significant at all.

Model 2 in Table 7B reports the estimated proportional hazard model including *inverse Mills ratio*. The inclusion of *inverse Mills ratio* increases the significance and the magnitude of the coefficients of *PeriodicLTV*, *NOIGrowthMkt*, *VacancyChangeMkt* and *HotelFlag*. This indicates that model 2 yields more efficient estimates by inclusion of *inverse Mills ratio*. The robustness of the variables representing a loan's LTV, the market-level NOI growth rates and market-level vacancy change is very encouraging, as these variables make perfect theoretical sense.

**Table 7B. Proportional Hazard Model Analysis Results**

Variable	Model 2				
	Parameter Estimate	Standard Error	Chi-Square	Pr > ChiSq	Hazard Ratio
PeriodicLTV	0.874	0.29	9.12	0.003	2.40
ValueGrowthMkt	-0.638	2.56	0.06	0.804	0.53
NOIGrowthMkt	-1.105	0.53	4.38	0.036	0.33
VacancyChangeMkt	0.334	0.16	4.16	0.041	1.40
JudicialForeclosure	0.249	0.18	1.96	0.161	1.28
HotelFlag	0.602	0.27	5.08	0.024	1.83
inverse Mills ratio	-2.968	2.67	1.24	0.266	0.05
-2 Log Likelihood Value:		957.2			
Schwartz B.I.C.		993.4			

Tables 8A and 8B present two alternative models. Model 3 in Table 8A shows that includes *LoanAge*, *PeriodicDSCR* and *LTVJudicial* in addition to the variables included in Model 2. *LoanAge* is measured as the months that a loans remains outstanding since the first payment due date. *PeriodicDSCR* is the current DSCR based on the estimated current property NOI and

**Table 8A. Proportional Hazard Model Analysis Results**

Variable	Model 3				
	Parameter Estimate	Standard Error	Chi-Square	Pr > ChiSq	Hazard Ratio
PeriodicLTV	0.715	0.31	5.34	0.021	2.04
ValueGrowthMkt	1.251	1.96	0.41	0.523	3.49
NOIGrowthMkt	-1.000	0.52	3.64	0.056	0.37
VacancyChangeMkt	0.347	0.17	4.40	0.036	1.42
JudicialForeclosure	0.285	0.36	0.64	0.425	1.33
HotelFlag	0.526	0.27	3.88	0.049	1.69
PeriodicDSCR	0.048	0.13	0.14	0.709	1.05
LoanAge	0.004	0.00	0.71	0.401	1.00
LTVJudicial	-0.052	0.40	0.02	0.896	0.95
inverse Mills ratio					
-2 Log Likelihood Value:		960.9			
Schwartz B.I.C.		1007.4			

mortgage payments. The methodology in estimating current property NOI using market-level NOI indices is similar to that in estimating *PeriodicLTV*, as we explained earlier. Following Ambrose, Capone and Deng (2001), we also include *LTVJudicial*, the interaction term of *PeriodLTV* and *JudicialForeclosure*. The results show that both *LoanAge* and *PeriodicDSCR* are not significant. The big change of the coefficient of *ValueGrowthMkt* also confirms that this variable does not possess explanatory power. The interaction term *LTVJudicial* is not significant, confirming our earlier conclusion that state foreclosure law is not a significant factor in the borrower's default decision making process.

Model 4 in Table 8B extends Model 3 by including the *inverse Mills ratio* variable. The inclusion of *inverse Mills ratio* not only increases the significance and the magnitude of the coefficients of the key variables, such as of *PeriodicLTV*, *NOIGrowthMkt* and *LoanAge*, the *inverse Mills ratio* itself is significant at the 10% level. This suggests that the more likely a loan is special serviced, the less likely the loan will end up in default. In other words, sending a problem loan to the special servicers does have a positive impact on the performance of the problem loan, and the special servicers appear to be functioning in its expected role.

In summary, a borrower is very likely to make his payment decision based largely upon his equity position in the mortgage and the potential cash flow condition as indicated by the current space market movement. The borrower also looks at the space market vacancy (occupancy) movement to aid his estimation of potential cash flows from the collateral. State foreclosure laws do not seem to have significant impact on the borrower's default process. In

**Table 8B. Proportional Hazard Model Analysis Results**

Variable	Model 4				
	Parameter Estimate	Standard Error	Chi-Square	Pr > ChiSq	Hazard Ratio
PeriodicLTV	1.210	0.40	9.15	0.003	3.35
ValueGrowthMkt	-3.302	3.19	1.07	0.301	0.04
NOIGrowthMkt	-1.189	0.54	4.91	0.027	0.30
VacancyChangeMkt	0.320	0.17	3.64	0.056	1.38
JudicialForeclosure	0.234	0.36	0.42	0.518	1.26
HotelFlag	0.614	0.27	5.30	0.021	1.85
PeriodicDSCR	-0.227	0.20	1.29	0.256	0.80
LoanAge	0.009	0.01	3.04	0.081	1.01
LTVJudicial	0.098	0.41	0.06	0.812	1.10
inverse Mills ratio	-8.102	4.39	3.41	0.065	0.00
-2 Log Likelihood Value:		954.0			
Schwartz B.I.C.		1005.7			

addition, the result from the fully-specified model seems to confirm the positive role of special service.

The two hypothesis regarding residential defaults: negative equity hypothesis and ability to pay (cash flow) hypothesis, seem to co-exist in commercial mortgage defaults. The proportional hazard model appears to validate the importance of both negative equity effect and cash flow effect. The results also highlight the significance of real estate market-wide variables, such as market-wide vacancy movement, as excellent proxies for the default determinants.

## V. Conclusions

All the existing literature in commercial mortgage defaults studies the default process for loans in the current status to the default status where default is either defined as foreclosure (e.g. Vandell et al. 1993 and Ciochetti et al. 2002) or as 90-days-late or worse (e.g. Archer et al. 2002). This study recognizes that commercial mortgage default is not a one-step process and examines a previously unexplored aspect in the whole default process, which is the stage between the initial delinquency to default, which we define as 90-days-late or worse. We also distinguish the servicers' behavior from the borrowers' behavior in the default process, where the servicers mainly make the initial workout strategic decisions that are expected to minimize the potential losses meanwhile the borrowers make the repeated decisions on the default put option exercise during the course of being special serviced. Because most problem loans become special serviced in the CMBS market, we empirically study the probability of special servicers' choosing one workout strategy versus others and the conditional probability of default after problem loans become special serviced.

We find that special servicers make initial workout strategic decisions based largely upon the real estate space market condition – proxied by market-level NOI growth rates. In other words, cash flow condition is the most significant factor in the servicers’ decision making process. We also find that borrowers are likely to make default decisions based upon both the equity position in the mortgage as suggested by the option theory and the cash flow condition as indicated by the space market movement, therefore negative equity hypothesis and ability to pay hypothesis appear to co-exist in the default process of commercial mortgages. In addition, key real estate space market variables, such as market-level vacancy rates, provide very useful information in explaining commercial mortgage defaults. State foreclosure laws do not have empirically significant relationship with the borrowers’ default process. Finally, special service seems to be functioning as it reduces the probability that a troubled loan will default.

## References

- Ambrose, Brent W. and Charles A. Capone (1998), "Modeling the Conditional Probability of Foreclosure in the Context of Single-Family Mortgage Default Resolutions", *Real Estate Economics* 26(3): 391-429
- Ambrose, Brent W., Charles A. Capone and Yongheng Deng (2001), "Optimal Put Exercise: An Empirical Examination of Conditions for Mortgage Foreclosure," *Journal of Real Estate Finance and Economics*, 23 (2), 213-234
- Ambrose, Brent W. and Richard J. Buttimer, Jr. (2001), "Embedded Options in the Mortgage Contract", *Journal of Real Estate Finance and Economics* 21(2): 95-111
- Ambrose, Brent W., and Anthony B. Sanders (2003), "Commercial Mortgage-backed Securities: Prepayment and Default", forthcoming in *Journal of Real Estate Finance and Economics*, 26 (2-3)
- Amemiya, Takeshi (1985), *Advanced Econometrics*, Harvard University Press
- Archer, Wayne R., Peter J. Elmer, David M. Harrison and David C. Ling (2002), "Determinants of Multifamily Mortgage Default", *Real Estate Economics* 30(3): 445-473
- Ciochetti, Brian A. (1997), "Loss Characteristics of Commercial Mortgage Foreclosures", *Real Estate Finance* 14(1): 53-69
- Ciochetti, Brian A., and Kerry A. Vandell (1999), "The Performance of Commercial Mortgages", *Real Estate Economics* 27(1): 27-62
- Ciochetti, Brian A., Yongheng Deng, Bin Gao and Rui Yao (2002), "The Termination of Mortgage Contracts through Prepayment and Default in the Commercial Mortgage Markets: A Proportional Hazard Approach with Competing Risks", forthcoming in *Real Estate Economics*, 30 (4)
- Brian A. Ciochetti, Rui Yao, Yongheng Deng, Gail Lee and James Shilling (2003), "A Proportional Hazards Model of Commercial Mortgage Default with Originator Bias," forthcoming in *Journal of Real Estate Finance and Economics*, 27 (1)
- Campbell, T. S. and J. K. Dietrich (1983), "The Determinants of Default on Insured Conventional Residential Mortgage Loans," *Journal of Finance*, 38: 1569-1385
- Capone, Jr., Charles A. (1996), "Providing Alternatives to Mortgage Foreclosure: A Report to Congress", Washington, DC: U.S. Department of Housing and Urban Development, August (HUD-1611-PDR)
- Clauretje, Terrence M. (1987), "The Impact of Interstate Foreclosure Cost Differences and the Value of Mortgages on Default Rates", *AREUEA Journal* 15(3): 152-167
- Deng, Yongheng (1997), "Mortgage Termination: An Empirical Hazard Model with a Stochastic Term Structure", *Journal of Real Estate Finance and Economics* 14(3): 309-331

- Deng, Yongheng, John M. Quigley, and Robert Van Order (1996), "Mortgage Default and Low Downpayment Loans: The Cost of Public Subsidy", *Regional Science and Urban Economics* 26(3-4): 263-285
- Deng, Yongheng, John M. Quigley, and Robert Van Order (2000), "Mortgage Terminations, Heterogeneity and the Exercise of Mortgage Options", *Econometrica* 68(2): 275-307
- Downing, Chris, Richard Stanton, and Nancy Wallace (2001), "An Empirical Test of a Two-Factor Mortgage Prepayment and Valuation Model: How Much Do House Prices Matter?" *Working Paper*.
- Fathe-Aazam, Dale (1995), "A Comparison for Prospective Investors", *Real Estate Finance* 12(1): 40-47
- Goldberg, Lawrence and Charles A. Capone, Jr. (2002), "A Dynamic Double-Trigger Model of Multifamily Mortgage Default", *Real Estate Economics* 30(1): 85-113
- Heckman, J. (1976), "Sample Selectivity Problems as a Specification Error", *Econometrica*, 44: 153-161
- Han, Jun (1996), "To Securitize or Not To Securitize? The Future of Commercial Real Estate Debt Markets", *Real Estate Finance* 1996(Summer): 71-80
- Harding, J.P. and C.F. Sirmans (2002), "Renegotiation of Trouble Debt: The Choice Between Discounted Payoff and Maturity Extension," *Real Estate Economics*, 30(3): 475-503
- Hendershott, Patric, and Robert Van Order (1987), "Pricing Mortgages: An Interpretation of the Models and Results," *Journal of Financial Services Research*, 1: 77-111
- Kau, James B., and Donald C. Keenan, Walter J. Muller III, and James F. Epperson (1987), "The Valuation and Securitization of Commercial and Multifamily Mortgages", *Journal of Banking and Finance* 11: 525-546
- Kau, James B., and Donald C. Keenan, Walter J. Muller III, and James F. Epperson (1990), "Pricing Commercial Mortgages and Their Mortgage-Backed Securities", *Journal of Real Estate Finance and Economics* 3(4): 333-356
- Lekkas, Vassilis, John M. Quigley and Robert Van Order (1993), "Loan Loss Severity and Optimal Mortgage Default", *AREUEA Journal*, 21(4): 353-371
- Quigley, John M., and Robert Van Order (1990), "Efficiency in the Mortgage Market: The Borrower's Perspective," *AREUEA Journal*, 18(3): 237-252
- Quigley, John M., and Robert Van Order (1995), "Explicit Tests of Contingent Claims Models of Mortgage Default," *Journal of Real Estate finance and Economics*, 11(2): 99-117
- Richard, S. F. and R. Roll (1989): "Prepayments on Fixed Rate Mortgage-Backed Securities," *Journal of Portfolio Management* 15: 73-82.

Riddiough, Timothy J. (2000), "Forces Changing Real Estate for at Least a Little While: Market Structure and Growth Prospects of the Conduit-CMBS Market", *Real Estate Finance* Spring 2000: 52-61

Riddiough, Timothy J., and Steve B. Wyatt (1994a), "Strategic Default, Workout, and Commercial Mortgage Valuation", *Journal of Real Estate Finance and Economics* 9: 5-22

Riddiough, Timothy J., and Steve B. Wyatt (1994b), "Wimp or Tough Guy: Sequential Default Risk and Signaling with Mortgages", *Journal of Real Estate Finance and Economics* 9: 299-321

Sanders, Anthony B. (1999), "Commercial Mortgage-Backed Securities", *The Handbook of Fixed-Income Securities*, edited by Frank J. Fabozzi, 2000

Schwartz, Edwardo S., and Walter N. Torous (1989), "Prepayment and the Valuation of Mortgage-Backed Securities", *Journal of Finance* 44(2): 375-392

Shilling, James D. (1995), "Rival Interpretations of Option-Theoretic Models of Commercial Mortgage Pricing", *Real Estate Finance* 12(3): 61-72

Springer, Thomas M. and Neil G. Waller (1993), "Lender Forbearance: Evidence from Mortgage Delinquency Patterns", *AREUEA Journal* 21(1): 27-46

Titman, Sheridan, and Walter Torous (1989), "Valuing Commercial Mortgages: an Empirical Investigation of the Contingent-Claims Approach to Pricing Risky Debt," *Journal of Finance* 44(2):

Vandell, Kerry D. (1984), "On the Assessment of Default Risk in Commercial Mortgage Lending", *AREUEA Journal* 12: 270-296

Vandell, Kerry D. (1992), "Predicting Commercial Mortgage Foreclosure Experience", *AREUEA Journal* 20(1): 55-88

Vandell, Kerry, Walter Barnes, David Hartzell, Dennis Kraft, and William Wendt (1993), "Commercial Mortgage Defaults: Proportional Hazards Estimations Using Individual Loan Histories", *AREUEA Journal* 21(4): 451-480